

Qualitative Research on Transformations in Water Management

Case-network analysis as a combination of case reconstruction and actor-network theory

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Transformations in Water Management?

In December 2023, the DVGW (German Association for Gas and Water) and the DWA (German Association for Water, Wastewater, and Waste) released their *Roadmap 2030. Action Agenda for the Future of Water Management* (DVGW and DWA 2023). The document focuses on the new requirements and challenges posed by “societal, political, and technological changes and describes priority measures that are needed to adapt and safeguard the future of water management” (DVGW and DWA 2023, p. 4). Six fields of action are identified, including sustainable water use, water quality, and climate-neutral water management. The associations have drafted a *Vision 2100* as the goal towards which adjustments and measures should lead. “The ‘Vision 2100 – Vision of a Water Conscious Society’ describes the ambition to achieve environmentally friendly, socially responsible, user-oriented action. The water industry is convinced that clean water can only be made available to everyone in sufficient quantity and quality in the long term in a protected environment” (DVGW and DWA, p. 4).

The paper shows that the water industry is aware of the need for transformation in water supply and wastewater disposal in Germany. Climate change and the associated dry periods in particular can lead to increased water shortages and, depending on the region, jeopardize security of supply (UBA 2024). Issues of water quality due to increasing pollution also require the expansion of wastewater treatment plants and the prevention of substances entering water bodies and soil (UBA 2022). Last but not least, increased heavy rainfall events require better coordination between water management and (urban) settlement planning. Other policy documents, such as the *National Water Strategy* (BMUV 2023) and the *EU Urban Wastewater Treatment Directive* (European Union 2024) on the implementation of a fourth stage in wastewater treatment plants, also call for adjustments and innovations in the field of water management that are part of a larger context of socio-ecological transformation.

In our research project ThWIC-VerNetzT,¹ we are conducting a regional sociological case and network study of water infrastructure (water supply and wastewater disposal). We are particularly interested in how water management organizations are dealing with these current transformation challenges. In addition, our research focuses on the question of how the transformation processes can be studied qualitatively. To this end, we are exploring a combined application of objective hermeneutics (OH) and actor-network theory (ANT), which will be discussed below after clarifying our understanding of transformation.²

Transformation—what kind and where to?

Transformation is a term that is used in many different contexts and ways (Hoffmann et al. 2023, p. 1; Kollmorgen et al. 2015, p. 11). There is no universally accepted definition. What all uses have in common is that they refer to changes or processes of change in societies or parts of them. However, there is debate about how fundamental a change must be in order to be considered a transformation rather than, for example, a transition (Christ and Sommer 2022, p. 462). Other discussions revolve around the question whether transformation is an intentional process of change (transformation by design) or a development that arises from circumstances and can hardly be controlled by the actors involved (transformation by disaster) (Sommer 2023, p. 2; Acksel 2024, p. 4).

The term “socio-ecological transformation” refers to approaches that usually include a normative component and are often linked to crisis discourses of the Anthropocene (Brand and Brad 2019, p. 279). Some argue that greater attention should be paid to existing power and dominance structures such as capitalism (Sommer 2023, p. 13; Brand 2021, p. 220), and claim that a radical socio-ecological transformation is needed to solve current crises (Howaldt and Schwarz 2023, p. 7; Hoffmann et al. 2023, p. 2). Others emphasize that we should speak of socio-ecological transformations in the plural rather than of a single ‘great transformation/transition’³ (WBGU 2011; Howaldt and Schwarz 2023, p. 6; Hummel et al. 2024, p. 19–20). Some approaches criticize widespread assumptions in the general discourse on transformation, such as technological utopianism (Christ and Sommer 2022, p. 463; Kropp 2023, p. 10) or regulative optimism, which do not take sufficient account of systemic internal logics and unintended side effects (Hoffmann et al. 2023, p. 3). The transformation of infrastructures—such as water infrastructures—involves additional special characteristics. Their resistance to change (Kropp 2023, p. 5) and path dependencies, which result from earlier decisions and make change difficult, are highlighted (Mahoney 2000).

In the water management sector, transformation is both an intentional process and induced by external factors, which lead to changes in water use. As shown at the example of *Roadmap 2030*, the water management sector is responding to climate change phenomena (such as heavy rainfall or drought) with its own strategies. In addition, the specific characteristics of the physical water infrastructure that has already been built must also be taken into account. For example, the existing water and sewage pipes determine the possibilities for transformation.

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² For a detailed description of the methodological principles and the combined use of OH and ANT, see also Lorenz et al. (2026). In the method sections here, we take over some translated text passages from this source.

