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## **Urban Water Management: Managing Drought and Scarcity in Europe**

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### **Abstract**

In Europe, the challenge of managing urban water resources sustainably is variations to, and increased demand for, water resources as a result of climate change and urbanisation respectively. To promote water conservation, water managers can use a variety of demand management tools to alter the attitudes and behaviours of individuals and society towards water resources. However, this process is not free of barriers; instead there are multiple barriers, both external and internal to managing water resources sustainably.

**Keywords** Sustainability, water resources management, climate change, diffusion, 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. As a result, there is a need to manage urban water in a sustainable way that balances water demand with supply and reduces conflict between all the sectors and users of water.

This study is about how urban water resources can be managed in a sustainable way that balances demand with supply. However, the question is what does sustainability mean? While the term 'sustainability' has been a buzz-word in various multilateral reports, media and political commentary there is in fact no unanimous international definition of the term. This study seeks to determine what the term 'sustainability' means and how it is applied in the context of water resources management.

In part one, this paper defines what sustainably is in general and in water resources in particular, while part two analyses the challenges to managing water resources sustainably. In Part three, the paper discusses the theoretical concept of diffusion and its application in the management of water resources (demand management) (part four). Finally, the paper identifies the barriers to demand management tools in water conservation.

## **1. What is sustainability?**

The Brundtland Report (Environment, 1992) defines sustainability as “development that fulfills the needs of the present generation, without compromising the ability of future generations to fulfill their needs”. However, while the term ‘sustainability’ has become popular in policy-orientated research, as what policies ought to achieve, the real question is what does sustainability really mean? (Kuhlman & Farrington, 2010; NSW, 2012).

### **1.1 Approaches to sustainability**

Sustainability proponents argue there are two approaches to achieving sustainability: the weak form and the strong form (Neumayer, 2012).

#### **1.1.1 Weak sustainability**

In weak sustainability, natural and other types of capital (human and physical) are substitutable. In particular, as long as natural capital is being replaced by even more valuable physical and human capital, then the aggregate stock of capital (human, physical and remaining natural capital) is increasing over time (Barbier, 2011). At the minimum in weak sustainability the present total value of capital should be at least maintained for future generations (Neumayer, 2012).

#### **1.1.2 Strong sustainability**

Strong sustainability proponents reject the weak form of sustainability arguing that natural capital cannot be substituted for other types of capital for three reasons: First, the depreciation of natural capital is irreversible, or it takes an extremely long period of time to recover, second, it is not possible to replace a depleted ecosystem with a new one and third, ecosystems can collapse abruptly (Barbier, 2011). As such, a dwindling natural capital base from climate change and urbanisation would result in irreversible damage to ecosystems that both humans and nature rely on for their survival (Dasgupta, 2008; Pike, Doppelt, & Herr, 2010).

In the strong form of sustainability, society:

- 1) Seeks to protect the integrity of ecosystems, and their various services necessary for human survival, from environmental degradation (Curwell & Cooper, 1998; Goodland, 1995).
- 2) Recognises the value of natural capital as all economic goods and services are dependent on ecosystems and their various services (construction material, fibre, food, fuel, purification of air and water etc.) (Salles, 2011).
- 3) Recognises intergeneration equity (equity of current and future generations), intragenerational equity (equity amongst the current generation), geographical equity (sustainability is a local and global issue), procedural equity (people have the right to information on the state of their environments) and interspecies equity (nature and biodiversity should not be degraded as they form the basis of ecosystem services necessary for human survival) (Haughton, 1999).

