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Achieving Sustainable Urban Water Resources Management in Europe

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Abstract

Traditionally, water managers mitigate the impacts of water scarcity by increasing supply. However, with urbanisation and uncertainty of climate change in Europe, these supply-side solutions have become too costly, both economically and environmentally. This paper argues that water managers need to transition towards actions that attempt to alter the norms and values of individuals and society towards scarce water resources. Using the framework of diffusion, water managers can use a variety of demand management tools to radically change people's culture, attitudes and practices towards water resources and reduce consumption patterns.

Keywords

Transitions, diffusion, natural resources management, water resources management, demand management

Introduction

In the 21st century, the world will see an unprecedented migration of people moving from rural to urban areas: In 2012 alone, human civilisation reached a milestone with 50% of the world's population living in urban settings. This is projected to reach 80% by 2050. In Europe, currently 75% of the population lives in urban and peri-urban areas and this is projected to rise to 80% in 2020 (E. Commission, 2012; Uhel, 2006). With demand for water expected to exceed supply by 30% in 2040, urban centres in Europe will face increased water scarcity and droughts as a result of climate change and urbanisation.

Traditionally, water managers have relied on large-scale, supply-side infrastructural projects such as dams and reservoirs to meet increased demand for water (supply-side management). However, these projects are costly both economically and environmentally. Therefore, there is a need to transition towards managing actual demand for water (demand management) as ultimately it is people‘s attitudes and behaviours towards water that determines the amount of water that needs supplying.

This paper seeks to explore the theoretical framework of transitions in general and in water resources management in particular. Specifically, the paper discusses in part one what a transition is and what it involves (drivers and forces). In part two the paper discusses transitions in natural resources management. Finally, the paper addresses transitions in water resources management (part three) and the tools involved in balancing demand with supply of water (part four).

1. What is a transition?

A transition is a well-planned, coordinated transformative shift from one socio-technical system to another, over a long period of time (usually one or two generations), where a socio-technical system is a stable configuration of infrastructure, institutions, markets, networks, regulations and technology along with the norms and values of the system's social users. In daily life, socio-technical systems serve societal functions such as water, energy, transportation and other services (Geels, 2005; E. M. Rogers, 2003; P. Rogers & Hall, 2003; Rotmans, Kemp, & Van Asselt, 2001; A. Smith, Stirling, & Berkhout, 2005; R. Van der Brugge, Rotmans, & Loorbach, 2005).

1.1 Transitions are structural changes

In particular, a transition is a structural change in the way society operates and occurs through a combination of behavioural, cultural, ecological, economic, institutional and technological developments that positively reinforce each other to create a new socio-technical system (Elzen & Wieczorek, 2005; Geels & Schot, 2007; Kemp & Loorbach, 2003; Pelling, 2010; Rotmans et al., 2001; Seyfang & Smith, 2007; R. Van der Brugge et al., 2005). In transitions, the role of institutions is to create a futuristic vision of what this new socio-technical system looks like and coordinate the appropriate resources (economic, financial, knowledge etc.) to achieve it (Geels & Schot, 2007).

1.2 Transitions occur over multi-levels

Transitions occur over multi-levels: Specifically, transitions occur in the system at the macro-level (landscape), meso-level (regime) and micro-level (individuals) (Elzen & Wieczorek, 2005).

1.2.1 Macro-level

The macro-level, or 'landscape', is the exogenous environment the system operates in and is beyond the direct influence of the meso and micro-levels (Geels & Schot, 2007). It is relatively static, or hard, and includes the institution's goals and visions that guide transitions at the meso-level (Kemp & Loorbach, 2003; McKenzie-Mohr, 2000). Changes at the macro-level are initiated by exogenous changes in the macro-cultural, economic, environmental and political aspects of society (Frantzeskaki & de Haan, 2009).

