Receptivity to transformative change in the Dutch urban water management sector

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ABSTRACT

Worldwide, the need for transformative change in urban water management is acknowledged by scientists and policy makers. The effects of climate change and developments such as urbanization, the European Water Framework Directive, and societal concerns about the sustainability of urban water system force the sector to adapt. In The Netherlands, a shift towards integration of spatial planning and water management can be observed. Despite major changes in water management policy and approach, changes in the physical urban water management infrastructure remain limited to incremental solutions and demonstration projects. Policy studies show that institutional factors and professional perceptions are important factors for application of innovations in urban water management. An online survey among Dutch urban water management professionals demonstrates that according to most respondents, optimization of the current system is sufficient to achieve both European and national objectives for sustainable urban water management. The respondents are most concerned with the effects of climate change on urban water systems. In contrast to current policy of the national government, priority factors that should be addressed to achieve a more sustainable urban water system are improving knowledge of local urban water systems, capacity building, developing trust between stakeholders, and improving involvement of elected officials and citizens.

Key words | receptivity, sustainable urban water management, transformative change, transitions

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INTRODUCTION

In recent years, researchers have become increasingly interested in the ongoing transformation of urban water systems. Changes in the urban water management approach can be classified as paradigm shifts, transitions, regime shifts or transformations (Van der Brugge *et al.* 2005; Brown & Clarke 2007; SWITCH 2007). According to many researchers urban water infrastructures should be structurally transformed because they are unsustainable in particular with regard to nutrient recycling and water efficiency (e.g. Otterpohl *et al.* 1997). The effects of climate change and developments such as urbanization, the European Water Framework Directive, and societal concerns about the sustainability of urban water system force the sector to adapt. Definitions that are used in urban water management describe sustainability as a balance between social, economic and ecological values. A sustainable approach should include sufficient flexibility in the system to accommodate future changes (Czemiel Berndtsson & Jinno 2008). The concept of sustainability, however, still lacks consensus about the exact meaning. As addressed by Rijsberman & Van de Ven (2000), the interpretation of what is sustainable depends on personal values and perceptions of participants in a debate. As a result, stakeholders are becoming more involved in urban water management. Urban water systems have to fulfill an increasing number of functions and are influenced

doi: 10.2166/wst.2009.179

by various conflicting values. Thus, the connection with urban planning and development, that is the process through which spatial functions are determined and values are negotiated, is increasingly important.

Concepts such as Water Sensitive Urban Design (WSUD), Sustainable Urban Drainage Systems (SUDS), Low Impact Development (LID) and Integrated Urban Water Management (IUWM) reflect approaches in which the connection with urban planning and social amenity is highlighted. Most approaches stress the necessity of an integrated system approach that includes the total urban water cycle. An important element in most approaches is the use of an integrated, cross-sectoral, multidisciplinary institutional framework (e.g. Butler & Parkinson 1997; Niemczynowicz 1999; Geldof & Stahre 2006). Some authors consider the urban water system as a complex adaptive system (Geldof & Stahre 2006) or sociotechnical system (Brown & Clarke 2007) rather than a technical system.

Also in Dutch water management, a structural change has taken place from a technological approach towards an integrated and interactive approach (Van der Brugge *et al.* 2005). Such a change in government policy may be referred to as a policy transition (Meijerink & Huitema 2007). However, a transition in a complex adaptive system is defined by Rotmans *et al.* (2001) as: “long term continuous process of societal change during which the structure of society, or a subsystem of society, fundamentally changes”. A transition is the result of transformative rather than incremental change. Despite the shift in water management policy, the Dutch urban water infrastructure predominantly consists of centralized end-of-pipe technologies. This system was developed and implemented in the nineteenth and the first part of the twentieth century.

