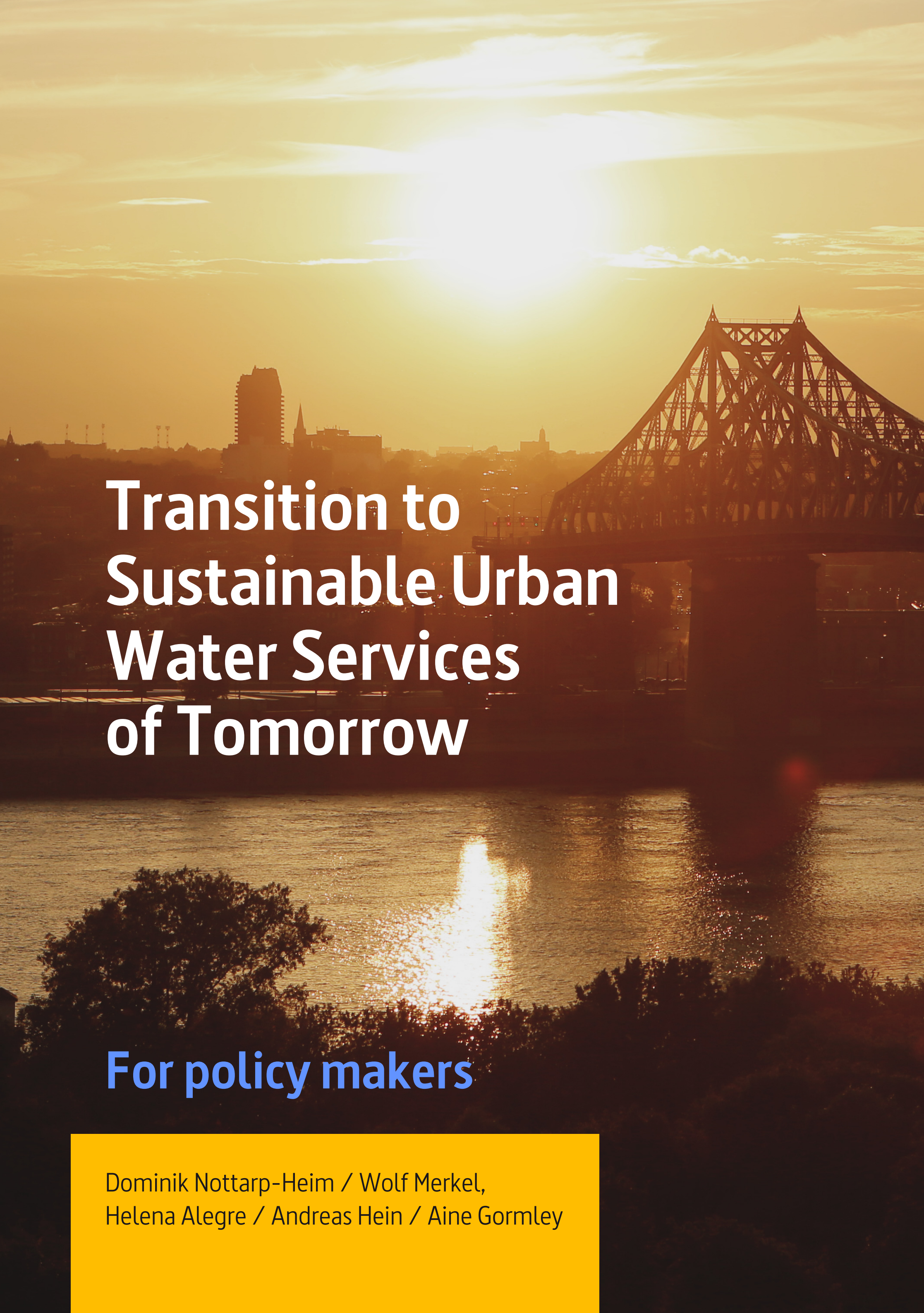

Transition to Sustainable Urban Water Services of Tomorrow

For policy makers

Dominik Nottarp-Heim / Wolf Merkel,
Helena Alegre / Andreas Hein / Aine Gormley

Transition to Sustainable Urban Water Services of Tomorrow

A handbook for policy makers

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Table of contents

Introduction

Sustainable urban water futures

1

Where to be 2050? How to facilitate change towards sustainable urban water services?

Transition processes to sustainable urban water services are adaptation measures beyond infrastructural changes.

Coping with future uncertainties and increasing challenges requires sustainable urban water governance practices facilitating the ability to change.

[This guide is intended to provide information and assistance for shaping the transition towards sustainable urban water services of tomorrow.]

> “Ultimately, adaptive capacity resides in institutions and individuals rather than in physical system parts such as pumps and pipes.”
>
> Blackmore & Plant, 2008

Policy makers are challenged with rising and emerging change pressures on traditional urban water management practices and infrastructures. Changing social, economic and environmental patterns will affect the urban water services of tomorrow - the backbone of our society.

Despite development of innovative integrated urban water management approaches and the availability of appropriate tools and technologies contributing to sustainable urban water services, the progress of implementation is slow and major barriers remain.

> “There are pretty clear policies on things like reducing greenhouse gas emissions and driving more sustainable futures - those are not always clearly linked into the different sectors. In particular, it is not always clear what the water sector is expected to do in that area.”
>
> Ian Tait, Water Industry Commission for Scotland

The aim is to assist policy makers in designing and refining strategic plans for sustainable urban water management.

Chapter 1:

Introduction

Chapter 2:

Where to be 2050? Visioning desired urban water futures

-The importance of visioning the desired state

-Statements of relevant government, ministry and regulator representatives provide insights into current thinking around desirable urban water futures and remaining institutional barriers.

Chapter 3:

Effective institutional frameworks

-Institutional arrangements of sustainable urban water management regimes. Capacity criteria and institutional barriers.

-Statement of Jaime Melo Baptista on major transformations of the water sector on Portugal.

Chapter 4:

Guideline on strategic planning

-Designing transition pathways in non-conventional ways, interactive supporting self-assessment tools assisting in different stages of decision making

-Assessment of the current state of sustainability and refined consideration of future

Chapter 5:

Financing and cost recovery

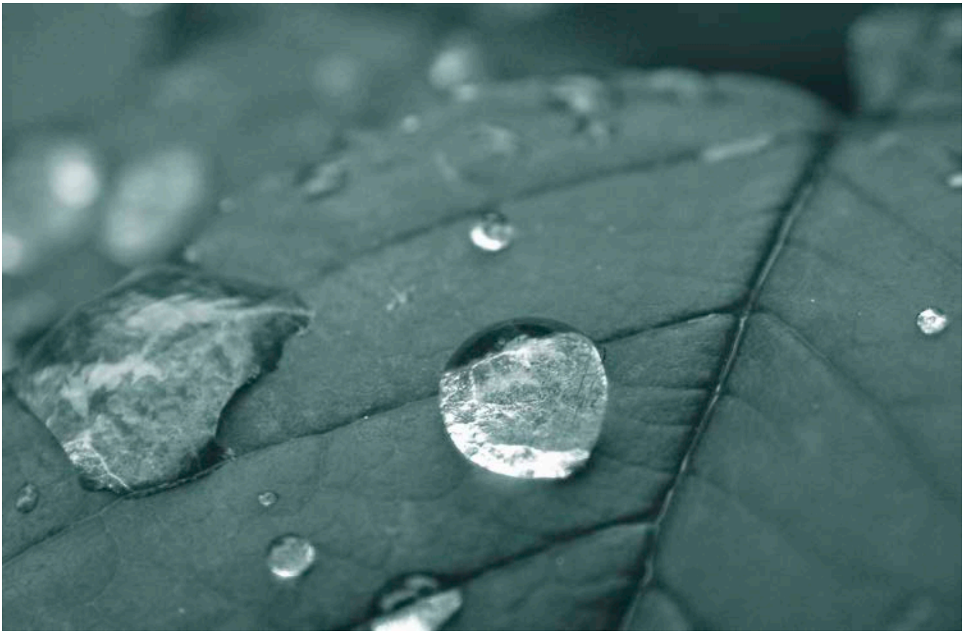
-Recommendations to ensure financial sustainability within the water sector

Chapter 6:

Adaptive urban water systems

-General principles of resilience, flexibility and adaptivity in terms of urban water systems

> "It is more about the ethos – we all know how to build public stations and treatment works. The value comes from looking at the governance around the engineering and the processes, because we all understand how to do the latter."
>
> Jon Rathjen, Water Industry Team, Scottish Government



Desired urban water futures

Sustainable urban water management, visioning, visions and the needed transition pathway

2

2.1 Sustainable urban water management

Sustainable urban water management is achieved when the quality of assets and water governance is sufficient to actively secure the water sector's needed contributions to urban social, environmental and economic development in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs (Alegre et al., 2013).

In order to achieve sustainable urban water management, it is essential to define a clear vision for the sector. This guide provides insights into:

- Visioning – How to define a clear vision for the sector
- Vision Statements: Current thinking around desirable urban water futures
- Urban water management transitions framework (Brown et al., 2009)

2.2 Visioning desired urban water futures

Strategic plans tend to focus on developing secondary and operative objectives. The description of a desirable future is often lacking.

Analysis of existing water policies and strategic plans revealed the importance of visioning the desired state contributing to the definition of objectives (van der Zouwen et al., 2012).

> "In most countries, there is a lack in capital maintenance. With the current pace of renewal and a no-change vision, water services fall into severe risk of collapse in the medium or long term in many countries of the world where they are currently taken for granted."
>
> Helena Alegre

M. van der Zouwen, C. Segrave, C. Büscher, J.A. Monteiro, A. Galvao, A. Ramoa, R. Hochstrat

Perhaps the most critical and complicated stage in the strategic planning process is the definition of a clear vision.

A vision represents the desired state of the urban water system and, to some extent, the transactional environment. It can also include the solution of existing or anticipated problems and maintenance of a desirable existing state. A vision may be defined qualitatively and/or quantitatively. The vision is a source of motivation for those being involved.

The various stakeholders in any given UWCS generally have diverse interests, perceptions, and understandings of the issues at hand. Defining a shared vision is a normative process for which social learning is required, to develop understanding of the various viewpoints, followed by a process of decision making and/or achieving consensus (Wals, 2007).

> "Will is prior to necessity and capacity."
>
> Adam & Groves, 2007

The first version or iteration of the vision should focus on that which is desired and not on what is perceived as necessary or possible: Will is prior to necessity and capacity (Adam & Groves 2007)

The motives for decisions regarding the desired future state do not depend on certainty but on hopes, values, responsibilities, interests and ethics.

Stakeholders in an urban water cycle may, for example, consider having a 'carbon neutral water supply system' or 'zero leakage losses in the distribution network' or 'water treatment without chlorine' or 'a 'bottom-up governance system' by 2030 as 'desired future states'

A vision is associated with a given time horizon, for example 2050.

Selection of a suitable time horizon is critical, since it should extend over the investment period of typical water supply, sanitation and stormwater infrastructure and allow for relatively slow processes such as climate change and demographic developments.

On the other hand, the time horizon also needs to be translated back to a human scale of years rather than decades because people tend to discount temporally distant events, so the vision may otherwise be ignored in everyday decisions and actions.

One of the main uses of a vision is to be a source of inspiration.

- Sometimes visions are confused with mission statements, which describe why the vision is important and how the organisation engages in its implementation.
- Visions can also become convoluted if they include strategies, which describe shorter term milestones or goals and the roadmaps or paths that have been chosen towards reaching the vision.
- A clear vision does not include these secondary dimensions, which are developed in the next step.

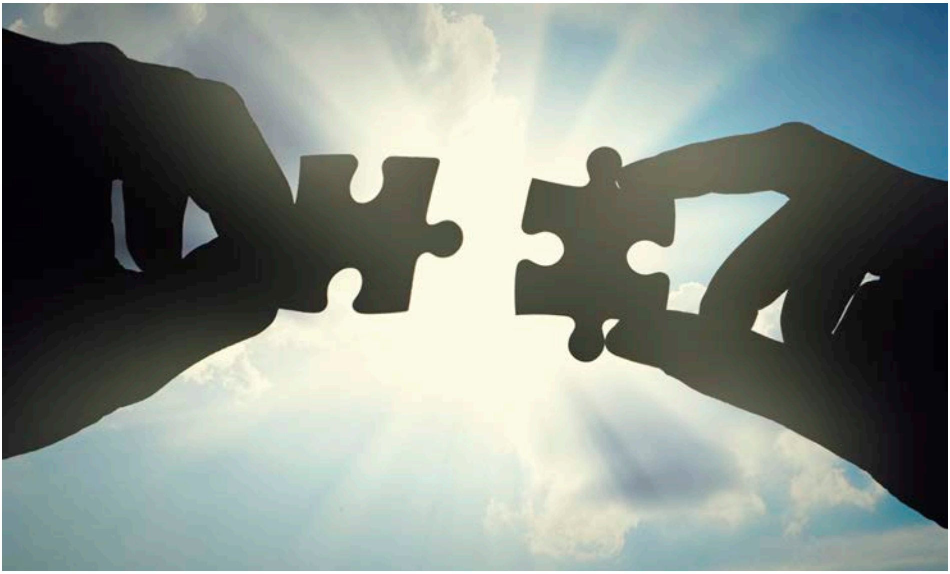
2.3 Vision Statements

Current policy maker's thinking around desirable urban water futures

Statements of relevant government, ministry and regulator representatives across Europe provide insights into current thinking around desirable urban water futures and remaining institutional barriers.

