# Saving water in cities:
# Urban water demand management policies as adaptation mechanisms


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## Introduction

### Problem context

Cities are facing an increasing risk of water scarcity. At a global scale, water demand is estimated to exceed supply by 40% by 2030, and 4 billion people are expected to live in water-stressed areas, many of which are cities. However, **water scarcity is mainly an issue of management,** a local problem due to a mismatch of available freshwater and population concentrations in cities, rather than a lack of overall renewable water resources. Population growth, increasing urbanization, climate change induced droughts and rising temperatures exacerbate these localized water scarcities. The hydrological consequences are increased risk of depleting reservoirs and reduced groundwater recharge. Further, it may pose a threat for socio-economic development, health, and well-being of residents. Reliable water and sanitation services in cities affect Sustainable Development Goals (SDG) 3, 6, 9, 11 and 12.

### What is WDM?

**Water demand management (WDM)** usually consists of a policy framework to limit water use to the amount that meets the socioeconomic needs without squandering resources, at reasonable cost and without stripping other areas and future generations of critical natural resources. It includes any measure – administrative, economic, financial, technical, or social – that achieves one or more of the following five objectives: 1) Reduce quantity or quality of water needed for specific task; 2) adjust task so it can be accomplished with less or lower quality water; 3) reduce losses in water transportation from source to use to disposal; 4) shift time of water use to off-peak periods; and 5) ncrease system's ability to operate during drought.

### WDM policies and tools

WDM policies fall into two main categories: **tariff measures** include water price increases or tariff reforms, while **non-tariff measures** can take the form of operational improvements, regulations and restrictions, information campaigns, and technological innovations. The effectiveness of different WDM policies and tools varies significantly depending on the context they are used in.

1. **Tariff policies:** water price, tariff structure
2. **Operation and regulation:** network leakage management, plumbing codes / efficiency labelling, restrictions
3. **Awareness:** metering, billing, public awareness campaign
4. **Technological innovation:** water-saving appliances

## Methods & Relevance

The objective of this study is to assess the effectiveness of WDM policies in reducing household use in **four cities with low per capita residential water consumption:** Berlin, Germany; Copenhagen, Denmark; Tallinn, Estonia; and Zaragoza, Spain.

The main research questions is:

- How much water was saved per capita over a period of 20 years?
- What **WDM policies** have been **most effective to reduce household water** use?
- What **lessons** can be learned for other cities?

A mixed method approach combining quantitative and qualitative data collection was used, including questionnaires, semi-structured interviews, and further information from case studies, sustainability rankings, and academic literature.

The lessons learned for WDM policy implementation and future research opportunities should be of particular interest to municipal policy makers, urban planners and utility managers, and researchers, in the water sector and beyond.

## Water governance in Europe

In Europe, water scarcity has also emerged as a challenge. At least 11% of Europe's population and 17% of its territory have been affected since 2007; higher temperatures due to climate change are expected to further deteriorate the situation. One important policy response has been the **European Water Framework Directive (WFD)** from 2000. Its main objective is to ensure water quality, i.e. to achieve good ecological status in all European waters, and it promotes WDM as a set of policies to achieve more efficient use among water users.

Cities face the problems of **too much, too little and too polluted water.** There are a number of **drivers for water use** in cities on which municipalities and their water utilities have very little to no influence: 1) number of water users in a city: more water users, more demand; 2) household income: available income, water bill as portion of income; 3) household size: more people, more water; economies of scale; 4) age composition: higher age, lower water use; 5) housing type: outdoor areas; 6) garden: landscaping; 7) urban density: higher density, lower per capita consumption; and 8) seasonality and climate.


### Contact and full paper

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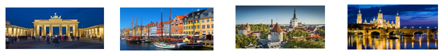
## Case studies

### Four cities



| | Berlin | Copenhagen | Tallinn | Zaragoza |
|---|---|---|---|---|
| Socio-economic indicators | | | | |
| Population | 3.6 million | 1.3 million | 450,000 | 650,000 |
| Population density | 3,944/km² | 2,052/km² | 2,800/km² | 680/km² |
| GDP/capita | US$ 48,000 | US$ 60,700 | US$ 20,100 | US$ 20,900 |
| Climatic data | | | | |
| Mean temperature (day time) | 2.9 ⁰C (Jan) 23.7 ⁰C (July) | 2 ⁰C (Jan) 20 ⁰C (July) | -1.8 ⁰C (Feb) 21.2 ⁰C (July) | 10.6 ⁰C (Jan) 32.7 ⁰C (July) |
| Total annual rainfall | 570mm | 525mm | 690mm | 320mm |
| Number of rain days | 106 | 168 | 127 | 83 |
| Liters per capita/day (Lpcd) | 113 | 104 | 96 | 96 |