Change in the physical urban water infrastructure is limited to incremental solutions that are either compatible with the current centralized system or small scale demonstration projects. An example is the Dutch program for disconnection of paved surfaces from combined sewer systems. This program started in the late 80’s to prevent mixing of runoff with wastewater in combined sewer systems. Other important considerations were the reduction of combined sewer overflows and improvement of wastewater treatment plant performance. The program is an incremental solution. It leaves the existing combined sewer system in place and improves the performance. While the disconnection program is now generally applied, in 2005 the total disconnection rate of paved areas in The Netherlands was 4.3% (Rioned 2009). Thus, even for incremental innovations long timeframes are needed to change the current system.

For transformative innovations, implementation is even more difficult. One of the reasons is that implementation of innovative solutions is hindered by institutional barriers and technical lock ins (Kotz & Hiessl 2005; Wong 2006). To address this obstacle, changing professional practice is mentioned as an important element (Mouritz 1996). Also, receptivity to both technical innovations and policy innovations is a determining factor for application of these innovations (Jeffrey & Seaton 2003). Therefore, this paper evaluates the receptivity of professionals to transformative change in urban water management. Currently, there are few international examples of research on professional perceptions in urban water management (e.g. Brown & Farrelly 2007). The aim of this study is to develop insights in the potential for transformative change in the Dutch urban water management sector.

METHODOLOGY

Study definition

In order to ensure a common point of reference, sustainable urban water management was defined as “the management of groundwater, surface water and stormwater in urban areas with regard to water quality and water quantity in order to successfully achieve the objectives of the European Water Framework Directive and the National Water Management Agreement. Furthermore, the urban water system optimally enables ecological and social functions against costs that are acceptable to society”. The European Water Framework Directive (EU 2000) is aimed at achieving good ecological and chemical status in all European water systems by 2015. The National Water Management Agreement (NBW) was signed in 2003 as a joint policy of the municipalities, waterboards, province governments and national government in The Netherlands, to reduce flooding to an acceptable level. The agreement has recently been updated (NWB 2008).

Framework

The receptivity framework of Jeffrey & Seaton (2003) was applied to analyze the professional perception on change in urban water management. Jeffrey & Seaton (2003) defined receptivity as "the extent to which there exists not only a willingness (or disposition) but also an ability (or capability) in different constituencies (individuals, communities, organizations, agencies, etc) to absorb, accept and utilize innovation options". For mainstreaming of new professional practices and alternative technological options, four attributes are required according to the receptivity framework:

- Awareness: being aware that a problem exists, and that alternative options are available.
- Association: associate these options with the stakeholders own agenda and objectives.
- Acquisition: being able to acquire, implement, operate and maintain the alternative options.
- Application: having sufficient legal and financial incentives to apply the alternative options.

A number of 20 key factors, essential to enable change in urban water management and based on previous studies, were investigated. Research of Van de Ven *et al.* (2006) found three dominant planning approaches that are used in developing urban water management plans. Characteristics of these approaches were used to develop a list of key factors. Brown *et al.* (2006) developed an overview of capacity building interventions targeted at improving adoption of more sustainable forms of urban water management. Rijke *et al.* (2008) found key factors that enable and constrain successful mainstreaming of innovations based on comparative casestudy research in Melbourne and The Netherlands. Comparing these research projects provided a list of key factors which were classified according to the receptivity framework, as shown in Table 1. The respondents were asked to value the importance and current quality of these factors in urban water management.

Participants

Urban water management professionals were invited to participate in an online survey by the professional organizations of the municipalities and the waterboards. In the Netherlands, waterboards are responsible for

Table 1 | Key factors that were tested in this survey, classified according to the receptivity framework

Awareness	Acquisition
1. Available knowledge about the local urban water system	11. Trust between cooperating partners in urban water projects
2. Water management knowledge of other stakeholders	12. Experience in connecting water management and spatial planning
3. Reliable scientific knowledge about the urban water system	13. Availability of networks and organizational arrangements for stakeholder cooperation
4. Knowledge of technical innovations in urban water management	14. Quality of design skills in urban water projects
5. Juridical and administrative knowledge in urban water management	15. Quality of negotiation skills in urban water projects
Association	**Application**
6. Enthusiasm and perseverance of individuals in urban water projects	16. Financial incentives and subsidy schemes from national government
7. Support and commitment of elected officials to sustainable water management	17. Accountability frameworks for stakeholders in urban water management
8. Involvement of citizens in urban water projects	18. A flexible interpretation of legal frameworks
9. Supportive organizational culture	19. Commercial viability for private organizations of technical innovations
10. Availability of a national overarching vision for urban water management	20. Binding targets for water quantity and water quality

