

Comparative case studies towards mainstreaming water sensitive urban design in Australia and the Netherlands

J.S. Rijke¹, R.E. De Graaf^{1*}, F.H.M. Van de Ven¹, R.R. Brown² and D.J. Biron^{1,3}

¹ *Section of Water Resources, Faculty of Civil Engineering and Geosciences, Delft University of Technology, Stevinweg 1, 2628 CN Delft, The Netherlands. Telephone: +31-15-2784673. Fax: +31-15-2785559*

² *School of Geography and Environmental Science, Monash University, Building 11, Monash University, Vic 3800, Australia*

³ *Witteveen+Bos, Alexanderstraat 21, 2514 JM, The Hague, the Netherlands*

**Corresponding author, e-mail r.e.degraaf@tudelft.nl*

ABSTRACT

This paper describes the lessons that can be drawn from comparative case studies about mainstreaming Water Sensitive Urban Design (WSUD) in the Netherlands and Melbourne (Australia) in order to advance and realise the societal change towards more sustainable urban water systems. Analysis of the transition pathways are used to determine the current state of the transition in urban water management in both areas. Subsequently, comparative studies for three cases in Melbourne and five cases in the Netherlands have been used to reveal the key success factors and obstacles within the transition processes. Because the focus of the case studies of this research is on individual urban development projects and not on the broader societal context, the emphasis of this paper is on the micro level (niches) and meso level (regimes) of the urban water management systems. It can be concluded that the transitions in Melbourne and the Netherlands have followed similar pathways, which have currently resulted in a similar state of both transitions. The comparative case studies that have been conducted within these settings have also resulted in similar key elements that act as enabling or disabling factors for advancing WSUD in Melbourne and the Netherlands.

KEYWORDS

Australia, Netherlands, transitions, urban development, urban water management, WSUD

INTRODUCTION

Urban water management practice across the world is characterised by an increasing complexity over time (Geldof, 2002, 2005). The number of involved actors increases, systems are under increasing pressure due to climate change and urbanisation and more demanding standards such as the European Water Framework Directive for water quality management in Europe and the Australian National Water Initiative.

This paper highlights the lessons that can be drawn from the comparative case analysis about the mainstreaming of WSUD in the Netherlands and Melbourne (Australia) in order to advance and realise the societal change towards more sustainable urban water systems. Urban water systems in the Netherlands and Melbourne are very different and face a number of different issues (such as the current dominant focus on flood protection in The Netherlands and alleviating the extended drought conditions in Australia). In the Netherlands, urban water

systems are facing increasing pressure from urbanisation, climate change and (European) legislation. The most important aspects of water management in the Netherlands are protection against flooding and preserving water quality. In Melbourne the water challenges are meeting the water demand of the increasing population, the growing economy, climate change and protecting water quality of surface water systems. However, across Australia and the Netherlands a transition appears to be taking place towards a more holistic water cycle approach that integrates urban water management with spatial planning (Van der Brugge et al., 2005; Brown and Clarke, 2007). In Australia this approach is generally known as Water Sensitive Urban Design (Mouritz et al., 2006; Wong, 2006). In the Netherlands, a similar approach is evolving which is referred to as WSUD in this paper. It is increasingly recognized that institutional aspects are key obstacle for realising the transition to more sustainable urban water systems (Ashley et al., 2005). This paper is based on an interdisciplinary research approach that balances on the edge of traditional engineering and social science through an in-depth investigation of this evolving transition with a particular focus on the mainstreaming of innovations in urban water management. In recognition that the institutional aspect are likely to pose the most significant barriers, it is a proposition of this paper that improved knowledge of the enabling and disabling factors related to the mainstreaming of WSUD innovations will assist future strategic processes with accelerating the current transition. Therefore, the key question that underpins this research is: “What are enabling factors and obstacles for mainstreaming innovations that advance the transition towards more sustainable urban water management in Melbourne and the Netherlands?”

RESEARCH METHODOLOGY

To address the research question and to make recommendations for accelerating the transition to more sustainable water management, two key objectives were established. The first objective was to characterise the pathway and the current state of the transition in urban water management in Melbourne and the Netherlands. The data on the current state and dynamics of the transition was collected by literature survey and in-depth interviews. The second objective was to determine the enabling factors and obstacles for successfully introducing innovations in urban water management on a broad scale in Melbourne and the Netherlands. An in-depth qualitative research approach was used through a comparative analysis of five case studies in the Netherlands and three case studies in Melbourne. The primary data included over 50 semi-structured interviews with key stakeholders (25 in Melbourne and 25 in the Netherlands), and the secondary data included a desktop study for all individual cases.

