Guidelines for assessment of UWSC current situation and future scenarios

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trust

D51.2

TRANSITIONS TO THE URBAN WATER SERVICES OF TOMORROW

Guidelines for assessment of UWSC current situation and future scenarios – D51.2

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Final Version for Distribution

June 2015

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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1. INTRODUCTION AND CONTEXT

1.1. Purpose and Scope of the guidelines

To establish a strategy to manage a transition for a more sustainable Urban Water Cycle Systems (UWCS) a water utility needs to develop initial steps to have:

- a current state evaluation of the UWCS they manage;
- a definition of possible future scenarios; and
- a preliminary portfolio of possible transition tracks.

The European project "TRansitions to the Urban Water Services of Tomorrow" (TRUST) has developed the tool "TRUST&GO" under the workpackage WP51, to guide urban water utilities in their TRUST path to a sustainable future in a straightforward and user-friendly way. The main idea is to drive anyone (water professionals, decision makers and other water sector's stakeholders) in the use of TRUST deliverables, or other available approaches identified as useful tools or best practices to assess the UWCS current state and possible tracks. With that in mind, the TRUST&GO tool is designed as a stand-alone online tool to easily help and guide inside the TRUST project. This document contains D51.2 and gives access to D51.1 online tool that can be found at: http://wp51.addition.pt.

The current deliverable is focused on this tool, as a paper version of it, offering a reading support to the user, comprising much information available in the online version.

Countless tools and methods have been developed for strategic planning. Some of the most prominent methods focus on a particular part of the strategic planning process. Take SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) for example: this method is commonly used for identifying the internal and external factors that may be favourable or unfavourable to achieving a certain vision. But it does not deal with the preceding step of defining the vision itself, or the subsequent step of designing a strategy. It is thus only one element of a comprehensive planning process.

Therefore it is important to design a roadmap for a strategic planning, and is why, under TRUST&GO tool, all the TRUST products have been organized in a simple path to assist the user in navigating the multiple choices and information levels, leading up to the appropriate sustainable transition path.

The tool is developed as a simple software – as an informative website – where the user is taken through the basic steps leading to a TRUST path, according to which all the documents developed in the project are organized. All TRUST products included in TRUST&GO tool were produced until June 2014.

It offers, above all, an uncomplicated way to pass on the knowledge to the user, through a simple decision path. For that, the guideline considers the classical stages of the roadmapping process: Scoping, Forecasting, Backcasting and Transfer, under which 9 basic steps are arranged. This structure translates the path for the TRansitions to the Urban Water Services of Tomorrow (TRUST) and allows representatives of the UWCS to identify individual pathways for sustainable water cycle services in the future.

Since the guide map tool intends to address all the normal steps through the TRUST process, the scope of this guidance tool is quite wide, evolving all water-related identities.

1.2. Document organization

This document is organized in six sections, the first of which is formed by this introduction.

Chapter 2 features an overview of TRUST project, its objectives and main characteristics, as well as its eight Working Areas.

Chapter 3 presents the strategic planning “roadmap” steps, under which are presented and organized in the TRUST&GO tool all products resulting from the project until June 2014. The TRUST&GO roadmap guideline is defined, incorporating its nine basic steps, under a four-stage process (Scoping, Forecasting, Backcasting and Transfer) and into five sustainability dimensions (social, environment, economic, governance and assets).

Chapter 4 corresponds to a "Quick Start Guide" to the TRUST&GO tool, presenting its structure and intrinsic flowchart framework. This tutorial presents the basic concepts, features and operation steps of this tool. Results are added to a Portfolio, which comprises all selected TRUST products in the form of summarized two-pages documents, named “Situation Analysis Factsheets” (SAFs).

Chapter 5 lists TRUST deliverables and tools that have relevant contents for each basic step of strategic planning roadmap, as well as the corresponding dimensions of analysis. It incorporates the TRUST&GO decision matrix of products that users can select, according to their own criteria.

Finally, in Chapter 6, the authors present some final remarks regarding the present guidelines and TRUST&GO tool.

The document also includes the consulted bibliography for the development of these guidelines and one Annex (I), presenting all the Situation Analysis Factsheets (SAFs) produced and included on this tool.

2. TRUST WORKING AREAS

Transitions to the Urban Water Services of Tomorrow (TRUST) is an integrated research project funded by the European Union. Over the course of four years and driven by the need of transformation and the wish to protect natural resources, 30 partners in eleven different countries researched innovations and tools to create a more sustainable water future. The results are being implemented and tested in nine participating different pilot cities or regions, grouped in green cities, water scarcity regions and urban/peri-urban metropolitan areas.

The central objective of the European project TRUST is to deliver co-produced knowledge to support Transitions to the Urban Water Services of Tomorrow, enabling communities to achieve a sustainable, low-carbon water future without compromising service quality. We aim to deliver this ambition through research driven innovations in governance, modelling concepts, technologies, decision support tools, and novel approaches to integrated water, energy, and infrastructure asset management. TRUST intends to demonstrate and legitimize these innovations by the implementation of the most promising interventions in the urban water system of the nine different participating city pilot regions.

The project is organized under 8 different Working Areas (WA):

WA1 – Diagnosis and vision: Where an initial assessment of the urban water situation in Europe is performed, going also beyond the TRUST pilot regions. It aims to suggest a solution-oriented planning approach with four key questions: Where are utilities now? Where do they want to be? How might the utilities get there? How does it ensure success?

WA2 – Policy, financing and society: Support the development and assessment of adaptive potential in the governance and socio-economic regimes, which shape urban water provision. Existing physical and institutional infrastructures are, by their very nature, conservative and resist change. A step change is urgently required in the capacity of the water sector to respond to contemporary challenges, one which requires a deeper understanding of how innovative solutions are generated, evaluated and embedded in existing systems. Work Area 2 delivered innovations to drive this step change through a targeted and scientifically authoritative programme of research, knowledge brokering and intervention.

WA3 – Analysis tools: The objectives of this Work Area was to develop, according to state-of-the-art systems analysis approaches, tools for metabolism analysis and systems performance evaluation of the urban water cycle services (UWCS). This was done by taking into account the economic, social and environmental boundary conditions of the urban water systems, and examining in detail the technical functions of the water services, including the physical assets, key activities and technologies of each subsystem of the urban water service system. This forms the basis for quantifying resource consumption inputs, waste and emission outputs, and risk issues, in order to document the present and possible future overall system sustainability performance (economic, environmental, safety).

WA4 – Technologies & operational options: The main objective of Work Area 4 was to develop technologies and management options to enhance urban water systems by providing new tools, methods and models for the planning, implementation and operation of enhanced urban water systems. The investigated intervention options will cover the entire urban water cycle from water supply via water use to wastewater disposal and water reuse. The work area has a strong focus on the needs of the pilot/case study cities and the end-users involved in the project. The work area had generated results applicable in the pilot cities to enable the desired transitions in urban water systems being also relevant for many other application areas in Europe and worldwide.

WA5 – Future water policies & integrated tools: The objective of Work Area 5 was to develop general-use integrated approaches and planning support tools aimed at the transition from current status to the desired sustainable urban water cycle services of tomorrow. The integrated approaches, developed both at the regional/national level and at the utility level, seek a balanced long-term asset management view between performance, risk and cost, and take into account social and political acceptance. The life cycle assessment paradigm was incorporated whenever appropriate and feasible. The proposed development work aims at empowering policy makers and water utilities.

WA6 – Implementation and demonstration: The objective of Work Area 6 was to promote the implementation of the outcomes of TRUST at a European level through validation and demonstration in pilot cities and regions. The participating cities/regions are considered as pioneering and very determined to radically change their existing water cycle systems and their associated governance and financial models to more sustainable systems. They also cover the broad spectrum of frameworks in which cities throughout Europe are operating (urbanisation, water scarcity, climate change and energy, transient populations).

WA7 – Dissemination and knowledge transfer: A high profile, a catalysing impact, and an enduring legacy are the hallmarks of a successful Framework project. The knowledge, tools and technologies generated through TRUST was putted available to a wide range of professional and lay communities. To promote a durable influence a set of innovative approaches to knowledge dissemination & utilisation has been adopted, which consortium members are well placed to exploit.

WA8 – Management: The objective of this Work Area was to co-ordinate and to manage the progress of the project, in order to ensure that the objectives were met. This includes the coordination of activities among the Work Areas and Work Packages, facilitation of the internal communication, organisation of meetings, guidance of the decision-making processes, reporting to the European Commission, monitoring of progress, quality control of the project deliverables, and re-adjustment of the work if necessary.

All the information and products resulting from the project until June 2014 are presented and organized in the TRUST&GO tool, under 9 basic steps of strategic planning roadmap, as presented on the following chapter.

3. GUIDELINES FOR ROADMAPING: THE TRUST PATH

As previously mentioned, the European project initiative TRUST produces knowledge and guidance to support transitions of Urban Water Cycle System (UWCS) of tomorrow and enables communities to achieve sustainable, low-carbon water futures without loosing service quality. The design and planning process towards a sustainable UWCS on the level of an individual urban system in TRUST is following the framework of "roadmapping". A roadmap enables the planning and implementation of the path to achieve desired objectives, while serving as an excellent communication tool. Roadmaps link strategy to future actions and explicitly incorporate a plan for needed capabilities and technologies to be in place at the right time.

The TRUST&GO roadmap guideline illustrates diverse aspects in water supply and waste water management in terms of sustainability with its five TRUST sustainability dimensions: social, environment, economic, governance and assets. It is defined as an iterative four-stage process, consisting of Scoping, Forecasting, Backcasting and Transfer, under which the 9 basic steps were arranged, as follows:

SCOPING: Defining the search area and target setting

Scoping defines the scope of analysis in terms of system descriptions and boundaries. It provides a baseline understanding of the UWCS status quo and elements. This stage identifies relevant actors, asset structures, today's status and the impact of existing pressures and trends on the individual UWCS.

In this stage 2 basic steps were defined:

- 1st – Who are we?
- 2nd – Where are we now?

FORECASTING: Envisioning UWCS in a future world

Forecasting creates a vision of the sustainable UWCS of the future – in the TRUST project the reference year is in 2040. It furthermore projects future scenario(s) of the external system and their potential impact on the UWCS. The rationale of forecasting is to project current trends into the future, to anticipate potential barriers and to obtain a perspective for a future scenario in 2040. It is a very creative working stage, translated into 2 basic steps of the TRUST guidemap:

- 3rd – Where do we want to be?
- 4th – How might our environment change?