flood control, water quality management, wastewater treatment and surface water management. Municipalities are responsible for the sewer system and stormwater management. The focus of this research was on urban water management and urban drainage, thus water utilities were not included in the survey. The respondents are regional contact persons of the professional organizations and characterized by: (i) involvement in national and European water policy implementation; (ii) overview of regional urban water management issues due to their representative professional role; and (iii) their knowledge of current issues in urban water management. Thus, the authors consider the respondents as policy experts who are working at local level in urban water management practice. Due to the method of selection, the results do not reflect the entire urban water management sector and should be considered as the perception of this specific group. Nevertheless, the results are considered relevant for three reasons. First, the respondents have a good overview and insight in local urban water management issues. Second, as policy experts they perform a role as representatives for the sector. Finally, as opinion leaders they influence their peers' behavior.

Procedure

An online questionnaire in NetQuestionnaire with 83 questions was available to urban water professionals in August and September 2008. The respondents did not receive any compensation and participated voluntarily and anonymously in the survey. The questionnaire was developed to investigate the professional perspective on how urban water management has changed in recent years. Topics included emerging themes that have increased most in importance over the last years. In addition, respondents had to indicate which tasks have increased most in size. Other questions examined the perceived importance of new functions of urban water systems. The questionnaire investigated the perceived necessity for transforming the urban water system and both the importance and current status of key factors to achieve sustainable urban water management. The importance of these key factors for change was measured using a ten-item scale ranging from 1 = extremely unimportant to 10 = extremely important. Rating of the present quality of the key factors were from 1 = extremely poor to 10 = excellent.

Data analysis

The data were analyzed with the Statistical Package for Social Science (SPSS) version 16.0. Descriptive statistics are used to evaluate the importance and present quality of key factors for transformative change. T-tests were executed to find differences in responses based on type of organization, professional experience, level of education, experience with innovative technologies and attitude towards transformative change. The significance level was set on $P < 0.05$. 'Transition thinkers' were defined in this research as those respondents who believe the present system should be replaced with new concepts and technologies in order to achieve sustainable urban water management. The perceptions of 'transition thinkers' were examined and compared with the mainstream thinkers among the respondents. In some cases, statistically significant differences between groups of respondents were found. These cases are reported separately from the overall results in this paper.

RESULTS

Over a 30 day period a total number of 89 urban water professionals completed the survey. The respondents were working at waterboards ($n = 46$; 52%), municipalities ($n = 26$; 29%), consultancy firms ($n = 7$; 8%), branch organizations ($n = 6$; 7%) or elsewhere ($n = 4$; 4%). The majority (52%) had between 5 and 15 years experience in the water management sector, 22% of respondents had less than 5 years experience, 26% more than 15 years. A percentage of 90% had a higher education degree on either university level or higher professional education level. More than 95% had a background in either engineering or natural sciences. The respondents were predominantly working as policy advisor, senior policy advisor or project leader. The geographical distribution of the respondents was reasonably balanced, with an equal amount of completed questionnaires from parts of the Netherlands below and above sea level. This prevented a possible over representation in results of certain issues such as flooding (lower parts) or groundwater depletion (higher parts). The distribution of small municipalities (< 100,000 citizens; 64%) and large municipalities (> 100,000 citizens; 36%) compared to 27% of the Dutch population living in large cities (CBS 2008).

Recent developments

Respondents were asked to choose water management themes, with a maximum of two, that have increased most in importance over the last years. In addition, they had to indicate which tasks increased most in size. Overall, results indicate that in recent years three themes have increased most in the importance: spatial planning (35%), water quantity (33%) and water quality (29%). The increased importance of spatial planning in urban water management was acknowledged by respondents from both waterboards and municipalities. Table 2 provides specific result of these groups. In general, tasks that have increased most in size over the past few years are: developing urban water management plans (32%), water quantity management/ urban flood control (27%) and spatial planning (25%).