³ In German, the WBGU report uses the term ‘große Transformation’ (great transformation). In Anglo-American countries, however, the term ‘transition’ is more commonly used, which is why this report was published under the English title ‘World in transition’.

At the backdrop of these rather general observations on transformations in water management, we examine a concrete empirical example: how does a regional water supply and wastewater disposal company deal with such transformation challenges? This article focuses on a new approach, a combination of methods that we have developed in our project, and on the insights that this approach provides regarding transformations in water management.

Method combination: OH and ANT

The project explores the combination of objective hermeneutics (OH, Oevermann et al. 1987; Wernet 2013) and actor-network theory (ANT, Latour 2005) with the aim of methodological development (see Lorenz et al. 2026). OH's case reconstruction approach is applied for data evaluation, while ANT primarily provides us with the data collection method, in particular the follow strategies known from ethnography (Marcus 1995). We supplemented this approach with an analytical model based on ANT (Callon 1986; Latour 2004).

Both methods will be briefly introduced before we outline the specific empirical access. OH allows for reconstructions of meaning structures by means of sequential analysis. A case can encompass different forms of "life practices": "be it individuals, groups, communities such as families or congregations, organizations of various sizes: in short, any aggregation of actors that have their own historically formed identity" (Oevermann 2002, p. 10; own translation). The aim of case reconstructions is to reconstruct the meaning structure of such units of action ("identity"). Thus, the meaning structures provide the constitutive characteristics of orientation and action.

ANT, on the other hand, is interested in actor-networks that are not conceived as fixed objects but as processes, as something emerging (Latour 2005, p. 131). It is precisely the network formation processes—in which the actors constitute each other and establish interconnections—that are examined and described in more detail. These processes are conceptually understood as translations. This term describes the "ongoing attempt to integrate actors into a network by 'translating' them into roles and interests (Latour 1987), i.e., by aligning and coordinating their interests" (Belliger and Krieger 2006, p. 39; own translation). Ideal-typically, network formation takes place in four phases, which were introduced by Michel Callon (1986) in the 1980s as problematization, interessement, enrollment, and mobilization. At the beginning, a problem arises that requires the networking of various actors. This is followed by the phase of interessement, in which potential actors are addressed in their specific roles. In the enrollment phase, these roles can be accepted or questioned. Only when all actors involved accept their roles is the actor network mobilized, i.e., it now functions or acts as a whole. Of course, these phases of network formation processes do not necessarily occur in such a clear-cut manner in empirical research. Nevertheless, this conception of network formation provides us with a suitable analytical model: we can empirically trace the 'phases' that a network goes through in the process of formation or transformation and how it stabilizes its interconnections. As mentioned at the outset, we also use the 'follow the actors' data collection strategy of ANT to follow the human and non-human actors, i.e., their respective connections to other actors. Here, a difference to OH becomes apparent: ANT rejects the separation of society/nature and subject/object and also recognizes non-human entities as actors. In our study, these are micropollutants, for example. Made visible by new measurement methods, their occurrence challenges established networks in wastewater disposal, for example the interactions among sewage treatment plants, bacteria, technical personnel, laws, and water bodies. The ANT concept of action does not exclude meaningfulness (e.g., intentions), but it does not presuppose it.

In summary, we assume that the objects of investigation are constituted differently in the case vs. network perspective and therefore must be analyzed differently. *Cases* are to be understood as language-based, meaning-structured units, whereas *networks* are conceptualized as heterogeneous gatherings without comparable meaning connections. Empirically, we can show that a combination of the two methodological approaches is particularly fruitful for this very reason: with the help of ANT, we identify networks of actors and trace their negotiation processes, while OH allows us to understand the meaningful orientation of the (human) actors involved.

At the same time, both methods are suitable for researching transformations, as crises play a significant role in both approaches. According to Bruno Latour (2005), the follow strategy is particularly useful in crisis situations such as the transformations introduced above, because established networks no longer function as usual and thus become more visible. It is therefore easier to follow the actors in the crisis when the connections have to be addressed by the actors themselves and thus stand out in a special way and can be traced. In OH, on the other hand, it is essential in the sequential analysis approach to see each sequence as an opportunity for the case to make new decisions. In addition, the options for action that the case did not choose are always considered in thought experiments. The aim is to work out the selection rules in the decision-making of the case.

Now that our approach has been outlined, we will present the empirical results of our project. This will demonstrate in practical terms how the two methods can be combined in a useful way.