Table 1. Overview of cases

Case	Development	Function	Scale	WSUD features	
Melb.	Docklands	Brownfield	Residential, commercial	200ha, ca 20.000 residents, 30.000 employees, 20 million yearly visitors	Integrated wetlands, bio-retention planter boxes, stormwater re-use
	Hunt Club	Greenfield	Residential	ca 230ha, 2000 dwellings	Integrated wetlands, third pipe network
	Aurora	Greenfield	Residential	650ha, 10.000 dwellings	Bio-retention strips, vegetated swales, raingardens, third pipe network, rainwater harvesting
Netherlands	Het Funen	Brownfield	Residential	5,5ha, 565 dwellings	Permeable pavement
	't Duyfrak	Greenfield	Residential	20ha, 800 dwellings	Building Site Preparation+, permeable pavement, disconnected stormwater run-off
	Leidsche Rijn	Greenfield	Residential, commercial	2100ha, 30.000 dwellings, 720.000m ² commercial	Permeable pavement, vegetated swales, disconnected stormwater run-off, vertical reed bed filters, third pipe network
	Lanxmeer	Greenfield	Residential, commercial	24ha, 250 dwellings, 40.000m ² commercial	Vegetated swales, disconnected stormwater run-off, wetlands, third pipe network (also public participation)
	IJburg	Land reclamation	Residential, commercial	450ha, 18.000 dwellings, 213.000m ² commercial	Disconnected stormwater run-off, vegetated swales (not implemented), third pipe network (not implemented)

The criteria established for the selection of cases (as briefly highlighted in Table 1) for investigation included that the case should: (1) aim towards improved or more sustainable urban water management; (2) involve multiple stakeholders; (3) have a certain level of faith in the future prospect of broad implementation; (4) be located in a non-laboratory like environment in society; (5) be located on sites with no existing infrastructure before development; (6) be (at least partially) residential developments; (7) be (nearly) completed.

SOCIO-TECHNICAL TRANSITIONS: AN ANALYTICAL APPROACH

Socio technical systems such as urban water systems, transportation systems and energy supply systems consist of technical components, regulations, government agencies, markets and user practices (Brown and Clarke, 2007). These components are connected into a network structure to perform societal functions and acquire resources to maintain the functioning of the system. Important societal functions that are fulfilled by the total urban water system are securing water supply, public health, flood protection and maintaining water quality. Resources that are acquired by the system are financial resources in the form of taxes, government subsidies, user fees, and natural resources such as water, building materials etc. The network changes its structure continuously to adapt to change that could be driven from both within and outside of the water management regime. These systems, once established are more competitive than competing systems in acquiring resources and maintaining their societal function. As a result, change of these systems implies significant barriers and obstacles (Van Vliet, 2002). They acquire a 'momentum' (Hughes, 1987) giving them competitive advantages over newly emerging systems. Developed technological systems are characterized by inertia, vested interests, fixed assets and sunk costs. Therefore it is expected that change and transitioning to a new system state could be fraught with difficulty and numerous barriers.

To analyse change processes of socio-technical urban water systems, this research employs transition theory (see also Rotmans et al. 2001; Geels and Kemp, 1998) as an analytical approach. According to Rotmans et al. (2001), a transition is a structural change in the way a social technical system operates, and can be described as a long-term process (25-50 years) that results from a co-evolution of cultural, institutional, economical, ecological and technological processes and developments on three levels. Rip and Kemp (1998) developed a multi-level framework (MLF) for socio technical systems. The MLF aims to understand technological innovation in a social context. They distinguished between three levels, the macro, meso and micro level. At the macro-level, slow trends are located, such as globalization, environmental awareness or climate change. The meso level consists of a regime of technical networks, institutions, rules, guidelines and user practices. At the micro-level, all sorts of technical innovations are developed that differ from the status quo. The MLF suggests that changes on these three levels can mutually reinforce each other to cause a system wide transformation. Therefore, in this paper developments at three levels are analysed for urban water systems in Melbourne and the Netherlands.