Respondents were asked to value the importance of strengthening three new functions of urban water systems; connection with urban renewal, contribution to social amenity, and enabling ecological development. Strengthening the connection between urban water management and urban renewal obtained the highest mean ranking; 8.4 on a 0–10 scale. A high importance was placed on enhancing urban water quantity and urban water quality to contribute to social amenity (mean ranking: 8.3). Third was improving the urban water system to improve ecology with an average ranking of 7.1.

Sense of urgency

The respondents were asked to choose the two most urgent problems in present day water management out of a list of 19 problems. Respondents were allowed to add a problem to the list. Pluvial flooding, effects of climate change, groundwater nuisance and increase in paved area were considered the most important problems (> 10%) by municipal employees. The effects of climate change and lacking citizen awareness were chosen most frequently

Table 2 | The importance of themes and tasks according to respondents of municipalities and waterboards

	Themes that have increased most in importance		Tasks that have increased most in size	
	Waterboards	**Municipalities**	**Waterboards**	**Municipalities**
First	Ecology ($n = 10$; 39%)	Spatial planning ($n = 16$; 35%)	Water quality management ($n = 9$; 35%)	Urban water plans ($n = 19$; 43%)
Second	Spatial planning ($n = 8$; 31%)	Water quantity/Flood control ($n = 15$; 33%)	Ecological management ($n = 7$; 27%)	Water quality management ($n = 13$; 28%)
Third	Water quality ($n = 8$; 31%)	Urban water plans ($n = 12$; 26%)	Developing basin management plans ($n = 7$; 27%)	Spatial planning ($n = 13$; 28%)
		Flood Safety ($n = 12$; 26%)		
		Water Quality ($n = 12$; 26%)		

by waterboard respondents. Notably, the lack of citizen awareness was listed by the respondents themselves. Problems that were not chosen were: illicit connections of sewer systems, soil pollution, pharmaceutical residuals in water systems, land subsidence, droughts and groundwater over extraction. The sense of urgency that results from the perceived importance of achieving societal objectives in urban water management was tested. The importance of achieving the objectives of the European Water Framework Directive received a medium rating (6.7 on a 1–10 scale). The importance of achieving the objectives National Water Management Agreement received an average rating of 7.6. A significant difference was found between waterboards (8.3) and municipalities (7.4).

Perceived necessity of transformative change

Most respondents considered the objectives in urban water management achievable by optimization of the current technical system. For the objectives of the National Water Management Agreement a percentage of 59% was found. For the European Water Framework Directive, the percentage was 48%. A minority ($n = 7$; 8%) expressed the opinion that the replacement of the current urban system with new concepts and technologies is required to achieve the European objectives. This was the case for 2% ($n = 2$) with regard to the national objectives. The remaining respondents chose a combination of optimization and replacement, had a different opinion, or did not know. Table 3 shows that the majority of respondents felt that adjustments are needed within the urban water management sector and in other sectors. The results also gave a strong indication the respondents do not support detailed binding targets and standards from the national government (81%).

Priority factors to achieve sustainable urban water management

The factors in Table 1 were ranked on current perceived quality and of discrepancy between perceived importance and perceived quality. The latter indicates the necessary level of effort to improve the quality to a level that matches its perceived importance. Plotted in a four quadrant diagram, key factors were classified in the following groups.

1. Relatively unimportant factors, with a relatively high discrepancy between importance and quality.
2. Relatively important factors, with relatively high discrepancy between importance and quality.
3. Relatively important factors, with relatively low discrepancy between importance and quality.
4. Relatively unimportant factors, with relatively low discrepancy between importance and quality.