1.2.2 Meso-level

The meso-level comprises the socio-technical system's regime, which is a constellation of behavioural patterns, cultures, practices, rules and structures of the system's social users (individual users, societal groups, public authorities, research networks and financial institutions etc.) (Frantzeskaki & de Haan, 2009; Geels, 2005; E. M. Rogers, 2003). While each of the system's social users are relatively autonomous of one another they are at the same time interdependent. This interdependence occurs because the activities at the societal level are coordinated and align with each other in the running of the socio-technical system (Geels, 2005): As such, regimes are stable and durable. If a transition is to be successful, institutions must change, in a coordinated way, the norms and values of the regime's social users (Hoffman, 2010).

1.2.3 Micro-level

At the micro-level, niches, or innovations (unusual applications, demonstrations, programmes and social improvements etc.), are tested against one another (Geels, 2005; Seyfang & Smith, 2007). If these innovations, which are essentially variations to the regime's status quo and deviations away from it, become successful (i.e. are deemed to be robust) they will branch out and attract mainstream audiences (Seyfang & Smith, 2007). If they are successful at this stage, the innovation will move from being 'innovative' to becoming a social norm (Lyndhurst, 2008).

1.3 Drivers of transitions

Before a transition can occur, however, there first needs to be a misfit or 'gap' between individuals and society's deeply-held values and the current conditions they face (T. A. Börzel & Risse, 2011; Pike, Doppelt, & Herr, 2010; Wendt, 1999). In the multi-level perspective of transitions, institutions create gaps at both the macro and micro-level.

- At the macro-level, institutions can create tension with the meso-level (regime) by creating a gap between the new strategic vision of the future and the current regime's outdated practices.

- At the micro-level, institutions can place pressure on the meso-level through innovations that attempt to create a gap between a new alternative regime and the current, outdated, regime (Frantzeskaki & de Haan, 2009; Geels & Schot, 2007; Pike et al., 2010).

- Transitions can also be triggered by changes in the external environment of the system leading to it being inefficient, ineffective or inadequate in fulfilling its societal function. As such, external triggers can throw the current practices of the regime into discredit, creating a gap between the regime's values and the current conditions the system faces (Frantzeskaki & de Haan, 2009; Lenz, 2012).

Table 1. STEEP Drivers of transitions

Drivers	
Social	Population growth, urbanisation, demand for cleaner environments
Technological	New technologies/technological innovations that help or hinder efforts of society
Economic	Economic growth, economic shocks, infrastructure growth, economic competition
Environmental	Climate change, environmental degradation, change in land-cover and land-use, disasters
Political	International commitments (Rio 1992, Agenda 21 etc., environmental laws and regulations, trans-boundary nature of environmental problems.

(Agency, 2013; Association, 2009; Dürrschmidt, 2002; Engel, 2011; Gifford, Kormos, & McIntyre, 2011; P. Kotler & Lee, 2008; OECD, 2012; Pelling, 2010; Schultz, 2011; Seyfang & Smith, 2007; G. Smith, 2005; Voora & Venema, 2008)

1.4 Forces in transitions

For a transition to occur – the closing of these gaps, there needs to be force applied (Philip Kotler & Zaltman, 1971). There are two types of forces that direct transitions, supportive and formative:

- Supportive forces are top-down (macro-level) forces that create tension with the regime by standardising practices or routines through standards and directives. This ensures practices or routines enjoy universal status by enabling the provision of services (subsidies, capital, investments etc.) to empower and scale up innovations at the micro-level so they become alternatives to the current regime (Frantzeskaki & de Haan, 2009).

- Formative forces are bottom-up (micro-level) forces that create pressure on the regime through innovations or groups of actors adopting innovative practices, routines, services or technology. These innovations have the potential to scale up and challenge the existing regime. Formative forces can emerge naturally or be artificially created by institutions (Frantzeskaki & de Haan, 2009).

1.5 Operationalisation of forces in transitions

In transitions, the application of supportive forces at the macro-level can take the form of alternative visions of the future, while at the micro-level formative forces can be in the form of diffusion, which is a process where ideas, norms and innovations are communicated over time among members of a social system (T. A. Börzel & Risse, 2011; E. M. Rogers, 2003).

