Local water resources and urban renewal. A Rotterdam case study

Utilisation locale de l'eau de pluie et rénovation urbaine - Une étude de cas à Rotterdam

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RESUME

Cet article présente une approche interdisciplinaire combinant un concept technique, les aspects sociaux et la mise en oeuvre pratique. Le changement climatique et les exigences plus élevées de la société exigent le développement de nouveaux modes d'approvisionnement en eau dans les zones urbaines. Le changement à d'autres modes d'approvisionnement en eau par le développement de nouveaux systèmes est un processus à long terme, causé par la longue durée de vie prévue des infrastructures des eaux urbaines, le niveau élevé du capital investi et le nombre d'incertitude. Dans une étude pour la partie sud de la ville de Rotterdam, nous avons démontré la nécessité d'expérimenter l'approvisionnement en eau à court terme et d'évaluer la capacité du système de gestion d'eau pour changer pour une gestion plus durable de l'eau à long terme.

ABSTRACT

This paper uses a transdisciplinary approach combining a technical concept, social aspects and implementation in practice. Climate change and higher demands from society demand learning about new modes of water supply in urban areas. Changing to other modes of water supply by system innovation is a long term process, impeded by the long expected lifetime of urban water infrastructure, high levels of invested capital and high levels of uncertainty. In this case study in the southern part of Rotterdam, we demonstrate the necessity to experiment with local water supply on the short term and assess the transformative capacity of the water management regime to change towards more sustainable water management in the long term.

KEYWORDS

Local water resources, sustainable urban water management, transformative capacity, transitions.

INTRODUCTION

The objective of this paper is to evaluate to which extent the water management system is able to transform itself. This so-called transformative capacity is the systems capability to adapt to changing circumstances through renewal of the water system. This paper is proposing a three circle framework for understanding the tipping point(s) between the different phases of transformative change. In the first circle the focus of the water system is optimization; improvements and adjustments take place while the same water system is maintained. The second circle is the development of additional systems. The original water system is maintained but expanded with new systems components. The third circle represents system innovation in which the original system is gradually replaced by a new system. The Rotterdam case study will be used to evaluate whether this tipping point is close. Moreover, the possibility to develop a self-supporting drinking water supply system as a part of this system wide transformation will be evaluated.

1 METHOD

In this paper first transition theory is presented as background to find out how systems can change and how the transition to a more sustainable system could take place. Subsequently, a framework for understanding transformative change is presented. In this framework systems can be in three states which are presented by circles. This framework is applied to the water system of Rotterdam. By literature research on policy documents and interviews with stakeholders it is investigated in which circle of transformative change the Rotterdam water system currently is. Moreover, this survey identifies drivers and obstacles for changing towards the system innovation mode. As an example of system innovation, it is investigated if the future urban water system of Rotterdam could also serve as a source for local drinking water supply. A water balance model has been used to calculate water self sufficiency of the southern part of Rotterdam.

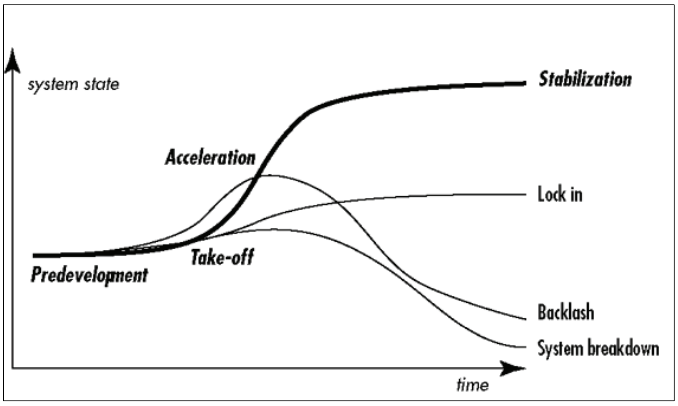

Figure 1. Possible system pathways of a complex adaptive societal system.