According to Geels and Schot (2007), different types of transition pathways can be characterised that are caused by multi-level interactions of different nature and timing. Figure 1 shows the transition pathways of Melbourne and the Netherlands as schematised by Rijke (2007). Using Geels and Schot (2007), both transitions can be characterised by a transformation pathway, followed by a de-alignment and re-alignment pathway. A transformation pathway is initiated by moderate pressure (disruptive change) from the macro-level at a moment when innovations in the micro-level have not sufficiently been developed,

resulting in actors at the meso-level that modify the direction of the development path and innovation activities. De-alignment and erosion of the old regime occurs when increasing pressure from the macro-level results in increasing problems that cause the meso-level actors to lose faith in the regime. If there is no clear substitute available, because innovations at the micro-level are not sufficiently developed, a space is created for the emergence of multiple niche-innovations that co-exist and compete for attention and resources until one niche-innovation becomes dominant and forms the core for re-alignment of a new regime.

In the 1960s, the transition in both Melbourne and the Netherlands started as a transformation pathway. It was triggered by an environmental macro driver, combined with events and developments at the micro level. Brown and Clarke (2007) describe that in Melbourne, after continuing environmental pressure from the macro and the micro level a protective space was created in the meso-level between different organisations to enable rapid expanding demonstration of stormwater treatment. The drought that started in 1997 and the worldwide increased awareness about climate change triggered a de-alignment and re-alignment pathway in the late 1990s, because these developments made clear that the existing regime could not sufficiently secure Melbourne's long term water supplies. The drought and climate change driver did not only trigger the uptake of alternative water sources, but is also causing the evolution of the USQM transition in the direction of a more holistic water management approach.

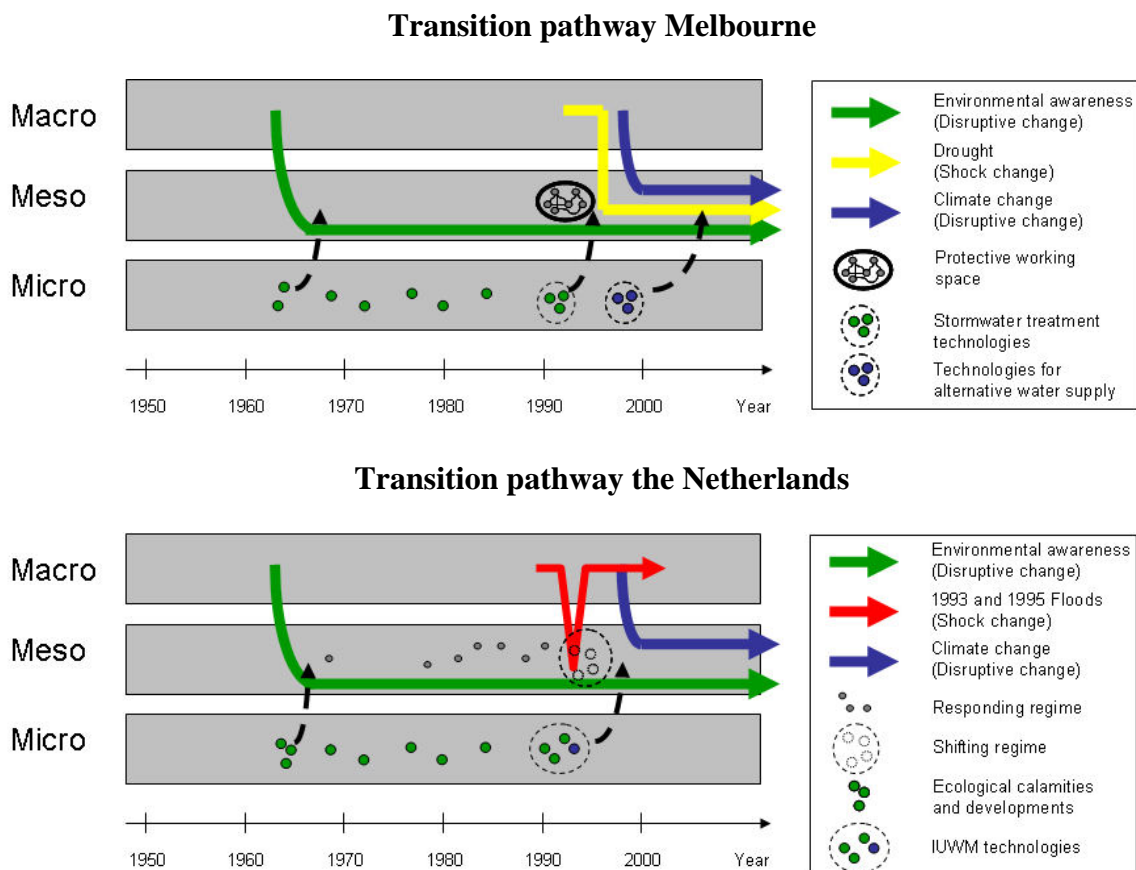


Figure 1. Transition pathways in Melbourne and the Netherlands (adapted from Geels and Schot (2007)).