BACKCASTING: Projecting possible visions back into present

Backcasting looks iteratively back from the envisioned future state of the UWCS and works backwards via (at least one) intermediate state(s). Backcasting identifies the needs for a multi-step transition from today's status quo to intermediate states and from intermediate state(s) to achieve the future desired state (vision 2040). The backcasting stage is defined in 3 of the 9-basic-step diagram, with the seventh step being also integrated in the Tranfer stage:

- 5th – Is our vision robust?
- 6th – Where are our strategic options?
- 7th – How do we select and design a strategy?

TRANSFER: Creating the roadmap

The stage of Transfer translates the identified measures into transfer action fields. This includes chronological information, recommendation with milestones, responsible actors and so on. The final steps of the guidemap used in this tool are focused in this stage:

- 7th – How do we select and design a strategy?
- 8th – How can we best implement our strategy?
- 9th – How can we iteratively adapt the vision & strategy?

4. TRUST&GO QUICK START GUIDE

4.1. Tool structure

In this chapter a "Quick Start Guide" to the TRUST&GO tool is presented. This tutorial presents the basic concepts, features and operation steps of this tool and is recommended that you follow this reading using the online tool available (http://wp51.addition.pt). Results are added to a Portfolio, which comprises all selected TRUST products in the form of summarized two-pages documents, named “Situation Analysis Factsheets” (SAFs).The software drives the user in a coherent flowchart of TRUST products to assess, in an integrated way, the UWCS current state and possible tracks.

TRUST&GO 9 basic steps are illustrated by a diagram (Figure 1), which is available at the top of the tool screen permanently. It is an adaptive approach, as represented in the diagram: the left-to-right direction is the general direction of the process and the right-to-left direction indicates that each step is iterative.

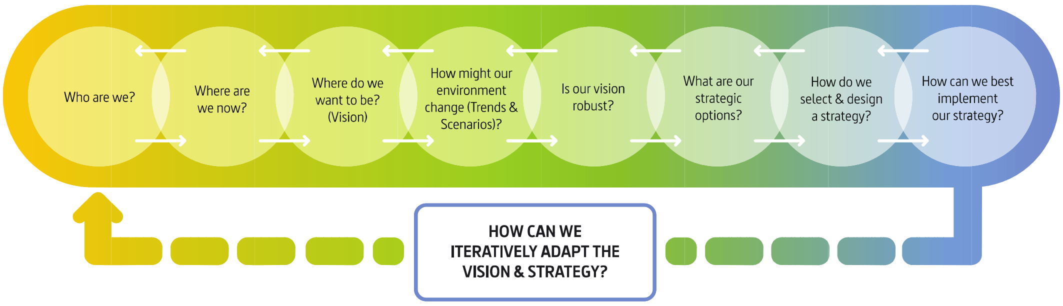


Figure 1 - TRUST&GO flowchart

To start the guidance process, the user must initiate TRUST&GO on the top menu and select a step at the top of the screen. Another alternative is to click in the images presented in the Home section of the tool, where the TRUST&GO flowchart image will send the user to the tool itself, and each step image will open the corresponding step in the tool.

After the selection of the step, a list of the most relevant documents/tools within the TRUST project will be presented (Figure 2). The relevant documents are presented along with their associated dimensions: social; environmental; economic; governance; and assets. This way, the user can have a second assessment of which document wishes to access.

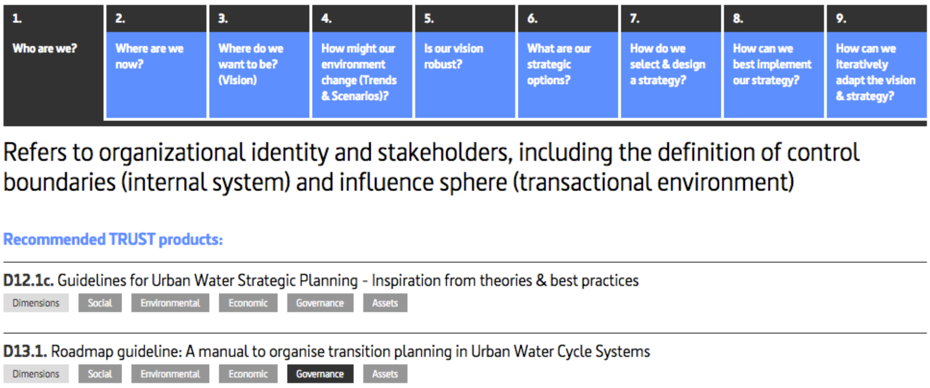


Figure 2 - Recommended TRUST products for the 1st basic step of the TRUST&GO diagram

Once selected the document, the objectives within the covered dimensions are listed, in order to obtain a more detailed characterization of the deliverable/tool. If the user decides to access the selected document he must select the option “add to Portfolio” available at the top/end of the dimension list (Figure 3). Once added to Portfolio, the related Situation Analysis Factsheet (SAF), which is the resume of the deliverable/tool in a two-pages document, will be available to download.

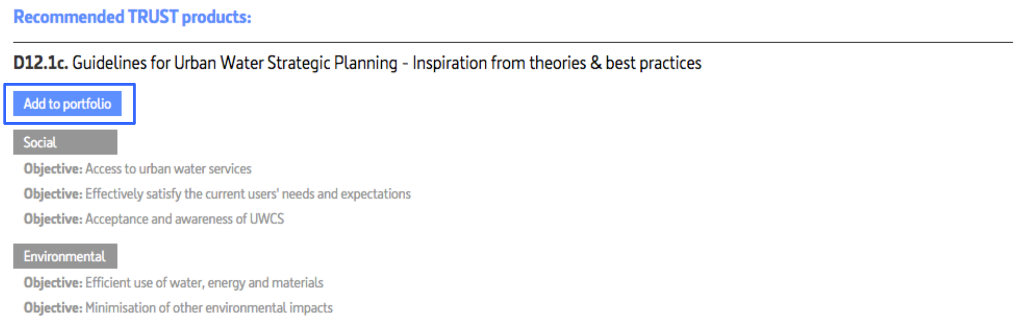


Figure 3 – Location of the “Add to Portfolio” section for one TRUST deliverable

At this stage, after the selection of the best-suited documents, the user can proceed to other relevant step and continue its TRUST path. Once the 9-step process of the sustainability path is finalized, the final Portfolio with all the chosen SAFs will be available at the upper right corner of the screen ready to be downloaded (Figure 4).

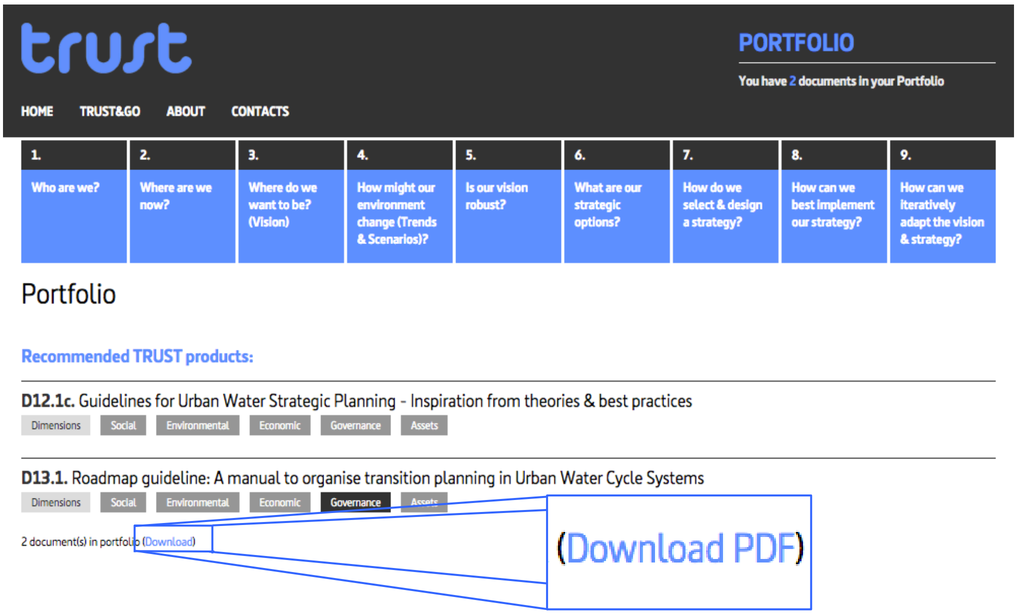


Figure 4 – Image of a final Portfolio with the "download PDF" option at the end of the list

4.2. Situation Analysis Factsheet (SAF)

Each document/tool produced in the TRUST project, and presented in the TRUST&GO online tool, is described in a Situation Analysis Factsheet (SAF), which summarizes the main content in two pages (Figure 5). The idea is for the user to initially have a quick look of what the deliverable/tool addresses without having to go trough the entire document.