### Water challenges

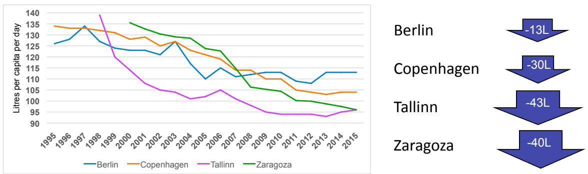
The hydrological situation the cities is somewhat different. In particular Berlin and Tallinn have an abundance of water resources at their disposal. However, the primary problem for most cities is **water pollution.**

- **Copenhagen,** located on an island, has limited resources, and faces pollution from intensive agriculture since at the 1980s.
- **Tallinn** and **(East-) Berlin** faced poorly maintained infrastructure, lack of attention for water quality, and very low water tariffs in the early 1990s.
- **Zaragoza** is located in an arid climate, and was hit by intensive droughts in the 1990s.

These moments of acute water crisis provided "policy windows" for municipalities to act on water issues, and to initiate policy reforms.

## Results

### Per capita household water consumption 1995-2015 (Lpcd)




### Results of self-assessment of water utilities

| | | Berlin | Copenhagen | Tallinn | Zaragoza | Sum |
|---|---|---|---|---|---|---|
| **Tariff measures** | | | | | | |
| **1** | Higher average water price | 1 | 2 | 2 | 3 | 7 |
| **2** | Changes in tariff structure | 1 | 1 | 1 | 5 | 8 |
| **Non-tariff measures** | | | | | | |
| **3** | Universal installation of individual water meters | 1 | 3 | 4 | 5 | 13 |
| **4** | Greater control of illegal consumption | 1 | 1 | 4 | 4 | 10 |
| **5** | Investment in renovation and maintenance of networks | 3 | 4 | 5 | 5 | **17** |
| **6** | Installing mechanisms for rapid leak detection | 2 | 4 | 5 | 2 | 13 |
| **7** | Impact of awareness campaigns and public awareness for sustainable use of resources | 1 | 3 | 4 | 5 | 13 |
| **8** | Campaigns for the use of water saving technologies (e.g. water-efficient appliances) | 3 | 3 | 3 | 5 | **14** |
| **9** | Federal legislation | 2 | 1 | 2 | - | 5 |
| **10** | Regional legislation | 1 | 2 | 2 | - | 5 |
| **11** | Municipal regulations | 1 | 5 | 2 | 5 | 13 |
| **12** | More efficient water use by industry | 1 | 2 | 5 | 4 | 12 |
| **13** | More control and more efficient use of water by the local administration | 1 | 4 | 2 | 4 | 11 |

**Tariff policies** were only considered as high impact in Zaragoza, and no city considered higher average water prices as effective. While tariffs have increased in all cities since 1995, sometimes significantly, most tariff reforms took place in the early 1990s.Among non-tariff policies, **renovation and maintenance of networks** – and thus reducing non-revenue water – was considered most effective, accompanied by rapid leak detection technologies in Copenhagen and Tallinn. **Campaigns for using water-saving technologies** took place in all four cities. Tallinn and Zaragoza also saw a huge uptake in water meters at the individual household level. Berlin experienced water use reductions without any specific WDM policy considered high impact.

## Conclusion & Recommendations

A variety of different WDM policies applied in the four cities led to a reduction in water demand. Policies can be complementary and reinforce each other – a **"package of policies"** and measures seems to lead to the best results. As municipalities adapt to hydrological changes induced by climate change, **reducing non-revenue water** (i.e. waste) in the network infrastructure must be accompanied by **behavioural change** of the water users. Municipalities need to **engage stakeholders** and **create awareness for water scarcity,** while implementing **incentives for water conservation.** Additionally, any WDM approach needs to take into account a city's specific situation, as past experiences and development are important and highly unique (path dependence).