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Editorial

Transitions through a lens of urban water

1. Introduction

The aim of this special issue is to showcase a selection of articles which, together, illustrate that in-depth studies of urban water transition cases can be instrumental in the further advancement of the sustainability transitions field.

Urban water scholarship and practice has been grappling with both the 'sustainability challenge', in terms of what a sustainable water future entails, as well as the 'transition challenge', in terms of how a desired future might be realised. These challenges have been particularly acute because urban water system functioning is so dependent on natural water ecosystems. Not only does urban water servicing impact on ecosystems, but it also critically depends on the health of the ecosystems and natural environmental rhythms such as rainfall. While the operations in many sectoral systems have negative consequences for ecosystems, in urban water, a degraded ecosystem also has negative consequence for the quality and safety of the sectoral services provided. For example, the security and safety of water supply depends directly on adequate rainfall and rivers' ecological health.

Against a backdrop of a sector that has been characterised as risk averse, technocratic and locked in (Brown et al., 2011), one can see pockets of progress around the world towards addressing the sustainability challenges at hand (see for example Brown et al., 2013; Fuenfschilling and Truffer, 2014). Front-running actors in these pockets have taken considerable steps towards identifying what a sustainable urban water future would look like. Common features of the visions developed by these actors include providing a diversity of water supply options, not viewing water as a disposable good, removing pollution from wastewater, improving waterway health, installing adaptable and flexible infrastructure that can cope with extremes, recognising that urban water planning ties in with urban design and managing the interactions between energy, food, heat, amenity and water.

Sustainability challenges have driven urban water scholars and practitioners in a number of cities to actively initiate transition processes towards delivering upon these visions, entailing innovative technologies as well as new management practices and governance arrangements. This is interesting for the study of transitions on three fronts:

1. Urban water provides a comprehensive and representative context for exploring the dynamics of sustainability transitions.
2. There are rich, well-known examples of urban water systems having moved beyond take-off phase of a sustainability transition despite strong path dependencies and the sector's typically risk-averse culture.

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3. The established scholarship on urban water provides a solid scientific basis, which enables deep case studies that can make ample use of primary data of contemporary, and ongoing, urban water transitions.

In the following, this article provides background to the historical development of urban water systems and transitions involved. It then makes a case for urban water as a valuable area of study for transitions scholars regardless of their sectoral interests, and introduces the articles in this special issue and their key contributions. It concludes by calling for the development of a shared agenda for urban water and transitions research to the advancement of both fields.

2. Transitions in urban water

2.1. Historical urban water developments

Historically urban water has seen a range of system innovations that occurred in a similar sequence around the world as the drivers for these systems progressively emerged. Typically, cities first dealt with their need for drinking water by installing main pipelines and plumbing to deliver centrally supplied water. This can be seen as a transition from low-technology solutions like village wells and pumps to high-technology solutions as part of large-scale public water networks.

Later, more people living in cities, outbreaks of diseases like typhoid and cholera, and the – back then – recent awareness that these were caused by polluted water paved the way for sewerage networks that transported human and industrial waste away from populated areas. While this involved the roll out of new infrastructure on a scale similar to water supply, this was not so much a transition as adding new services to the portfolio of an existing servicing approach. Similarly, the roll out of separate stormwater[1] drainage infrastructure, predominantly in the new world because of different climatological conditions, added new services to an existing portfolio.

These stages of development have been described by Brown et al. (2009) as part of a nested urban water continuum that identifies distinct socio-technical states emerging in response to accumulating socio-political drivers (Fig. 1). In addition to the above sketched historical development, the continuum also defines aspirational states in the light of newly emerging socio-political drivers. In contrast to the more incremental expansion of the water regimes through the *water supply*, *sewered* and *drained cities*, moving to the *waterways*, *water cycle* and *water sensitive cities* would constitute a transition because their infrastructural and institutional solutions do not align with the established regimes. Researchers found these aspirational stages on the right-hand side have rarely been reached in water practice to date (Jefferies and Duffy, 2011). Similar to other sectors, this is typically attributed to path-dependencies and lock-in (Pahl-Wostl et al., 2007; Dominguez et al., 2009; Brown et al., 2011).