2 BACKGROUND: TRANSITION THEORY

Transition theory attempts to explain why and how regimes might transform. Scientific work on societal transitions emerged from various authors (Davis 1945; Boulding 1970; Rotmans 1994; Ness, Drake et al. 1996; Kemp, Schot et al. 1998; Rip 1998; Geels 2002; Berkhout 2003; Elzen, Geels et al. 2004; Van der Brugge, Rotmans et al. 2005; Loorbach and Rotmans 2006). Much of the recent work on transitions is descriptive and case study oriented. The majority of these historical cases have focused on the role of technology in changing technological regimes (Kemp, Schot et al. 1998; Geels 2002; Elzen, Geels et al. 2004). Some authors (Loorbach 2004; Rotmans, Grin et al. 2004; Van der Brugge, Rotmans et al. 2005) attempt to broaden the scope towards a general systems approach for societal systems. In this approach transitions are “transformation processes from one equilibrium to another that is qualitatively different” (Rotmans 1994). Case studies from this perspective focus less on the role of technology but attempt to identify qualitatively different phases in the transition process with regard to the co-evolutionary dynamic of institutions, economies, technologies and cultures.

Rotmans (2003) and Rotmans, Kemp et al.(2000) distinguish four phases during transitions which are illustrated in figure 1. During the pre-development phase the system dynamics do not visibly change but under the surface, the system is slowly changing. In the take-off phase the structural change of the system begins to show off, manifested by emergent phenomena and changing relations between actors. During the acceleration phase the actual structural changes take place. At the systems level, new dynamic patterns are observed as a result of accumulation of socio-cultural, economic, ecological and institutional innovations that reinforce each other. The stabilization phase is characterized by the new system structure that has stabilized and a new social order has established.

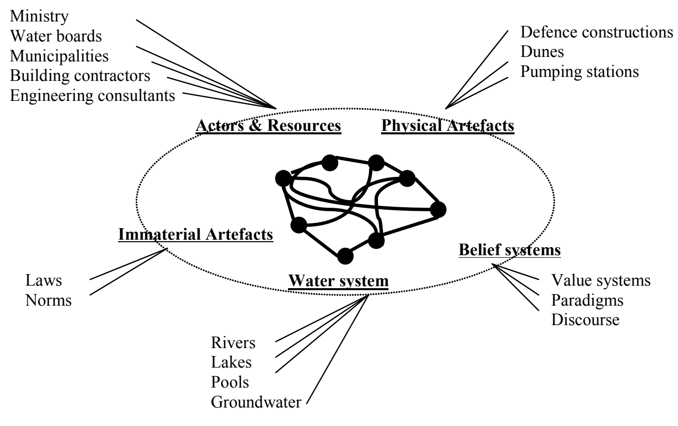

Figure 2. Conceptualization of the Dutch water management regime

2.1 Niche-regime interaction

Berkhout, Smith et al. (2003) define regimes as dominant cluster of artifacts, institutions, rules and norms assembled and maintained to perform economic and social activities. According to (Rotmans, Kemp et al. 2000), regime dynamics are determined by shared assumptions, social norms, interests, belief systems and company strategy, summarized as culture, structure and practice. Figure 2 illustrates the Dutch water management regime.

Transitions are trajectories during which regimes transform and head into a new direction. The selection environment is changing and strategies and operations arise that differ from the earlier selection environment. Radically new innovation networks manage to sustain and mature. This is the result of reinforcing developments at different levels of scale. Transitions involve system innovations that emerge from experimentation in niches and eventually scale up to be incorporated in the regime.

3 PROPOSED FRAMEWORK FOR UNDERSTANDING TRANSFORMATIVE CAPACITY

A conceptual framework is proposed for understanding the way a regime improves the technical system it is involved with. The more fundamental change a specific improvement implies the more institutional barriers on is likely to be confronted with. The three types of improvement we consider here are: optimization, development of additional system and system innovation.

