Article

Institutional Barriers and Bridges for Climate Proofing Waterway Infrastructures

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Abstract

Although the urgency for climate proofing waterway assets grows, to date, little is known about the organizational learning process of infrastructure operators to address this urgency. Climate proofing infrastructure increasingly requires infrastructure operators to rethink the original aims of their networks (such as bringing prosperity by enabling transportation), which relates to the notion of double-loop learning. The goal of this article is to identify institutional barriers and bridges that condition learning processes of infrastructure operators in climate proofing waterway infrastructures. This article is based on a case study of the Dutch national inland waterway network. Our findings suggest that climate proofing infrastructure requires an integrative and inclusive approach, in which the focus on waterway assets is loosened and infrastructure operators become more oriented towards wider, larger regional developments. However, the barriers and bridges encountered in the case study suggest that the Dutch waterway operator Rijkswaterstaat mainly focuses on refining and optimizing the current waterway network, i.e., single-loop learning. The questioning of underlying values, i.e., double-loop learning, is more complicated and has to be actively organized.

Keywords

transportation: waterways, infrastructure: development and land-use, infrastructure: planning, maintenance strategies, resources, organizational design and structure

The Challenge of Climate Proofing Waterway Infrastructures

In January 2018, the River Seine in France was one of the many waterways that was closed off for navigation due to flooding. The director general of the operating agency

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Voies Navigables de France was at a loss, as he noted that only in the previous summer, water levels were extremely low because of drought (Agence France-Presse, 2018). Climate change effects, such as the extreme weather events in France last year, threaten infrastructure networks in their functionality and performance. Waterway infrastructures such as weirs, bridges, and navigation locks, increasingly have to be able to withstand periods of both drought and flooding to ensure well-functioning networks. Extreme weather events outline the boundaries of infrastructure systems: against what costs do infrastructure operators have to ensure the functionality? In a context of increasing needs for infrastructure investment, but decreasing public funding (Gil & Beckman, 2009), re-assessing the functionality of waterway networks becomes topical.

Climate proofing infrastructure—i.e., the planning, designing, and constructing of infrastructures to be able to withstand new climate circumstances (see Giordano, 2012; Kabat, Van Vierssen, Veraart, Vellinga, & Aerts, 2005)—increasingly requires infrastructure operators to rethink the original aims of their networks (such as bringing prosperity by enabling transportation). To what extent are the required efforts to maintain the established network functionality feasible and desirable? Such questions relate to the notion of double-loop learning, a concept originally proposed by Argyris and Schön (1974). Double-loop learning involves the reflection on existing functionalities and related frames of reference. This includes a reconsideration of the infrastructure system boundaries and its functionality. To illustrate, the establishment of the integrated water resources management paradigm can be considered a form of double-loop learning, in which boundaries and functionalities are defined more interdisciplinary and in an integrated manner (Pahl-Wostl, 2009). However, infrastructure operators are inclined to operate within the limits of their mandate and focus on refining the established infrastructure system; a process Argyris and Schön (1974) refer to as single-loop learning. For example, Brown, Ashley, and Farrelly (2011) demonstrate how operators typically refine existing management systems rather than transform them.

For anticipating change, both single-loop learning and double-loop are considered essential. In doing so, both existing functionalities will be optimized and established functionalities will be questioned and potentially transformed. Translated to climate proofing infrastructures, infrastructure operators not only have to refine and develop new approaches to accommodate extreme weather events (e.g., creating either robust waterworks or more flexible designs), but also have to re-assess the feasibility and desirability of ensuring established waterway system functionality, particularly, under extreme circumstances.

Given the prevalence for single-loop learning, double-loop learning has to be actively organized. A mediating factor in the organization of double-loop learning is the institutional environment, in which learning takes place. Typically, waterway networks are advanced networks with firmly established institutions. Institutions, operating as "rules of the game," can be both formal (e.g., legal frameworks, mandates, budget allocations) and informal (e.g., norms, values; North, 1991). These institutions can restrain learning, for instance, by imposing compliance to current values and

Table 1. Three Institutional Bridges and Barriers.

	Explanation
Bridge 1	Maturing of waterworks as a window of opportunity
Bridge 2	Potential of combining national and regional interests
Bridge 3	Innovative pilots
Barrier 1	Anticipation paradox
Barrier 2	Institutional fragmentation hinders learning
Barrier 3	Narrow mission of infrastructure operators

routines. They can also enable learning, for example, through stimulating stakeholder involvement and interactive decision making.