Despite the challenges there is persistent policy rhetoric around sustainable urban water management, integrated water cycles, water sensitive cities and the like, as a constant reminder that the drivers on the aspirational side of the continuum are real and must be dealt with. Climate change projections indicate that cities all over the world will face threats to water supply security, heightened flood risks and severe heatwaves (Bates et al., 2008, p. 210); impacts which are already being felt in many places. For example, in the last fifteen years Melbourne has faced chronic drought to an extent that water security could not be guaranteed with the existing infrastructure (Grant et al., 2013). Extreme heat reached levels far beyond discomfort, resulting in spikes in mortality and morbidity over summer periods (Loughnan et al., 2013), all this in times when water was too scarce to be used for keeping the city cool and green. This drought was followed by rain so intense that the drainage networks could not cope and severe flash flooding events occurred (Rogers et al., 2013).

Apart from climate change impacts, waterway pollution is recognised as putting urban ecosystems around the world at risk, for example in the United States (Roy et al., 2008), Denmark (Birch et al., 2011), United Kingdom (Ashley et al., 2010), South Africa (Armitage and Rooseboom, 1999) and

[1] Stormwater is rainwater or melted ice or snow running off elements of the built environment, e.g. hard surfaces like roofs or roads.

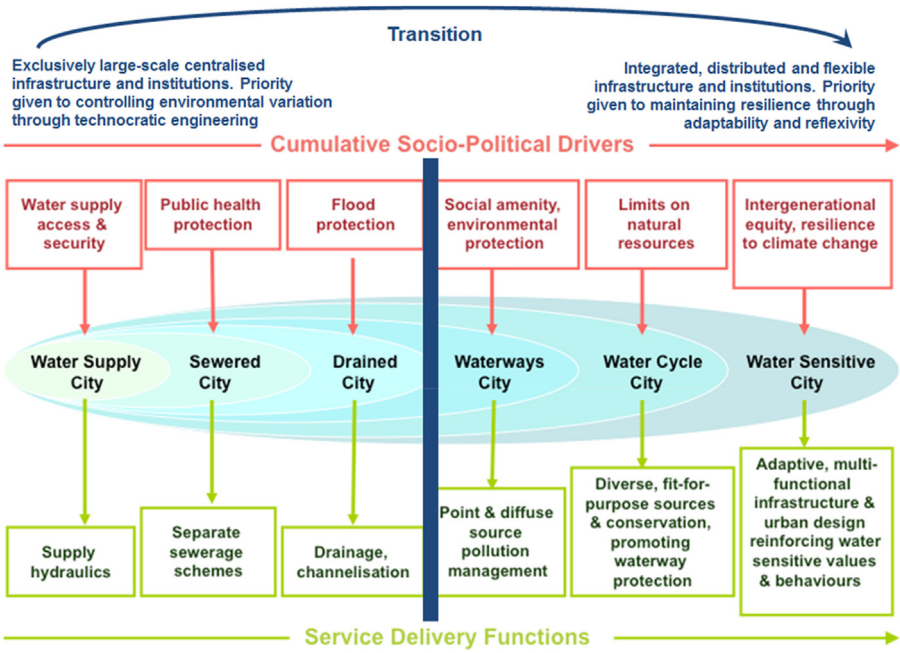

Fig. 1. Urban water management and transitions continuum: historical and aspirational states of urban water systems. Adapted from Brown et al. (2009).

New Zealand (Winz et al., 2014). It is now well accepted that rainfall that washes oils, metals and nutrients directly from streets into rivers and seas, poses an additional, and hard to treat, pollution threat. Adding to all this, the universal problems of ageing infrastructure, demographic changes and financial uncertainty reinforce the awareness that water investment and management decision-making cannot simply continue along the path on which it has become so dependent (Rodriguez et al., 2012).

2.2. New visions and solutions

In light of the pressing challenges, front-running actors in cities around the world have been developing new visions that articulate aspirations and change agendas for future urban water systems, focussing on key concepts such as transitions, sustainability, liveability, resilience, productivity, prosperity, adaptive capacity, integration and interdisciplinarity. These visions are emerging through dialogues being held in an era where public sectors around the world are being corporatised, which has implications for how the water system can respond to the socio-political drivers. The global manifestations of these water visions are found in changing policy directions, research agendas, technological innovations, actor networks and on-ground practices.