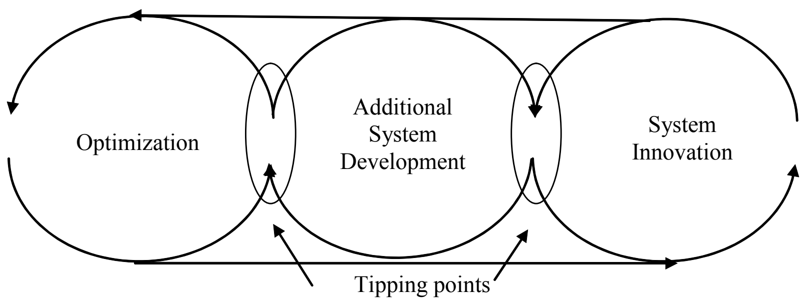

Figure 3. Illustration of conceptual framework of transformative change

3.1 Optimization

The first circle is the optimization circle. The regime responds to changes by optimizing the existing system in order to counter the increase. For instance, the regime could decide to improve wastewater treatment facilities as a result of increased pollution from a new factory upstream. By internal or external distortions that will be elaborated in the next chapter, the pressure on the regime may increase until it reaches a 'tipping point'. This tipping point is a critical point in time where the system continues optimizing its technical infrastructure or where it enters the next phase of additional system development.

3.2 Development of additional system

The second circle is that of additional system development. If optimizing the existing technical system is not sufficient, the regime might start experimenting with other technical modules. For instance optimizing sewer capacity will not go on forever. In Rotterdam, the sewer system is already at the top of its performance. Because societal demands increase, additional stormwater facilities are developed

3.3 System Innovation

During the third circle the regime is inducing system innovation. System innovations are kinds of innovation that replace the old system since that system was not sufficiently fulfilling the demands of time. Often this will involve a new kind of technology that is the basis of the system. Considering the long lifetimes of urban water infrastructure however, it will take decades before the old system is entirely replaced. During the second circle basically three things can happen. Some experiments are that promising that they are developed further and are at a certain moment ready to become the new dominant practice. Also optimizing and experimenting may continue because neither the old nor a new technology is ready to win the competition. The third option is that the experiments are that disappointing that the regime pulls back to the old solutions at the tipping point and reverts back to the optimization circle.

4 RESULTS FROM ROTTERDAM CASE STUDY

The Rotterdam municipality wants to transform the city to an attractive and competitive area to live and work. For this reason the municipality and the housing corporations are executing huge urban restructuring and renewal plans. This objective should be accomplished by realizing more diversity, for instance to have more private houses in addition to the current majority of social corporations owned houses. Both the spatial planners and the water managers now see opportunities to combine the urban planning effort and the water management effort.

4.1 Optimization of current water system

During the last decades the urban water system of Rotterdam has been optimized. The combined sewer network has been maintained and expanded. Moreover, central operational control of the sewer system in Rotterdam has been implemented recently to comply with national sewer system emission standards. By means of central operational control the performance of the sewer system is optimized for minimizing emissions and reducing the variation of wastewater supply towards the wastewater treatment plant.

4.2 Development of additional system

In addition to the conventional combined sewer system, more recently additional facilities have been added to this system. The municipality of Rotterdam has the policy to collect and discharge stormwater separately from wastewater. Disconnection of paved surfaces has taken place resulting in a stormwater collection system which was not there before. Moreover, for innovative water facilities are developed like water squares, green roofs and water storage under a parking lot in the centre of Rotterdam. More surface water is constructed in urban renewal projects. Increasingly, additional systems to the conventional system can be noticed in Rotterdam. Therefore the water system of Rotterdam seems to be in the second circle of transformative change.

4.3 System Innovation

System innovation means replacing the conventional system by a new system. At the moment of the survey, we did not find indications of replacement of the current water system by an entirely new system. However, a future vision that aims to do just that has been made. In 2005 the ambitious report “Rotterdam Water city 2035” (Gemeente Rotterdam, 2005) was published. This vision aims to enhance living quality in the urban area. In this plan the south of Rotterdam will be transformed to ‘Waterway City’, an extensive network of waterways integrated into an urbanized environment, each household having garden access to the waterway network. The network is connected to the river delta and new recreation areas with small lakes on the south side of Rotterdam. This report was the result of extensive cooperation between urban planners and water experts which has been taken up further in 2006 where complete integration of urban water plans and spatial plans is realized.