For the transition in the Netherlands, Van der Brugge et al. (2005) describe that the regime gradually responded to developments at the micro level and the persisting environmental

macro-driver, but did not radically change until the river floods of 1993 and 1995. After the floods of 1993 and 1995 it was widely acknowledged that the existing regime could not fully control the water. Climate change awareness reinforced this public opinion. This opened a window of opportunity for technologies to emerge and caused the shift to the de-alignment and re-alignment pathway.

CURRENT STATE OF THE TRANSITIONS

Figure 2 shows that the current state of the urban water transitions in Melbourne and the Netherlands is leaving the take-off phase and entering the acceleration phase. For the Netherlands, there are a number of indications that the transition is currently entering the acceleration stage. The take-off stage was triggered after the 1993 and 1995 floods. It was acknowledged that the 'higher dikes paradigm' was no longer sufficient and spatial measures were necessary. As a result new technologies emerged rapidly. This has resulted in a widespread implementation of technologies that integrate water management and spatial planning, such as emergency water detention basins. The implementation of such technologies still faces many practical problems, such as cost allocation, maintenance and knowledge. The regime will therefore have to adapt to this to remove the incompatibilities between the strategies and the implementation before the stabilisation phase will be reached. At the national level, there are many strategic water visions, indicating that one unambiguous vision and strategy is not present at the meso-level.

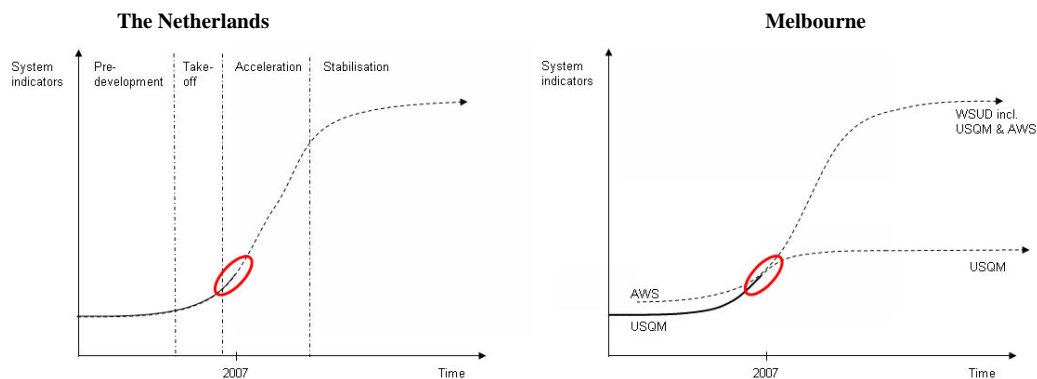


Figure 2. Current state of the transitions in the Netherlands (left) and Melbourne (right)

The urban water transition in Melbourne consists of two components: a transition towards Urban Stormwater Quality Management (USQM) that has merged with an Alternative Water Sources (AWS) component towards a transition towards Water Sensitive Urban Design. The USQM component is approaching the stabilisation stage. There are a number of indications for this. The USQM transition has been in the acceleration stage for the past 10 years. This has resulted in a revised Clause 56 of the Victorian Planning Provisions that mandates on-site stormwater treatment for all new residential subdivisions. However, the USQM transition has not reached the stabilisation phase yet. Implementation of on-site stormwater treatment is only mandated in new residential developments and not yet in re-development of urban area or the development of commercial and industrial areas. Cost-allocation issues are still present and mainly developers and builders have insufficient knowledge for the correct implementation of on-site treatment systems.