Starting point of the analysis: Case reconstruction (OH)

Across Germany, there are very different forms of organization and ownership of water and wastewater infrastructures.⁴ In our study, we focus on a regional case study. There, two organizations are jointly responsible for drinking water supply and wastewater treatment. These are a public special-purpose association (Zweckverband) comprising a city and surrounding municipalities, and a local company (organized under private law but owned by the municipality), which is responsible for technical and commercial management. This relationship is regulated by a contract. The analysis is based on the respective websites (especially the self-presentation) and six interviews with employees/members of the two organizations. We reconstructed a common case structure for both organizations, which makes them a collective actor in practice.⁵ Two interrelated characteristics proved to be essential and are presented in the following two paragraphs.

„A community of solidarity with the surrounding rural area“⁶

Firstly, the case reconstruction shows the importance of internal ‘*community spirit*’ and external demarcation. The emphasis is not on the formal and purpose-oriented tasks within the association, but on the communal aspects and collective belonging. ‘Solidarity’ between the member municipalities is emphasized and the claim is made that the weaker members should be supported by the stronger ones:

⁴ In Germany, there are various operating models for water and wastewater infrastructures. In most cases, independent companies—under (partially) public, municipal, or (partially) private ownership—are responsible for these tasks. Drinking water supply and wastewater disposal are often carried out by separate companies (UBA 2017, p. 48 ff.).

⁵ This is also supported by the fact that many staff members have dual membership. The interviewees themselves found it difficult at times to distinguish between the two organizations.

⁶ The following two headings are quotes from our interviews (Interview 4 and Interview 1). We have translated them and shortened them for clarity.

So if X City [anonymized] were to do it [the water services; authors] as a town by themselves, they could probably pay less [...]. Because it is precisely this rural area that incurs higher costs due to the longer distances and everything that goes with it. [...] In this respect, as association chairman [anonymized] and mayor of the city [anonymized] repeatedly emphasize, they form a community of solidarity with the surrounding rural areas. And you can definitely feel that. (Interview 4, own translation).⁷

The informal orientation toward the “inside” corresponds with a particular focus on people. The aim is to retain staff in the long term and promote informal communication. Internal orientation and close cooperation between both organizations have consequences for the fulfillment of water infrastructure management tasks. This includes a claim to autonomy even against federal state politics to some degree: „But no, politics has no place there. Nothing good will come of it.“ (Interview 2, own translation) A takeover of the water and wastewater infrastructure from “outside” by a private-sector corporation was also successfully prevented. Preference in the awarding of contracts was given to the local public utility company, with which there has been a long-standing cooperation. The interviews make it clear that the conflict over the threatened takeover was not based on the form of ownership (the public utility company is also a private-law enterprise), but on the categories of abstract outside and belonging inside. In addition, there is explicit opposition to greater involvement of the public or citizens in the sense of participatory involvement. Citizens are seen as people who need to be provided for, but who lack the expertise to be involved in the planning of water and wastewater infrastructure.

„According to the Water Act, that is the great credo“

The second key feature of the case structure is a technical-administrative professional ethos. The interviewees identify “water management” and its professional associations (DVGW and DWA) as the binding technical reference framework. In their self-image, their own professional expertise is primarily technical. As the interviews further illuminate, state and federal legal requirements (e.g., the Drinking Water Ordinance) and their official monitoring by environmental and health authorities in particular structure the practice of water and wastewater infrastructures. The metaphorical description of the federal state’s Water Act as the “great credo” (see interview quote above) refers to a quasi-religious commitment to the law, which reinforces the already reconstructed meaning structure of a confessional sense of community belonging.

Dealing with transformation challenges

In the project, we took a closer look at various transformation challenges, including heavy rain precaution, dealing with drought phenomena, but also heat and the introduction of the fourth treatment stage in sewage treatment plants. This article focuses on the example of heavy rain precaution, which we use to illustrate our methodical approach.

Heavy rainfall is widely recognized as a problem, and water suppliers and wastewater disposal companies are already working on early-stage precaution concepts and technical solutions (such as the use of AI to control sewer flaps). At the same time, the challenge still seems very elusive overall in the interview:

⁷ The following transcription symbols are used in the interview sections: “I” = interviewer; “/” = interruption of a sentence; (.) = pause (dots for duration in seconds); [] = insertions by interviewer and for anonymization or [...] for omissions.