1.6 The aim of diffusion in transitions

The aim of diffusion is to initiate social change, in particular, change in the structure and functions of society (E. M. Rogers, 2003). This can be achieved through changes in the norms and values of society, where norms are defined as the range of tolerable behaviour (effectively serving as a guide or standard for the behaviour of members of a particular social system), while values are defined as important and enduring beliefs shared by members of a particular community, and therefore underpin people's decisions and actions (E. M. Rogers, 2003; Service, 2012; Spence & Pidgeon, 2009).

1.7 Approaches in decision-making

In diffusion there are two approaches as to how people make decisions: the rationalist approach and the constructivist approach:

- Rationalist approach: Individuals are assumed to be rational and goal-orientated. When rationalists make their decisions they aim to maximise their utilities by weighing up the costs/benefits of different options before 'actioning' a decision (the logic of consequentialism).
- Constructivist approach: Individuals are not always rational in their decision-making processes. Instead, their decisions are guided by beliefs and judgments, which themselves are guided by collectively-shared understandings of what is considered proper and socially-acceptable behaviour (logic of appropriateness) (T. Börzel & Risse, 2000).

1.8 Mechanisms in diffusion

In diffusion there are two types of diffusion mechanisms that can induce social change: Direct and indirect mechanisms. In direct diffusion mechanisms, institutions can actively promote ideas, norms and innovations (vertical diffusion), while indirect diffusion mechanisms involve actors, independently, emulating best practices and solutions that serve their needs (horizontal diffusion) (T. A. Börzel & Risse, 2011).

Table. 2 Direct diffusion mechanisms

Direct diffusion mechanisms	
Legal or physical coercion	Laws, directives and regulations etc.
Manipulation of utility calculations	Use of market-based instruments to induce social change
Socialisation	Institutions promote rules, norms, ideas and practices through the providing of authoritative models, from which actors internalise them into their domestic structures
Persuasion	Institutions influence individual's attitudes and behaviours through reasoning

(T. A. Börzel & Risse, 2011; Checkel, 2005; Geels & Schot, 2007; Jackson, 2005; Patchen, 2010; Steg & Vlek, 2009)

Table 3. Indirect diffusion mechanisms

Indirect diffusion mechanisms	
Competition	Individuals independently adjust their behaviour towards 'best practices' which in turn promotes competition between individuals
Lesson-drawing	Individuals look to others for rules that have effectively solved similar problems elsewhere and that are transferable into their own domestic context
Emulation and mimicry	Individuals emulate others in order to be seen as a legitimate member of a particular community, while mimicry involves a less active process and resembles more the automatic downloading of 'institutional software' without modification simply because it's 'what everyone else is doing'

(T. A. Börzel & Risse, 2011)

2. Transitions in natural resources management

In natural resources management drivers of transitions can be grouped into climatic and non-climatic drivers.

2.1 Climatic drivers

In natural resources management, there are two approaches society can take in adapting to the pressures of climate change: Mitigation and adaptation.

2.1.1 Mitigation

Traditionally, it is common for local authorities to mitigate the impacts of climate and environmental change by taking actions that prevent the impact of an event, for example the construction of dams and reservoirs to protect communities from variability in precipitation as a result of climate change. However, these 'hard' infrastructural solutions are typically both economically and environmentally costly to implement (A. G. P. Commission, 2012).

2.1.2 Adaptation

Adaptations towards climate change aims to: First, increase the adaptive capacity of a system to successfully respond to climate and environmental change through behavioural, resource and technological adjustments and second, reduce the risks associated with the impacts of climate and environmental change (Adger et al., 2007; Kolikow, Kragt, & Mugera, 2012). Adaptations occur over multiple dimensions including spatial (local, regional, national), across many sectors (water etc.) and involve numerous actions (physical, technological, investments, regulations and markets) and actors (local authorities, government, public and private sectors, communities and individuals) (Adger et al., 2007).