Where to be 2050? - We asked relevant government, ministry and regulator representatives across Europe to describe their vision of the urban water services of tomorrow.

[This section represents policy maker's vision statements and opinions expressed in interviews which were conducted by the trust consortium in autumn 2013.]



A vision of a senior government representative

Where to be 2050?

"We have a vision for water in general - formulated in a national policy. Under that policy, we essentially are looking to develop the value of water. That applies to the urban setting where we will be looking to ensure continuity of supply and high quality of supply regardless of any changes to urban structures over time or a greater volume of people in the cities and/or pressures through climatic changes and other population growth in a general sense. We want to achieve continuity of service, continuity of quality, continuity in terms of equality, and by that time, we would want to have removed all lead and ensure that we were disposing of all waste water in a way that minimising the degradation of the environment as well."

"We want to achieve continuity of service, continuity of quality, continuity in terms of equality."

Jon Rathjen, Water Industry Team, Scottish Government

Where to be 2050?

"Today's urban water infrastructure can be almost inexistent in developing regions, […] and becoming longstanding in developed countries, because this generation of infrastructures started to be adopted by the end of the 19th century. […] Customers have the greatest risk of suffering from undesirable developments in urban water infrastructure, paying high and unnecessary tariffs and not improving or even decreasing the level of public health and environment. The global challenges in this sector will be investing in the missing infrastructures, improving management of the existing ones and promote sound asset management practices for the future. The search for more efficient and less costly water treatment technologies will allow the use of more and closer water sources to supply urban areas, reducing transportation costs and probably introducing more competition, with a gradual reduction of its natural monopolistic characteristics. The waste water treatment will become more and more sophisticated due to increasing environmental constrains and waste water will turn slowly from a problem into a desired resource of water and nutrients. The storm water system will become more minimalistic and physically fragmented, being a component of the urban design, and rain water will turn slowly from a problem into a desired resource of water for aesthetic and leisure purposes."

> "Waste water will slowly turn from a problem into a desired resource of water and nutrients."
>
> Jaime Melo Baptista, ERSAR, Portugal

Where to be 2050?

"One of the things we are promoting a lot is looking at more innovative ways of delivering water and wastewater services. There is obviously a cost element to that in terms of deciding what are reasonable costs. We will be looking for a high quality service, having drinking water that meets all the requisite standards, wastewater that is properly treated, and suitable drainage systems. And, at the end of the day, we want to be providing a service where customers are satisfied that they are getting value for money."

> "We will be looking for a high quality service, having drinking water that meets all the requisite standards, wastewater that is properly treated, and suitable drainage systems. And, at the end of the day, we want to be providing a service where customers are satisfied that they are getting value for money."
>
> Ian Tait, Water Industry Commission for Scotland

Clean, reliable and energy efficient - An environmental regulator's vision.

Where to be 2050?

"I would expect to see: clean reliable drinking water delivered in an energy efficient way; waste water carried away efficiently without causing any environmental impact, surface water managed in an energy efficient way and in a way that minimises the risk of flooding to its residents, but also provides for drainage basin biodiversity within the city; and good quality environments within and around the city and any other parts at its disposal."

> "Clean reliable drinking water delivers in an energy efficient way; waste water carried away efficiently without causing any environmental impact...."
>
> Jennifer Leonard, Scottish Environment Protection Agency

We have been visionary for 100 years! The vision of a senior Ministry official.

Where to be 2050?

"The guiding principle to organise the water management in the urbanised and industrialised *Ruhr* river catchment was visionary 100 years ago - and would still be my best choice. However, the raw water will be transported via pipelines instead of rivers, existing combined sewers are replaced by a separate sewer system apart from rainwater harvesting and a more integrated planning and operational approach covering both, drinking water and waste water in the whole region is implemented. Although there is much progress in decentralised systems, I still believe that, for metropolitan areas, a centralised waste water collection and treatment is more efficient and more effective in terms of protecting human health and of saving the environment."

"I still believe that, for metropolitan areas, a centralised waste water collection and treatment is more efficient and more effective in terms of protecting human health and of saving the environment."

Gerhard Odenkirchen, Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of the German State of North Rhine-Westphalia

Mission, vision, values. Maintain high reliability. For metropolitan areas, there is no alternative to centralised systems, but... - The view of a senior Ministry representative

Where to be 2050?

"For existing metropolitan areas, there is no alternative to centralised supply and sanitation infrastructures. In general, they proved to be effective in terms of service, quality and public health protection, and efficient in terms of cost-benefit. The future challenge is to develop the existing systems along changing boundary conditions, to adopt better technology, and to integrate industrial and public infrastructure. However, in rural areas, I see a strong potential of decentralised systems, given that people move out and the technology has become more and more reliable and efficient. Decentralised systems show better failure-proof characteristics – this part I'd also like to adopt to larger systems to maintain high reliability.

> "Decentralised systems show better failure-proof characteristics – this part I'd like to adopt to larger systems to maintain high reliability
>
> Dr. Fritz Holzwarth, Former German Water - and Marine Director, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany

2.4 Transition pathway - historical, current and future urban water management

Cities and the urban water system can be seen as complex social-technical systems which evolved over decades (Jeffrey et al., 1997).

The **historical development of urban water management** started back in the 19th and 20th century to **meet the current needs at that time** such as **supply security**, **public health protection** and **flood protection** (Brown et al., 2009).

Imposed institutional, legal and financial frameworks have favoured a specific sub-set of available urban water technologies and configurations (Jeffrey et al., 1997).

Due to high path dependence, capital lock-up and the relatively low level of adaptivity to changing conditions, the long-term sustainability of traditional urban water management becomes increasingly challenged.

Brown et al. 2009 developed a transitions framework characterising the evolution of urban water management including possible urban water futures - transition to sustainable urban water services:

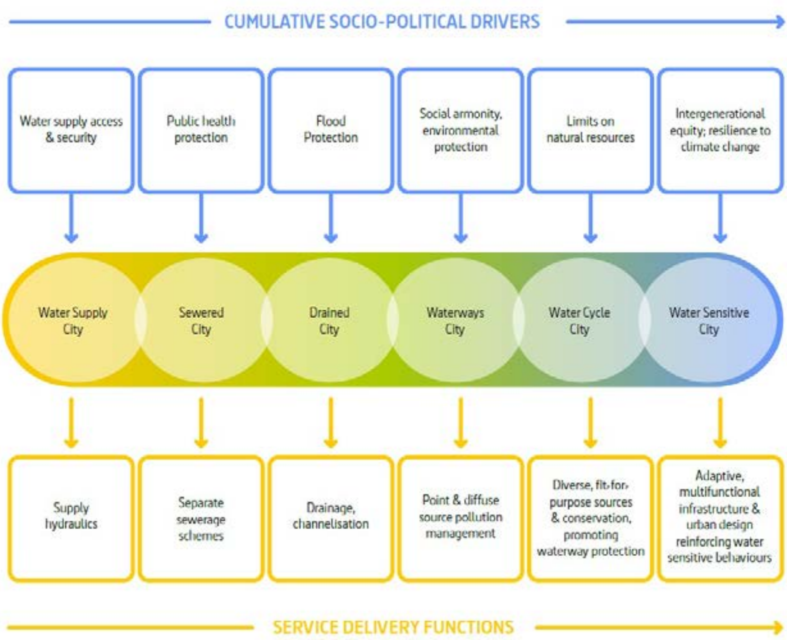


Figure 1: Urban water transitions framework (Brown et al., 2009)

"One of the values of this framework is that it **can be used** by strategists and policy makers **as** a heuristic device and/or the basis for a future city state **benchmarking tool**. From a research perspective it can be an underpinning framework for future work on transitions policy research."

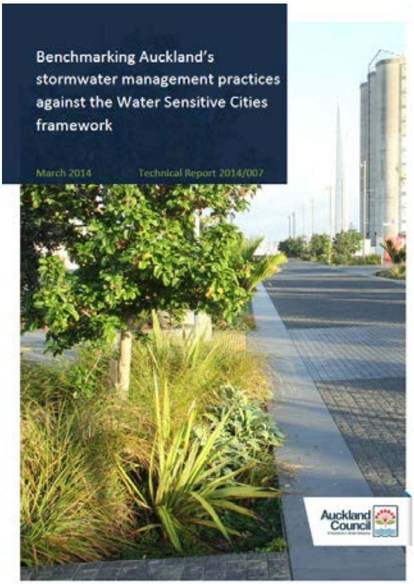
Brown et al., 2009.

2.5 Further Reading:

Auckland's progress from a Drained City to a Waterways City by B.C. Ferguson, R.R. Brown and L. Werbeloff (2014).

Prepared by the Cooperative Research Centre for Water Sensitive Cities for Auckland Council.

Auckland Council technical report, TR2014/007



Effective institutional framework

3

Institutional arrangements of sustainable urban water management regimes

3.1 Institutional arrangements of sustainable urban water management regimes.

The shift in emphasis from 'government' to 'governance' highlights how current thinking has moved beyond 'command and control' approaches towards a greater understanding of water management systems as multi-level, multi-actor and poly-centric (Pahl-Wostl et al., 2007).

Good water governance requires clear legal frameworks covering the entire water cycle service area as well as the organisation model of the water sector (institutional, regulatory, governance models) supporting the definition and clarification of the general rules and norms governing the sector for all stakeholders: Relevant authorities, responsible bodies as well as users and citizens.

Comprehensive sustainable water policies based on clear objectives, strategies are fully considering the system complexity as well as future uncertainties which are reflected in the legislation. Institutions for implementing the policies maintain collaborative and cooperative relationships.

"The institutional framework conditions needed for success are: clear definitions of the roles, responsibilities, principles and rules minimising the risk of conflict, e.g. between central and local government; a clear strategy supported by all parties; a framework favouring synergies and partnership and the availability of the resources (human, financial, legal) necessary to achieve it.."

José Tomas Frade, Coordinator of PENSAAR and former head of EIB Water & Sanitation Division

Regardless of the diversified legislations and regulation models found in European Member States, an effective, coordinated institutional framework ensuring sustainable urban water governance is characterised by the **collaboration**, **coordination** and **partnership** between organisations (van de Meene & Brown, 2009); OECD, 2003).

> “[...] Coordination and cooperation is easier if organisations have responsibilities for multiple water services [...] inter-organisational conflict will decrease as collaborative and cooperative relationships become the norm.”
>
> van de Meene & Brown, 2009

To manage transition towards sustainable urban water management it is essential to understand the adaptive capacity residing in institutions and individuals as well as the institutional barriers. This guide highlights:

- Institutional capacity criteria
- Statement on transformations in the regulation of water services in Portugal
- Institutional barriers

3.2 Institutional capacity criteria

> "I am convinced that the national and regional administration should reclaim more competences in the long-term development of the sector. We must focus more on strategic perspectives and a reliable legal framework rather than jumping from one crisis to the next."
>
> Gerhard Odenkirchen, Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of the German State of North Rhine-Westphalia

Institutional capacity at the administrative and regulatory level:

- **Objective-oriented strategies:** The arrangement of the legal and regulatory framework and the formulation of government policies is based on an long-term strategic perspective including a refined consideration of future uncertainties and system complexity (van de Meene & Brown, 2009, Pahl-Wostl et al., 2007)
- **Policy tools and instruments:** Various adequate financial and regulatory mechanisms are applied (van de Meene & Brown, 2009) ensuring cost-covering operation and socially acceptable refinancing according to the economic capacity of the society.
- Processes are integrated, participatory, transparent, adaptive, innovative (van de Meene & Brown, 2009; OECD, 2003).
- Broad stakeholder participation ensures the consideration of diverse views and interests.

Institutional capacity at inter-organisational level

Clear defined institutional roles and responsibilities of the var ious entities in different sectors promotes authority to organisational authority to partnership and information sharing and shared qualities are essential to ensure a sound governance promoting trust and transparency between organisations at different institutional levels (van de Meene & Brown 2009). Traditional bottlenecks in the current policies or overlapping of institutional responsibilities have to be avoided.

Transition to sustainable urban water management requires **cooperation** of ministries and agencies at national and regional level as well as **networking** between the national, regional and local governments, NGOs and private organisations based on:

- Clear defined institutional roles and responsibilities of the various entities in different sectors (JMB, Pahl-Wostl et al. 2007)
- Interdisciplinary coordination of activities
- Open transparent communication
- Collaborative planning
- Partnership
- Information sharing
- Shared qualities
- Rules for interaction

Capacity at organisation and individual level

- Knowledge and human resources at managing and technical level is sufficiently available also in the future

3.3 Statement on transformations in the regulation of water services in Portugal

Statement of Jaime Melo Baptista on major transformations in the regulation of water services in Portugal

Jaime M. Baptista is president of the board of directors of the Water and Waste Services Regulation Authority (ERSAR) in Portugal. He outlined the major transformations in the regulation of water services in Portugal that have been applied during 2003 and 2013 and was also involved in the definition of the strategy for the Portuguese water sector. His background is civil engineering, with a PhD in Engineering at the National Laboratory of Civil Engineering (LNEC), and BSc in Civil Engineering, specialisation in Sanitary Engineering.

Creating a sound legal framework

The public policies need to be reflected on the legislation with the goal of further supporting the reorganisation and clarification of the general rules governing the sector. That's why it is important to create an appropriate and comprehensive legal framework for the water services, reflecting the sector's organization model (institutional, regulatory, governance models) and defining rules for all stakeholders (public administration, public and private service providers, users and citizens).