For example, new aspirational government policies are appearing such as Europe's Water Framework Directive (European Commission, 2000), the Dutch Room for the River Programme (Dutch Department for Public Works and Water Management, 2007), Melbourne's Water Future strategy (Office of Living Victoria, 2013), Singapore's Active Beautiful and Clean Waters program (Public Utilities Board, 2006), Plan Ooievaar in the context of the Dutch Delta Works (de Bruin et al., 1987). Professional associations are also setting new policy agendas around these topics, like the International Water Association's Cities of the Future (2006) and ICLEI – Local Governments for Sustainability's Water Campaign (2006).

In the research arena these visions are being manifested through the emergence of research programs that are typically applied and problem focused, inter disciplinary and in partnership with

industry and government players. These programs aim to address the technical, ecological, social and governance aspects of questions relating to transitions towards the various envisioned water futures. National centres of excellence also address these questions, like EAWAG in Switzerland (1946) and new centres are being established focussing on these topics, such as ReNUWIt in the United States (2011) and the Australian Cooperative Research Centre for Water Sensitive Cities (2012). Also, there have been investments in a number of large scale, multi-stakeholder research projects such as the European Union Framework Programmes 6 and 7 projects "SWITCH" (see e.g. Jefferies and Duffy, 2011) and "PREPARED Enabling Change" (2010).

In the infrastructural space, new technological approaches are being developed to reduce environmental impact, improve urban liveability (e.g. shading and cooling) and utilise wastewater as an additional water resource. These include highly technical solutions, such as membrane filtration for on-site wastewater recycling, bringing the potential of recycling wastewater or stormwater for direct human consumption. Green infrastructure solutions are also being developed, such as constructed wetlands and biofilters, which are central in a range of new design approaches, such as Water Sensitive Urban Design (WSUD), Sustainable Urban Drainage Systems (SUDS) and Low Impact Design (LID).

As these new visions and solutions enter the water governance discourse, different actors enter the stage as well, shifting the power balance. No longer are central governments the sole protagonist, there is now a new governance composition comprising municipalities, water utilities, private enterprises, community cooperatives and individual households who share responsibilities regarding ownership, maintenance and potential revenues. For example, municipalities have the potential to become water suppliers by harvesting their stormwater (e.g. City of Salisbury, 2009). Private corporations and consortia are having an increasingly important role in delivering and managing the infrastructure, such as Suez Environment and Veolia. Alliances of local community and volunteer groups are doing important restoration and maintenance work on local environments, for example, collecting waste, removing concrete pipes, planting native vegetation and removing invasive species. In some cities, the relationship between the households and the city is changing, as citizens move from a purely passive, consumer role to a hybrid consumer-supplier role, for example through the use of raintanks which exempts them from water restrictions in times of drought.

These more complex governance arrangements lead to new requirements regarding the management of a spectrum of risks, including ownership, investment and capital; operation and maintenance responsibilities; accountabilities; political responsibilities, legitimacy and regulatory roles; and knowledge, know-how and expertise.

In summary, in-depth studies of the above challenges and solutions accompanying the new visions for urban water management have the potential to provide a significant contribution to the empirical and theoretical body of knowledge of the transitions field. Conversely, as urban water sectors around the world grapple with the challenge all too well known to transitions researchers, they are becoming progressively more receptive, indeed eager, to translate theoretical insight from transitions studies into practice and are thus growing into experimental gardens for research on transitions in action.

3. Why urban water transitions?

Reflecting on the significant historical and contemporary shifts described in the previous section, it is clear that urban water provides an inspiring sector for studying sustainability transitions. Here we highlight three reasons for why the study of urban water transitions has something to offer for scholars of transitions in all contexts.