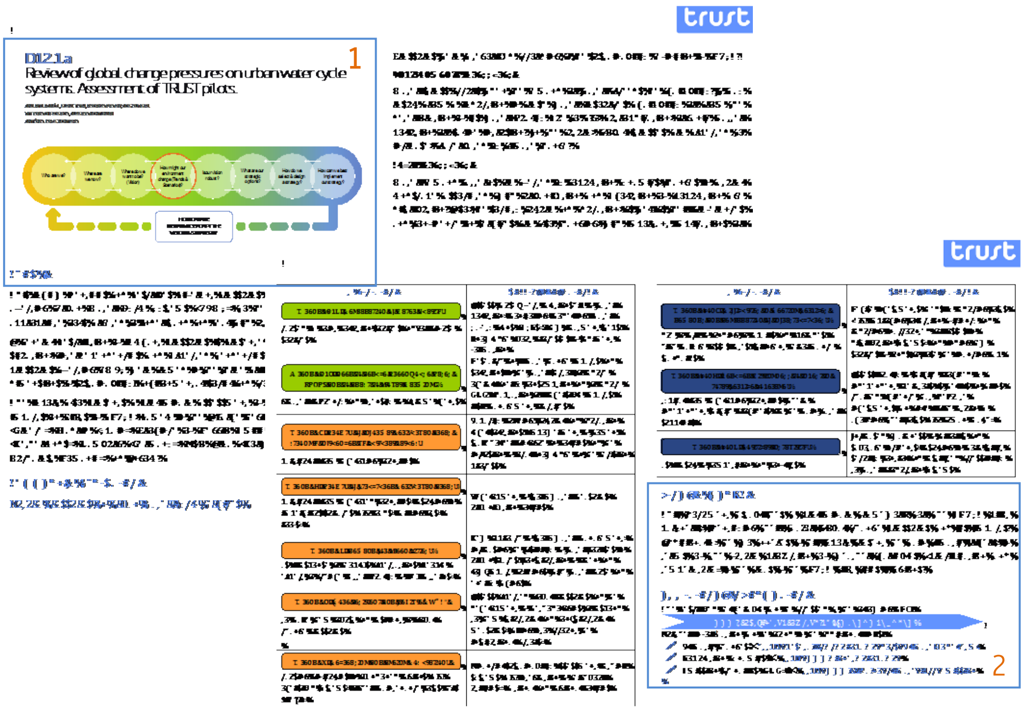


Figure 5 – Example of a Situation Analysis Factsheet (SAF)

This two-pages abstract starts with the classification of the document under the 9-basic-steps diagram of the TRUST path, followed by a small scope where the main topics addressed in the document are described (see Figure 5 (1)). The SAF then continues with a more detailed resume of the deliverable/tool and ends with the most relevant final remarks (see Figure 5 (2)).

At the end of each SAF there is also a link to the original document/tool as well as to other related documents, allowing the user to see the documents and continue the research for what best fit its need.

5. TRUST&GO TOOL AND THE STRATEGIC PLANNING STEPS

5.1. Step 1 - Who are we?

This step of strategic planning refers to organizational identity and stakeholders, including the definition of control boundaries, the internal system, and influence sphere, the transactional environment (including three levels: internal, transactional and external).

In this early stage, the sphere of control and influence of the utility is delineated. It considers which parties need to be involved in the various steps and also sets stakeholders involvement, expectations management, and communication issues.

Table 1 presents the recommended TRUST products for these tasks and the corresponding application level for each dimension ("high" for very relevant contents, "medium" for average relevance and ""low/null" for very vacantly or null contribution).

Table 1 - Step 1: recommended TRUST products and associated dimensions

TRUST PRODUCT	DIMENSIONS (*)				
	SOCIAL	ENVIRONMENTAL	ECONOMIC	GOVERNANCE	ASSETS
D11.1b Part II. Current State of Sustainability of Urban Water Cycle Services. Part 2	+	+	+	+	+
D12.1c. Guidelines for Urban Water Strategic Planning - Inspiration from theories & best practices	+	+	+	+	+
D13.1. Roadmap guideline: A manual to organise transition planning in Urban Water Cycle Systems	+	+	+	++	+
D21.1. Report on carbon sensitive urban water futures	○	++	+	+	+
D21.2. Web based self-audit adaptive potential tool for urban water stakeholders	○	○	○	○	++
D31.1. Framework for Sustainability Assessment of UWCS and development of a self-assessment tool	+	+	+	+	+
D31.2. UWCS Performance self-assessment tool	++	++	++	++	++
D46.1. TRUST mobile application	○	○	○	○	++
D46.2. Report on system development, method applicability and pipeline condition data for modelling purposes	+	○	○	○	++
T22.1. Contemporary water market report	+	+	++	+	+
T22.2. Costumers perspectives on new urban water services	++	○	++	++	○

(*) Application level: ++- high; + - medium; ○ - low/null.

5.2. Step 2 - Where are we now?

Step 2 of strategic planning, "Where we are now?", defines the reference point, including state of infrastructure assets and resources as well as social and governance structure. It defines the current state of the internal system, including physical assets and resources and social conditions.

From the perspective of the present, this step can be useful for indicating the need for change and creating a sense of urgency.

Table 2 presents the recommended TRUST products for these tasks and the corresponding application level for each dimension.

Table 2 - Step 2: recommended TRUST products and associated dimensions

TRUST PRODUCT	DIMENSIONS (*)				
	SOCIAL	ENVIRONMENTAL	ECONOMIC	GOVERNANCE	ASSETS
D11.1b Part II. Current State of Sustainability of Urban Water Cycle Services. Part 2	+	+	+	+	+
D11.1b Part I. Current State of Sustainability of Urban Water Cycle Services. Part 1	+	+	+	+	+
D12.1c. Guidelines for Urban Water Strategic Planning - Inspiration from theories & best practices	+	+	+	+	+
D13.1. Roadmap guideline: A manual to organise transition planning in Urban Water Cycle Systems	+	+	+	++	+
D21.1. Report on carbon sensitive urban water futures	○	++	+	+	+
D21.2. Web based self-audit adaptive potential tool for urban water stakeholders	○	○	○	○	++
D22.1. Financial sustainability rating tool for urban water systems	++	+	++	○	+
D31.1. Framework for Sustainability Assessment of UWCS and development of a self-assessment tool	+	+	+	+	+
D31.2. UWCS Performance self-assessment tool	++	++	++	++	++
D33.1. Conceptual UWCS metabolism model	+	++	+	○	+
D33.2. Quantitative UWCS performance model	+	++	+	○	+
D34.1. Performance analysis for model city	+	++	+	○	+
D43.1 Part I. Pilot-city specific, new technological options for stormwater separation and optimized WWTP. Part 1	○	++	+	○	++
D43.1 Part II. Pilot-city specific, new technological options for stormwater separation and optimized WWTP. Part 2	+	++	++	++	+
D46.1. TRUST mobile application	○	○	○	○	++
D46.2. Report on system development, method applicability and pipeline condition data for modeling purposes	+	○	○	○	++
T22.1. Contemporary water market report	+	+	++	+	+
T22.2. Costumers perspectives on new urban water services	++	○	++	++	○

(*) Application level: ++ - high; + - medium; ○ - low/null.

5.3. Step 3 - Where do we want to be? (Vision)

A "Vision", in a strategic planning roadmap, represents the desired state of the internal system and, to some extent, the transactional environment.

The first version or iteration of the vision, before it is tested against context scenarios and adapted, should focus on what is desired: "will" is prior to "necessity" and "capacity".

At the end of this step, planners should set short- medium- and long-term objectives.

Table 3 presents the recommended TRUST products for this step tasks and the corresponding application level for each dimension.

Table 3 - Step 3: recommended TRUST products and associated dimensions

TRUST PRODUCT	DIMENSIONS (*)				
	SOCIAL	ENVIRONMENTAL	ECONOMIC	GOVERNANCE	ASSETS
D11.1a. An overview of and enabling and constraining factors for a transition to sustainable UWCSs	+	++	○	++	++
D12.1c. Guidelines for Urban Water Strategic Planning - Inspiration from theories & best practices	+	+	+	+	+
D13.1. Roadmap guideline: A manual to organise transition planning in Urban Water Cycle Systems	+	+	+	++	+
D21.1. Report on carbon sensitive urban water futures	○	++	+	+	+
D23.1. Set of policy briefs for water management practitioners	+	++	++	+	+
D33.1. Conceptual UWCS metabolism model	+	++	+	○	+
D33.2. Quantitative UWCS performance model	+	++	+	○	+
D34.1. Performance analysis for model city	+	++	+	○	+
D43.1 Part I. Pilot-city specific, new technological options for stormwater separation and optimized WWTP. Part 1	○	++	+	○	++
T22.1. Contemporary water market report	+	+	++	+	+
T22.2. Costumers perspectives on new urban water services	++	○	++	++	○

(*) Application level: ++ - high; + - medium; ○ - low/null.

5.4. Step 4 - How might our environment change? (Trends & Scenarios)

This step includes an inventory and analysis of factors and trends that may impact on the organization and its transactional environment. A broad palette of trends and their interdependencies should be considered, in order to select a method that matches the time horizon of the plan.

It is recommended that this approach includes an assessment of uncertainty, using for example the Scenario Planning method. Urban water utilities may wish to test their plans against climate scenarios, as the Global Environment Outlook (GEO) scenarios, by UNEP. The SCENES project, under the EU 6th framework directive, has already enriched these GEO scenarios to be specifically relevant for the European water sector. The EU 7th framework PREPARED project also works with scenarios that may be useful.

Table 4 presents the recommended TRUST products for these activities and the corresponding application level for each dimension.

Table 4 - Step 4: recommended TRUST products and associated dimensions

TRUST PRODUCT	DIMENSIONS (*)				
	SOCIAL	ENVIRONMENTAL	ECONOMIC	GOVERNANCE	ASSETS
D12.1a. Review of global change pressures on Urban Water Cycle Systems.Assessment of TRUST Pilots	++	++	++	○	+
D12.1c. Guidelines for Urban Water Strategic Planning - Inspiration from theories & best practices	+	+	+	+	+
D13.1. Roadmap guideline: A manual to organise transition planning in Urban Water Cycle Systems	+	+	+	++	+
D21.1. Report on carbon sensitive urban water futures	○	++	+	+	+
D33.1. Conceptual UWCS metabolism model	+	++	+	○	+
D33.2. Quantitative UWCS performance model	+	++	+	○	+
D34.1. Performance analysis for model city	+	++	+	○	+
D54.1. Integrated DS framework	+	++	+	○	+

(*) Application level: ++ - high; + - medium; ○ - low/null.

5.5. Step 5 - Is our vision robust?

After setting the previous criteria, it should be conducted an iterative comparison between the vision with the current state and with the possible future states of external systems. Planners ought to consider approaches that match local situation, regarding resilience.

The process of testing a vision against context scenarios should be iterative. One useful means of categorizing data about internal and external systems and presenting decision makers with alternatives is the Driver-Pressure-State-Impact-Response framework.

Table 5 presents the recommended TRUST products for these tasks and the corresponding application level for each dimension.

Table 5 - Step 5: recommended TRUST products and associated dimensions

TRUST PRODUCT	DIMENSIONS (*)				
	SOCIAL	ENVIRONMENTAL	ECONOMIC	GOVERNANCE	ASSETS
D12.1c. Guidelines for Urban Water Strategic Planning - Inspiration from theories & best practices	+	+	+	+	+
D13.1. Roadmap guideline: A manual to organise transition planning in Urban Water Cycle Systems	+	+	+	++	+
D21.1. Report on carbon sensitive urban water futures	○	++	+	+	+
D33.1. Conceptual UWCS metabolism model	+	++	+	○	+
D33.2. Quantitative UWCS performance model	+	++	+	○	+
D34.1. Performance analysis for model city	+	++	+	○	+
D54.1. Integrated DS framework	+	++	+	○	+
T22.4. Funding Alternatives for Sustainable Water Services	++	○	++	○	○

(*) Application level: ++ - high; + - medium; ○ - low/null.