Efforts to achieve a sustainable urban water system should be targeted to those key factors that receive a combination of both a relative high importance and a high discrepancy between importance and current perceived quality (second quadrant). Figure 1 provides a list of 5 priority factors that should be improved to achieve sustainable urban water management (Table 1 explains the numbers): available local urban water system knowledge, trust between cooperating partners in urban water projects, experience in connecting water management and spatial planning, support and commitment of elected officials to sustainable water management, and involvement of citizens in urban water projects. A sensitivity analysis of the factors' 95% confidence interval was executed to analyze whether any of the factors could be situated in another quadrant. For none of the factors this was the case (Table 4).

Table 3 | Perceived required adjustments in different sectors to achieve national and European urban water objectives

	Adjustments within the urban water sector	Adjustments in other sectors	Adjustments to both the urban water sector and other sectors	Other/does not know
National objectives	11.2%	8.8%	72.5%	7.5%
European objectives	6.2%	26.2%	62.5%	5%

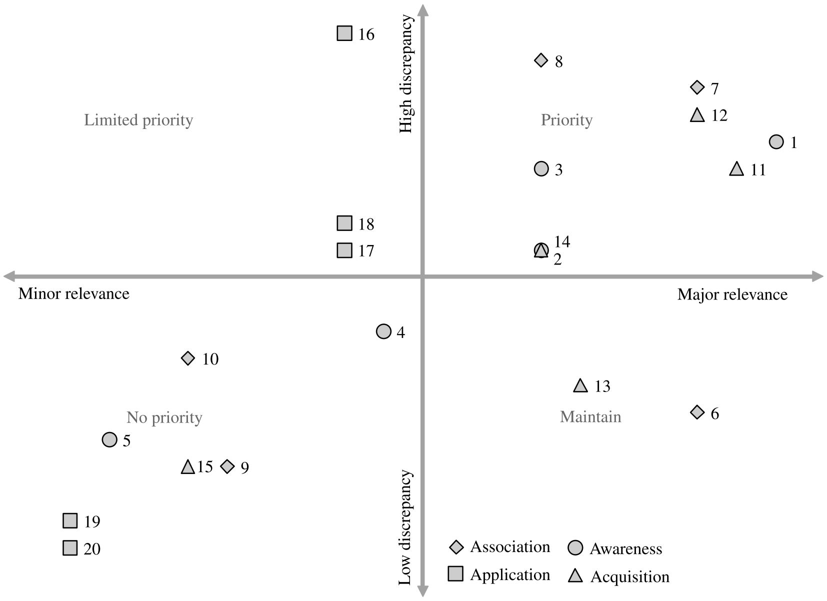

Figure 1 | Key factors to achieve sustainable water management plotted according to relevance and discrepancy between importance and current quality. Numbers are in accordance with Table 1.

Statistical differences

The survey allowed testing differences within the professional community. There were only limited statistical significant differences between subgroups as shown in Table 3. In most cases the answers were consistent across groups. Type of organization and experience with innovative technologies influence the perceived importance of some key factors. Professional experience and attitude towards transformative change affect the perceived quality differences of some key factors. Professional experience with innovative technologies results in a lower acknowledgement of the importance of some application and awareness key factors. A remarkably high score (average $= 9.3$) was ascribed to the key factor trust by transition thinkers. Although the group of transition thinkers was small ($n = 7$) none of them gave a lower score than 8.0 to this factor. Professional experience influenced the perceived quality of financial incentives and subsidy schemes from national government.

DISCUSSION

Worldwide, the need for transformative change in urban water management is acknowledged by scientists and policy makers. However, according to the professionals in this study, there is no need for large-scale implementation of innovative solutions. Most respondents are convinced that the objectives of sustainable urban water management can be achieved by optimization of the current water system. There is a lack of receptivity for transformative change. It is therefore not surprising that innovations that are not compatible with the current centralized systems, have failed to break through to mainstream practice. At the same time, the professionals are convinced that cooperation with other sectors is required to achieve the objectives of sustainable urban water management. In particular, strengthening the link between water management and urban renewal is seen as an important element. This finding corresponds to the broader national change in Dutch water management in which spatial planning, and water management become integrated (Van der Brugge *et al.* 2005) and recent urban water management approaches in which the connection with urban planning and social amenity is highlighted.