Firstly, urban water provides a comprehensive and representative context for exploring transition processes and dynamics. Transitions towards sustainability are often studied as the uptake of sustainable solutions, i.e. low impact technologies. However, a broad appreciation of sustainability involves an integrated assessment of the ecological, social and technological domains. Urban water systems combine these aspects and bring together many, if not all, the facets and dynamics found in the diverse types of systems studied in the sustainability transitions field. Consider, for example, the many aspects of urban water servicing, and how they have parallels in other often-studied systems:

- Volume aspects, like drinking water supply in a similar way to which energy systems provide electricity or gas for example.
- Quality aspects like waterway pollution levels and water quality standards, similar to concerns (e.g. health, taste) in the agro-food sector.
- Integration of the infrastructures in the urban form with visual impacts on the landscape (e.g. green infrastructure) and implications for cross-sectoral planning, in a way similar to transport.
- Human dimensions and ethical considerations, such as water being a fundamental right and necessity, raising similar concerns and expectations around service provision as found in health care.

Secondly, there are a number of examples of urban water systems having moved beyond the predevelopment phase of a sustainability transition, despite the sector's strong path dependencies and the typically risk-averse culture. As the transition research field matures, and hopefully with more sustainability transitions taking off, a need for theory and cases on later phases of transitions emerges. Urban water cases may therefore offer fertile empirical contexts for studying transitions beyond the take-off. This special issue introduces some of these cases and provides a glimpse of the general insights and new theorising they bring along.

Thirdly, the established scholarship on urban water examines cases of contemporary, and ongoing, urban water transitions. This provides a solid scientific basis for deep case studies that can make ample use of primary data and explanatory concepts specific to the sector. Case study research has always been a pillar of transitions research and as the field pursues a next level of sophistication, rigorous engagement with primary sources of data and sector specific knowledge will become more important to enhance the explanatory capacity of transitions frameworks. The urban water scholarship itself is also taking on the challenge of understanding transitions towards sustainability and has started to integrate some of the transitions studies' concepts, which provides an interesting platform for cross-fertilisation of the research fields. This special issue demonstrates the potential of such cross-fertilisation through case-studies by authors that are both urban water experts and transitions researchers, enabling them to enrich or operationalise transitions frameworks with deep sectoral knowledge.

4. Articles in this special issue

This section provides an overview of the articles in this special issue, based upon the specific foci of their urban water cases, geographic region, transition phase and theoretical concepts employed (Table 1).

Each article in this special issue contributes to research on transitions and urban water in its own right, providing empirical, methodological and theoretical contributions. Taking a bird's eye view reveals the following four specific areas of contributions:

1. Putting urban water on the map as one of the main sectoral avenues worthy of study by the transitions community alongside the long established routes of energy and transport.
2. Fuelling the knowledge base for this journey with new empirical data from in-depth case studies on urban water transitions.
3. Mapping the transitions territory yet to be charted with new navigational tools, incorporating concepts and frameworks from other research areas.
4. Critically reflecting on the scholarly journey of transitions studies through application and critique of existing transitions conceptual frameworks and theory.

4.1. Putting urban water on the map

The variety of articles in this special issue clearly illustrates that urban water presents one with the breadth and diversity of transitions studies in general: Transitions management was studied from a high-level theoretical perspective by Jhagroe and Loorbach and through detailed empirical analysis by Bos et al. The uptake of new water management practices and technologies was investigated as a process of sectoral learning by Domenech et al. and as a result of actors creating new

Table 1
Overview of the special issue.