This legal framework shall comprise:

- an improved legal framework for the organisation of water services, including the different governance models (for instance State owned, Municipal owned and private utilities);
- legislation regarding tariff setting, quality of service requirements, water quality, and technical issues;
- and a legal framework governing the role of the regulatory authority.

In Portugal a set of legislation has been approved in the last two decades (first generation in 1993 and the second one in 2009), with the establishment of rules governing the sector, including legal framework for services, legal framework for regulation, tariff regulation, quality of service regulation, water quality regulation and technical regulation. The regulatory authority is responsible for legal monitoring of the utilities.

A great attention was paid to the contribution to the clarification and improvement of rules and legislation governing the sector, with proposing new legislation, proposing the improvement of legislation, approving regulations and issuing recommendations.

A significant attention was also paid to the legal-contractual monitoring of utilities, analysing the creation of new utilities, analysing tender processes, analysing contract documentation, analysing contract modifications, approving utility contracts with consumers, monitoring contractual compliance, promoting the conciliation, analysing contract terminations, assessing the global situation annually and disseminating information annually.

Clarifiying institutional responsibilities

The public policies shall be implemented efficiently by a good structured administration. For that, it is essential a clear definition of institutional responsibilities of various entities, with the establishment of the authorities for water services, for environment and water resources, for consumers protection, for public health and for competition. It is essential to avoid the traditional bottlenecks in the current policies or strategic guidance of emptiness or overlapping of institutional responsibilities.

Introducing a regulatory authority was an important tool to improve effectiveness and efficiency by management and reduce risks to the potential beneficiaries, with the provision of quality services at socially acceptable prices, due to the fact that these services are local or regional monopolies with no competition. Although the overarching goals have been protecting consumer's interests, other factors are taken into account such as: safeguarding the financial sustainability of service provision; promoting the development of a competitive water service cluster; guaranteeing sustainable management of natural resources and promoting environmental quality.

"In Portugal a quite rational institutional framework has been created or improved in the last decade"

Jaime Melo Baptista

In Portugal a quite rational institutional framework has been created or improved in the last decade, with the establishment of the authority for water services (The Water and Waste Services Regulation Authority – ERSAR), the authority for environment and water resources (The Portuguese Agency for Environment – APA), the authority for public health (The

General Direction for Public Health – DGS), the authority of consumers protection (The General Direction for Consumers Protection) and, for some situations, the authority for competition (The Competition Authority – AdC). The regular presence of these authorities in the Consultative Council of the regulatory authority improves the global performance, clarifying responsibilities and articulations between them. As part of the institutional framework, explicit regulation of the activities of utilities covers the quality of service and price setting. It was decided to implement regulation with a sound regulatory model and an integrated (holistic) approach, considering the context and level of development of the country, operating at national level (mainland), integrating the water, wastewater and solid waste services, regulating all the utilities, regardless the governance model and adopting a supportive regulation.

3.4 Institutional barriers

Cities and urban water systems can be seen as social-technical systems which evolved over decades. The co-evolution of socio-institutional components and the large technical infrastructure systems created significant lock-in effects: A stable system which is costly and difficult to change.

Brown & Farelly 2009 identified institutional barriers to sustainable urban water services of tomorrow being socio-institutional rather than technical. Statements of European senior relevant authority representatives underline the existence, but also the awareness of these barriers in European contexts.

"I have some doubts on the effectiveness and the long-term efficiency. In many cases, the important problem-solution or strategies are developed within informal settings, with a **limited number of stakeholders** in basically **non-transparent decision-making**. We also experience an **increasing friction between the different actors** from government, public and private utilities and their associations. The boundary between public benefit and company's interest is more often than not unclear. So, I am convinced that the national and regional administration should reclaim more competences in the long-term development of the sector."

Gerhard Odenkirchen, Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of the German State of North Rhine-Westphalia

Institutional barriers identified by Brown & Farelly, 2009:

- Uncoordintated institutional framework
- No long term vision
- No long term strategy
- Limited community engagement, empowerment & participation
- Limits of regulatory framework
- Insufficient resources (capital and human)
- Unclear, fragmented roles & responsibilities
- Poor organisational commitment
- Lack of information, adaptive forms of management
- Poor communication
- Lock-in effects, path dependencies
- Little or no monitoring and evaluation, and
- Lack of political & public will

Pahl-Wostl et al. 2007 argues that costs and fears are also barriers to sustainable urban water services:

- High costs of information collection and monitoring
- Individuals who fear increased transparency and loss of control
- Fear to failure

Strategic planning for urban water services of tomorrow

4

Ensuring consistency in management and systemperformance over changing conditions.

Planning for urban water systems involves high levels of uncertainty, complexity, as well as diverse views and interests. In response, planning processes are becoming more integrated, adaptive and participatory.

> "It is important to define a clear strategy for the sector, approaching together water supply, sanitation and stormwater management embodied in a national or regional water services strategic plan with clear objectives to serve the population, acting in response to health and environmental national or local regulations and standards and properly articulated with urban and rural planning."
>
> Jaime Melo Baptista, President of the board of directors of the Water and Waste Services Regulation Authority (ERSAR) in

Objective-oriented strategic planning with a long-term time horizon and a broad scope, covering the whole service area and involving all relevant stakeholders, is needed to achieve sustainable urban water services.

Managing transition: This proposed guideline on strategic planning is aimed to assist policy makers in designing transition pathways in non-conventional ways, exploring the potential of multi-stakeholder expertise, communication and interactive supporting self-assessment tools.

- The importance of integrated planning
- Planning horizons and analysis horizons
- Planning process
- Definition of objectives and visioning
- Diagnosis: Measuring sustainability - How sustainable are we today?
- Defining the system - Who are we?
- Lock-in effects - Many decisions to 2050 have already been made
- Refined consideration of future uncertainties
- Understanding the urban water system's metabolism
- Developing long-term water sector strategies that perform well under conditions of change
- Conclusions – Key messages for policy makers

4.1 The importance of integrated planning

Urban water cycle services (UWCS) are highly complex social-technical-systems that bring together human, ecological and technological components. Social-technical-systems have been defined as systems 'which encompass production, diffusion and use of technology'. They represent the 'linkages between elements necessary to fulfil societal functions (e.g. transport, communication, nutrition)', technology playing a crucial role in that sense (Geels, 2004).

Policy Makers are often faced with the need for deciding where to allocate limited financial resources, trying to maximize the benefit for the society. Multiple actors - i.e. service providers or societal sectors - tend to argue in favour of their direct interest, and the decision makers need to assess the overall advantages and disadvantages

Increasing spatial competition and poor coordination between the different sectors hinders sustainable urban development. Traditional urban development planning tends to give low priority to urban water systems planning, thus forcing urban water systems planning to a reactive mode, responding to the needs identified in the urban master plans.

“Water infrastructures have always been behind urban planning, and the negative result was that they have been more expensive than necessary, to overcome with lack or inappropriate urban planning. The responsibilities for planning tasks distributed in this field of activity are not articulated enough. Other planning priorities than water resources and water services are controlling urban planning, and the water sector pays part of the bill.”

Jaime Melo Baptista, President of the board of directors of the Water and Waste Services Regulation Authority (ERSAR) in Portugal

Integrated planning of urban water services is the process of defining and implementing coherent solutions and transition paths that lead to sustainable urban water services.

This requires several levels of detail, from long-term to short-term, and from national or regional to local level, in an aligned way.

It should take into account not only the economic, social and environmental aspects of sustainability, but also governance of the services and the quality of the human, information and knowledge, and infrastructure assets.

4.2 Planning horizons and analysis horizons

Analyses of existing strategic plans for urban water management showed that the planning horizon varied from 4 to 92 years.

Given the long useful life of many assets of the urban water infrastructures, it is highly recommended that long term objectives and analysis horizons are adopted. Analysis horizons may be of the order of 30 to 100 years. There is always a balance.

Planning horizons, corresponding to the intervention period being incorporated in a given plan, may be shorter than the analysis horizon. However, there is a clear **need for long term strategic plans** of the urban water services, both at the national or regional level and at the utility level.

EXAMPLE: ECONOMIC EFFICIENCY

Less than 5 years:
Promotes cuts in capital maintenance

More than 15 years:
Sustainable capital maintenance becomes crucial

Figure 2: Strategic planning horizons

Typical planning horizons for tactical plans are 3 to 5 years and for operational plans 1 year. Planning horizons may significantly differ from case to case.

4.3 Planning process

At each level of management and planning – strategic, tactical and operational – a structured loop comprises the following stages:

- 1 definition of objectives and targets
- 2 diagnosis
- 3 plan production, including the identification, comparison and selection of alternative solutions
- 4 plan implementation
- 5 monitoring and review

An effective alignment between the different management levels and review mechanisms, which is a way to measure compliance with set objectives is often missing.

Figure 3: The planning process at each planning level

Establishing objectives, assessment criteria, metrics and targets is a crucial stage in order to set up clear directions of action, as well as accountability of results through timely review, within a given time frame (short, medium or long-term) (ISO 24510:2007, 24511:2007, 24512:2007). These metrics and targets are an essential basis for establishing the diagnosis, prioritizing intervention solutions and monitoring the results.

The process cascades through the decisional levels within the management structure. The global approach is based on plan-do-check-act (PDCA) principles aiming at the continuous improvement of the Infrastructure Asset Management (IAM) process. The key notions in this process are:

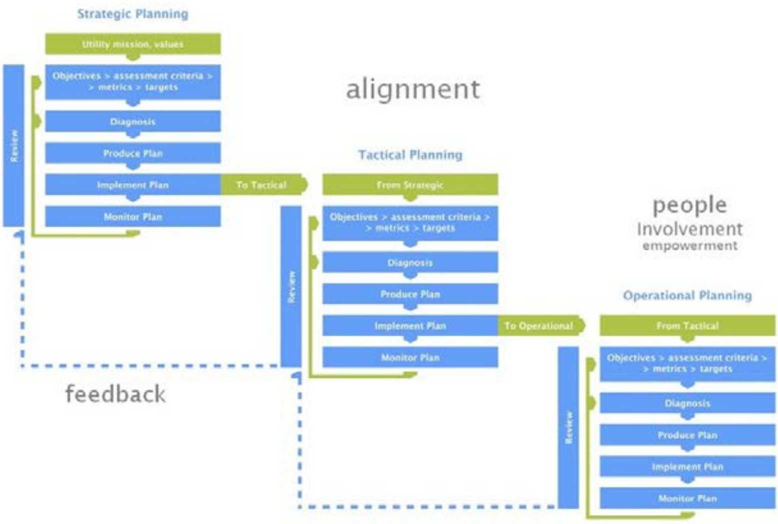


Figure 4: Interlinks, alignment and feedback mechanisms between IAM planning levels. http://www.aware-p.org/np4/approach/

4.4 Definition of sustainability objectives

Sustainability in urban water cycle services (UWCS) is met when the quality of assets and governance of the services is sufficient to actively secure the water sector's needed contributions to urban social, environmental and economic development in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs (Alegre et al., 2013).

Sustainability assessment of urban water cycle services in TRUST includes the main dimensions of social, environmental, economic and the supporting dimensions of assets and governance sustainability.

The framework for sustainability assessment allows policy makers and public decision makers for benchmarking the sustainability of the UWCS.

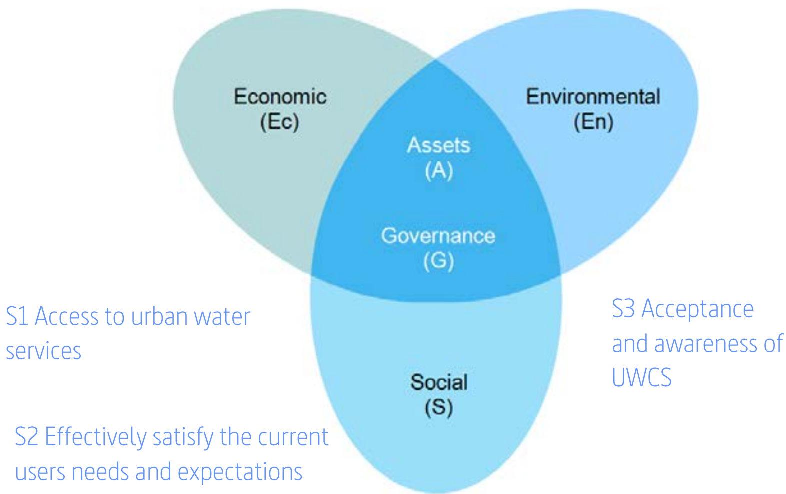


Figure 5: TRUST approach to sustainability assessment: Exemplary key objectives for the social dimension of sustainability.

Note:

- Focusing on physical assets and resources alone might ignore the diversity of perspectives of stakeholders in the transactional environment.
- The assessment method should be inclusive and flexible with respect to stakeholder involvement and decisions regarding target setting and trade-off as part of a multi-criteria decision analysis process.
- The assessment is made operational by critically and carefully examining a chosen set of performance metrics and how they comply with a predefined set of sustainability objectives and criteria.
- The performance metrics/indicators may be quantitative and/or qualitative, and are specifically chosen in order to take account of the particular context and challenges of a given urban water cycle system, in a medium- and long-term transition context.