The AWS component is entering the acceleration stage at this moment. Macro-drivers and developments at the micro level have pushed the regime in such a way that it started to respond by developing guidelines and regulation for the use of reclaimed water. This has

resulted in the development of more projects with recycled water in Metropolitan Melbourne. However, a common methodology of developing third pipe systems still has to be created. Also cost-allocation is an issue that needs to be addressed. An indication that could shift the diffusion into the acceleration phase is the fact that the Victorian Government has mandated the uptake of recycled water schemes for 40.000 planned homes in Melbourne. If the two components of the transition towards WSUD are combined, it could be concluded that the transition towards WSUD in Melbourne is entering the acceleration phase. Understanding the current state of the transition can be used to accelerating towards the next transition stages.

RESULTS FROM THE CASE STUDIES

The key elements for mainstreaming innovations in urban water management in Melbourne and the Netherlands are presented in Table 2 and outlined below. All elements were identified in the case studies and are classified according to the MLF of socio technical change. From the case studies in Melbourne and the Netherlands similar key elements were identified that were able to contribute enabling and/or disabling to the introduction of innovations in specific cases. The following is a brief summary of the case study results, and further details can be found in Rijke (2007).

Table 2. Key elements for successfully mainstreaming innovations in urban water management in Melbourne and the Netherlands.

Level	General key elements
Macro	<ul style="list-style-type: none"> • Climate • Urban growth • Socio-political capital and sustainability
Meso	<ul style="list-style-type: none"> • Attitude of stakeholders • Knowledge and trust • Complexity of stakeholders • Co-operation, involvement and communication • Regulation, guidelines, agreements and contracts • Cost and cost allocation
Micro	<ul style="list-style-type: none"> • Added value • Enthusiasm of individuals • Location characteristics • Construction, operation and maintenance

Key elements at the macro level

- **Climate:** Especially for Melbourne this is an important driver for the uptake of WSUD. It is also a reason for a change of the concept of WSUD in Melbourne. It started with integration of water (quality) management and spatial planning and has evolved to a holistic water management approach that also included the use of alternative water sources such as wastewater, rainwater and stormwater run-off. In the case studies in Melbourne climate was explicitly highlighted by interviewees as a driver for WSUD in contrary to the case studies in the Netherlands. This is probably caused by the effects of the drought having a direct impact on the population of Melbourne.
- **Urban growth:** Urban growth was identified as a driver for the implementation of new water systems in urban developments and urban re-development projects in both

Melbourne and the Netherlands. The difference between the Netherlands and Melbourne is the housing market, which does not provide an incentive for developers in the Netherlands to create high quality developments, because the housing demand is that high that everything that is built will be sold. In contrast, developers in Melbourne try to create a development with a high quality living environment in order to ensure sales.

- **Socio-political capital and sustainability:** When people in Melbourne talk about sustainable water management, they refer to minimising environmental impact, creating amenity and securing future water supply. In the Netherlands, for sustainability it is mainly referred to minimising environmental impact, creating amenity and protection against floods and droughts. The analysis of the cases strongly suggests that public perception has more influence in Melbourne, because all residents of Melbourne are directly influenced for a long period by the water restrictions that are a result of the drought. This creates a public awareness and sense of urgency that put water high on the political agenda. In the Netherlands this is not the case, because the challenges are not directly visible to the broad public. If the water challenges in the Netherlands are visible it is only for a small period. Further numerous interviewees suggested that this has smaller impact on public opinion than enduring visibility. Public opinion can have significant influence on political decisions leading to innovation or stopping innovation. In the Netherlands, the government is involved differently in innovation processes compared to Melbourne. Local governments play a more active role in driving innovations, while they often act as developers. In Melbourne most innovation is driven by private initiatives and facilitated by the government.

Key elements at the meso level

- **Attitude of stakeholders:** The role of the attitude of stakeholders towards innovation in urban water management appears to be similar in Melbourne and the Netherlands. Commitment of stakeholders towards introducing innovations in urban water management is a requirement while a conservative approach towards innovation can be a barrier for a successful introduction of an innovation. A barrier that is revealed in the case studies in the Netherlands is that organisations are only considering their own interests without seeing the ‘bigger picture’. This phenomenon also takes place between different departments of local governments in the Netherlands, because they have conflicting interests.
- **Knowledge and trust:** The role of knowledge and experience is similar in Melbourne and the Netherlands. All interviewees agreed that knowledge and experience with new technologies create trust and lack of it creates agency reluctance to enable the introduction of an innovation. Reliability of technologies and trust of stakeholders in those technologies are important factors in both Melbourne and the Netherlands for stakeholders to co-operate in an introduction process of innovative technologies. Robustness has been identified to increase the reliability of an implemented system. Therefore, this factor increases the probability of widespread practice. An important lesson from the cases in Melbourne is the importance of knowledge that should be present in all organisational levels and during all development phases. The case studies in the Netherlands revealed the importance of implicit knowledge that is lost with personnel changes.