Authors and title	Conceptual approach (see individual articles for relevant references)	Transition phase	Water system focus	Geographic region
Bos et al. Applying the instruments of Transition Management outside the cycle: does it work?	Transition Management	Acceleration	Urban stream health and catchment management	Sydney (Australia)
Domenech et al. Learning processes during regime shifts: empirical evidence from the diffusion of greywater recycling in Spain	Multi-Level Perspective, Policy Learning	Pre-development	Recycled greywater as an alternative supply source	Barcelona (Spain)
Rogers et al. Analysis of institutional work on innovation trajectories in water infrastructure systems of Melbourne, Australia	Multi-Pattern Approach, Institutional Work, Institutional Pillars	Acceleration and pre-development	Desalinated seawater, recycled wastewater and harvested stormwater as alternative supply sources	Melbourne (Australia)
Jhagroe and Loorbach See no evil, hear no evil: the democratic potential of Transition Management	Transition Management, Post Foundational Democracy	Pre-development	Port redevelopment	Rotterdam (Netherlands)
Van Herk et al. Understanding the transition to integrated flood risk management in the Netherlands	Multi-Pattern Approach	Stabilisation and acceleration	Flood management policy and paradigm change	The Netherlands
Lieberherr and Truffer The Impact of Privatization on Sustainability Transitions: a comparative analysis of dynamic capabilities in three water utilities	Dynamic Capabilities, Governance Modes	All	Water utilities as key actors	Berlin (Germany), Leeds (UK) and Zürich (Switzerland)
Wen et al. Transitions in urban water management and patterns of international, interdisciplinary and intersectoral collaboration in urban water science	Social Network Theory, Bibliometrics	Acceleration and pre-development	Research and practice communities	International

institutions by Rogers et al. Transitions studies' frameworks were employed, for example ven Herk et al.'s use of the Multi-Pattern Approach (MPA, de Haan, 2010; de Haan and Rotmans, 2011) and frameworks new to transitions were introduced, for example by Lieberherr and Truffer. A range of transitions phenomena were studied, from change processes in actual urban water systems, for example by van Herk et al., to Wen et al.'s study of transitions in the urban water research community.

Therefore, it seems fair to say that urban water serves as a valuable and useful lens to study transitions in general, providing the basis for ongoing conceptual and theoretical development. The transitions community would be well served investing in the further exploitation of this fertile empirical and conceptual ground, towards developing a comprehensive understanding, both of urban water transitions specifically and in the broader urban context. A fruitful approach could also be

cross-sectoral comparisons, for example comparing the lessons learnt in energy with those in water as a means to inform general transitions theory.

4.2. Fuelling the knowledge base

This special issue features in-depth case studies on different aspects of urban water management from regions all over the world. Rogers et al. focused on recent and ongoing water supply innovations in Melbourne, Australia, through a detailed empirical analysis of the institutional creation processes that were needed to advance these innovations within an established water supply regime. Van Herk et al. examined the contribution of the innovative Room for the River project to an ongoing transition towards a new flood management paradigm in the Netherlands. Domenech et al. shed light on different aspects of policy learning that took place in the uptake of greywater recycling and reuse in Barcelona, Spain, providing insight into how technological breakthroughs, policy developments and local regulations were instrumental in transforming the water supply paradigm. Lieberherr and Truffer also compared case studies in three countries, focussing on the impact of privatisation on the capacity of water utilities to innovate in Berlin, Leeds and Zurich. Bos et al. studied an innovative governance arrangement that resulted in transitional change in how the Cooks River catchment in Sydney, Australia, is managed to address its ecological degradation.

Looking at the several cases, common transition challenges become apparent across many different geographic contexts and dimensions of an urban water system: the social and environmental vulnerabilities related to traditional approaches for managing rainfall and flood events; the need to diversify the water resources available to secure supplies in drought conditions; the changing economic climates and market liberalisation. This provides a rich opportunity for comparing the transition dynamics across multiple cases dealing with similar challenges, as a basis for theoretical generalisation.

4.3. Mapping the uncharted transitions territory

A number of the articles in this special issue employed conceptual tools from different scholarly fields to add to the explanatory power of the transitions theoretical toolbox in order to fully exploit the empirical detail of in-depth case studies.

Rogers et al. formulate new hypotheses on how innovations become established within an existing infrastructure system and adopted the Multi-Pattern Approach as the conceptual architecture for framing their case studies. They enriched the constellation as an analytic unit with concepts from new institutionalism, enabling more detailed empirical analysis of how an innovation matures and becomes embedded within an established regime. This innovation provides conceptual tools for further unlocking what Geels (2004) calls “the black box of institutions”.