## 1.2 Strong sustainability in water resources management

In water resources management, strong sustainability recognises that:

- 1) Water provides vital ecosystem services for humans and nature including: provisioning services (direct supply of food, non-food products from water flows), regulatory services (groundwater recharge, soil water infiltration, flood prevention), supporting services (maintaining flows for habitats and ecosystem functioning) and cultural and amenity services (recreational, inspirational, cultural and spiritual) (M. Smith, De Groot, & Bergkamp, 2006; UN-Water, 2013).
- 2) Water is to be allocated to the most beneficial uses in society (Jønch-Clausen & Fugl, 2001; OECD, 2010). This is achieved through the pricing of water which is conducted to achieve two objectives in managing water sustainably: First, pricing is used to recover the cost of providing water services and second, pricing provides a clear signal to users that water is a scarce good and should be conserved/used wisely (P. Van der Zaag, 2005; P Van der Zaag & Savenije, 2006).
- 3) The use of water should not exceed the limits of its natural recharge rate so that future use is safeguarded.
- 4) Water users should avoid unnecessary use which can be achieved through the promotion of water conservation (Bithas, 2008; Corfee-Morlot et al., 2009).

## 2. Challenges to managing water sustainably

In water resources management, managers must contend with variability of supply from climate change and increased demand for water resources from urbanisation. In particular, the challenges are detailed in table 1.

Table 1. Challenges to traditional water resources management

<b>Climate</b>	
<b>Precipitation and storm events</b>	Storm events (flooding) wash pollutants from urban areas into surface water bodies as well as contaminate ground water supplies. As urban populations encroach into river basins they are at increased risk of contaminated water supplies during flooding events
<b>Heat-island effects</b>	Built environments, including buildings and roads, absorb sunlight and re-radiate heat. This combined with less vegetative cover, which provides shade and cools moisture in the air, means air temperatures of urban areas are 3.5 to 4 degrees Celsius higher than surrounding rural areas. The result is an increase in demand for water for cooling and drinking
<b>Heat waves and droughts</b>	During heat waves and droughts demand for water increases (drinking water and water for cooling). In addition, with increased temperatures, oxygen levels in water will decrease while algal levels will increase, degrading the quality of water resources leading to increased treatment costs and energy use in the treatment process
<b>Sea-level rise and coastal flooding</b>	Globally, cities are mainly concentrated in coastal zones resulting in a large portion of the world's urban population exposed to the risk of sea-level rise and intensifying storm-surges, which contaminate groundwater supplies and damage water infrastructure
<b>Urbanisation</b>	
<b>Increase in population</b>	Rapid population growth has increased demand for water, for both domestic and non-domestic use, leading frequently to over-exploitation of water resources. This results in excessive withdrawals and water scarcity
<b>Land-use change</b>	Urbanisation (urban sprawl or encroachment into river basin catchment areas) lowers the availability of good quality water of sufficient quantity through point source pollution (industrial, domestic wastewater) and non-point source pollution (pathogens, organic and inorganics)
<b>Degradation of ecosystems</b>	Over-exploitation of ground and surface water degrades ecosystems and their services (e.g. reduced ability to purify water etc.)
<b>Competition</b>	Over-exploitation can lead to inter-sectoral, inter-regional and even international competition over scarce 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 et al., 2006).

### **3. What is diffusion?**

Diffusion is a process in which ideas, norms and innovations are communicated over time among members of a social system (T. A. Börzel & Risse, 2011; Rogers, 2003). The aim of diffusion is to initiate social change, in particular a change in the structure and functions of society (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 guides or standards for the behaviour of members of a particular social system), while values are important and enduring beliefs shared by members of a particular community and underpin people's decisions and actions (Rogers, 2003; Service, 2012; Spence & Pidgeon, 2009).

#### **3.1 Approaches in decision-making**

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

- In the 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) (T. Börzel & Risse, 2000).
- In the 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).

#### **3.2 Diffusion mechanisms**

Utilising the rationalist/constructivist framework of decision-making, there are two types of diffusion mechanisms that can induce social change: Direct and indirect mechanisms:

- In direct diffusion institutions can actively promote ideas, norms and innovations (vertical diffusion).
- In indirect diffusion actors, independently, emulate best practices and solutions that serve their needs (horizontal diffusion) (T. A. Börzel & Risse, 2011).