4.4.1 Visioning: Defining a clear Vision as part of the definition of objectives

Strategic plans tend to focus on developing secondary and operative objectives. The description of a desirable future is often lacking.

A source of inspiration: Will is prior to necessity

Visions may be more conservative (compatible with a smooth evolution of the current solutions) or be more disruptive, especially when the current solutions are not sustainable or are unable to respond to pressures and challenges.

Sharing perspectives and reaching consensus about the desired state

- As regards forming a vision iteratively, will is prior to necessity and capacity. Define a clear vision for the internal system and the transactional environment.
- Distinguish between short-, medium- and long-term targets to translate abstract future (objective) ambitions into practical actions.
- Be aware that dealing with different perceptions in planning processes involves sharing perspectives and reaching consensus about the desired state. Defining such visions can therefore be a very complex process.

4.4.2 Defining the Key Objectives

The TRUST framework for sustainability establishes **key objectives of the urban water services** and corresponding **assessment criteria** for each sustainability dimension, aiming at a transparent, valid and holistic method for target definition and assessing results (Table).

TABLE 1: OBJECTIVES AND CRITERIA OF THE UWCS SUSTAINABILITY

DIMENSION	OBJECTIVES	ASSESSMENT CRITERIA
Social	S1) Access to urban water services S2) Effectively satisfy the current users' needs and expectations S3) Acceptance and awareness of UWCS	S11) Service coverage S21) Quality of service S22) Safety and health S31) Affordability
Environment	En1) Efficient use of water, energy and materials En2) Minimisation of other environmental	En11) Efficiency in the use of water (including final uses) En12) Efficiency in the use of energy En13) Efficiency in the use of materials En21) Environmental efficiency (resource exploitation and life cycle emissions to water, air and soil)
Economic	Ec1) Ensure economic sustainability of the UWCS	Ec11) Cost recovery and reinvestment in UWCS (incl. cost financing) Ec12) Economic efficiency Ec13) Leverage (degree of indebtedness) Ec14) Willingness to pay
Governance	G1) Public participation G2) Transparency and accountability G3) Clearness, steadiness and measurability of the UWCS policies G4) Alignment of city, corporate and water resources planning	G11) Participation initiatives G21) Availability of information and public disclosure G22) Availability of mechanisms of accountability G31) Clearness, steadiness, ambitiousness and measurability of policies G41) Degree of alignment of city, corporate and water resources planning
Assets	A1) Infrastructure reliability, adequacy and resilience A2) Human capital A3) Information and knowledge management	A11) Adequacy of the rehabilitation rate A12) Reliability and failures A13) Adequate infrastructural capacity A14) Adaptability to changes (e.g. climate change Adaptation) A21) Adequacy of training, capacity building and knowledge transfer A31) Quality of the information and of the knowledge management system

Setting up objectives, assessment criteria, metrics and targets is a crucial stage in order to set up clear directions of action, as well as accountability of results through timely review.

- **Objectives** are the goals that the organization aims to achieve. According with the ISO 24510:2007, 24511:2007, 24512:2007 standards, TRUST performance assessment should always be linked to objectives that are clear and concise, as well as ambitious, feasible and compatible, and take into account the ultimate goal for the utility of providing a sustainable service to society. For each objective, it is recommended that key assessment criteria be specified.
- **Assessment criteria** are points of view that allow for the assessment of the objectives. For each criterion, performance, risk and cost metrics must be selected in order for clear targets to be set, and for further monitoring of the results.
- **Metrics** are the specific parameters or functions used to quantitatively or qualitatively assess criteria; metrics can be indicators, indices or levels.
- **Targets** are the actual proposed values to be achieved for each metric within a given time frame (short, medium or long term).

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- **Targets** are the actual proposed values to be achieved for each metric within a given time frame (short, medium or long term).

4.5 Diagnosis: Measuring sustainability - How sustainable are we today?

- Defining the current state of the UWCS sustainability includes all dimensions of sustainability: social, environment, economic, governance and assets.

4.5.1 Trust sustainability self-assessment tool

Are we sustainable enough? Is the water utility on track for 2050?

An Easy-to-use assessment tool provides institutions and utilities with a first glimpse of readiness towards the 2050 target. The scope of the assessment will be the city and those issues that can be resolved at city level, related to water supply, waste water and stormwater.

The web based TRUST sustainability self-assessment tool is intended to provide a qualitative assessment of whether the city/region is on track for 2050 and to identify key areas with potential for improvement. The tool aims at being:

- an entry-point to TRUST that helps the user to get acquainted with the TRUST approach to sustainability and tools
- a simple and motivating instrument that provides a preliminary assessment of the current sustainability level of the city and/or region
- the tool allows partial assessments of the UWCS (drinking water, waste water and stormwater)
- The scope of the assessment will be the city and those issues that can be resolved at city level, related to water supply, waste water and stormwater services
- The self-assessment tool allows a full evaluation (if the user has all available data) within 3 hours

The tool will not provide:

- any specific measures for improvement
- any specific strategic direction for improvement

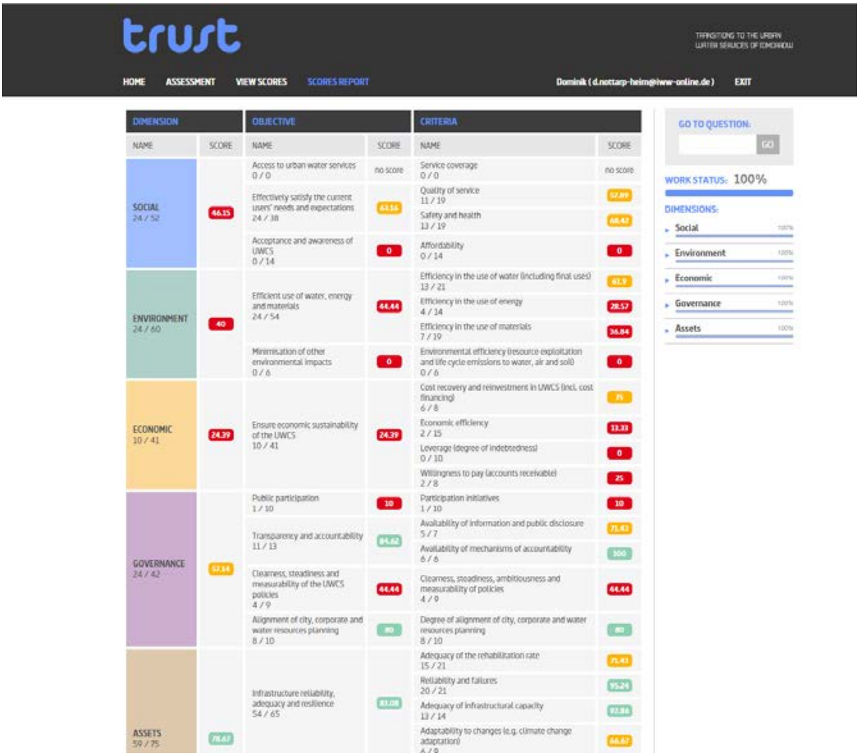


Figure 6: Web based TRUST sustainability self-assessment tool: Example score report. http://self-ssessment.trust-i.net

4.5.2. City Blueprints: Baseline assessments of sustainable urban water management of 11cities.

The City Blueprint has been developed to assess the sustainability of UWCS. The quick sustainability scan evaluates e.g. the efficient use of water, energy and non-renewable resources, climate change, safety (adaptation strategies, public participation, compliance to (future) legislation, transparency, accountability and costs.

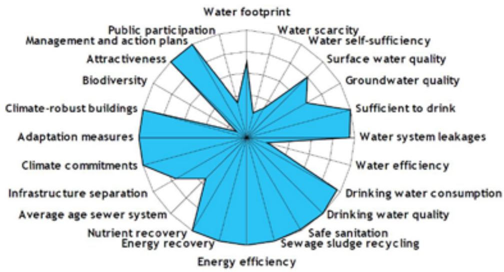


Figure 7: City Blue Print

Transition is already on track...

Different scenarios to improve urban water supply, in the context of already well developed and equipped cities, have to be evaluated in respect to different aspects of sustainability.
The City Blueprint (van Leeuwen et al., 2012) has been developed to assess the sustainability of UWCS. The baseline

> "Cities can learn from each other in their transition towards more sustainable UWCS."
>
> Kees van Leeuwen

assessment has been applied in 9 cities and regions in Europe

(Amsterdam, Algarve, Athens, Bucharest, Hamburg, Reggio Emilia, Rotterdam, Oslo and Cities of Scotland) and in 2 African cities in Angola (Kilamba Kiaxi) and Tanzania (Dar es Salaam).

The assessments showed that cities vary considerably with regard to the sustainability of the UWCS. This is also captured in the Blue City Index (BCI), the arithmetic mean of 24 indicators comprising the City Blueprint (van Leeuwen et al., 2012). Theoretically, the BCI has a minimum score of 0 and a maximum score of 10. The actual BCIs in the 11 cities studied varied from 3.31 (Kilamba Kiaxi) to 7.72 (Hamburg).

An important result from this study is that the variability in sustainability among the UWCS of the cities offers great opportunities for short-term and long-term improvements, provided that cities share their best practices (UNEP 2008).

> “Even cities that currently perform well, can still improve their UWCS”
>
> Kees van Leeuwen

Cities can learn from each other. Theoretically, if cities would share their best practices, the BCI might reach a value of 9.70, which is close to the theoretical maximum of 10. It shows that even cities that currently perform well, can still improve their UWCS. Of course, this would depend on many other factors, such as socio-economic and political considerations (van Leeuwen 2007), and is ultimately the responsibility of the cities themselves. The ideas presented in this paper have recently been prioritized as action by the European Commission in the context of the European Innovation Partnership on Water (European Commission 2013). Read the full report on City Blue Prints

4.6 Defining the system – who are we?

M. van der Zouwen, C. Segrave, C. Büscher, J.A. Monteiro, A. Galvao, A. Ramoa, R. Hochstrat

The first question is one of identity. Social identity theory and self-categorisation theory provide a general theoretical basis for analysing organisational identities. Basically, people define themselves by acting in social groups that are important to them.

Social psychologists have argued that people assume various identities according to the role they are performing (Goffman 1959, Ting-Toomey 1993). An individual may alternate between being parent, friend, sportsperson, and water manager - all in one day. By a process of 'identity negotiation' individuals establish mutual expectations of one another to form groups (Swann 2009).

Since a strategic plan concerns the future of an organisation that comprises various individuals who fulfill diverse roles, divergent images of the organisation may exist. An analysis of the current organisational identity can provide key strategic insights and a point of reference against which future changes can be assessed. One useful method is to examine how individuals within an organisation characterise the organisation and to compare these views with each other and also with how external parties view the organisation.

A second aspect of identity, which is an important starting point for any system analysis, is to define "the sphere of influence". This concept is often used to delineate the boundary between the internal (focus) and the external system.

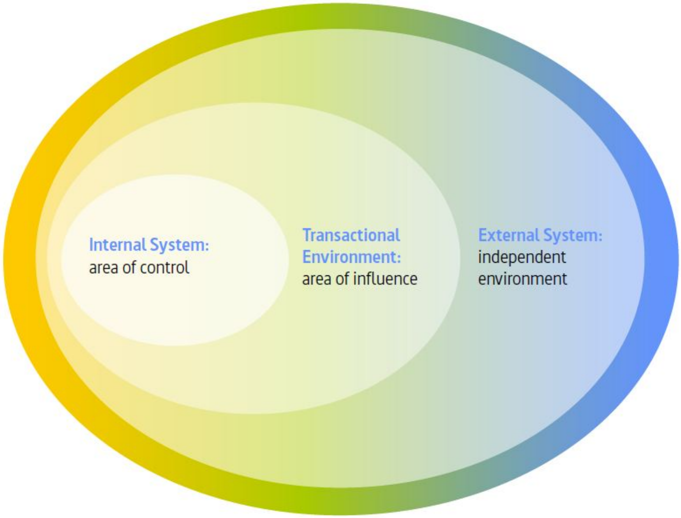


Figure 8: Defining system boundaries (Gharajedaghi, 1999).

The internal system is thus defined as the spatial and conceptual realm over which the organisation has significant cultural, economic, political, or physical control. On the other hand, the external system is the rest of the world, over which the organisation has no influence. There is a grey area on this boundary, which is referred to as the transactional environment. The organization does not have direct control over the transactional environment but may, for example through lobbying, influence other organisations or individuals to change circumstances in a certain way (Figure). Both the transactional environment and the internal system are embedded in the external system.

Detailed definition of these boundary conditions can be quite time consuming and may be perceived as unnecessary. However, strategic plans that rest on unclear system boundaries run the risk of becoming trapped in cyclic logic or failing to plan for aspects of the system that they do have control or influence over. For urban water utilities the boundaries of the internal system depend on the aspects of the UWCS over which the organisation has direct control. The Transactional Environment is likely to include the entire UWCS and may extend into, for example, the agricultural or industrial sectors. The external system, on the other hand, is the context in which the UWCS is located. This external system is typically characterised by social, economic, political, technological, ecological, and demographic dimensions over which water utilities have no influence.

It is interesting to discuss how the urban water cycle systems are typically bounded in practice, looking at existing strategic plans, because this reveals how organisations perceive their sphere of influence and responsibility. From a theoretical perspective, these boundaries are arbitrary and so there is little value in attempting to define a generically applicable delineation of the sphere of influence of an organisation or an urban water utility.