5.6. Step 6 - What are our strategic options?

At this point, planners select of a series of actions that establish the proposed pathway between the current state and the desired future state. They should consider methods that match the level of stakeholder development, the variance between options, and the complexity of the system.

There are several available methods to develop this step, like Relevance-tree Analysis, Multi-criteria Analysis or SWOT (Strengths, Weaknesses, Opportunities, and Threats).

Table 6 presents the recommended TRUST products for these activities and the corresponding application level for each dimension.

Table 6 - Step 6: recommended TRUST products and associated dimensions

TRUST PRODUCT	DIMENSIONS (*)				
	SOCIAL	ENVIRONMENTAL	ECONOMIC	GOVERNANCE	ASSETS
D11.1a. An overview of and enabling and constraining factors for a transition to sustainable UWCSs	+	++	○	++	++
D12.1b. Review on flexible UWCS and transitional pathways	+	+	○	++	+
D12.1c. Guidelines for Urban Water Strategic Planning - Inspiration from theories & best practices	+	+	+	+	+
D13.1. Roadmap guideline: A manual to organise transition planning in Urban Water Cycle Systems	+	+	+	++	+
D21.1. Report on carbon sensitive urban water futures	○	++	+	+	+
D23.1. Set of policy briefs for water management practitioners	+	++	++	+	+
D32.1. Metabolism Risk-controlled Model	+	+	+	+	+
D33.1. Conceptual UWCS metabolism model	+	++	+	○	+
D33.2. Quantitative UWCS performance model	+	++	+	○	+
D34.1. Performance analysis for model city	+	++	+	○	+
D42.1. Technical guidance on evaluation and selection of various water saving technologies	+	++	+	○	○
D45.1. Report on intervention concepts for energy saving, recovery and power generation from the UWS	+	++	++	○	+
D54.1. Integrated DS framework	+	++	+	○	+
T22.4. Funding Alternatives for Sustainable Water Services	++	○	++	○	○

(*) Application level: ++ - high; + - medium; ○ - low/null.

5.7. Step 7 - How do we select & design a strategy?

This step is crucial for stakeholder engagement, in order to achieve proper planning processes and good governance.

Regarding this phase, there has been much European research to help implement the theories of stakeholder engagement. One suitable method is backcasting, i.e, the assessment of the present state from the perspective of a normative (desirable) vision or target, which typically results on a rough pathway defining milestones & transition measures.

Table 7 presents the recommended TRUST products for these tasks and the corresponding application level for each dimension.

Table 7 - Step 7: recommended TRUST products and associated dimensions

TRUST PRODUCT	DIMENSIONS (*)				
	SOCIAL	ENVIRONMENTAL	ECONOMIC	GOVERNANCE	ASSETS
D12.1b. Review on flexible UWCS and transitional pathways	+	+	○	++	+
D12.1c. Guidelines for Urban Water Strategic Planning - Inspiration from theories & best practices	+	+	+	+	+
D13.1. Roadmap guideline: A manual to organise transition planning in Urban Water Cycle Systems	+	+	+	++	+
D32.1. Metabolism Risk-controlled Model	+	+	+	+	+
D33.1. Conceptual UWCS metabolism model	+	++	+	○	+
D33.2. Quantitative UWCS performance model	+	++	+	○	+
D34.1. Performance analysis for model city	+	++	+	○	+
D42.1. Technical guidance on evaluation and selection of various water saving technologies	+	++	+	○	○
D43.1 Part II. Pilot-city specific, new technological options for stormwater separation and optimized WWTP. Part 2	+	++	++	++	+
D54.1. Integrated DS framework	+	++	+	○	+
T22.4. Funding Alternatives for Sustainable Water Services	++	○	++	○	○

(*) Application level: ++ - high; + - medium; ○ - low/null.

5.8. Step 8 - How can we best implement our strategy?

Implementing a strategy regards broad issues like social changes, political pressures and cultural influence.

Water utilities are generally more than capable of planning and executing the engineering tasks involved in a strategy. The main issues tend to arise when ambiguous social, political, and cultural processes assert influence on the implementation of the plans. It is important to recognize this fact from the outset and to learn from the past by analyzing and accounting for known issues, limitations, & considerations. It is also essential to define the roles of the various actors, specifically stipulating which actors are to be involved in the implementation, evaluation, and/or adaptation of the strategic plan.

Table 8 presents the recommended TRUST products within this phase, as well as the corresponding application level for each dimension.

Table 8 - Step 8: recommended TRUST products and associated dimensions

TRUST PRODUCT	DIMENSIONS (*)				
	SOCIAL	ENVIRONMENTAL	ECONOMIC	GOVERNANCE	ASSETS
D12.1c. Guidelines for Urban Water Strategic Planning - Inspiration from theories & best practices	+	+	+	+	+
D13.1. Roadmap guideline: A manual to organise transition planning in Urban Water Cycle Systems	+	+	+	++	+
D22.1. Financial sustainability rating tool for urban water systems	++	+	++	○	+
D43.1 Part II. Pilot-city specific, new technological options for stormwater separation and optimized WWTP. Part 2	+	++	++	++	+
D54.1. Integrated DS framework	+	++	+	○	+

(*) Application level: ++ - high; + - medium; ○ - low/null.

5.9. Step 9 - How can we iteratively adapt the vision & strategy?

Strategic planning assumes that a plan will be continuously optimised, learning through evaluation.

Annual progress reports can be used to demonstrate the transparency of the evaluation process, using performance indicators, multi-criteria factors or other. One common used method is the SMART approach.

The evaluation process and periodical monitoring rises the fundamental questions that compose the early steps of this planning roadmap: “where are we now?” and “where do we want to be?”.

Table 9 presents the recommended TRUST products to perform this step and the corresponding application level for each dimension.

Table 9 - Step 9: recommended TRUST products and associated dimensions

TRUST PRODUCT	DIMENSIONS (*)				
	SOCIAL	ENVIRONMENTAL	ECONOMIC	GOVERNANCE	ASSETS
D12.1c. Guidelines for Urban Water Strategic Planning - Inspiration from theories & best practices	+	+	+	+	+
D13.1. Roadmap guideline: A manual to organise transition planning in Urban Water Cycle Systems	+	+	+	++	+
D54.1. Integrated DS framework	+	++	+	○	+

(*) Application level: ++ - high; + - medium; ○ - low/null.

6. FINAL REMARKS

The TRUST&GO tool was developed to provide anyone involved with the water sector an easy and user-friendly way to explore TRUST deliverables. These documents were produced along the development of the TRUST project and include the approaches identified as useful tools or best practices to assess the UWCS current state and possible tracks towards a sustainable future of the water sector.

It is intended that TRUST&GO steps reflect the adaptive approach of the transition processes. It offers, above all, an uncomplicated way to pass on the knowledge to the user through a simple decision path. For that, the guideline considers the classical stages of the roadmapping process: Scoping, Forecasting, Backcasting and Transfer, under which 9 basic steps are arranged. This structure translates the path for the TRansitions to the Urban Water Services of Tomorrow (TRUST) and allows representatives of the UWCS to identify individual pathways for sustainable water cycle services in the future.

To select the most relevant documents for the user, the information was summarized in Situation Analysis Factsheets - SAF, each with two pages. The first selection of SAF is done according to the 5 main dimensions that reflect sustainability, the 5 pillars of sustainability. All SAFs included in the current document correspond to TRUST deliverables developed until June 2014 but the available version of the software allows the update of the SAF database, when needed.

BIBLIOGRAPHY

Alegre, H., Cabrera JR, E., Hein, A., Brattebø, H. (2012). *Framework for Sustainability Assessment of UWCS and development of a self-assessment tool.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D31.1.

Bandermann, S., Potrawiak, J., Sommer, H. (2013). *Flood mitigation by on-site stormwater management (SUDS) - Preplanning of SUDS in Sandnes City - A case study associated with TRUST.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications.

Behzadian, K., Kapelan, Z., Rozos, E., Makropoulos, C. (2012). Deliverable D33.1:WaterMet2 Conceptual Model. Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Internal Report D33.1.

Behzadian, K., Kapelan, Z., Govindarajan, V., Brattebø, H., Sægrov, S., Rozos, E., Makropoulos, C. (2014). *Quantitative UWS performance model: WaterMet2.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D33.2.

Bello-Dambatta, A., Kapelan, Z., Butler, D., Oertlé, E., Wintgens, T., Rozos, E., Makropoulos, C., Mamassis, N. (2013). *Guidance on evaluation and selection of sustainable water demand management technologies.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D42.1.

Bhimani, Alnoor, et al. (2012): *Management and Cost Accounting*, 5th Edition, Pearson, Essex.

Brattebø, H., Alegre, H., Cabrera JR, E., Marques, R.C., Hein, A., Cruz, C.O. (2013). *A Master Framework for UWCS Sustainability.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications.

Brattebø, H., Sægrov, S., Venkatesh, G. (2011). *Metabolism modelling of urban water cycle systems - System definition and scoping report.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications - Internal deliverable, WA 3.3.

Brenna, L., Dyrkoren, P.A., Vangdal, A.C., Poulton, M., Bruaset, S. (2013). *Report on system development, method applicability and pipeline condition data for modeling purposes.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D46.2.

EPA (2012). *Condition Assessment Technologies for Water Transmission and Distribution Systems.* United States Environmental Protection Agency. Office of Research and Development National Risk Management Research Laboratory - Water Supply and Water Resources Division.

Frijns, J. (2014). *Report on intervention concepts for energy saving, recovery and power generation from the UWS*. Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D45.1.

Halle, C. et al (2013). *D43.1 - Pilot-city specific, new technological options for stormwater separation and optimized WWTP. Part I - Curative actions in wastewater treatment systems*. Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Internal Report D43.1 (Part 1).

Hein, A., Neskovic, M., Hochstrat, R., Smith, H. (2012). *Roadmap guideline: A manual to organise transition planning in Urban Water Cycle Systems.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D13.1.