Table. 2 Direct diffusion mechanisms

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

<b>Indirect diffusion mechanisms</b>	
<b>Competition</b>	Individuals independently adjust their behaviour towards 'best practices' which in turn promotes competition between individuals
<b>Lesson-drawing</b>	Individuals look to others for rules that have effectively solved similar problems elsewhere and that are transferable into their own domestic context
<b>Emulation and mimicry</b>	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 its 'what everyone else is doing'

(T. A. Börzel & Risse, 2011)

#### **4. Diffusion in the context of promoting water conservation**

Using the definition of diffusion, demand management is a process in which ideas, norms and innovations of water conservation are communicated across individuals and households in a community. The purpose being to radically change people's culture, attitudes and practices towards water and reduce consumption patterns (Muller, 2007; Partnership, 2012).

#### 4.1 Behavioural change strategies

Using the rationalist/constructivist approach in diffusion, water managers can use two types of demand management strategies to modify attitudes and behaviour towards water: antecedent and consequential strategies (Gifford, Kormos, & McIntyre, 2011; Maheepala et al., 2010; 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. This assumes 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).

#### 4.2 Demand management

In water resources management, water managers can apply antecedent and consequential strategies in the form of direct and indirect demand management tools.

##### 4.2.1 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 4 provides a brief description of direct demand management tools available to water managers in promoting water conservation.

Table 4. Direct demand management tools

<b>Direct demand management tools</b>	
<b>Legal or physical coercion</b>	Water bans or water restrictions, rules and regulations in homes and commercial buildings on water-efficiency
<b>Manipulation of utility calculations</b>	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)
<b>Socialisation</b>	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.
<b>Persuasion</b>	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)

#### 4.2.2 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 saved water. Specifically, table 5 provides a brief description of indirect demand management tools available for water managers to promote water conservation.

Table 5. Indirect demand management tools

<b>Indirect demand management tools</b>	
<b>Competition</b>	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.
<b>Lesson-drawing</b>	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
<b>Emulation and mimicry</b>	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

### **5. Barriers to diffusion and demand management**

In diffusion it is not assumed that actors at the receiving end are passive recipients of innovations. Instead, the process of diffusion involves the active interpretation and incorporation of new norms into existing structures as well as resistances, or barriers, that slow down the process of diffusion (T. A. Börzel & Risse, 2011; Stumbaum, 2012)

#### 5.1 Multiple barriers

There is rarely only one barrier to diffusion; instead there are multiple barriers that inhibit the introduction and diffusion of innovations. These multiple barriers interact and reinforce each other leading to inertia and a lack of uptake and application of innovations (Kemp, Schot, & Hoogma, 1998; Spence & Pidgeon, 2009).

#### 5.2 External and internal barriers

Barriers in diffusion can be both external and internal. In particular, external barriers inhibit change by contributing to existing problems or constraining the effectiveness of diffusion mechanisms, while internal barriers are factors within actors that inhibit them from changing their behaviours and attitudes (Kaplan, 2000; Wendt, 1999).

### 5.3 Barriers in demand management

Similarly to diffusion, none of the demand management tools used to promote water conservation assumes that individuals and communities at the receiving end are passive recipients of innovations. Instead, demand management involves the active interpretation and incorporation of new norms of water conservation into existing structures as well as barriers to particular ideas.

#### 5.3.1 Multiple barriers in demand management

Like diffusion, there are multiple barriers to water conservation which are both external and internal:

#### 5.3.2 External barriers

External barriers inhibit change towards water conservation by contributing to existing problems or constraining the effectiveness of demand management tools (Kemp et al., 1998; Wendt, 1999).