Theories and practical experience does, however, **substantiate the need to explicitly define stakeholders and the roles of different actors at the outset of a strategic planning process.** These stakeholders need to be actively involved from the beginning of the project: they are part of the answer to the question "who are we?" There are various methods of Stakeholder Mapping (Hemmati et al., 2002), that are also useful in the next step: defining the current state of the internal system.

The first planning step of describing the identity has far reaching consequences for all following steps. Distinguishing between the **internal system, transactional environment and external system** is important, as objectives in these different spheres ask for different strategies. Within the internal system, the utility itself can directly influence what is happening. For issues in the transactional environment, a utility needs other stakeholders to meet its objectives.

4.7. Lock-in effects - Many decisions to 2050 have already been made

Gaining experience from considering past decisions

Past key drivers and earlier decisions of urban water mangers on changing conditions characterise the evolution of urban water systems (cf. Brown et al. 2009).

Short-term effective end-of pipe solutions as responses to change

The historical development of urban water management started back in the 19th and 20th century to meet the current needs at that time such as supply security, public health protection and flood protection (Brown et al. 2009). Environmental impacts moved legislation and research activities.

Cities and the urban water system can be seen as complex social-technical systems which evolved over decades (Jeffrey et al. 1997). The co-evolution of legal and institutional frameworks and large infrastructure systems created significant lock-in effects.

> "In the short-run, technological fixes proved to be efficient in solving environmental problems e.g. increasing sophistication of WWTP. However, these problems were generally dealt with in isolation, potentially undesirable long-term consequences were not taken into consideration."
>
> Pahl-Wostl et al., 2007

Lock-in effects

Due to high path dependence, captial lock-up and the relatively low level of adaptivity to changing conditions, the long-term sustainability of traditional urban water management becomes increasingly challenged.

Imposed institutional, legal and financial frameworks have favoured a specific sub-set of available urban water technologies and configurations, constraining appropriate practice (Jeffrey et al. 1997): A stable system which is costly and difficult to change:

- no immediate change of decision-making processes (command-and-control paradigm (Pahl-Wostl et al., 2007)
- a costly massive centralised infrastructure, lack of investment in maintenance, vulnerability to decreasing water availability and increasing rainfall variability.

Coping with future uncertainties and increasing pressures requires major changes of traditional urban water management practices.

4.8 Refined consideration of future uncertainties

Planning for urban water systems involves high levels of uncertainty and complexity: Changes over time in social priorities, politics, economy, spatial and temporal water demand and rainfall patterns, economic and demographic change and science and technologies.

Taking uncertainties into account

Within the strategic planning process, the vision will be confronted with the current state of the internal system. How sustainable are we today, and the various probable and possible future states of the external system:

How might change environmental, political, social and economic patterns?

> "Large-scale infrastructures or rigid regulatory frameworks increase the costs of change, but **costs** may also be related to **loss of trust and credibility** if **uncertainties** and the possible need for changes are **not addressed** by relevant authorities during policy development"
>
> Pahl-Wostl et al., 2007

Types of uncertainties

Pahl-Wostl et al. 2007 and Jeffrey et al. 1997 defined different types of uncertainties needed to be addressed in water management:

- Lack of knowledge
- lack of data,
- uncertainty of our understanding of the system (historical trends, system elements, interactions),
- social,
- environmental,
- political, and
- economic uncertainties.

Pahl-Wostl et al. 2007 argues that environmental uncertainties are mostly addressed in strategic planning while **uncertainties being not quantifiable such as political and social uncertainties are often not addressed.**

> "Because of tradition rooted in the hydrological and engineering sciences, water managers have vast experiences, methods, and tools with which to address environmental and quantifiable uncertainties. However, the knowledge and methods needed to address uncertainties in decision-making processes are largely lacking"
>
> Pahl-Wostl et al., 2007

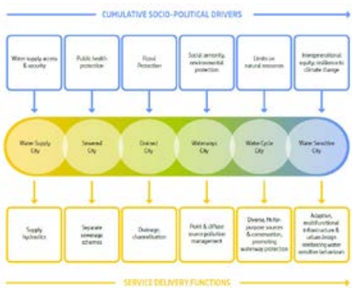
Identification of key uncertainties

- Strategic planning includes **scenario analyses** projecting the **future of the external system** and its potential impact on the UWCS.
- Each type of **uncertainty** (listed above) should be addressed during strategic plan or policy development.

> “How can we directly study and analyse transition processes when the scale of change approaches or exceeds the time horizon of careers?”
>
> Pahl-Wostl et al., 2007

The predictability of future developments is limited, hence considering

- lessons learned from past decisions -, and
- past key drivers (Urban water transition framework)- should be incorporated in scenario analyses.



Addressing complex interactions

Urban water cycle services are highly complex social-technical-systems that bring together human, ecological and technological components ;Strategic plans and policies should also account for complex interactions of social, environmental, political and economic pressures and trends.

M. van der Zouwen, C. Segrave, C. Büscher, J.A. Monteiro, A. Galvao, A. Ramoa, R. Hochstrat

Context scenarios are the most comprehensive way of testing the robustness of a vision. But forecasts and what-if scenarios can also be used, depending on the level of determinacy and uncertainty:

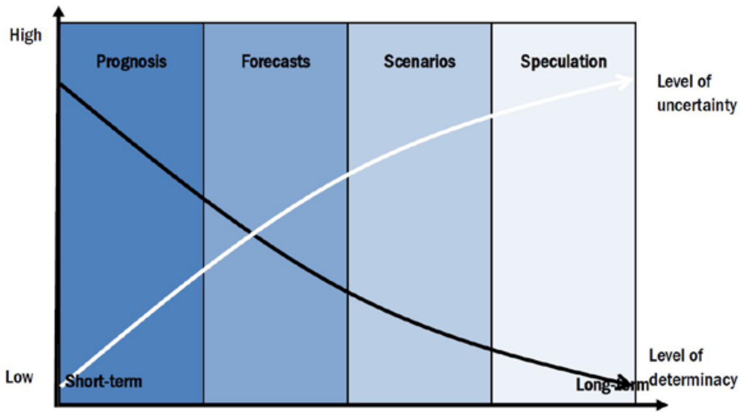


Figure 9: Methods for future research Nekkers, 2006.

On the shorter term (0-5 years), forecasts can be useful for trends with relatively certain probability distributions such as demographics.

What-if scenarios may be useful for testing known weaknesses of the internal system against extreme conditions in the external system.

Conclusions on Future Research

- Select a method of future research that matches the time horizon of the strategic plan
- Consider a broad palette of uncertainties and the interdependencies between them.
- The combined effect of various pressures and trends (the interdependency of pressures and trends) (e.g. population growth, hotter and drier summers and community expectations) should be addressed
- When little attention is paid to possible interdependencies, utilities run the risk of overlooking relevant threats and challenges by underestimating the complexity of reality.

TRUST Roadmap Guideline is a reference to a confrontation of the questions

'Where do we want to be?' with 'Where are we now?' and 'How might our environment change?'

4.9 Understanding the urban water system's metabolism

Designing and managing sustainable urban areas requires an understanding of the highly complex and dynamic interactions of the city system and its component sub-systems.

The TRUST Metabolism Model analyses complex interactions of the urban water systems elements and thus contributes to our understanding of the system itself which is also a type of uncertainty.

H. Alegre, D. Covas

4.9.1 Urban water systems behave as organic bodies

Urban water systems evolve over time similarly to an organic body, the performance of which depend on how their vital organs function. In living bodies, backbone and muscles provide the structure, but blood circulation, a functioning liver and brain, are key for a healthy body. They need to consume nutrients, water and oxygen in order to live and function. They generate by-products, some of them are further reused. Urban water systems have complex behaviours that can be addressed, from the physical perspective, as they were a living metabolism: the backbone is the infrastructure, the vital organs are the management processes. They consume resources (e.g., water, chemicals and other materials, manpower, energy, capital), produce functions (in this case services) with given levels of performance and associated risks, and generate outflows, such as waste, by-products and emissions to water and air. The physical components and the technologies of the urban water infrastructure operate under given local boundary conditions (geographic, climatic and socio-economic).

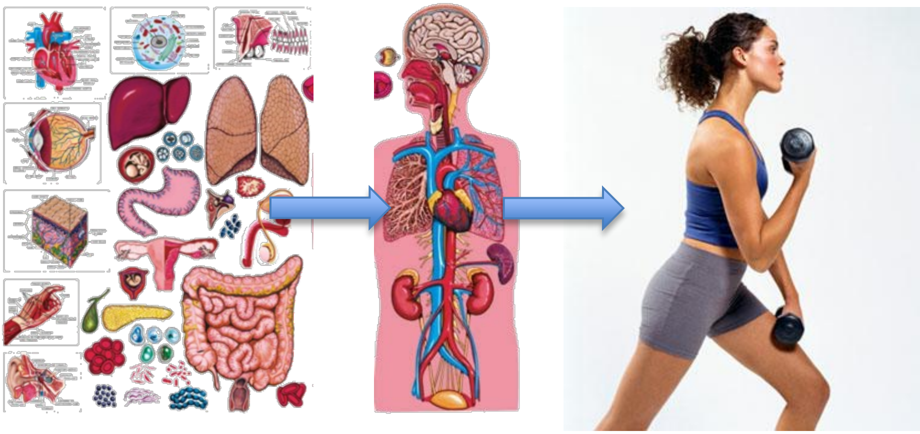


Figure 10: Metabolism of a human body

Metabolism (from Greek metabolismós) is the set of chemical reactions that happen in living organisms to maintain life. These processes allow organisms to grow and reproduce, to maintain their structures, and to respond to their environments. The notion of metabolism has also been applied outside the discipline of biology, such as, urban metabolism and industrial metabolism.

?

Why financial efficiency requires the understanding of the infrastructure metabolism?

The choice, the design and the operation of technologies critically influence the overall quality of the urban water services in terms of performance, risk and cost, as well as the overall system sustainability. The metabolism depends not only on the specific characteristics of the systems, but also on the local boundary conditions, including technology and management choices.

Understanding the metabolism of the urban water systems helps managing the transition paths and choosing the best options to pave the way for more sustainable services.

The application of metabolism models to industrial processes and to cities behavior is still relatively a new field of research(Barles 2010), although it has already been used for some time. For instance Browne et al., 2009 has measured metabolism inefficiencies for different sectors (e.g. food, textiles, paper) by relating the final disposal of wastes to consumption in the city of Limerick in Ireland. However, metabolism models had never been developed or applied to the urban water cycle services prior to TRUST.

4.9.2 The TRUST metabolism model

The TRUST Metabolism Model (Behazadian et al. 2014, Govindarajan et al. 2014) analyses highly complex interactions of the urban water systems elements and thus contributes to our understanding of the system itself which is also a type of uncertainty.

The TRUST metabolism model can be used to provide a physical basis for quantifying resource flows and for quality and sustainability assessment of future intervention strategies in urban water services in the long term.

When referring to the metabolism of an urban water system, there is a need to consider relevant flows and conversion processes of all kinds of materials and energy, which are mobilized by the development and operation of the system in order to fulfill the necessary functions. An example of partitioning a sub-catchment area into a number of local areas is shown here:

Figure 11: Scheme of a zone in a city with different types of local areas.

As a result of including the cyclic water recovery and resource recovery subsystems, the metabolism modelling may in a direct way also address emerging opportunities such as decentralised stormwater/waste water management and recovery, use of treated waste water, and recovery of resources from all parts of the system (i.e. any kind of material and energy recovery option).

The objective of a metabolism model is to directly assist water utilities in their systematic search for strategic improvements.

Metabolism studies tend to be data-demanding and to have a non-straightforward application. The TRUST metabolism model was developed with a complexity that limits its applicability to cities with reliable and comprehensible data systems. However, if the model as such is not applicable, it is important, at least, to identify and quantify the key resources needed (water, materials, manpower, energy), the outflows produced (waste, by-products and emissions) and the main mass-balances for each transition path or technological solution considered.

In this way, the metabolism approach supports the utility in the better understanding of critical system variables and the selection of the best infrastructure asset management options.

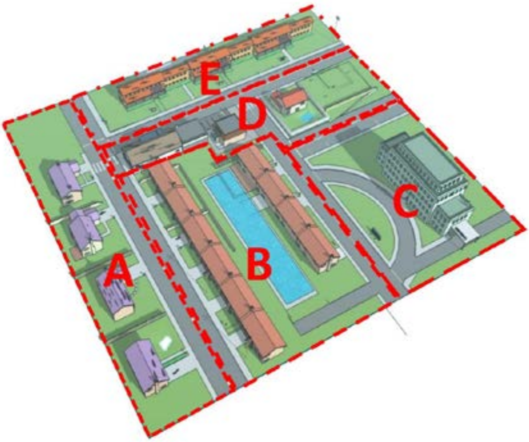


Figure 12: Scheme of sub-catchments in a city area

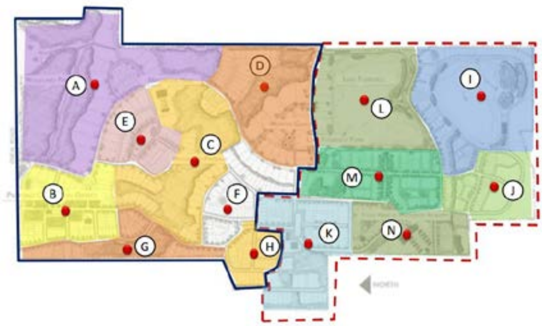


Figure 13: Scheme of local areas in different sub-catchments.