There are two main types of adaptations in climate change: green actions and soft actions. Green actions ensure ecosystem health is maintained in order to reduce society's vulnerability to risks; this can be achieved by ensuring natural resources are used as efficiently as possible, an example is the maintaining of healthy riparian wetlands and forests to reduce the impacts of floods (Agency, 2013). Green actions are usually less resource-intensive than mitigation (hard actions) in terms of financial and technical capacity, as green actions do not usually require the development and maintenance of high-tech, innovative solutions (Agency, 2013). In addition, green actions are also less environmentally costly to implement compared to mitigation as they focus on preserving the health of ecosystems (A. G. P. Commission, 2012). Nonetheless, green actions frequently overlook the social dimensions of climate and environmental change: Instead they focus on economic and technological solutions to the problems (Hoffman, 2010). In soft actions, the focus is on using management, legal and policy approaches to alter human behaviour as a way of reducing the vulnerability towards climate change risk (Agency, 2013).

2.2 Non-climatic drivers

In natural resources management, institutions seek to reduce the vulnerability of society from environmental degradation and resource scarcity, as a result of urbanisation and population growth, by transitioning from a first-order scarcity socio-technical system to eventually a third-order scarcity socio-technical system.

2.2.1 First-order scarcity

In first-order scarcity, institutions rely on mitigation as a way of meeting actual or perceived supply inadequacies. In particular, natural resources managers address resource scarcity by constructing large-scale infrastructural projects to increase supply. Because of the large economic and environmental costs associated with supply-side projects, natural resource managers have turned to second-order scarcity policies, which focus on improving economic and technological efficiency in managing demand and supply of natural resources (Wolfe & Brooks, 2003).

2.2.2 Second-order scarcity

In second-order scarcity, adaptations involve the use of economic and technological measures to manage natural resources more efficiently. However, while economic instruments and technological developments may appear to provide solutions to resource scarcity, individual beliefs, norms and values drive environmental change (Hoffman, 2010; Lieberherr-Gardiol, 2008). As such, in order to properly address environmental degradation and resource scarcity there needs to be a transition in societal values, in particular changes in the behavioural patterns, thinking and value structure towards the environment, so that society recognises that environmental degradation is not only a scientific fact but a social fact too (Hoffman, 2010; Milbrath, 1995; Wolfe & Brooks, 2003).

2.2.3 Third-order scarcity

In third-order scarcity, the focus is on behavioural change as a way of decreasing demand for resources, which in turn lowers environmental degradation (Williams & Millington, 2004; Wolfe & Brooks, 2003). Specifically, in third-order scarcity natural resources managers recognise that a transition to a sustainable society is not only a technological matter but a social matter too, requiring deep and wide social relearning of thinking, value structures, behavioural patterns and institutional arrangements towards scarce resources (Milbrath, 1995).

2.3 Managing climatic and non-climatic drivers in natural resources management

Combined, natural resources can be managed in a way that adapts to both climate change and increased demand:

Table 4. Managing the impacts of climate change and scarcity in natural resources management

Adaptation type	**Order**	**Description**
Mitigation	1st order	Hard infrastructural projects
Green adaptation	2nd order	Economic/technological solutions
Soft adaptation	3rd order	Managing demand for resources through altering of behaviour

3. Transitions in water resources management

A transition in water resources management is a well-planned, coordinated transformative shift from one water system to another, over a long period of time (usually one or two generations), where a water system is comprised of physical and technological infrastructure, cultural/political meanings and societal users (Najjar & Collier, 2011; Pahl-Wostl, 2007). In a water system, society is both a component of the water system and a significant agent of change in the system, both physically (change in processes of the hydrological cycle) and biologically (change in the sum of all aquatic and riparian organisms and their associated ecosystems) (Pahl-Wostl, 2007).

More specifically, a transition from one water system to another involves a structural change in the way society manages its scarce water resources and occurs through a combination of behavioural, cultural, ecological, economic, institutional and technological developments that positively reinforce each other to create a new water system.