Although the urgency for climate proofing waterway assets grows, to date, little is known about the organizational learning process of infrastructure operators to address this urgency. Because of the mediating role of institutions, the goal of this article is to identify institutional barriers and bridges that condition learning processes of infrastructure operators in climate proofing waterway infrastructures. This article is based on a case study of the Dutch national inland waterway network, which we have researched since 2014 (Willems, 2018). The national inland waterways in the Netherlands consists of 1,500 km of both natural rivers (Rhine, Meuse) and man-made canals. The operation of the network is commissioned by the Ministry of Infrastructure and Water Management to the agency Rijkswaterstaat, which dates back to 1798. In contrast to executive agencies in many other countries, Rijkswaterstaat has a broad mission, which includes well-functioning national highway and waterway networks, national flood protection, and a sustainable environment. Climate change impacts, as well as aging infrastructure components and new societal demands, assign Rijkswaterstaat with the task to retrofit their infrastructures to ensure network functionality in the upcoming decades. New ways of working are being developed that not only consider the technical impacts of climate change on the condition of infrastructures, but also spatial developments adjacent to the waterway.

Institutional Bridges and Barriers

This study identifies three institutional bridges and barriers that respectively enable or constrain processes of double-loop learning (Table 1). The bridges and barriers refer to dominant institutions in the waterway sector that condition actors in their behavior. To illustrate, formal institutions can lead to the obstruction of double-loop learning through narrowly defined funding streams and organizational "silos," but these institutions can also be designed in a way that they stimulate double-loop learning. This applies also to informal institutions: a risk-averse institutional culture might hinder reflexive learning, whereas an institutional culture that fosters values such as flexibility and openness might enhance this.

First, the ongoing maturing of waterworks induces a search for innovative funding schemes to rebuild and renew waterway infrastructures. In this search, waterway planners and managers are challenged to reconsider and re-assess the infrastructure for which they are responsible. Climate change effects are increasingly included in this reflection. To illustrate, supported by Rijkswaterstaat, the Dutch national government has announced a large infrastructure investment agenda for renewal and renovation, including references to addressing climate change (Ministry of Infrastructure and Water Management, 2012). Often, this leads to upgrading particular waterworks, but it can also result in a different functional implementation of a complete waterway corridor, in which waterborne transportation becomes restricted and other functionalities are promoted (e.g., related to recreation and ecology).

Second, our case study demonstrated that just climate proofing waterworks results in missed opportunities. Currently, budgets are often allocated to individual waterworks that are upgraded one-by-one. Our case study suggested that more societal benefits may be generated out of infrastructure investments through combining national renewal budgets with regional development investments. To illustrate, the recent upgrade of the Sea Lock IJmuiden in the Netherlands not only protects the Amsterdam region against rising sea levels, but also included the development of an adjacent wind park that provides renewable energy for the region. The grouping of budgets can result in more inclusive and integrative approaches to climate proofing infrastructure. Although traditional planning approaches often ensure the current functionality of the waterways and receive limited public and political attention, the grouping of budgets through cofunding and cocreation in new transactions can create waterways that serve multiple purposes and that contribute to area-oriented transformations. For example, the construction of the abovementioned Sea Lock IJmuiden has started in 2017 with significant co-investments of Rijkswaterstaat, the municipality of Amsterdam and the regional province of Noord-Holland. This followed out of a process in which the national operator Rijkswaterstaat initially decided to renovate the existing sea lock only in 2029. However, the regional government and Port of Amsterdam considered the port so important to regional economic development and for the accessibility of large ships of the port that both parties decided to co-invest. By combining investments from these three public governments, the starting date could be brought forward and all governments could demonstrate that they supported economic development.

Third and final, innovative pilot projects will help demonstrate the wide range of strategies to deal with climate change. Organizing these pilot projects can stimulate new ideas and concepts that may challenge existing values and routines. Until now, promising exploratory studies that investigate the potential of linking interests when investing in infrastructure have yet to be applied to practice. For example, the reconsideration of the Meuse river system in the Netherlands, which consists of seven interrelated weirs, has brought forward ideas related to hydro-energy, protection of waterworks as cultural heritage, and recreation as part of regional economic development. These ideas can complement the original, often transportation-related aims of the waterways. Engaging in these types of debates urges infrastructure operators to look beyond the existing functionality of their network.