In both Melbourne and the Netherlands, education is used to create knowledge among organisations and within different organisational levels. In Melbourne, the presence of bridging organisations that collect and store information has an enabling role for mainstreaming WSUD in Melbourne. This could be a valuable lesson for The Netherlands.

- **Complexity of stakeholders:** The role of this factor is similar for Melbourne and the Netherlands. The ability of stakeholders to cope with change appears to be dependent on the complexity of the organisational structure. The case studies illustrated that complexity of an organisation is dependent on the size and capacity of the organisation, the number of different departments that are involved with the development of an urban water system, and conflicting interests between those departments.
- **Co-operation, involvement and communication:** Good co-operation between stakeholders, early involvement and good communication between stakeholders have appeared to be crucial factors in both Melbourne and the Netherlands. Early involvement is important to prevent conflicts or problems in later stages. The cases of the Netherlands show that a participatory approach in which relevant stakeholders are involved, makes co-operation and communication easier. From the case of IJburg it can be learned that if too many stakeholders are involved communication can be a slow process. This can be a barrier to innovation.
- **Regulation, guidelines, agreements, and contracts:** Regulation and guidelines are facilitating factors for developing urban water systems. Regulation protects the bottom line and guidelines provide assistance for developers to meet the requirements. According to numerous interviewees, regulation and guidelines can create trust for developers, because they know what to do and how to do it. In Melbourne WSUD features for on-site stormwater treatment are mandated for new residential developments. This accelerates mainstreaming of this technology in Melbourne. Although guidelines provide assistance for developers to design WSUD features, the case studies have revealed that there is still insufficient knowledge among builders about WSUD. This needs extra attention in the near future. Contracts are binding factors that can play a role in securing ambitions and quality of the outcome of the work. Oral agreements have the same function, but appear to have less binding value. A covenant between several stakeholders can be used to define and secure ambitions. A requirement for this is that all stakeholders should have a shared ambition. For example in the case of IJburg in the Netherlands, where the ambitions of the original plan were not shared among the stakeholders, insufficient contracting resulted in the abandonment of the original plans. In Melbourne contracts between the developer and the council for public open space define the outcome of the work. Often a hand-over period is used to reveal possible hidden failures. This decreases the probability that the council has to invest extra capital after take-over of the assets. The same takes place in the case of 't Duyfrak in the Netherlands, where the outcome of building site preparation is precisely defined. This approach is highly unusual in the Netherlands. Traditionally, only the activities that have to be conducted for building site preparation are described in the Netherlands. This does not safeguard the quality of the work.
- **Cost and cost allocation:** Cost is mentioned frequently as a barrier for introducing innovative technologies in urban water management in Melbourne and the

Netherlands. However, cost allocation often appeared to be the real problem. In Melbourne the fragmented institutional arrangements do not support a holistic water management approach. This often causes benefits and costs for WSUD to be unfairly distributed among stakeholders. The case studies in the Netherlands reveal that water management practice faces similar problems there.

Key elements at the micro level

- **Added value:** All case studies revealed that added value is in both Melbourne and the Netherlands crucial for the success of innovative technologies. If a new technology does not have added value over conventional technologies, it is not likely that it will become a substitute for this technology. Added value can take different forms: financial benefits, environmental benefits, amenity, water efficiency (Melbourne), reduced claim for space (NL), and educational values.
- **Enthusiasm of individuals:** Enthusiasm of individuals has appeared as an important factor that drives innovation. These individuals were able to convince their own organisations and other stakeholders to co-operate with the introduction of an innovative technology. This factor has been encountered in the case studies in the Netherlands, but it is likely that this is also a very important factor in Melbourne, because there is much research being done towards the role of influential individuals that drive innovation. These persons are being referred to as ‘champions’ or change agents.
- **Location characteristics:** The role of location characteristics is similar in Melbourne and the Netherlands. Location characteristics offer opportunities and set requirements to the planned water systems. Variety in characteristics of different locations leads to different optimal solutions in each case. As a result, the transition towards WSUD will probably include a wide range of technologies in both Melbourne and the Netherlands.
- **Construction, operation and maintenance:** Examples from both Melbourne and the Netherlands have showed that all phases of the development process are important for successfully introducing an innovative water system. A good design is not automatically translated into a good implemented system. Mistakes can be made during the construction phase. Even if a system is being implemented correctly, things can still go wrong during the operation and maintenance phase because of improper use or lack of maintenance. Follow-up through all phases is therefore important to safeguard the quality of the developed system.