Table 5. Components of a water system

Socio-technical system for water supply	
Regulations and policies	Managing the quality and quantity of water resources
Infrastructure	Drinking, storm and wastewater network
Treatment	Drinking and wastewater
Markets and users	Domestic and non-domestic users habits, expectations and practices
Drinking water	Quality of supply
Culture	Cultural and symbolic meanings (social and cultural values of water, the use of water and water technologies)

(Geels, 2005; Sofoulis, 2005).

3.1 Drivers of transitions in water resources management

In water resources management, transitions to new water systems are triggered by changes in the external environment of the system, leading to it being inefficient, ineffective or inadequate in fulfilling its societal function. The main drivers in transitions towards new socio-technical systems in water are climate change and urbanisation.

Table 6. External drivers of transitions in water resources management

Driver	Impact	Description
Climate change	Variability of supply	• Spatial and temporal variation in precipitation • Storm events • Heat-island effects • Droughts • Sea-level rise and coastal flooding
Urbanisation	Increased scarcity of good quality water	• Increased demand for water • Increased competition for scarce water resources • Land-use change leading to degradation of ecosystems • Point source pollution (from industrial, domestic wastewater) • Non-point source pollution (from pathogens, organic and inorganics) degrading the quality/availability of water resources

(Arnell, 1999; Bank, 2012; Bithas, 2008; Corfee-Morlot et al., 2009; Darrel Jenerette & Larsen, 2006; Engel, 2011; Offermans, Haasnoot, & Valkering, 2011; Partnership, 2012; Policy Research Initiative, 2005; M. Smith, De Groot, & Bergkamp, 2006)

3.2 Transitioning from first to third-order in water resources management

In water resources management, managers must contend with variability of supply as a result of climate change and increased demand from urbanisation. In transitions towards managing scarcity, water mangers move from first to third-order scarcity.

3.2.1 First-order scarcity in water management

In traditional water resources management (first-order scarcity) water managers mitigate the impacts of both variations to, and rising demand for, water resources by increasing supply (Gleick, 1998). These supply-side solutions have typically consisted of large-scale dams, reservoirs and pipelines transporting water over large distances (Sofoulis, 2005). Over-time, these traditional supply-side engineering projects have become unfavourable due to their environmental costs (François Molle, 2009; Rutger Van der Brugge & Van Raak, 2007). In addition, there are large economic costs involved with supply-side solutions, in particular, the reliance on more distant water, often of inferior quality, to meet increasing demand has not only increased the costs of transportation (energy costs) but treatment costs too (Van Roon, 2007). As such, with increases in populations and the complexity, variation and uncertainty of climate change leading to water scarcity traditional water management practices have become outdated (Bahri, 2012; Rutger Van der Brugge & Van Raak, 2007).

3.2.2 Second-order scarcity in water management

In second order scarcity, water managers focus on increasing economic and technological efficiency in the management of water resources. In particular, attention is placed on the economic value of water resulting in the pricing of water to manage demand (Wolfe & Brooks, 2003). However, second-order scarcity policies eventually have to give way to third-order policies because they do not address the drivers of water scarcity: human behaviour (Wolfe & Brooks, 2003).

3.2.3 Third-order scarcity in water management

In third-order scarcity, water management policies are directed towards addressing the demand for water resources itself. Specifically, third-order scarcity focuses on actions that seek to reduce demand for water by altering individual's and society's norms and values towards water resources. The reasoning is that both environmental problems and solutions are culturally-rooted (Haughton, 1999; Hoffman, 2010; Wolfe & Brooks, 2003).

3.3 Forces of transitions to third-order scarcity in water management

In a transition towards third-order scarcity, the application of supportive forces at the macro-level can be in the form of targeted levels of water consumption (per capita litres/day for example) with the baseline for comparison being current levels of (unsustainable) water consumption, while at the micro-level, using the definition of diffusion, the application of formative forces can be in the form of demand management tools (pricing of water, education, public awareness campaigns etc.) that modify human behaviour to achieve the targeted level of water consumption (Wolfe & Brooks, 2003).