Lieberherr and Truffer provided new empirical insight into the capacity of water utilities to engage with radical innovations as a contributing factor of sustainability transitions. To enable this analysis through in-depth empirical case studies, they dealt with the firm as an analytic unit by introducing frameworks from the fields of management and political science. Notably they used the concept of Dynamic Capabilities (Teece, 2007) to reveal the barriers to sustainability transitions across the spectrum from public to private, finding for example that certain aspects of privatisation may foster radical innovation, whereas others may hinder them. They conclude that there does not appear to be a clear-cut relation between privatisation reforms and a utilities’ capacity to engage with radical innovation, from which one could surmise that the mode of ownership is a contextual factor but, in itself, is neither a barrier to nor an enabler for sustainability transitions.

Wen et al. fill a methodological gap relating to ways to quantitatively assess the progress of an ongoing transition. They apply established methods from social network science, science metrics and bibliometrics to show how the levels of intersectorality, interdisciplinarity and internationality have progressed over time and in doing so, provide insight into the extent a transition in urban water research itself. Such quantitative methods may be useful for the transitions community to measure the temporal development of transitions pathways.

The above articles enrich transitions theory in the following three ways: (1) Extending transitions frameworks by embedding concepts from other fields. (2) Introducing complete frameworks

addressing under-theorised units of analysis. (3) Appropriating methods to provide metrics for assessing transitional change processes. In doing this, these articles create valuable bridges to other scholarly fields.

4.4. Inviting critical reflection on the journey through the transitions landscape

Several articles in this special issue provided critiques and refinements of two of the current transitions frameworks, namely Transition Management and the Multi-Pattern Approach, drawing upon deep sectoral knowledge. As mentioned, Rogers et al. used the MPA to frame their case studies and enriched the constellation concept, while Van Herk et al. applied the MPA to analyse transitions pathways in terms of transition patterns. Moreover, Van Herk et al. devoted an entire section to reflections on the MPA. In applying the approach to their empirical case study of the Room for the River project, they found it an operational challenge to clearly demarcate the individual patterns in the ongoing transitions, but argued that this can provide a way to enrich the transition analysis through allowing different perspectives on the timing of transition patterns.

Bos et al. extended the Transition Management framework by providing policy guidance on how to make shadow network concepts operational through building coalitions with prescribed Transition Management instruments. This guidance is based upon empirical evidence of a case study of significant policy change where the Transition Management features were not instigated through a mandated Transition Management process.

Taking a deliberate meta level stance, Jhagroe and Loorbach revisited a long standing concern about the democratic deficit in the transitions management framework (i.e. 'who manages the transition, and who gave that person that right') by reinterpreting the broader democratic context the transition processes are part of using a case study of transitioning harbours in Rotterdam. They applied the heterodox concept of post-foundational democracy, which enabled them to give a critical appraisal of the deviant democratic aspects of Transition Management. In doing so, they conclude that there is more to democratic legitimacy than compliance with existing democratic institutions, which could be interpreted to mean that transitions management should not endeavour to be compliant with the democratic institutions, but should gain legitimacy through its own distinct but deviant democratic merits.

These articles demonstrate the value of the expertise of urban water researchers, primary data through interviews, focus groups, document analyses, participatory processes and the tacit knowledge and experience of practitioners. Such case studies can truly extend, refine and critique existing transitions frameworks, like in the aforementioned articles. To illustrate, transition frameworks like the Multi-Level Perspective are typically used to organise case study results and interpretations, rather than to inductively draw on empirical evidence from the case studies to drive further framework developments. In contrast, an in-depth sectoral approach requires methodologies and operational forms of the high level concepts to link between the abstract and the rich empirical evidence in the case studies.

5. Conclusion

With this special issue we aim to bring urban water into the limelight as a key area for the study of sustainability transitions. The seven articles in this special issue offer important individual contributions for furthering transitions scholarship, as well as a collective contribution in bringing a coherent focus to the sustainability challenges and solutions that underpin urban water transitions. Looking across the special issue as a whole, it is clear there is value in scholars from the urban water and transitions fields working towards a shared research agenda. We suggest that an important element of this agenda would be to engage in deep case studies that make the transitions concepts combined with rich empirical detail and sector-specific knowledge available to the advancement of both fields.

In closing, we hope that this special issue – looking at sustainability transitions through a lens of urban water – will serve as inspiration for establishing this research agenda as well as providing a number of thought-provoking inputs towards it.

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