One topic we haven't touched on yet is heavy rainfall. [I: Hm.] So, precaution measures are currently a major topic in urban development. Because, (.) well, due to soil sealing, we simply have more / (..) well, more / more water to deal with during heavy rainfall. And that somehow / Well, (.) topic somehow sounds / sounds / sounds / sounds silly, but it's kind of an expression of knowledge from the city. So, and that's then a kind of / a kind of internment [sic] process with urban development, with the housing associations, uh, with us, uh, in X City [anonymized] with the K-operation [anonymized: municipal in-house operational enterprise], in the surrounding area, with the / with the road construction authorities (.) and with the / with the respective municipal building yards. Well, that's the kind of process that's coming our way. It's already underway. We've already come up with some ideas and approaches, uh, (..) so it's taking longer. (Interview 1, own translation)

The reconstruction using OH can be summarized as follows: the transformation requirements are presented to the interviewee from outside ("from the city") and remain vague in the description, which appears to be a search for fitting words. Accordingly, they are introduced abstractly as a non-specific "topic." Since problem contexts cannot be precisely defined, this applies even more so to solutions—despite "some ideas and approaches" being mentioned. The characterization as an "internment process" is illuminating; problems are to be made manageable by 'detaining' them.

At the same time, it becomes clear that the challenges of transformation are not only technical problems, but also involve coordination with other municipal and regional actors. This serves as an empirical starting point for extending our analysis to other actors—and for connecting it to the network perspective.

From an ANT perspective, heavy rain precaution reveals a crisis phenomenon that requires and highlights new networks of actors. In line with the follow strategy, we traced these references to the human actors mentioned in the interview. In practice, however, the search for interviewees in municipal institutions proved difficult. Responsibilities were often denied or requests were forwarded to other departments. In terms of the ANT model, this can be interpreted as an indication that we are dealing with a network in which there are not yet any established responsibilities and processing patterns (phases of problematization and interessement, Callon 1986). Ultimately, we were able to conduct various interviews, and we reconstructed their meaning structures using OH. Here, we take a closer look at two actors for whom, on the one hand, established cooperation can be demonstrated, but on the other hand, a lack of coordination on heavy rain precaution measures can also be demonstrated. These are the *construction management service* (in the quote, part of "K-operation") and the regional *water authority* (in the quote, part of "urban development"). To date, exchanges between *construction management* and our key water management stakeholders have taken place when infrastructure measures are planned or implemented (such as installing drinking water and sewage pipes in a street). Cooperation is purpose-oriented and functional, with economic efficiency and technical feasibility being the declared guiding principles. Coordinating meetings are held that have no formal (legal) basis but are established on a practical basis when required. At these meetings, long-term plans are discussed and solutions to specific problems are sought. The *water authority*, on the other hand, has a regulatory function. As an authority, it ensures that no legal provisions are violated by water management stakeholders. In contrast to the informal exchange with the *construction management*, cooperation here is based on formal procedures such as application and approval processes as well as legal reviews.

According to the ANT analysis model, an existing network of actors in crisis becomes visible, which must adapt to dealing with a new problem. Accordingly, on the one hand, routine cooperation can be observed, while on the other hand, the early phases of problematization and interessement have begun

for heavy rain precaution. Cooperation between the actors requires ongoing negotiation and coordination of their different perspectives. While the water management actor is primarily focused on the implementation of infrastructure projects, the construction management service is responsible for coordinating existing transport infrastructure and potential construction site conflicts. At the same time, the authorities ensure compliance with environmental regulations. However, what they all have in common is their focus on technical and administrative procedures. Even when new problems arise, the initial attempt is to deal with them in a routine manner, using the established and familiar technical procedures. From an ANT perspective, this suggests that more far-reaching transformations would also require the involvement of new actors who could influence the action program with new impulses, activities, and criteria. Using our combination of methods, we were able to determine that cooperation is limited to actors with primarily technical or legally-based meaning structures.

Conclusion: Implications for dealing with transformation challenges

With our method of combining OH and ANT, we can show how case structures and networks stabilize each other. This allows us to combine the different strengths of the methods very effectively in this study: while ANT reveals the networks of actors, OH reconstructs the underlying structures of meaning and orientations for action. In addition, ANT offers the possibility of including non-human actors such as micropollutants in the analyses. During the project, we developed a general procedural model showing how the different steps of our approach are alternated (see Figure 1; for details, see Lorenz et al. 2026), i.e., how case-network analyses, as we now call them, can be used.