4. Demand management in third-order scarcity

In third-order scarcity, water managers use demand management to radically change people's culture, attitudes and practices towards water and reduce consumption patterns (Muller, 2007; Partnership, 2012). Using the rationalist/constructivist approach of diffusion, water managers can use two types of demand management strategies to modify attitudes and behaviour towards water: antecedent and consequential strategies (Gifford et al., 2011; Maheepala et al., 2010; Francois Molle & Berkoff, 2009):

- Antecedent strategies attempt to influence the determinants of target behaviour prior to the performance of the behaviour.
- Consequential strategies attempt to influence the determinants of target behaviour after the performance of the behaviour.

In practice, consequential strategies assume that feedback, both positive and negative, of the consequences of that behaviour, will influence the likelihood of the behaviour happening/not happening in the future (Gifford et al., 2011).

4.1 Demand management tools

Using the framework of diffusion, there are two types of demand management tools water managers can use to promote water conservation: Direct and indirect demand management tools.

4.1.1 Direct demand management tools

Direct demand management tools attempt to modify individuals and communities attitudes and behaviours towards water resources through coercion, pricing of water resources, promoting authoritative models of water conservation and persuading people on the need to conserve scarce water resources. Specifically, table 7 provides a brief description of direct demand management tools available to water managers in promoting water conservation.

Table 7. Direct demand management tools

Direct demand management tools	
Legal or physical coercion	Water bans or water restrictions, rules and regulations in homes and commercial buildings on water-efficiency
Manipulation of utility calculations	Pricing of water can be used as an incentive to increase water efficiency and promote water conservation. In particular, the pricing of water internalises the environmental and social costs of water use (in addition to raising revenue for the operation and maintenance of water supply infrastructure)
Socialisation	Water managers can promote water conservation through the use of authoritative schemes such as labeling, accreditation and certification of water efficiency in appliances, building designs etc.
Persuasion	Water managers can use public education to persuade individuals to conserve water. This can be conducted through various multi-media formats (TV, radio, newspapers, internet etc.) Education programmes at schools can also be used to persuade young people to conserve water resources

(Association, 2009; Bank, 2012; Checkel, 2005; Gifford et al., 2011; Keramitsoglou & Tsagarakis, 2011; OECD, 2012; Partnership, 2012; Policy Research Initiative, 2005; Sofoulis, 2005; Van Roon, 2007)

4.1.2 Indirect demand management tools

Water managers can utilise indirect demand management tools in an attempt to modify individuals and communities attitudes and behaviours towards water resources. In particular, water managers can facilitate competition between individuals and communities, provide lessons on how others saved water and provide the means for communities to emulate or mimic other communities that have achieved water savings. Specifically, table 8 provides a brief description of indirect demand management tools available for water managers to promote water conservation.

Table 8. Indirect demand management tools

Indirect demand management tools	
Competition	Water managers can promote competition between water users by enabling the comparison of one's own water consumption or savings with the average water consumption or savings of others.
Lesson-drawing	Water managers can provide individuals and communities with information on water conservation practices that have worked elsewhere and are easily transferable into the local context
Emulation and mimicry	Water managers can promote communities that have made considerable water savings as a standard for other communities to emulate. Similarly, water managers can provide tips on how to mimic another community's water savings

(Service, 2012)

Conclusion

Traditionally, water managers, in first-order scarcity, mitigate the impacts of water scarcity by increasing supply. However, with urbanisation and uncertainty of climate change, traditional supply-side solutions, consisting of dams, reservoirs etc. have become too costly, both economically and environmentally. In an attempt to manage supply, water managers have implemented economic and technological measures (second-order scarcity) to increase the efficient use of scarce supplies. Nonetheless, this ignores the fact that human behaviour itself is the driver of water scarcity. As such, water managers need to transition towards third-order scarcity policies that focus on actions that alter the norms and values of individuals and society towards water resources. In particular, water managers, using the theoretical framework of diffusion, can use a variety of demand management tools to radically change people's culture, attitudes and practices towards water resources and reduce consumption patterns.

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