Hoffjan, A., Müller, N.A. (2012). *Contemporary water market report.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Internal report on task 2.2.1.

Hoffjan, A., Müller, N.A., Federico, V., Liserra, T. (2014). *Funding alternatives for sustainable water services*. Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Internal report on task 2.2.4.

IRC - International Water and Sanitation Centre (2001). *Key Factors for Sustainable Cost Recovery*. URL from 14th September 2013: http://www.ircwash.org/sites/default/files/Brikke-2001-Key.pdf.

Jeffrey, P., Gormley, A., Smith, H., Rochera, E.C., Marques, R.C. (2014). *Web based self-audit adaptive potential tool for urban water stakeholders.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Internal Report D21.2.

Makropoulos, C., Rozos, E., Bruaset, S., Frijns, J., Van der Zouwen, M. (2012). *An overview of and enabling and constraining factors for a transition to sustainable UWCSs.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D11.1a.

Morley, M.S., Kapelan, Z., Savic, D.A. (2012). *Integrated Decision Support Framework.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D54.1.

OECD - The Organisation for Economic Co-operation and Development (2009). *Strategic Financial Planning for Water Supply and Sanitation.* URL from 17th February 2014: http://www.oecd.org/env/resources/43949580.pdf

Parsons, D., Marcet, E.C., Jeffrey, P. (2012). *Report on carbon sensitive urban water futures.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D21.1.

Parsons, D., Marcet, E.C., Jeffrey, P. (2013). *Policy Brief on Carbon sensitive urban water futures.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications.

Ramôa, A.R., Toth, E., Oliveira, R.P., Frederico, V., Montanari, A., Monteiro, A.J. (2012). *Guidelines for Urban Water Strategic Planning - Review of global change pressures on Urban Water Cycle Systems. Assessment of TRUST Pilots.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Internal Report 12.1a.

Revsine, Lawrence; Collins, Daniel W., Johnson, w: Bruce, Mittelstaedt, H. Fred (2012): *Financial Reporting and Analysis*. 5th Edition, Mc Graw-Hill, New York.

Ridolfi, E., Smith, H., Müller, N., Hoffjan, A. (2012). *Customer perspectives on new urban water services.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Literature review WA2 (Internal report for task 2.2.2).

Røstum, J. et al (2013). *Set of policy briefs for water management practitioners.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D23.1.

Ross, Stephen A.; Westerfield, Randolph W.; Jaffe, Jeffrey (2010). *Corporate Finance*. 9th Edition, Mc Graw-Hill, New York.

Sieker, H., Bandermann, S., Potrawiak, J. (2013). *D43.1 - Pilot-city specific, new technological options for stormwater separation and optimized WWTP. Part II - Minimization of stormwater runoff into wastewater piping systems*. Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Internal Report D43.1 (Part 2).

Smith, H., Ramôa, A.R., Galvão, A., Monteiro, A.J., Jeffrey, P. (2012). *Guidelines for Urban Water Strategic Planning - Review on flexible UWCS and transitional pathways*. Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Internal Report 12.1b.

Smith, H., Ugarelli, R., Van der Zouwen, M., Allen, R., Gormley, A.M., Segrave, A. (2013). *Risk, vulnerability, resilience and adaptive management in the water sector.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications.

The World Bank (2008): Accounting for Infrastructure Regulation.

Ugarelli, R., Almeida, M.C., Liserra, T., Smeets, P. (2014). *Metabolism Risk-controlled Model.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D32.1.

Van Der Zouwen, M., Segrave, A., Büscher , C., Monteiro, A.J., Galvão, A., Ramôa, A.R., Hochstrat, R. (2012). *Guidelines for Urban Water Strategic Planning - Guidelines for Urban Water Strategic Planning - Inspiration from theories & best practices.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Internal Report 12.1c.

Van Leeuwen, K., Marques, R.C. (2012). *Current State of Sustainability of Urban Water Cycle Services. Part 1 - Towards a baseline assessment of the sustainability of urban water cycle services.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D11.1b.

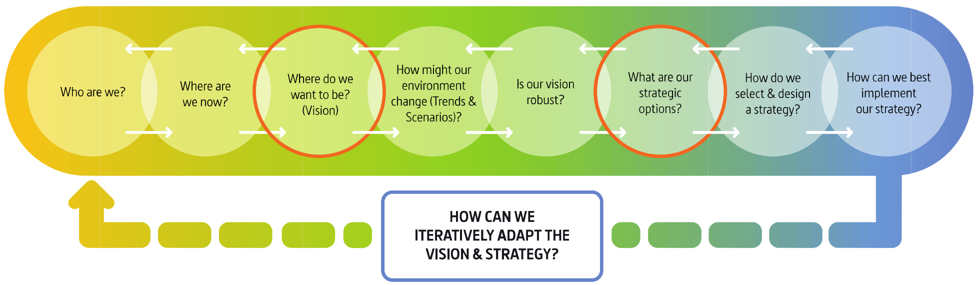
Van Leeuwen, K. (2012). *Current State of Sustainability of Urban Water Cycle Services. Part 2 - Baseline assessment of the sustainability of urban water cycle services.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Prepared Deliverable D11.1b.

Venkatesh, G., Sægrov, S., Ugarelli, R., Brattebø, H. (2014). *Performance Analysis of Model City. WaterMet2 & Dynamic Metabolism Model – Testing on Oslo's water and wastewater system.* Transitions to the Urban Water Services of Tomorrow (TRUST) publications – Internal Report D34.1.

7. ANNEX I: SITUATION ANALYSIS FACTSHEETS (SAFS)

D11.1 a
Best practices for sustainable urban water cycle systems.

CHRISTOS MAKROPOULOS, EVANGELOS ROZOS
STIAN BRUASET, JOS FRIJNS
MARIËLLE VAN DER ZOUWEN



SCOPE

The ‘Best practices for Sustainable Urban Water Cycle Systems’ report presents an overview of best practices that might support water professionals and other urban stakeholders in identifying possibilities for strategic options. The document refers to a best practice as an on-the-ground practice where an approach, technology or technique has been implemented successfully.

It addresses four different themes: ‘demand management’, ‘reuse and recycling’, ‘water and energy’, and ‘leakage and loss reduction’. Each theme contains a description of best practices and – as far as the sources enabled – factors enabling or constraining the transition to sustainable UWCSs.

SUMMARY DESCRIPTION

Demand Management

Water Demand Management (WDM) is the implementation of policies or measures that serve to control or influence the amount of water used. A definition from a social perspective is that WDM is a practical strategy that improves the equitable, efficient and sustainable use of water. This TRUST report includes examples that fall into one or more of the five categories of action, those being:

- Reducing the water quantity/quality required to accomplish a specific task;
- Adjusting the nature of the task so it can be accomplished with less water or lower quality water;
- Reducing losses in movement from source through use to disposal
- Shifting time of use to off-peak periods;
- Increasing the ability of the system to operate during droughts.

The report presents 13 cases of best practices:

1. Public awareness of water issues in Jordan;
2. Water budget rate structure in California;
3. Progressive water tariff structure in Singapore;
4. Metering in Ontario and Sofia;
5. Examples of efficient household appliances (washing machines, self-closing faucets, toilets and urinals);
6. Residential Water Conservation in Miami-Dade, USA;
7. Pressure control in São Paulo, Brazil;
8. Integrated management in Melbourne;
9. Water efficiency in Sydney;
10. Use of seawater for toilet flushing in Hong Kong;
11. Centralized rainwater harvesting in Germany;
12. Rainwater harvesting in Southampton University;
13. Low water gardening in Cyprus.

In order to help identifying enabling and constraining factors, within the cases of best practices listed above, the report also presents a chapter on transferable lessons for sustainable UWCS.

Reuse and Recycling

Urban water recycle is the procedure where the greywater or the wastewater from showers, baths and washbasins is treated appropriately in order to cover non-potable demands. This report focuses on the technologies that can be used for:

- Reducing domestic (in-house and outdoor) and non-domestic (industry, tourism, public uses, etc.) urban water consumption;
- Covering non-urban water demand (agriculture, etc.) with used urban water.

The report presents some examples related to the theme, which in this case concern systems that are characterized by a simple link (from management point of view) between the first use of water and consumption of the recycle/reused water. The location of these two can be either at the same place (e.g. local grey water recycling scheme) or can be distant (use of treated wastewater for irrigation). The given examples with transferable lessons are:

1. Wastewater reclamation in Barcelona;
2. Wastewater reuse in Mexico City;
3. Management aquifer recharge in Salisbury, South Australia;
4. Cooling water recirculation in Wyoming, USA;
5. Rinsing in Singapore;
6. Recycling water for industry in Sydney;
7. Indirect wastewater reuse through dune infiltration in Belgium;
8. Local greywater recycling in Vietnam;
9. Integrated water recycling in Birsbane, Australia;
10. Wastewater use for garden irrigation in Cyprus;
11. Beddington zero fossil energy development: key lessons.

Water and Energy

After manpower, energy is the highest operating cost item for most water and wastewater companies. High-energy consumption will affect the water industry worldwide and is inextricably linked to the issue of climate change. In the European water industry, building and managing its infrastructure in a cost-effective, energy efficient manner is nowadays seen as an important responsibility. The European case studies described in the report show significant energy savings in all parts of the water cycle, with an overall energy efficiency gains between 5-25%. It is also noted that the two areas with most potential, regarding energy saving, are pumps of most types and functions, and aerobic wastewater treatment systems.

Leakage and Loss Reduction

The importance of water losses in the overall total distributed water is well known. The amount of water leaked in water distribution systems varies widely between different countries, regions and systems, from as low as 3-7% of distribution input in the well-maintained systems to 50 % and even more in some undeveloped countries and less well maintained systems.

Moreover, the report also indicates that water leaks are expected to increase due to climate change since:

- Dehydration and settling of the ground in hot climates may cause pipes to break;
- Colder climates during winter in already cold climates can increase the break rate due to thaw;
- Higher number of frost/defrost periods annually (in some climates), increasing the strain on pipes, causing them to break;
- It leads to an increased corrosiveness of the ground.