Table 6. External barriers to demand management tools

<b>External barriers in demand management</b>	
<b>Economic</b>	New innovative practices and technologies often lack economies of scale and therefore cannot compete on price.
<b>Infrastructural</b>	Often current infrastructure cannot support alternative technologies or practices
<b>Political/institutional</b>	Institutions often lack political-will in implementing projects due to lack of clear authority, capacity or coordination across sectors
<b>Regulatory</b>	Existing regulations often support current practices rather than the implementation of more efficient, or optimal, choices that violate those regulations
<b>Technological</b>	Often new innovations require complimentary technology which could be expensive to develop or culturally undesirable to implement

(Adger et al., 2007; Barbier, 2011; Elzen & Wieczorek, 2005; Frantz & Mayer, 2009; Geels, 2005; Hoffman, 2010; Kemp et al., 1998; Kolikow, Kragt, & Muger, 2012; Moser & Ekstrom, 2010; Pelling, 2010; Seyfang & Smith, 2007; Sofoulis, 2005; Vallance, Perkins, & Dixon, 2011)

### 5.3.3 Internal barriers

Internal barriers are factors within actors that inhibit them from changing their behaviours and attitudes towards water resources (Kemp et al., 1998; Wendt, 1999).

Table 7. Internal barriers to demand management tools

<b>Internal barriers in demand management</b>	
<b>Information/knowledge/awareness barriers</b>	The majority of people do not understand the basic water cycle and therefore do not recognise the importance of water conservation
<b>Lack of connection with nature</b>	With the vast majority of people living in urban centres, people lack a basic connection with nature and therefore are not aware of the impacts of humans on the environment in general and water resources in particular
<b>Uncertainty or skepticism towards climate change</b>	Many people are uncertain of the actual impacts of climate change or are skeptical on whether it is human-driven or even exists
<b>Fear framing</b>	Framing conservation messages in guilt often results in lack of action because people feel helpless
<b>Over-optimistic belief in technology</b>	It is common for people to believe that technology can solve climate change and environmental degradation
<b>Climate change is a distant problem in time and space</b>	Climate change is often seen as something happening far in the future, in the remotest locations e.g. Arctic sea ice melting. This means people believe climate change will not impact them locally now or later
<b>Reluctance to change lifestyles</b>	Sustainability is often related to a loss of lifestyle from consuming less
<b>Feeling of helplessness</b>	People need to know their conservation efforts do have an impact
<b>Lack of action by Big Business and Government</b>	It's common for people to believe that businesses and governments should solve climate change and environmental degradation instead of individuals
<b>Free rider effect</b>	People fail to act environmentally if they perceive others are not doing their part too
<b>Demographic</b>	Each society has a variety of demographic groups, each having differing beliefs and worldviews. Some groups may associate sustainability with left-wing political groups, others may not believe in climate change etc.

(Adger et al., 2007; Association, 2009; Balmford & Cowling, 2006; Brechin & Bhandari, 2011; A. G. P. Commission, 2012; Frantz & Mayer, 2009; Gero, Kuruppu, & Mukheibir, 2012; Hoffman, 2010; Kaplan, 2000; Kemp et al., 1998; Kollmuss & Agyeman, 2002; Milbrath, 1995; Pacala & Socolow, 2004; Patchen, 2010; Pike et al., 2010; Schultz, 2011; A. Smith, Stirling, & Berkhout, 2005; Spence & Pidgeon, 2009)

## Conclusion

In water resources management, the challenge is to manage scarce resources sustainably. However, the question is what does sustainably mean in general and in water resources management in particular. This paper argues that the most appropriate form of sustainability in water resources management is the strong form, which recognises water as a vital component of ecosystems and therefore should be used wisely. This is critical given that Europe will experience variability of supply due to climate change and increased demand from urbanisation.

To promote water conservation, water managers, using the theoretical framework of diffusion, can use a variety of demand management tools to alter the attitudes and behaviours of individuals and society towards water resources. In particular, water managers can use direct and indirect demand management tools to radically change people's culture, attitudes and practices towards water resources and reduce consumption patterns. However, the process of diffusion in general and in the context of water resources management is not free of barriers; instead there are multiple barriers, both external and internal to managing water resources sustainably.

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