Interventions suggested by the water-sanitation utility in Oslo Oslo Vann og Avlopsetaten, had been tested using both the models – the WaterMet 2 (WM2) model and the Dynamic Metabolism Model (DMM).

The models have been extensively tested at Oslo VAV. A brief summary of the initial feedback from personnel at Oslo VAV is provided. The models were also introduced to pilot cities to understand their points of view, which have been presented in brief.

4.10 Developing a sustainable water sector strategy

Linking the vision, the current state of sustainability and pressures and trends

Within the strategic planning process, the vision will be confronted with the current state of the internal system - How sustainable are we today? - and the various probable and possible future states of the external system:

How might change environmental, political, social and economic patterns?

The TRUST Roadmap Guideline is a reference to a confrontation of the questions 'Where do we want to be?' with 'Where are we now?' and 'How might our environment change?'

Visions may be more conservative (compatible with a smooth evolution of the current solutions) or be more disruptive, especially when the current solutions are not sustainable or are unable to respond to pressures and challenges. In this latter case, the design of the transition path needs to be designed also in non-conventional ways, and **roadmapping is an adequate technique**, exploring the potential of multi-stakeholder expertise and communication.

O Resilience can be achieved from a perspective of robustness and/or flexibility. It is useful to consider which approach(es) match the local circumstances.

How to find clear long-term strategies that perform well under conditions of change? How does back casting help to get there?

Roadmapping stages relate to general phases of an adaptive strategic planning process.

The TRUST roadmap links strategy to future needs and actions and incorporates a plan for needed adaptations measures to be available at the right time. It addresses to managers and decision makers of urban water services related institutions in each city and can be adapted in general for all strategic UWCS planning activities.

The roadmap process also sets out a creative process for establishing an interdisciplinary planning procedure, which facilitates a lot of expert discussions.

TRUST Roadmap guideline: A manual to organise transition planning in urban water cycle services

A roadmap enables decision makers to plan and implement a pathway to achieve desired objectives. At the same time it serves as an excellent communication tool.

Roadmap motivation:

- Review and fine tuning of existing visions and strategic plans
- Need for a strategic plan and its implementation
- Dissemination of own sustainability strategies
- Anticipation of non-sustainable developments in advance
- (Re)launch of a systematic discussion on sustainability issues
- Examination of an innovative planning procedure

The roadmap process can consider good practices of water service related institutions (e.g. drinking water/wastewater utility, local administration, local government, NGOs etc.) for urban water management and its sustainable planning. It will help to find the individual pathway to sustainable UWCS focussing on individual/regional/local adaptation needs and ambitions of the TRUST cities/demonstration clusters. The roadmap is designed as a communication approach that organises a collaborative strategic planning for sustainable USWC in a pre-defined date (e.g. 2050). It supports a direct exchange between all relevant actors. An open interest of the cities/demonstration areas in transition and adaptation issues is a very important element for a successful roadmap demonstration. The roadmap exercise needs data and information about the status quo and (realistic) assumptions about selected future trends and pressures of each participating city. This information will be collected, analysed and assessed with an active participation of the cities in workshops to define a catalogue of measures for a stepwise implementation of the urban water system and service transition. The roadmap guideline describes the roadmap demonstration and provides supporting templates.

The TRUST roadmap approach considers the following stages: **scoping**, **forecasting**, **backcasting** and **transfer.**

The role of communication and synthesis:

- A core element for a successful roadmap exercise is the role of communication and exchange between the partners. Participants in the roadmapping process should have an open interest in the transition and adaptation needs of "their" existing UWCS.
- The development of a roadmap supports communication between involved operators, stakeholders, administration and the public, which is necessary for establishing a mutual understanding of the needs of transition, and for supporting a collaborative planning process.
- The implementation of a sustainable future for UWCS within a city or region will be supported by this collective preparation.

4.11 Key messages for policy makers

Most existing urban water systems were typically designed using a linear approach with high predictability and controlability in mind and a focus on technical problems only. Pahl-Wostl et al. (2007) describe this as "the command-and-control paradigm that has been dominating the water management community for decades."

Adaptive planning processes are systematic strategies to consider past experiences, to deal with future uncertainties and system complexity to improve water management by investing in flexibility and learning to implement iterative adjustments and redefine objectives as new insights arise (Pahl-Wostl et al., 2007).

To achieve sustainable urban water services, it is essential:

- to consider diverse views and interests: integrated planning of water services - broad stakeholder participation
- to have a long term vision of the service
- to take into account all dimensions of sustainability
- to consider the complexity of the system and interdependencies with other natural and anthropogenic systems
- to gain experience from considering past decisions,
- to consider future uncertainties and the limits of predictability
- to ensure that service objectives and targets are permanently met in the transition path while implementation and adaptation of objectives

Financing and cost recovery

Promoting an adequate level of cost recovery

5

N.A. Müller

5.1 Sustainable Financing

A central tension in water services financing is the conflict of objectives between capital investors, who want to recover their investments, and (often heavily regulated) operators, who are ensuring a stable value of the infrastructure.

> “The overall public and private investment needs for improved water supply and sanitation [...] are considerable. However, at the country level, meeting such investment challenges is highly feasible and within reach of most nations.”
>
> SIWI WHO, 2005

By taking into account these tensions between public and private perspectives, both market and non-market based financing strategies shall be presented.

The role of sustainable financing within the water sector will be clarified based on the TRUST sustainability indicators:

- The definition and role of sustainable financing
- Recommendations to ensure financial sustainability within the water sector
- Financial Sustainability Rating Tool
- Costs associated with water services, models for tariff structures, willingness to pay

5.2 The definition and role of sustainable financing

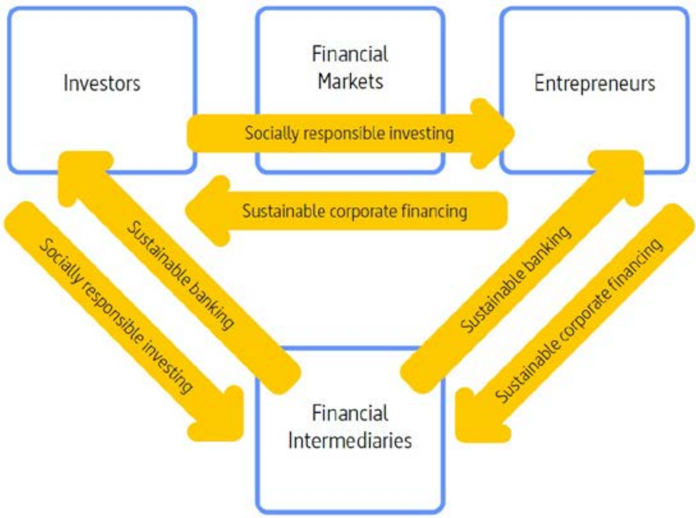


Figure 14: A framework for sustainable finance, Salzmann (2013)

The figure above shows a framework for sustainable finance from the foundations of financial theory. It is noticeable that sustainable finance is a complex network, which is influenced by different stakeholders in the market. The targets and methods of sustainable finance are depending on perspectives of investors, entrepreneurs and financial intermediaries.

Salzmann (2013) points out that socially responsible investments have significantly gained importance over the last decade, which reflects "[…] the increasing awareness of the financial community to social, environmental, ethical, and governance concern." Further, financial institutions can have impact on sustainable finance through their lending policies.

Considering social and environmental effects of their investments and loans, they can impose certain pressure on the borrowers. But also the companies themselves have influence on sustainable finance (Salzmann, 2013. Within a sustainable corporate finance approach, "[…] maximizing long-term firm value should […] not contradict maximizing long-term social welfare, including the welfare of all stakeholders like employees, society, environment, and so forth" (Salzmann, 2013).

In contrast to this perspective from financial theory on sustainable finance, the meaning of utilities' financial sustainability within this report is less holistic. The company shall ensure service provision and maintaining of the assets with the help of financial stability. This means particularly an adequate planning and management of financial resources.

Ensuring financial sustainability may affect certain sustainability dimensions, objectives and criteria for Urban Water Cycle Services (UWCS) within the TRUST project.

Especially the Economic Dimension with its objective Ec1 'Ensure economic sustainability of the UWCS' includes a sustainable financing of water infrastructures. The financial component can particularly be seen within the following assessment criteria:

- **Ec12 - Economic efficiency:** The available financial resources must be used wisely. Economic efficiency within a production setting includes allocative but also technical components: "Production is technically efficient when maximum possible output is generated with a given set of inputs, or when a selected output is produced at minimum cost" (Billi et al., 2007)
- **Ec13 – Leverage (degree of indebtedness):** The degree of indebtedness is an indicator of how financially independent a utility is. Nonetheless, the use of debt plays an important role in many utilities' financial strategies and represents a common financing model.
- **Ec14 - Affordability:** Water prices and the associated tariff designs must not compromise the ability for customers to be able to afford the costs. The ability to pay is "a measure of whether individuals or communities are able to pay for services, given levels of unemployment, other indicators of poverty, and social capital (IRC, 2003).

Due to their high importance, these criteria shall be considered within this section. However, it is striking that conflicts of objectives can occur. For example, tariff adaptations can help to ensure cost recovery (Ec11), but have also to be weighted under affordability issues (Ec14).

Generally, it can be stated that there are mainly two adjustment screws to reach financial stability within a utility:

- fundraising due to revenues or alternative financial sources
- the reduction of costs and/or effective allocation of resources

5.3 Financing Strategies

Before actual financial decisions are taken, an appropriate strategic direction should be developed. Financial policies determine the extent to what a utility will rely on various financial sources, such as tariffs, debt and equity to meet systems' expenses. Further, it can define how long-term debt will be structured and repaid (Rothstein & Galardi, 2007).

Within § 9 of the European Water Framework Directive (WFD)

> "Member States shall take account of the principle of recovery of the costs of water services, including environmental and resources costs […], and in accordance in particular with the polluter pays principle"
>
> European Water Framework Directive, 2000

This is associated with an adequate cost allocation "[…] into at least industry, households and agriculture […]." In combination with previously mentioned sector specific challenges, reliable cost calculations, allocations and estimations are essential and will be further discussed in the section 5.3 Recommendations to ensure financial sustainability within the water sector.

From the Water Framework Directive, it can be deduced that revenues from water pricing should be the main financial source for water utilities (see also WHO (2012)). Water pricing is an important and powerful management tool for utilities since the price level and tariff design has significant influence on the revenues, the fairness as well as the water demand (e.g. Tsagarakis, 2005).

Nonetheless, water pricing is mostly based on the recovery of basic operation and maintenance costs. Costs for major repairs, rehabilitation and replacement are in practice, however, only rarely covered (IRC, 2001).

“Economic and financial sustainability of the water sector is key for its development and future performance, and will become a relevant driving force. Sustainable cost recovery as defined by the OECD must be achieved and among the three sources – the 3 Ts, tariffs are already the major contributor and will continue to grow in view of public spending and tax raising constraints, progressive phasing out of transfers and the positive role of tariffs as a water demand management tool. The only limit to this trend is affordability and the need to ensure access to basic service. Political misinterpretation of water services as a social and non-economic good has also been a strong obstacle to cost recovery and economic and financial sustainability of the sector.
The sector is still capital intensive thus requiring financial bridging mainly through loans. **Private equity has not played a major role and its cost is considered high and above what would be acceptable for the provision of a good that is highly social.** Its contribution is also proportional to the level of participation of the private sector. Pension funds that fit well in the nature of the sector due to the long lifetime of urban water assets and low demand risk of the service provided (drinking water) could play an important role in funding urban water infrastructure provided that the political risk, i.e. random setting of tariffs is mitigated.”

JOSÉ TOMAS FRADE, Coordinator of the Portuguese water strategy PENSAAR and former head of EIB Water & Sanitation Division

The 3 Ts

The Organisation for Economic Cooperation and Development (OECD, 2010 points out that usually a certain mix of tariffs, taxation and transfers (the 3 Ts) present the utilities' revenues. Whilst tariffs are direct funds contributed by customers for the service, taxes are transfers from local, regional or national government, which originate from domestic taxes (WHO 2012).

Beside these two sources of revenue, in some countries transfers can also play a role. "Transfers refer to funds from international donors and charitable foundations [...] that typically come from other countries" (WHO, 2012). If these revenues are not sufficient to cover all costs, a financing gap results. The problem which arises is illustrated in the following figure:

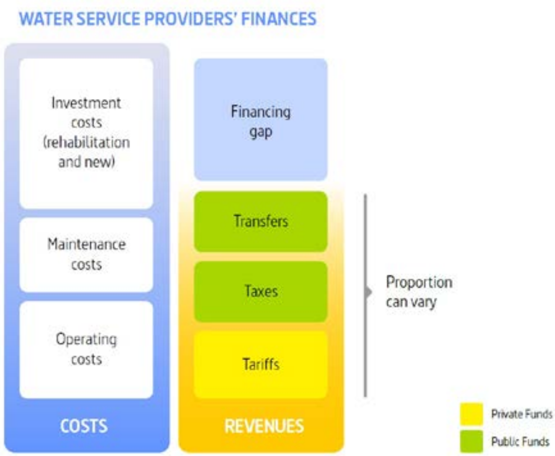


Figure 15: Financing gap within water services (WHO, 2012) adapted from (OECD, 2010).