As in the others chapters, the document also presents some good practices cases, followed by the usual 'transferable lessons for sustainable UWCS':

1. Brescia – On site inspection results, noise logger, District Metered Areas Monitoring (DMA) and step testing;
2. Trondheim – DMA, GIS system for registration of failures and water leaks, real-time monitoring Systems, different acoustic techniques for leak localization;
3. Molde - pressure management, DMA;
4. Khayelitsha, city of Cape Town – Pressure management;
5. Sebokeng, Emfuleni local municipality – Control valves;
6. Enia Italy – Pressure management;

FINAL REMARKS

This TRUST report presents various best practices in different areas towards a more sustainable UWCS, identifying different available technologies and approaches that can really increase the performance of current urban water services. Moreover, it also identifies possible, enabling and constraining factors associated with the presented cases. However, since these factors might be different for each and every practice, it cannot draw general lessons. At the same time, these factors hint towards some key messages for urban water utilities and stakeholders who are envisioning a transfer to a sustainable UWCS.

LINKS TO ADDITIONAL INFORMATION

This report can be accessed at the following URL:

http://www.trust-i.net/downloads/index.php?iddesc=67

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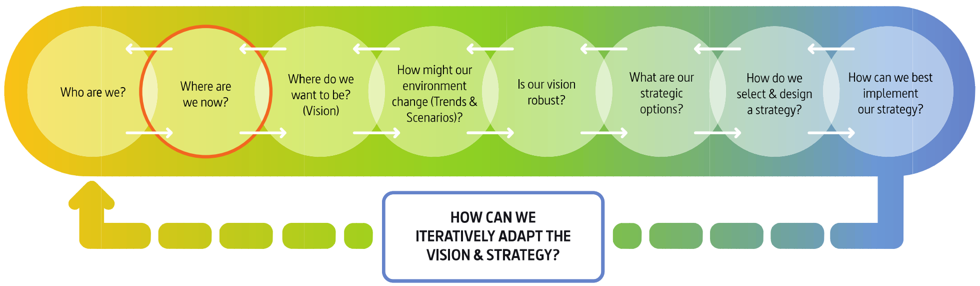

SCOPE

The current report 11.1b – Part I presents a tool for the baseline assessment of the actual state of the UWCS that could support water professionals in utilities and other stakeholders in TRUST to creating a general insight into how cities score on dimensions of sustainability. Based thereon, these parties might discuss more detailed options for the evaluation of the current state and discuss the first steps towards the definition of a clear vision as regards the transition to a sustainable UWCS.

The report starts with a brief introduction followed by a presentation of the concept of sustainability in broader terms. It then goes into the various dimensions of sustainability and gives an overview of the literature on UWCS sustainability, presenting experiences across the globe. The document continues with the description of the dimensions, objectives, criteria and performance metrics for the UWCS sustainability, finalizing with a short introduction to the questionnaire that has been developed which links the dimensions of sustainability with the (subjective) choices.

SUMMARY DESCRIPTION

Sustainability of UWCS

TRUST concept of the UWCS sustainability and its dimensions, assumes (TBL) as the skeleton of the UWCS, and a common area corresponding to the infrastructural and governance dimensions without which the objectives of the TBL dimensions are not able to be achieved. Therefore, sustainable development in the UWCS requires the consideration of these dimensions at least to a certain extent, as instrumental for sustainability achievement.

It's also important to consider the broader water footprint concept as developed by Hoekstra (http://www.waterfootprint.org/). It is a comprehensive indicator of freshwater use, which encompasses the direct and indirect use of water per nation or per product.

In this chapter is also referred a typology of cities that may be relevant in the TRUST context. Though each city is different, one could group cities into certain categories, based on a number of city characteristics. Van der Steen categorized cities according to the following characteristics:

- Cities where affordability of basic services is an issue;
- Cities with strong capacity in the water sector;
- Cities with a tropical rainfall pattern;
- Cities with a moderate rainfall pattern, affected by climate change;
- Cities with scarcity in water resources;
- Cities with potential for reuse of treated wastewater.

Furthermore he concluded that cities could be divided in 3 groups, each with a separate typology:

1. Type 1 – Water management driven by basic service issues;
2. Type 2 – Water management driven by water scarcity;
3. Type 3 – Water management driven by climate change effects on rainfall patterns, flooding and water quality.

As expected and understandable, in most developing countries sustainability is not a priority yet. This report highlights some Australian examples and afterwards presents other examples across the world including the EPAL (Portugal), Water UK (UK), Watercare (New Zealand), Public Utilities Board (Singapore), Manila Water (Philippines), Tel-Aviv-Yafo urban water system (Israel), and Seattle and San Francisco Public Utilities (USA).

Objectives, criteria and performance metrics

This section proposes a UWCS sustainability scorecard, which is associated with its dimensions, objectives, criteria and indicators (or other performance metrics). Note that the aim of this section is not to define in detail the performance metrics that assess the UWCS sustainability. The report discusses adopted criteria and performance metrics and include some of them in a very draft proposal, in particular those concerning the social, environmental and economic dimensions.

Associated with dimensions or the principles of UWCS sustainability, it's defined its specific objectives. These objectives, in opposition to the dimensions that have a more transversal scope, depend on the field where sustainability is being assessed. Therefore, we set out specific and elaborated objectives for the UWCS, which can change in intensity according to water utilities patterns and their stakeholders. As for the criteria, they are associated with each objective of the UWCS sustainability. Those objectives are achieved if the corresponding criteria are fulfilled.

Also, there will be metrics for each criterion (not only performance indicators but other metrics, such as best practices check lists, results of inquiries,...) which will allow for its assessment. As mentioned, the objective of this report is not to define the metrics for each criterion of each objective of UWCS sustainability. However, some suggestions are given for the guidelines of MCDA and for a first preliminary assessment of UWCS sustainability.

A questionnaire for the Baseline Assessment of UWCS

Water is essential for economic development and for the wellbeing of humans and ecosystems. According to the UN (http://www.un.org/waterforlifedecade), two main challenges related to water are affecting the sustainability of human urban settlements: the lack of access to safe water and sanitation, and increasing water-related disasters such as floods and droughts. Furthermore, half of humanity now lives in cities, and within two decades, nearly 60 per cent of the world's people will be urban dwellers. In developed countries more than 80 per cent of the people will live in cities.

According to the European Commission, the balance between water demand and availability has reached a critical level in many areas of Europe (water scarcity) as in the rest of the world. In addition, more and more areas are facing droughts resulting from climate change.

As part of the TRUST context, a questionnaire has been developed for a baseline or preliminary assessment to assess the sustainability of the urban water cycle. This questionnaire can be seen as a basic SWOT matrix framework (, with a focus on the water and wastewater utilities, but also addressing the external developments (such as urbanization, climate change) and the ambitions and plans to address these in the very near future. The questionnaire consists of five parts highlighting the TBL aspects:

1. Part A – General information;
2. Part B – Drinking water that needs to be provided by the cities involved in TRUST;
3. Part C – Wastewater;
4. Part D – Environmental quality, biodiversity and attractiveness;
5. Part E – Governance.

FINAL REMARKS

This document presents the Part I of the TRUST report entitled *Current state of sustainability of urban water cycle services*, on the '*Where are we now' basis*, with some baselines for assessment of the actual state of the UWCS. However the report only introduced the theme, being recommended the reading of Part II of this report for further knowledge.

LINKS TO ADDITIONAL INFORMATION

The Deliverable D11.1b can be accessed at the following URL:

http://www.trust-i.net/downloads/index.php?iddesc=66

Further information can be found in the additional links:

- Report 11.1a - 'Best practices for sustainable urban water cycle systems' → http://www.trust--i.net/downloads/index.php?iddesc=67

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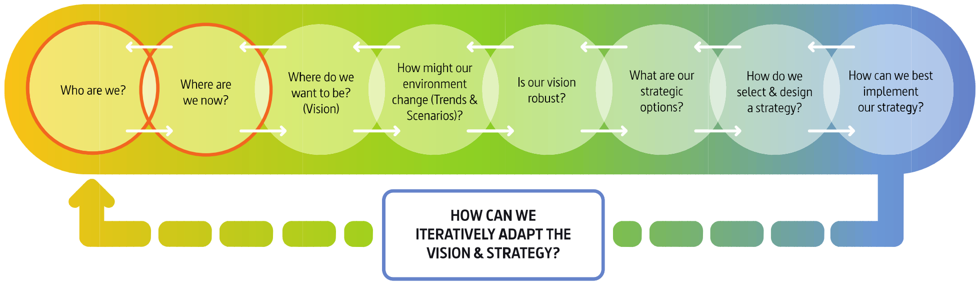

SCOPE

The variability in sustainability among the UWCS of the cities offers excellent opportunities for short-term and long-term improvements, provided that cities share their best practices. Even cities that currently perform well, can still improve their UWCS, cities can learn from each other, being in this light that this report falls under.

The document covers an introduction to UWCS followed by the scope, method, data sources and the process of assessing the sustainability of UWCS. Results are described, placing the cities in their regional and/or national context, followed by a discussion and main conclusions. However, annex 2 is the main part of this report in which the information is presented based on the completed TRUST questionnaires and regional/national information provided in public sources.

SUMMARY DESCRIPTION

Introduction to UWCS

The negative consequences of poor water resource management on socio-economic development are more frequently arising. This is clearly apparent in the agricultural and other water-sensitive industries. However, industries where water is less evident in the supply chain, and even other sectors such as energy, are becoming increasingly aware of the risks and consequences associated with a potentially unreliable water resource.

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. TRUST aim is to deliver knowledge to support urban water cycle services (UWCS) towards a sustainable and low-carbon water future without jeopardising service quality. There is no single or clear pathway for the adoption of sustainable practices for water utilities, cities, or any other organization involved in UWCS. Equally, there is currently no consensus on how to assess the sustainability of UWCS.

In the context of the TRUST project it has been decided to obtain data from contact persons in TRUST pilot cities and regions in order to enable a quick scan of the sustainability of UWCS. The quick scan is a baseline assessment which:

1. Provides stakeholders in TRUST pilot cities and regions with a basic insight in the current status of the sustainability of their UWCS;
2. Enables stakeholders to internally reflect upon the current status in terms of possible consequences for future UWCS management;
3. Enables stakeholders to share the results with other colleagues, to discuss potential improvements and to learn from each other's experiences.