In addition to the three bridges, three barriers that obstruct double-loop learning can be identified. First, the act of anticipation to climate change embodies an interesting paradox. In general, a sense of urgency is required to well-anticipate new developments. Yet, once anticipation is institutionalized in the operational routines, the potential threat is likely not to occur, which might suggest to some that "nothing has happened." Consequently, predominantly single-loop learning will occur and actors are unlikely to reflect upon their routines and ways of working, associated with double-loop learning. The prevalence for single-loop learning diminishes the original sense of urgency. Only exogenous factors, such as unforeseen extreme events, will then create political commitment required for anticipating climate change. To illustrate, in the case of the Dutch waterways, the established way of working led by the operator Rijkswaterstaat seems to suffice for sustaining and optimizing the Dutch waterway network, hence a reconsideration of this way of working is considered irrelevant. A deeper reflection is only initiated by other parties that question the desirability of current waterway configurations. However, there is limited interaction between the operator and other stakeholders, so the infrastructure operator has relatively much freedom to draft its own strategies.

This relates to the second barrier of institutional fragmentation. Addressing climate change in waterways is an issue of multilevel governance, for which different actors on different levels are responsible. Each stakeholder has its distinct time horizon and own organizational aims. The case study revealed that public governments in the Netherlands have difficulty finding each other. Local and regional governments are only partially included in discussions about national infrastructure investments. For instance, the national infrastructure operator, Rijkswaterstaat, is occupied with inventorying local and regional interests based on explorations conducted by its own intraorganizational regional divisions. Yet, these divisions often do not engage in depth on the interorganizational level with local and regional governments to hear their views and suggestions. As such, participants from local and regional governments consider the national government to be a "black box." At the same time, the national government has difficulty finding an entrance on the local and regional level. Because of the fragmentation, learning occurs individually, within the organizational boundaries. The fragmentation thus obstructs multilevel governance, which hinders the re-assessment of the functionality of the waterway network.

Third, and related to the previous barrier, infrastructure operators have a narrow mission and mandate, yet they have a central role in climate proofing infrastructure. Waterway operators often have a sectoral, monofunctional aim, such as ensuring the performance of the national inland waterways in terms of transportation, which has to be obtained in a cost-efficient fashion. This promotes a process of single-loop learning that is oriented toward optimization of the narrow goal and that protects the original mission, marginalizing other interests. For example, the agency Rijkswaterstaat strongly adheres to new public management principles focusing on cost-effectiveness (Willems, Busscher, van den Brink, & Arts, 2018). Questions related to potential new functionalities are considered to be outside the original mission, as this may contribute to "mission creep" by the operator. Technical solutions are brought forward to

guarantee the operator's mission of a smooth operation of the Dutch waterways. Other participants are simply considered irrelevant to the discussion, as ensuring network performance is defined as a technical matter that is the responsibility of the operator.

Promoting Double-Loop Learning for Managing Waterworks

The institutional bridges and barriers operate as both enablers and constraints for stimulating double-loop learning. Based on the bridges and barriers, suggestions for planning approaches that assist waterway planners and managers in addressing climate-related risks can be formulated. However, this is not a quick fix, because it should be noted that these planning approaches still need to be implemented in an institutional environment that is hard to change.

Whereas refinement and optimization as seen in single-loop learning often occurs in daily interactions, the questioning of underlying values in double-loop learning has to be actively organized. As such, planning approaches are required that do not take the status quo for granted. To illustrate, a pilot study in the Meuse River deliberately aimed at considering a complete waterway corridor instead of seven individual weirs, which forced the dominant authority Rijkswaterstaat to involve other regional parties and land users in the process. In this example, current, "narrow-in-scope" approaches were detangled and complemented with new parties and insights. This requires that the focus on waterway assets is loosened and infrastructure operators become more oriented toward wider, larger regional developments. Involving a broad range of stakeholders helps in connecting national infrastructure investments with broader, regional developments. On one hand, infrastructure operators are then stimulated to position technical information in relation to functional and political discussions. In doing so, infrastructure operators are urged to critically assess the current network function in relation to broader future needs and developments. On the other hand, other stakeholders can familiarize themselves with the challenges infrastructure operators face. This will foster an ongoing dialogue between both worlds, in which both parties regularly have to legitimize their stances. Dutch examples of platforms that facilitate the dialogue are a governmental Community of Practice, in which both policy makers and operators participate, and the sectorwide National Water and Climate Knowledge and Innovation Program, with a subtrack on retrofitting water infrastructures.

Altogether, instead of the traditional transportation-oriented planning approaches, climate proofing infrastructure requires a more integrative and inclusive approach. This will not only enable the opportunity to tailor waterway infrastructures to climate change impacts but also to wider future societal demands. Until now, this is hindered by established institutions that mainly stimulate the optimization rather than transformation of existing waterway networks. The identified institutional barriers and bridges can guide the implementation of a more critical learning system, which will support the creation of waterway networks fit for the 21st Century.

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Author Biographies

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