If reducing costs cannot close the financing gap or increasing revenues from tariffs, taxes or transfers, alternative funding sources can be a solution, however, the different approaches need to be checked by financial planners on their availability, suitability and sustainability (IRC, 2001; WHO, 2012). Options for alternative financial sources are mainly (IRC, 2001):

- existing community sources,
- private or corporate financing,
- credit-loan mechanisms,
- grants, or
- specific funds.

The use of repayable finance can help to bridge the financing gap, before the financing gap results in an investment gap (WHO, 2012), which would conflict with the overall goal of sustainable service operation. The following figure shows options of using repayable finance to bridge the financing gap (OECD, 2010):

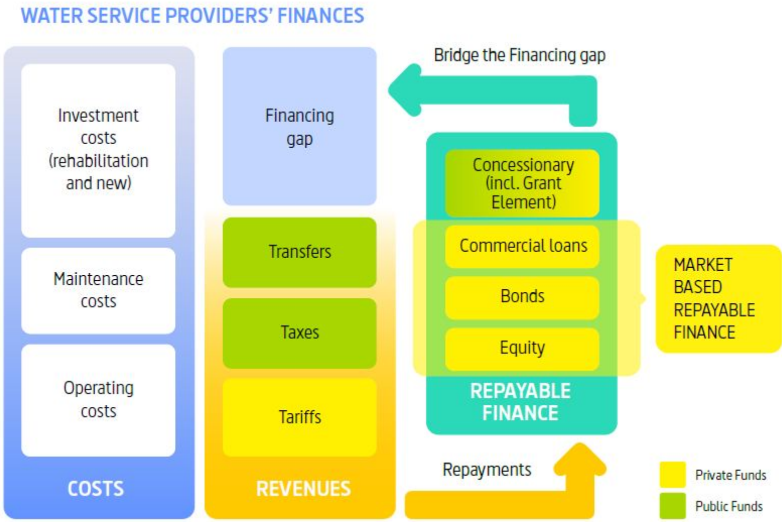


Figure 16: Options to bridge the finance gap (WHO, 2012) adapted from (OECD, 2010).

However, the type of finance, which is adequate in a certain situation, is highly dependent on the national and regional circumstances, as e.g. the access to some types of repayable funding is much more limited in developing countries than in developed ones. Further, the credit-worthiness of a utility strongly depends on the current level of cost recovery and predictable revenues as well as the strength of its balance sheet (including the current levels of indebtedness) (OECD, 2010). This emphasizes that cost recovering water pricing strategies are not only important from revenue perspective, but allow also a better access to alternative, repayable funding sources for urgently needed investments.

Ideally, a company should find the right balance between debt and equity under consideration of the Weighted Average Cost of Capital (WACC). The most efficient financial structure appears at the debt-equity-mix with the lowest WACC (Frontier Economics, 2013).

All in all, Rothstein & Galardi (2007) point out that "self-sufficient water and wastewater utilities recover adequate revenues to support operations, finance all capital investment needs, and provide for adequate renewal and replacement of system assets." This requires an appropriate financial management including the determination of a corporate financing policy as well as financial planning (including cost & revenue forecasting and capital planning & financing) Moreover, an adequate tariff design with respect to the affordability of prices is very important (Rothstein & Galardi, 2007). Therefore, the costs and revenues are considered in more detail in the following section 5.3: Recommendations to ensure financial sustainability within the water sector.

5.4 Recommendations to ensure financial sustainability within the water sector

The first step to reach financial sustainability is the identification of certain areas of action. Different questions should be raised continuously within every utility, for example:

- Can costs and revenues be separated for each service/field of business?
- Are the costs for each service recovered by its revenues now and will the current revenue structure (e.g. tariff designs) also meet future challenges?
- Are the current financing and investment policies adequate to ensure long-term asset maintenance?

This analytical process can be supported by the use of special tools (e.g. the TRUST Financial Sustainability Rating Tool) or the participation in financial sustainability benchmarking (Berg & Sanford, 2010). Larsson et al. (2002) give comprehensive insights in financial key performance indicators, data collection and cost allocation within the special context of process benchmarking. The comparison with other utilities is highly recommended. Regional, national and particularly also transnational benchmarking projects offer an opportunity to see how the market has evolved, and where the utility stands in comparison to others in the sector (Hoffjan et al., 2014).

After having identified certain problems, the application of appropriate measures is typically in the task pane of the utility. The options for sustainable financing and recommendations for improvement actions presented within this report shall encourage utilities to take the next step to reach financial sustainability.

- Implementation or development of efficient cost type accounting, cost centre accounting and product cost accounting under consideration of the current law and actual information needs within a utility.
- Awareness of the costs' ascertainability, structure, controllability and decision relevance.
- Development of efficient cost management systems
- Identification of cost drivers and their optimization
- Identification of cost reduction potential in favour of investments (e.g. in old infrastructure, new technologies and ecologic measures).
- Analysis of capital structure and increase in the equity ratio (e.g. recruiting new partners)

Asset Management

Assessment of the infrastructure replacement cost, of the current fair value and of the annual rehabilitation invested needed to keep the infrastructure value:

- Objective-driven diagnosis, identifying key problems with regard to the long term objectives defined.
- Dynamic identification and reporting of critical assets.
- Design, analysis and selection of intervention alternatives, taking advantage of existing methods and software and aiming at balancing cost, performance and risk in the long term.
- Enhanced investments in renewal and replacement of old and/or critical tangible assets.
- Increased use of profitability calculations (e.g. asset life cycle costing).
- Consideration of the Return on Investment (ROI) for improved investment planning.
- Implementation of cost-benefit analysis for outsourcing alternatives.

- Structured leakage detection and implementation of leakage reduction measures.
- Advanced energy saving measures (e.g. implementation of energy management systems or energy audits).

Business Operations

- Approximation of revenue structure to the actual cost structure to avoid lack of cost recovery (the fixed costs should be almost covered by fixed revenues).
- The use of cost transparency as driver for customers' price acceptance and willingness to pay.
- Analysis of the customers' payment behaviour and reduction of late payments via enhanced customer contact as well as systematic and stringent collection procedures.
- Consideration of the inflation rate in the context of price adjustments.

Forecasts

- Early identification and consideration of future trends.
- Detailed analysis of cost development (e.g. rising energy costs).
- Detailed analysis of revenue development (e.g. demographic change, future water demand).
- Development of sustainable pricing strategies.

A utility has different opportunities to avoid a financing and investment gap. Market-based and non-market based strategies are generally applicable. Thereby, the funding should primarily be based on a cost recovering pricing strategy. However, in practice this is not always realizable, so that repayable finance is needed.

From utility's perspective the capital structure is of major relevance, since the costs of capital are quite high in the sector. Thus, in the context of finding the right financing policy, the **W**eighted **A**verage **C**ost of **C**apital (WACC) should play a decisive role (Frontier Economics, 2013). However, it must be stated that also national regulatory frameworks can have significant influence on the applicability of potential financial models.

5.5 Financial Sustainability Rating Tool

A. HOFFJAN, V. DI FEDERICO, T. LISERRA, N. A. MÜLLER

Solid financial position of water and waste water utilities builds the basis for their sustainable services in the future, because it allows adequate investments into infrastructure renewal, technical innovations and ecological measures.

Whether operating in a developed or developing country context, well-run utilities are founded on being financially sustainable.

“Whether operating in a developed or developing country context, well-run utilities are founded on being financially sustainable.”

Rohtstein & Galardi, 2007

Most utilities already decided for a financial policy. Starting point for further strategy decisions should be an analysis of the current financial situation. Therefore, the Financial Sustainability Rating Tool (FSRT) was developed within TRUST.

It gives the user an indication, which area from financial situation over asset management to business operation needs optimization. The FSRT also evaluates different forecasts (e.g. population development) and country specific characteristics (e.g. inflation rate) to assess future trends.

The tool encompasses 21 selected performance indicators, which help to analyse a utility’s financial position. Using primarily performance indicators for water and/or wastewater, published by the International Water Association (IWA), based on annual values allows a holistic perspective and analysis of the utility's development (see Alegre et al. (2006) and Matos et al. (2003)).

If the application of the FSRT detects deficits in one of the evaluated areas, specific recommendations help to take the first step to improve financial sustainability. Due to its standardisation, the online tool cannot offer individual recommendations - nonetheless, the following general suggestions could be identified:

- Financial Situation
- Asset Management
- Business Operations
- Forecasts

The Financial Sustainability Rating Tool offers water supply and/or wastewater management companies an opportunity to rate the utility's financial sustainability.

It gives the user an indication, which area from financial situation over asset management to business operation needs optimization. The Tool also evaluates different forecasts (e.g. population development) and country specific characteristics (e.g. inflation rate) to assess future trends. Barometers with green to red indicators for each area as well as overall scores visualize the results of the web based rating.

To achieve meaningful results the tool is directed at utilities, which provide either only one of the two services or are able to split up the information and costs related to each service.

Adaptive urban water systems

6

Ensuring consistency in system performance over changing conditions.

What is resilience in terms of Urban Water Systems?

Resilience indicates durability or continuity. Its achievement is promoted by enhancing both the potential for change (flexibility), and the ability to change (adaptivity).

The decision issues faced by water professionals and policy makers concern the selection of appropriate technology options and network configurations that cope with future uncertainties and that can meet system design criteria such as cost and user acceptance (Jeffrey et al., 1997).

Adaptive infrastructure systems on an appropriate scale have diverse sources of design, power and delivery (Pahl-Wostl et al., 2007) to ensure consistency in technological system performance over changing conditions (Jeffrey et al. 1997).
By viewing various regional pressures arising in Europe and thus different water demand and supply dynamics, the criteria for desirable infrastructure characteristics and technologies are strongly region or context-specific.

“Often we need ‘appropriate practice’ rather than ‘best practice ‘.”

David Marlow, CSIRO

This chapter outlines the concepts of resilience, flexibility and adaptivity in terms of urban water systems, gives and overview on innovative urban water technologies:

- Flexibility and adaptivity in general
- Resilience of urban water systems
- Flexible and adaptive stormwater systems
- Adaptive potential self-assessment tool
- Understanding responses to innovation
- Supporting research and innovation

6.1 Flexibility and adaptivity

> "According to Darwin's Origin of Species, it is not the most intellectual of the species that survives it is not the strongest that survives; but the species that survives is the one that is able best to adapt and adjust to the changing environment in which it finds itself. '."

LEON C. MEGGINSON, *Lessons from Europe for American Business*, Southwestern Social Science Quarterly (1963) 44(1): 3-13, p.4

In evolutionary terms...

Flexibility is the potential for change - have options for alternative action; adaptivity is the ability to change - be able to utilise these options (Jeffrey et al., 1997).

Flexibility is promoted **diversity** and **learning**; **Diversity** alludes to the totality and relative proportions of different typological groups in a community. Flexibility is also promoted by **learning** about the own environment which enables organisms to **adapt** their behaviour (Jeffrey et al. 1997).

Adaptation is a process of modification of the organisms physical characteristics. Acclimatisation is an example of **reversible adaptation** (Jeffrey et al. 1997).

Projected on urban water management:

Major modifications to the configuration and operation of the urban water system will be necessary to cope with **future uncertainties.** Changes over time in social priorities, spatial and temporal water demand and rainfall patterns, economic and demographic change and science and technologies.

Broad stakeholder participation ensures the consideration of **diverse views and interests**

The **diversity** of **perspectives** and i**ndividual capacity** and the will to **learn** promotes the **flexibility** of the group of the stakeholders ensuring to be on track toward sustainable urban water management.

The **consideration of past experiences and future uncertainties** (climate change, demographic change etc.), can be seen as **learning about the own environment**, which enables **adaptation** of water management and infrastructures as well as development of innovative urban water technologies and operational options.

6.2 Resilience of urban water systems

Resilience indicates durability or continuity. Its achievement is promoted by enhancing both the potential for change (flexibility), and the ability to change (adaptivity).

Urban water systems which support changes are capable of adapting to temporal and spatial variations in the demand profile. An adaptive technical infrastructure system has an "appropriate scale" and "diverse sources of design, power and delivery" (Pahl-Wostl et al., 2007) in order to "ensure consistency in technological system performance over changing (operating) conditions" (Jeffrey et al. 1997).

[Flexibility is the potential for change (have options for alternative modes of operation)]

This includes diversity and learning:

- knowledge and experience, availability of/ development of technologies, technical feasibility and technical performance
- diversified technology base
- flexibility and cost benefits through decentralised concepts / the flexibility of an urban water system might be enhanced by decentralised technologies
- new opportunities for the design of water and waste water networks arise from the implementation of decentralised technologies at different spatial scales
- such as rain water basins or water recycling technologies at the district, street or building level
- alternative sources of water for fire fighting

[Adaptivity is the ability to execute such change (be able to exploit these alternatives)]

Adaptation through modification of a structure, a technical configuration or operation of urban water systems: Adaptive changes to ensure consistency in technological system performance over changing operating conditions (Jeffrey et al., 1997).

Regarding spatial competition of fundamental services (water, waste disposal, energy, telecommunications and transport), sufficient space, accessibility, economic feasibility (capital costs, maintenance costs), meeting legal requirements and public acceptance.

The presence of different types of infrastructures can enable **resilience at system level** and contribute to an adaptation to distinct pressures the system may face.
In order to increase preparedness to meet future needs in **water supply, more diversity & alternative supplies**, **increased storage** capacity and **separated supply of water for fire fighting** are main issues.