Material and Methods

Urban water management is complex. It has a wide scope and many stakeholders are involved. Therefore, the baseline assessment of cities and regions needs to reflect this and cover a broad range of aspects. The TRUST sustainability assessment of UWCS includes the main dimensions of social, environmental, economic and the supporting dimensions of assets and governance sustainability. In this section the report presents the criteria developed within the TRUST project plus 24 indicators selected for the City Blueprints. For the calculation of the City Blueprint, the following requirements were established:

- Scope: water security, water quality, drinking water, sanitation, infrastructure, climate robustness, biodiversity and attractiveness, as well as governance;
- Data availability: data must be easily obtainable;
- Approach: a qualitative approach is the preferred option;
- Scale: indicators need to be scored on a scale between 0-10, being 0 'very poor performance' and 10 'excellent performance;
- Simplicity: relatively easy calculations and scoring of the indicator values;

- Comprehensibility: results need to be interpreted and communicated relatively easy;
- Workability: data collection, further selection, calculations and graphical representation of the results need to be doable.

Results

In this chapter the report introduces the context of cities and regions within the TRUST project (1.), their UWCS comparison (2.) and their best practices (3.):

1. Information was gathered on water scarcity, surface water quality, biodiversity of surface water, and (shallow) groundwater quality. As voluntary participation of the civil society is crucial for the sustainability of cities, this and the mentioned aspects are presented in a detailed way in this section.
2. The information from the TRUST questionnaire and the additional information gathered for water security, public participation and the regional or national estimates for local environmental quality were used to make short reports of the cities and regions of TRUST. These short reports of the TRUST cities, together with the information for the cities of Rotterdam, Kilamba Kiaxi and Salaam are presented in the Annex 2 of the report.
3. In this section the report lists the City Blueprint indicators together with the best performing cities and the best score per indicator to indicate what the current best practices are. In order to illustrate this further, a theoretical City Blueprint is provided in which all the best practices are given (see figure below)

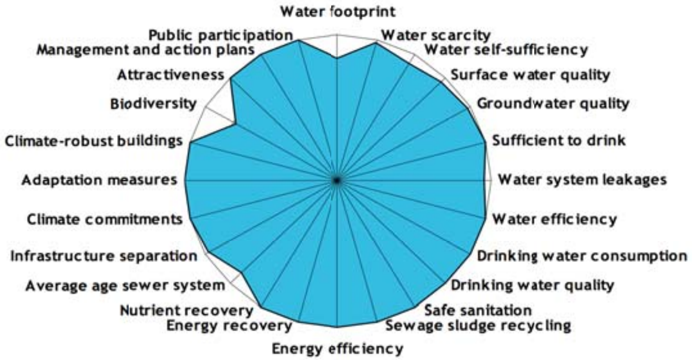

Figure 1 – theoretical City Blueprint

Discussion

The choice of indicators for the TRUST Questionnaire and the City Blueprint are per definition subjective. There are many options for other indicators and a variety of methods to quantify them. However, the selected questions and indicators provide for a good overview of the key sustainability issues in UWCS. In fact, the baseline assessment of the TRUST cities has shown that the choice of the indicators is driven by the availability, quality and comparability of the input data. For some indicators only national data are available.

FINAL REMARKS

This TRUST report is a quick scan on the current state of UWCS and it doesn't cover all its aspects. Some are addresses very generally, and the assessment is also static and not dynamic. It is a snapshot and therefore it does not address long-term trends in UWCS stress and adaptations. Also, care should be taken to attach absolute value to the results. The City Blueprint and reports in Annex 2 can be use as a preliminary decision support tool and information, but other aspects need to be included as well.

However, when these limitations are taken into account, the baseline assessment provides stakeholders with a basic insight in the current status of sustainability in their UWCS and most importantly can be used to learn from each other's experiences.

LINKS TO ADDITIONAL INFORMATION

The Deliverable D1.1b PART II can be accessed at the following URL:

http://www.trust-i.net/downloads/index.php?iddesc=66

Further information can be found in the additional links:

- Report 11.1a - 'Best practices for sustainable urban water cycle systems'. http://www.trust-i.net/downloads/index.php?iddesc=67
- Environmental Performance Index. http://epi.yale.edu/
- EIP Water. City Blueprints® of 30 cities and regions. http://www.eip-water.eu/sites/default/files/EIP-Water-City_Blueprints_Action_REPORT_June_2014_0.pdf
- FAO (2012). Aquastat. Global information on water and agriculture. http://www.fao.org/nr/water/aquastat/main/index.stm
- WFN (2012). The water Footprint Network. http://www.waterfootprint.org/?page=files/home

D12.1 a

Review of global change pressures on urban water cycle systems. Assessment of TRUST pilots.

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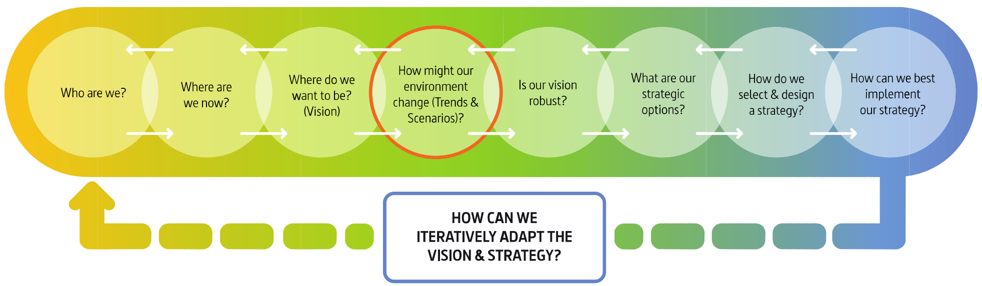
ANTÓNIO JORGE MONTEIRO



SCOPE

This review identifies and describes different pressures of critical importance affecting Urban Water Cycle Systems (UCWS), to help in the design of appropriate tools targeted to understand and deal with future stresses.

A general description of relevant pressures is presented in terms of context situation, interdependencies and expected tendencies for the future. All pressures affecting UWCS were framed in the three Triple Bottom Line basic dimensions of sustainability: environmental, social and economic.

The report also presents a preliminary assessment of those pressures and impacts on Pilots of TRUST, namely in the Algarve Region (Portugal), Athens (Greece), Madrid (Spain), Province of Reggio Emilia (Italy), Amsterdam (Netherlands), Hamburg (Germany), Oslo Area (Norway), Scotland cities, Bucharest (Romania), and Angola.

SUMMARY DESCRIPTION

Future pressures on Urban Water Cycle Services

Pressures were categorized according to the sustainability definition of TRUST.

Environmental pressures

Water stress occurs when the demand for water exceeds the availability. It may result from a reduction in fresh water resources availability or from the deterioration of its water quality due to e.g., eutrophication, organic matter pollution or saline intrusion. In the future, global stresses are expected to increase, exacerbated by climate change.

Social pressures

Water demand patterns are affected by population dynamics, changes in natural landscape associated with urbanization and evolution of population age distribution. Also, the society culture and education, as well as their preferences and confidence on services, are also changing, with important implications for water-related services.

Economic pressures

In general, globalization induces competition for existing resources and the conflicts among potential users are expected to increase, as well as costs associated with UWCS. Funding will continue to be a limiting factor for an effective management.

Possible future trends

Plausible trends for the water sector are presented, as summarized on the next table.

DEFINITION	POSSIBLE SOLUTIONS
"Trend Env1: water scarcity" caused by insufficient or contaminated water resources, lack of adequate treatment and large losses	Alternative sources (e.g. groundwater, desalination); preference for drought resistant crop varieties; water-saving devices; improved rainwater harvesting; demand management
"Trend Env2: Excess of water" caused by inadequate land use; inflow; surcharges; clogs in drainage system, inadequate street cleaning, etc	Combined stormwater and groundwater management
"Trend Env3: Degradation of water quality" caused by point pollution sources and/or diffuse sources	Assess cause-effect relationship of water pollution, monitoring, modelling; Water Safety Plans (WSPs); new treatment steps; knowledge about processes of sediment formation

DEFINITION	POSSIBLE SOLUTIONS
"Trend Env4: need to reduce GreenHouse Gases (GHG) and to adapt to global warming" greater frequency and intensity of extreme events	Research on climate change impacts and solutions in the water sector to reduce overall energy consumption and to reduce GHG; adaptation to irreversible impacts; risk management practices
"Trend S1: Growth of informal peri-urban areas strongly influenced by cultural values" particular from developing countries	Capacity building; cultural and education level solutions; empowerment of women; stakeholder dialogue on policies and the inclusion of local knowledge on the decision process
"Trend S2: Growth of structured peri-urban areas" particular from developed countries, resulting in impervious surfaces (e.g. roads, parking lots, roofs)	Development of stormwater measures, urbanization policies
"Trend S3: demand for green cities" as a response to people's expectations (people expect to achieve better 'quality of life' patterns)	New approach of stormwater management, increasing the visibility of water courses in urban spaces; construction of green and low-impact buildings, with water reuse and energy savings
"Trend S4: More resilient and flexible UWCS" to make them robust and resilient to global change pressures	Assess expected global pressures and the development of methodologies to respond to them (structural and non-structural measures, taking into account the institutional factors)
"Trend S5: Decreasing and ageing population" causing difficulties in abandoned regions (e.g. oversized systems, higher maintenance costs *per capita*)	Financial sustainability assessment, rethink systems (e.g. integration of neighbour utilities), national and regional policies
"Trend Econ1: Difficulties in meeting services demands and degradation of infrastructures" due to lack of funding to repairs and upgrades; high leakage losses rates; stringent performance standards	Revise investments needs by reducing costs (e.g. improving collection efficiency and reducing unaccounted for losses in distribution systems) and finding new sources of funds to close the financing gap

DEFINITION	POSSIBLE SOLUTIONS
"Trend Econ2: Reduced willingness to invest in total service coverage" typical from developing countries, where independent service providers are the main water suppliers	Assess quality of service provided by independent operators as well as on tariffs charged; evidence that adequate investments can yield a high return by avoiding other costs (e.g. human health)
"Trend Econ3: Political instability" as a result of competition and conflicts	Increased awareness of terrorist and sabotage incidents, resulting in more strict security control and restricted accessibility to water production systems

FINAL REMARKS

This document establishes a preliminary framework for the TRUST pilot partner's, identifying their major global change pressures and its impacts. Additionally, the two annexes of this report present the main climatic drivers, in terms of the future projection of weather variables (precipitation and temperature) in the areas of the TRUST pilot cities / regions.