4.3.1 Drivers at tipping point

In Rotterdam a number of developments can be indicated that put the existing conventional water system under pressure. First, the European Framework Directive demands good ecological quality of all surface water bodies in 2015. At present, quality of urban surface waters is poor because of combined sewer overflows and diffuse pollution. Secondly, climate change will have impact on the Rotterdam water system. The Rotterdam water supply is at present more or less guaranteed by Rhine water. Rising temperatures in Europe are expected to increase snowmelt, generating faster runoff patterns earlier in the season, thus increasing the chance of water shortages in late summer. Summer periods with low river discharge, low precipitation and high evaporation are expected to occur more frequently in the future (Riza, 2005). As a result Rotterdam will be increasingly vulnerable for droughts. Additionally, Rotterdam faces increased salt intrusion into the delta due to expected sea level rise. Thirdly, Rotterdam faces strong competition from other harbours and delta cities. To remain an attractive location for inhabitants and companies, Rotterdam is executing a drastic urban renewal program. Moreover, urban renewal is thought to be the only opportunity to realize the required water storage effort to prepare the city for the expected impacts of climate change. For urban planning water offers opportunities to make the city a more attractive location for companies and people by realizing waterfronts and building near water.

4.3.2 Obstacles at tipping point

Although the integration of water management and spatial planning is proceeding rapidly, literature and stakeholder research at local district level still indicated a number of obstacles for fully integrating urban renewal and water management. Although many plans have been made including cost estimations of water management measures, it is not clear who is responsible to pay for these measures. As a result distribution of costs becomes subject of long negotiations and many measures get never implemented.

Strong competition of urban functions for means and space often results in a relatively small share for water. Other functions such as recreation and parking space are often considered to be more important by inhabitants and local district government than water storage that is design to accommodate a once in 100 years rainfall event.

The number of actors that is involved in both urban planning and water management is high. Moreover, involved actors such as the municipality and waterboards are not single actors but consist of multiple stakeholders. The municipality includes the Municipal Works, The Urban Planning Agency and the Development Corporation. The Waterboard consist of water quantity, water quality and flood control managers. These stakeholders have different objectives and perceptions. This makes the implementation process even more complex and unclear.

Crucial actors for the integration of water management and urban planning are not involved in developing the urban water plan of Rotterdam. The most significant ones are the housing corporations, the local district government and the drinking water company. Considering the opportunity of urban renewal at local level for implementing additional water storage involvement of these actors is crucial for realizing the urban water management ambitions of the municipality of Rotterdam.

4.4 System innovation in the future: utilization of local water resources

The development of large areas of urban surface water offers opportunities for innovation of the water system. Rotterdam currently still relies on centralised water supply infrastructure with the large rivers as a resource. However, by climate change the variation of river water resources will increase, making Rotterdam more vulnerable for droughts. Rainfall in urban areas is a relatively clean source which could be used as resource for local drinking water production. Instead, storm water is treated as wastewater in combined sewer systems. For the southern part of Rotterdam, Valkenburg (2006) evaluated if construction of large scale water storage areas in Rotterdam would also make a self supporting water supply system possible. He found that by constructing large amounts of surface water for urban quality, storing stormwater combined with local drinking water production can cover 93% of the total residential water use at current levels of use. The result would be a city that depends on multiple water resources, both internal local resources and external river resources. The result is more flexible water resources. This has advantages for both reducing vulnerability and dependence of urban areas (De Graaf, 2006) as well as adapting to climate change related consequences (Meuleman et al, 2006).

5 CONCLUSIONS

In Rotterdam there is an increasing cooperation between water managers and urban planners. The Rotterdam water regime is in the second circle of the proposed framework for transformative capacity. The conventional water system is still in place, however, additional stormwater collection and transportation facilities are realized. By connecting the water management regime to the rapidly transforming urban planning regime the transformation capacity of the urban water management system will increase and may be able to go through to the circle of system innovation. Opportunities created by the urban transformation in Rotterdam can be used to implement an additional or even new urban water infrastructure. An example of system innovation is the use of the urban surface water system as a source for local drinking water production. Water can make an important contribution to urban planning objectives such as a high quality living environment and being a favourable location for companies and people. However, research at local level still shows considerable obstacles for realizing improved water systems in urban renewal projects.

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