The effect of climate change on urban water systems was regarded the most urgent problem. However, unexpectedly some problems such as land subsidence and droughts were not at all mentioned. In The Netherlands, land subsidence

Table 4 | Statistical differences in rating of importance and quality of key factors between subgroups

Aspect	Factor	Receptivity attribute	Waterboard (n = 46)	Municipal (n = 26)
Importance	Achieving the national objectives in urban water management	–	8.3	7.4
Importance	Financial incentives and subsidy schemes from national government	Application	7.7	7.2
Importance	Involvement of citizens in urban water projects	Association	8.1	7.5
			Innovation experience $n = 42$	No innovation experience $n = 32$
Importance	Water management knowledge of other stakeholders	Awareness	7.4	8.0
Importance	Commercial viability for private organizations of technical innovations	Application	5.6	6.6
Importance	Binding targets for water quantity and water quality	Application	5.3	6.8
			Transition thinker $n = 7$	Mainstream thinker $n = 82$
Importance	Trust between cooperating partners in urban water projects	Acquisition	9.3	8.4
Quality	Availability of a national overarching vision for urban water management	Association	5.3	6.0
Quality	Juridical and administrative knowledge in urban water management	Awareness	6.8	5.4
			$>$ 10 years experience $n = 36$	$<$ 10 years experience $n = 53$
Quality	Financial incentives and subsidy schemes from national government	Application	4.1	5.3

is the most important factor contributing to the relative sea level rise and the drought of 2003 dominated the news with items on salt intrusion and fresh water flushing of polders. Moreover, a national enquiry on this topic was completed recently (RIZA 2005). Professionals expect the national government to outline the main objectives. The provision of a general direction creates flexibility for professionals to adapt objectives to the local environmental, spatial and administrative conditions. The high priority given to improving knowledge of the local urban water system supports this finding. Binding targets for water quality and water quantity were considered least important. Although Australian research (Brown & Clarke 2007) listed binding targets and private sector feasibility as key enabling factors for the transition in urban water management, the Dutch urban water professionals in this survey are not convinced of the importance of these factors. This may be due to the fact that private sector involvement in Dutch urban water management is small compared to Australia.

Association factors and acquisition factors were considered most important. Priority factors that should be addressed to achieve a more sustainable urban water system are improving knowledge of local urban water systems, capacity building, developing trust between stakeholders, and improving association of elected officials and citizens with urban water management. This finding is opposite to current government policy that is targeted at improving awareness and application factors. The Dutch findings are consistent with the results of the Australian survey that indicated serious acquisition factors that need to be addressed (Brown & Farrelly 2007). The professionals in this survey wish to improve involvement of elected officials and citizens in urban water management. Generally, priority should be given to the association and acquisition factors to achieve sustainable urban water management. In addition, knowledge of the local water system should be improved.

CONCLUSION

The objective of this study was to gain insight in the potential for transformative change in the Dutch urban water management sector. The receptivity framework used in this research consists of four attributes; awareness, association, acquisition and application. The framework was applied to classify 20 key factors to provide empirical evidence regarding receptivity for transformative change in urban water management. The receptivity to transformative change is small. The professionals are convinced that the societal objectives in urban water management can be achieved by optimization of the current centralized urban water system. In addition, cooperation with other sectors is necessary and five key factors are regarded top priority to be further improved: (1) Available knowledge about the local urban water system, (2) Trust between cooperating partners in urban water projects, (3) Experience in connecting water management and spatial planning, (4) Support and commitment of elected officials to sustainable water management, and (5) Involvement of citizens in urban water projects. The respondents stress the importance of improving association and acquisition factors, in contrast to current government policy. The results of this study may therefore be helpful to policy makers to take into account professional perceptions in the development of national policy, in order toz achieve better translation of policy to practice.

ACKNOWLEDGEMENTS

The participants of the Leven met Water Research project P1002, Transitions to more Sustainable Urban Water Management are thankfully acknowledged for funding this research. The authors also wish to thank the urban water professionals who completed the questionnaire.

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