CONCLUSIONS

Based on the transition analyses and the outcome of the case studies several key lessons have been revealed that could contribute to successful mainstreaming of innovations in urban water management. For Melbourne the key lessons are:

- A good design does not automatically lead to a well functioning system.
- While cost is mentioned as a barrier, the real barrier is often cost allocation instead of cost.
- To complete the transition, knowledge should be adapted in each organisational level.

For the Netherlands the key lessons are:

- Integral development approach can deliver increased quality and financial benefits.

- Conflicting interests of local councils are inhibiting innovation.
- A collective centrally directed approach enables innovation.
- Ambitions or plans are not sufficient to safeguard implementation in practice.
- Definition of quality and hand-over periods can improve the quality of urban development.

Analysis of the transitions in urban water management in Melbourne and the Netherlands has revealed that in both contexts the transition pathway could be characterised by a transformation pathway followed by a de-alignment and re-alignment pathway. It has been argued that for both contexts the pathways have resulted in entering the acceleration stage of the transition. Within these settings, qualitative in-depth case studies have revealed similar key elements that can either act as enabling or disabling factors. Identification of the key elements clarifies the issues that successful introduction of innovative technologies is facing and therefore results in key lessons that can be drawn for Melbourne and the Netherlands.

ACKNOWLEDGEMENTS

I would like to thank the National Urban Water governance Program at the School of Geography and Environmental Science of Monash University in Melbourne as well as the Section Water Resources Management at Delft University and Witteveen+Bos in the Netherlands for making this research possible.

REFERENCES

- Brown R.R. and Clarke J.M. (2007). Transition to Water Sensitive Urban Design: The story of Melbourne, Australia, Report No. 07/1, Facility for Advancing Water Biofiltration, Monash University, June 2007, ISBN 978-0-9803428-0-2.
- Geels F. and Kemp R. (2000). Transities vanuit sociotechnisch perspectief, International Centre for Integrative Studies, Maastricht, The Netherlands.
- Geels F.W. and Schot J. (2007). Typology of sociotechnical transition pathways, *Research Policy* 36, p399-417.
- Geldof G.D. (2002). Omgaan met complexiteit bij integraal waterbeheer (Coping with complexity in integrated water management), PhD dissertation, University of Twente, The Netherlands.
- Geldof G.D. (2005). Interactive implementation, Conference proceedings 10th International Conference on Urban Drainage, Copenhagen, Denmark.
- Hughes T.P. (1987). The evolution of large technological systems. In: Bijker W.E., Hughes T.P., Pinch T. (Eds.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*. MIT Press, Cambridge, MA, pp. 51–82.
- Huisman P. (2004). Water in the Netherlands, managing checks and balances, Netherlands Hydrological Society, Utrecht, ISBN 90-803565-6-5.
- Mouritz M., Evangelisti M. and McAlister T. (2006). Water Sensitive Urban Design. In: Wong T.H.F. (ed.), *Australian Runoff Quality: A Guide to Water Sensitive Urban Design*, Engineers Australia, Canberra.
- Rijke J.S. (2007). Mainstreaming innovations in urban water management – Case studies in Melbourne and the Netherlands, MSc thesis, October 2007, Delft University of Technology, The Netherlands.
- Rip A. and Kemp R. (1998). Technological Change. Human Choice and Climate Change. S. Rayner, and E.L. Malone. Columbus, Ohio, Battelle Press. Volume 2: 327-399
- Rotmans J., Kemp R. and Van Asselt M. (2001). Transition Management in Public Policy, *Foresight*. Vol.3, no.01.
- Van der Brugge R., Rotmans J. and Loorbach D. (2005). The transition in Dutch water management, *Regional Environmental Change*, Vol.5:164-176.
- Van Vliet B. (2002). Greening the Grid, the ecological modernization of network bound systems. PhD thesis Wageningen University
- Wong T.H.F. (2006). Introduction. In: Wong T.H.F. (ed.), *Australian Runoff Quality: A Guide to Water Sensitive Urban Design*, Engineers Australia, Canberra.