Due to s**ensitive decentralised stormwater management** and **reduction of stormwater flows**, combined sewers can be replaced with the aim of separated collection of stormwater and rainwater. Cost, public health and environmental benefits due to modification of sewer diameters and avoidance of sewer overflow events promote sustainable modifications of the waste water infrastructure and the reduction of the volume of waste water to be treated.

Securing supply and/or the service over conditions of change can be handled by **modular technology design** of water and waste water treatment plants.

By viewing various regional pressures arising in Europe and thus different water demand and supply dynamics, the criteria for desirable infrastructure characteristics and technologies are strongly region- or context-specific.

An example for securing water supply by diversification

Even in the presence of demand-side strategies to reduce water consumption, when demand still exceeds water availability, alternative supply sources need to be considered. Diversifying water supplies prevents an overreliance on just one source and therefore reduce risks of water shortage (Ingham et al., 2007) and a region's over-reliance on a single source of imported water (Loftus, 2011). The following figure illustrates the interconnection between these main issues in securing supply.

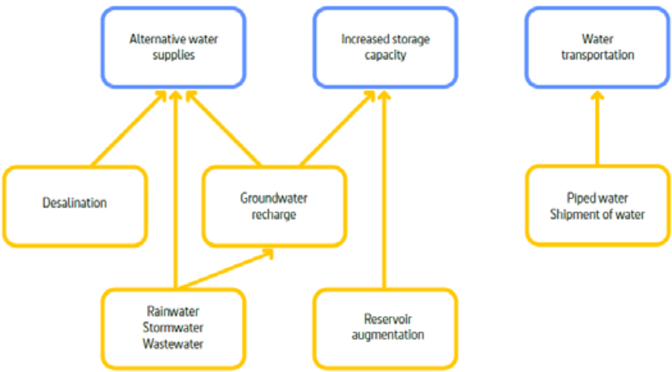


Figure 17: Options that provide flexibility and resilience to secure water supply (Smith et al., 2012)

6.2.1 Flexible and adaptive stormwater systems

Existing urban water drainage systems fail frequently because current pressures as growing cities and populations, continuing soil sealing and heavy rains overload the urban drainage infrastructure.

The transport of waste water and storm water to receiving waters can be achieved through a series of different pathways and combination of infrastructures, which interconnect and also interact with the receiving waters. The interconnections that exist in combined sewerage systems can produce significant impacts to the receiving waters during wet weather due to the discharge of combined sewer overflows (CSO), and fail to ensure that all waste water that is produced is adequately treated in a waste water treatment plant (WWTP) before the final discharge.

Historically, the main objectives in the design of urban drainage systems were to ensure an efficient management of peak flows and the adequate treatment of polluted waters, in order to maintain public hygiene and to prevent flooding (Rauch et al., 2005). More recently, integrated approaches for urban water management emerged and other key issues were identified for a sustainable water management such as surface and ground water quality, ecological concerns, and recreation (Shutes and Ragatt, 2010).

In order to operationalise these concepts, in the last decades several management practices in urban drainage management have been developed. These are mostly directed towards stromwater management practices, to face the highly variable flows and increasing pollution levels. Stormwater managment practices have evolved from highly engineered solutions, which did not blend with the environment, to eco-engineered solutions with multipurpose functions (Novotny et al., 2010). These eco-engineered practices are more sustainable than traditional ones since they can provide sustainable services, namely the following (Novotny et al., 2010):

Provide and enhance surface drainage, repair hydrology by reducing flooding and providing enhanced infiltration and provide some ecological base flow to sustain aquatic life as well, remove pollutants from the ecological flow, Provide water conservation and enable water reuse, Buffer and filter pollutants and flow for restored/day lighted streams, enhance recreation and the aesthetic quality of the urban area, save money and energy.

Stormwater management practices are commonly divided into structural and non-structural measures. Structural management practices involve the construction of a physical infrastructure whereas non-structural involve either the introduction of a new management practice or the modification of an existing management practice (Ellis et al., 2006).

Some examples of structural storm water management practices are also classified as Sustainable Urban Drainage Systems (SUDS).

These technologies consist of different modular elements, which are compatible with each other and can be replaced or changed independently. This modular characteristic enables a decentralized application which facilitates the allocation of resources to locations that are most affected by change (Eckart et al., 2011).

6.2.2 Sustainable urban water drainage systems (SUDS)

- infiltration basins
- porous pavements
- detention ponds/basins (dry ponds),
- trenches,
- green/brown/blue roofs,
- swales

Potentials of SUDS implementation

Short term potential
Implementation of SUDS is technically easy to perform. The realization can take place within the next one to five years. The costs are moderate because space for SUDS is already available.

Long term potential
Implementation of SUDS is technically not easy to perform. In general some changes in infrastructure or structural measures at buildings are necessary, like unsealing of areas or reconstruct drainage of buildings. The long-term disconnection potential turns into short-term potential, when the renewal of infrastructure (new sealing for streets, new design of areas etc.) is planned within the next years.
The decentralized application of SUDS has been pointed by Eckart et al. (2011) as turning drainage systems more flexible, when compared to traditional, centralised options. This flexibility will enable utilities and other stakeholders to perform an adaptive management of the system.
The modular characteristic of most SUDS will potentially be relevant since a transitioning pathway to achieve more sustainable urban water systems will need to take into

consideration existing infrastructures, and possibly the introduction of new ones in urban areas already consolidated.

6.3 Adaptive potential self-assessment tool

Organisations in the water sector are facing increasingly complex and evolving challenges - from meeting stricter performance requirements, to dealing with global trends such as population growth, economic downturns and climate change. This dynamic context increasingly requires organisations to be more flexible and adaptive - to adjust themselves to suit changing circumstances.

The TRUST self-audit adaptive potential tool for urban water stakeholders has been developed specifically to help water sector organisations understand and improve their capacity to be adaptive. By doing so, an organisation can learn more from their experiences and adjust management practices as a result of what is learned.

The tool guides users through a series of targeted questions, in which they are asked to assess particular practices within of their organisation. The purpose is to instigate thoughts about how their organisation operates and how practices might be improved. Once the tool questions are completed, an overall assessment scores that reflects the adaptive capacity of the user's team is provided. A suite of on-line resources is also given to the user. These are specifically tailored to help build on the strengths and reduce the weaknesses in their adaptive capacity.

6.4 Understanding responses to innovation

The exploration and use of innovative technologies and approaches are important concerns in relation to the water sector.

Many of the technologies that are currently of interest in the European water sector are those that could be used by customers themselves – e.g. smart meters, household supplies of non-potable water, or building-level stormwater management measures such as green roofs. For these kinds of technologies in particular, it is important for water service providers (and other governance bodies) to understand how customers might react to such technologies, and how water service providers might respond to such reactions.

Considerable research has been undertaken to explore how societies react to new things – particularly innovative technologies. There has long been a dominant perception that public reactions to innovations are mainly based on knowledge – i.e. the more the public is 'educated' about the benefits of a particular innovation the more likely they are to accept it. However, the reality is much more nuanced than that.

Within the academic literature on responses to innovation, there is considerable variation in the terms used to characterise and define responses. Below is an example typology of different potential responses to innovation, based on a synthesis of such literature.

- **Opposition** – This implies that consumers have made a conscious and (at least somewhat) informed evaluation of an innovation, and based on their assessment, they strongly contest it and deem it unacceptable not only to themselves, but to society as a whole
- **Rejection** – This implies that consumers have evaluated an innovation and deemed it unacceptable within their own lives (but not necessarily unacceptable to society)
- **Apathy** – This implies a lack of either positive or negative attitudes towards an innovation – i.e. indifference and therefore inaction. It can reflect a lack concern for the 'problem' a given innovation is meant to address or even the inertia from consumers simply persisting with what's familiar and therefore comfortable.
- **Acceptance** – As with rejection, this implies that consumers have evaluated an innovation and deemed it acceptable within their own lives.
- **Postponement** - This implies that a consumer has consciously decided to wait for a more suitable period to make use innovation, despite potentially finding the innovation, despite potentially finding the innovation acceptable in principal. For instance, consumers may decide to wait until a technology is tested or proven before purchasing it.
- **Adoption** – While acceptance does not necessarily a behavioural response, adoption implies that consumers do take action to make full use of an innovation and incorporate it within their lives. However, it is worth noting that the public may only 'accept' or 'adopt' an innovation because they perceive they have no other choice or that their choice is limited.
- **Social Acceptance**> – As with opposition, this implies that consumers have evaluated an innovation and deemed it worthwhile not only for themselves but for society as a whole. It could also imply positive reception to an innovation at a broader scale – e.g. support for an innovation within policy frameworks, or within markets.

6.5 Supporting research and innovation

The implementation of new technologies or management approaches within the water services sector is often not straightforward. The Water supply and sanitation Technology Platform (WssTP, http://wsstp.eu/), which is the European Technology Platform for water, has identified five key challenges for the European water services sector, including the need for 'facilitating technology transfer' within the sector. To help address such challenges, the WssTP has developed a long-term Strategic Research. Agenda for the water services sector, which is geared in part towards strengthening the link between cutting edge research and water service providers.

Concerns over the way in which water service providers could explore and ultimately make use of up-to-date research, as well as innovative technology and management approaches are highlighted in practice: Examples of the innovative technologies include for instance:

- Waste water recycling,
- non-potable supply systems in homes,
- smart meters,
- pipe replacement systems, and
- stormwater management technologies (e.g. green roofs)

Such technologies are not necessarily new but may still be considered innovative if they are not yet embedded in everyday processes and practices.

Often it is difficult to know whether particular technologies or research findings were valid and/or appropriate for their particular context.

Concerns about an increasingly risk-averse attitude in water sector governance (e.g. within national policy frameworks), as well as more stringent demands around the justification of expenditures, might prevent service providers from trialling new and potentially unproven technologies and approaches. As a result, water, waste water and stormwater service providers may have some desire to ensure that water sector governance could support the exploration and use of innovative technologies and approaches, and not unnecessarily stifle such activity.

Considerations when developing and/or proposing the interventions

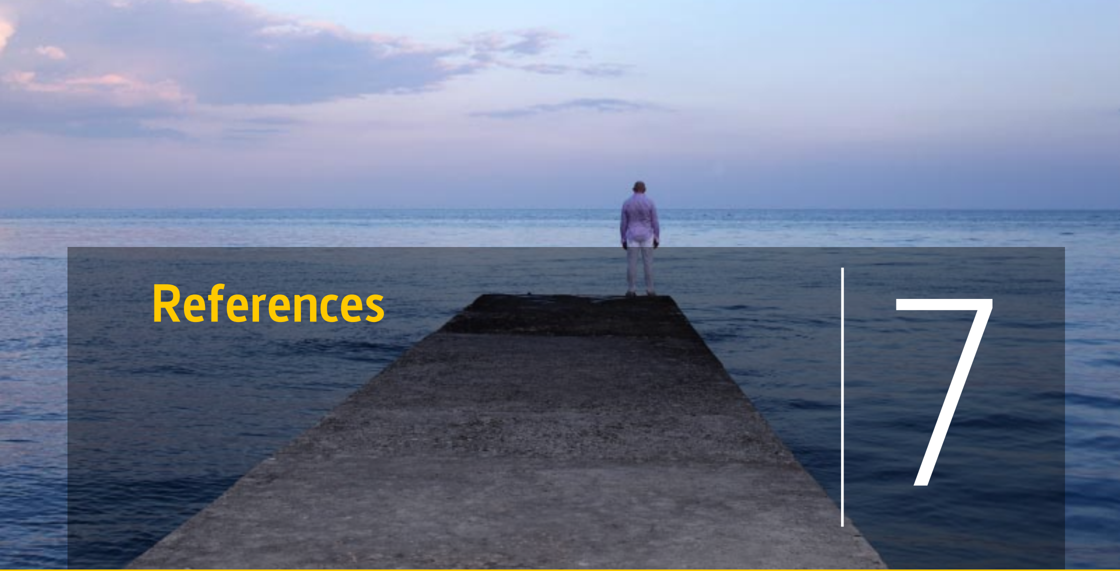
One of the most important considerations around water sector research and innovation is where the centres of research are primarily located – e.g. within universities, state-funded research agencies, or within water service providers themselves. It is also important to consider the nature of the relationship between these centres of research and the rest of the water sector. For instance, how are the key topics of research decided, and do water service providers have any opportunity to shape the research agenda? In regards to the trial and implementation of innovative technologies and approaches within the water sector, it is important to understand where the burden of cost falls, and where the burden of risk falls (e.g. the risk of technological failure). If those burdens are borne primarily by water service providers, this may act as a disincentive towards the use of new technologies and approaches. Finally, it is important to consider potential reactions towards innovations among water service customers, as well as other stakeholders – long-term strategies around customer engagement and stakeholder interactions may help water service providers to anticipate and respond to such reactions.

6.6 Key messages for policy makers

To achieve sustainable urban water services, it is essential:

- to consider diverse views and interests: integrated planning of water services - broad stakeholder participation
- to have a long term vision of the service
- to take into account all dimensions of sustainability
- to consider the complexity of the system and interdependencies with other natural and anthropogenic systems
- to gain experience from considering past decisions,
- to consider future uncertainties and the limits of predictability
- to ensure that service objectives and targets are permanently met in the transition path while implementation and adaptation of objectives

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 265122.



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Transition to Sustainable Urban Water Services of Tomorrow
For policy makers

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