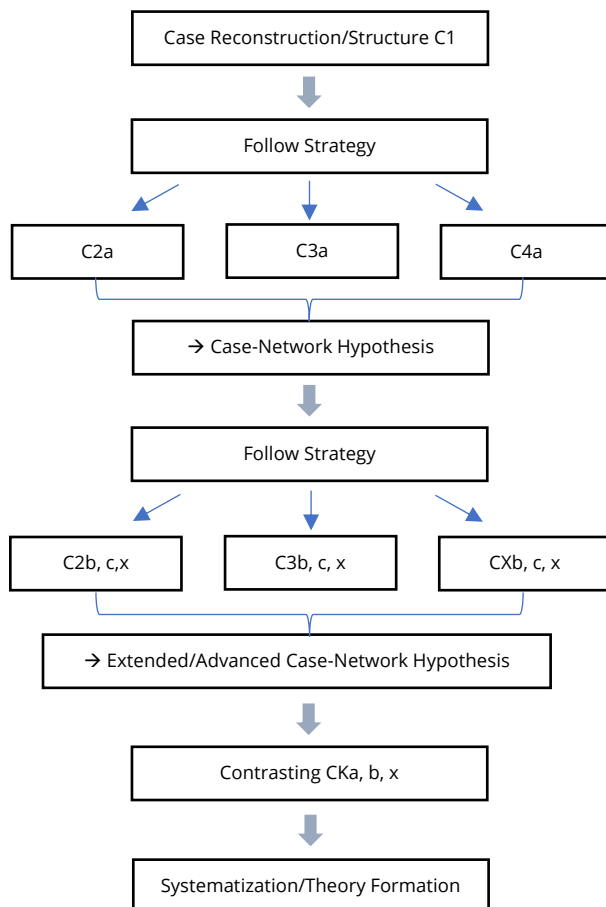


Figure 1: Model of the combined approach using case and network analyses (C = case)

The starting point for such a study is the case reconstruction of a central case/actor (selected according to research interests and questions). Using the follow strategy, problem-related networks to other actors are then identified, which are now also reconstructed as cases. In addition, the ANT analysis model is used to trace the operational networks. The aim is to form a case-network hypothesis about what holds the case-network together in terms of meaning and operation, and how it reproduces and/or transforms itself. Our project thus highlights how the strongly technically-oriented professional ethos is supported by a network in which the other cases/actors also follow highly technical-administrative patterns of action. In the further course of the project, this case-network hypothesis can be verified or further developed using additional data (collected by reapplying the follow strategy). This process can be continued until saturation is reached, i.e., until no new insights are gained by reconstructing cases or tracing further actors. We finally supplement the collection of data with the contrast strategies of Grounded Theory in order to analytically include cases/actors which would otherwise remain excluded from the empirically researched network.

In terms of content, our study reveals selective perspectives and operations in the water management sector with regard to socio-ecological transformation challenges. We have illustrated this using the example of precaution activities for heavy rainfall events. However, the same applies to the challenges posed by persistent drought and micropollutants in wastewater. New supply risks—particularly those caused by climate change and pollutants—are primarily interpreted as technical problems and dealt with accordingly. Water requirements also appear to be a fixed quantity that cannot be negotiated but must be made technically feasible. This perspective proves to be limited because predictable ecological and health risks will increasingly affect social practices of water consumption and may therefore lead to new conflicts (Lorenz 2024; Walter 2021). Cost pressures and a lack of (human) resources further hinder the transformations. The technical focus and informal external demarcation also create significant obstacles to networking with other actors and cooperative learning processes. The prevalent technical and administrative cooperation was illustrated in the article using two technical-administrative actors, but empirical results from other actors that we included in our analyses reinforce this. Broader socio-ecological perspectives—such as those of civil-society actors who demand democratic negotiations on water needs and ways of use—remain unconsidered. According to Grounded Theory's contrast strategies, we therefore integrated additional perspectives from nature conservation and consumer protection later in the project (Lorenz et al. 2026). Their orientation and actions on transformation issues in water infrastructures are different. Thus, we could broaden the understanding of the sector and, by contrast, highlight the selectivity of the operations in our empirical case-network. One conservationist, for example, criticizes a purely technical approach to flood and heavy rain protection:

And when our bodies of water are straightened out like sewers, when our flood protection strategy is limited to building the highest possible walls and the highest possible dikes so that the water can continue to flow, it basically has more and more energy, and then those downstream have huge problems. [...] So we are trying to question this way of thinking a little bit. (Interview 18, own translation).

Overall, our exploration demonstrates that the socio-ecological transformation of water infrastructure in the region studied has so far been limited. Although the water management sector is willing to change in general and the actors comply with a strong professional ethos, the prevailing focus on technical solutions stands in the way of more encompassing transformations. Established collaborations with actors who follow similar meaning structures confirm the technical perspective rather than enhancing it.

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