ADDITIONAL INFORMATION

The described deliverable can be accessed at the following URL:

www.trust-i.net/project/d.php?wa=1&wp=2&d=1

Further information can be found in the additional links:

- Climatic changes: http://peseta.jrc.ec.europa.eu/docs/ClimateModel.html
- Population dynamics : http://www.eionet.europa.eu/
- Emission scenarios (GHG): http://www.grida.no/climate/ipcc/emission

D12.1 b
Review on flexible urban water cycle services and transitional pathways

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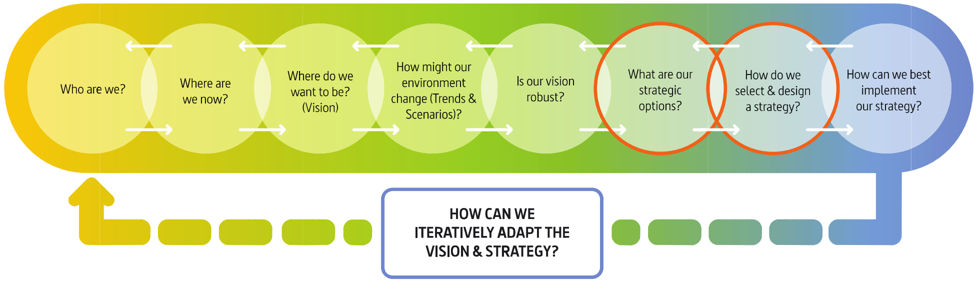
PAUL JEFFREY



SCOPE

This report aims to identify best practices for a flexible and resilient operation of Urban Water Cycle Systems (UWCS) and their associated transitional pathways, divided into governance and technical issues. Guidelines for developing sustainable UWS are proposed.

The analysed governance issues are focused on literature case studies, including policy and regulation, financial mechanisms and water service organisation and management. Technical issues address the main infrastructure components of the UWCS, namely water supply, urban drainage and wastewater treatment, as well as asset management issues.

A broad review of key concepts in academic literature concerning resilience and transition processes are also included, outlining some of the significant developments in theories of complex systems (e.g. socio-ecological systems - SES, socio-technical systems - STS).

SUMMARY DESCRIPTION

General overview of resilience and transition (review of key concepts)

The concept of resilience was established in the study of ecosystems from the 1970's, dominated by the idea that ecosystems had a single, relatively fixed point of equilibrium – one 'steady state'. As a result of this assumption, resilience was generally seen in terms of recovery from disturbance, to return to its steady state. However, this definition was challenged by the proposition that ecosystems have multiple 'domains of stability', shifting between those alternate states, which means they are fundamentally dynamic.

These ideas about the resilience of ecological systems likewise affected how other complex systems are understood. A resilient system does not necessarily 'absorb' a disturbance and return to its previous state. Instead, it is in a perpetual state of flux, continually adjusting and adapting to new disturbances.

The organic nature of these concepts means that there is no definitive road map for bringing about a beneficial transition, and no concrete measures detailing what a resilient urban water system might look like. Instead, a 'transition towards resilience' translates into rethinking what a management intervention actually consists of. By encompassing a multitude of actors spread across many levels of authority, comprehensive prediction and control of such a system becomes infeasible.

Resilience and transitions in the water sector – Governance issues

Policy and regulation
In the Dutch case, a 'managed transitions' approach was instigated, by destabilizing the *status quo* of national environmental policy. Another described case study was CALFED water management programme (California), with innovative governance features.

Financial mechanisms
The CALFED example is described, as it implemented a scheme of 'environmental water account – EWA' (similar to a tradable permits scheme). It enabled stakeholders to acquire water rights to support endangered species protection in rivers and wetlands.

Organization and management

Some English water companies have experimented sustainable land management initiatives, working directly with landowners and managers (e.g. farmers), in order to directly address the causes of certain forms of pollution, thereby decreasing the need for more costly forms of water treatment.

Resilience and transitions in the water sector – Techical issues

Water supply

Alternative water resources in the cities may include rainwater, stormwater and wastewater injection into aquifers. The groundwater recharge, together with augmentation of reservoirs will contribute to increased storage capacity (which can then be pumped during dry periods).

Urban drainage

In the last decades, several Best Management Practices (BMPs) in urban drainage management have been developed, having evolved towards eco-engineered solutions. Some are classified as Sustainable Urban Drainage Systems (SUDS).

a) Infiltration basin b) Infiltration trench c) Porous pavement d) Swale

Examples of structural stormwater BMPs

Wastewater treatment

The following key targets were identified as relevant to act upon in order to improve the wastewater treatment system's resilience: managing flows; ensuring water quality levels; enhancing energy saving and production; and adopting low carbon footprint technologies.

Asset management

Most of the advanced asset management techniques are risk-based approaches that measure and forecast asset performance. Some of the available guidelines already include frameworks for adaptation and mitigation to climate change or are specific for asset resilience to flood hazards (e.g. Asset Resilience to Flood Hazards, Ofwat).

FINAL REMARKS

Although it is difficult to draw out concrete best practices for resilience and transitions approaches, there are a few principles to take into account, namely: *destabilise the status quo*, *create linkages* between different actors, e*ncourage experimentation and support learning* and *instil flexibility,* through redundancies or decentralized options.

ADDITIONAL INFORMATION

The described deliverable can be accessed at the following URL:

http://www.trust-i.net/project/d.php?wa=1&wp=2&d=1

Further information can be found in the additional links:

- “CALFED water management programme (California) - Governance for Resilience“ http://www.ecologyandsociety.org/vol15/iss3/art35/ES-2010-3404.pdf
- “Review of the adaptability and sensitivity of current stormwater control technologies to extreme environmental and socio-economic drivers “ http://www.switchurbanwater.eu/outputs/pdfs/W2-1_GEN_RPT_D2.1.1_Review_of_stormwater_control_technologies.pdf
- “Asset Resilience to Flood Hazards, developed in behalf of Ofwat “ http://www.ofwat.gov.uk/pricereview/ltr_pr0912_resilfloodhazglos.pdf

D12.1 c

Guidelines for urban water strategic planing - Inspirations from theories & best practices

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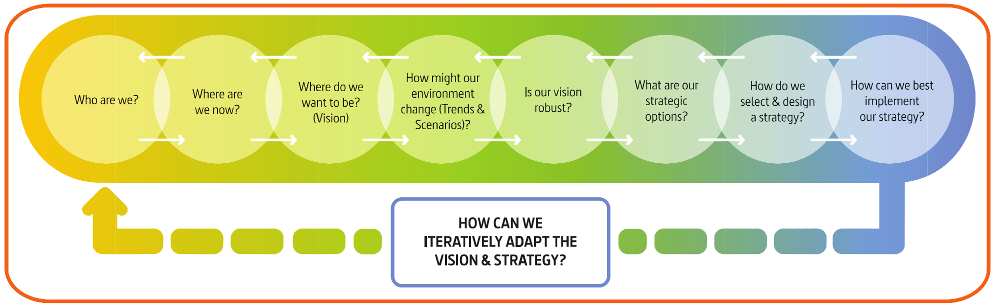
RITA HOCHSTRAT, HEATHER SMITH



SCOPE

This report establishes the basic steps and guidelines in an adaptative strategic planning process that can be seen as best practices for European urban water management, resulting from the structure and contents of 12 existing strategic plans. The analysis covered a diverse and inspiring group of leading utilities, sampling plans from water scarce areas, urban and peri-urban areas , and green areas.

The proposed methodology corresponds to the framework presented in the beginning of this factsheet, and also in all SAFs (Situation Analysis Factsheets). It is an adaptative approach, as represented in the Figure: the blue arrows show the general direction of the process and the white arrows indicate that each step is iterative.

It is strongly linked with TRUST 'Template on roadmap structure and process, protocols and guidelines', which provides a manual of how the ideal typical strategic planning process here presented can be employed in practice.

SUMMARY DESCRIPTION

Strategic planning

Most urban water cycle systems were originally designed using "command-and-control" approaches, which are progressively being replaced by more integrated, adaptive and participatory management methods.

The proposed basic steps for the strategic planning process are now briefly described.

Who are we?

Refers to organizational identity and stakeholders, including the definition of boundaries of control (internal system) and sphere of influence (transactional environment)

Includes the definition of "sphere of influence", in three levels: internal, transactional and external.

Where are we now?

Definition of the reference point, including state of infrastructure assets and resources as well as social and governance structure

From the perspective of the present, this step can be useful for indicating the need for .hange and creating a sense of urgency. It also generates a reference point for evaluation.

Where do we want to be? (Vision)

Represents the desired state of the internal system and, to some extent, the transactional environment

The first version or iteration of the vision, before it is tested against context scenarios and adapted, should focus on that which is desired.

How might our environment change (Trends & Scenarios)?

Includes an inventory and analysis of factors and trends that may impact on the organization and its transactional environment

It is recommended that this approach include an assessment of uncertainty, using for example the Scenario Planning method. Urban water utilities may wish to test their plans against climate scenarios, as the Global Environment Outlook (GEO) scenarios, by UNEP. The SCENES project, under the EU 6th framework directive, has already enriched these GEO scenarios to be specifically relevant for the European water sector. The EU 7th framework PREPARED project also works with scenarios that may be useful.

Is our vision robust?

Iterative comparison between the vision with the current state and with the possible future states of external system

The process of testing a vision against context scenarios should be iterative. One useful means of categorizing data about internal and external systems and presenting decision makers with alternatives is the Driver-Pressure-State-Impact-Response framework.

What are our strategic options?

Selection of a series of actions that establish the proposed pathway between the current state and the desired future state

There are several available methods to develop this step, like Relevance-tree Analysis, Multi-criteria Analysis or SWOT (Strengths, Weaknesses, Opportunities, and Threats).

How can we best implement our strategy?

Stakeholder engagement for proper planning processes and good governance

Regarding this phase, there has been much European research to help implement the theories of stakeholder engagement (e.g. HARMONICOP, NEWATER, SWITCH, and CONVERGE). One suitable method is backcasting, i.e, the assessment of the present state from the perspective of a normative (desirable) vision or target, which typically results on a rough pathway defining milestones & transition measures.

HOW CAN WE ITERATIVELY ADAPT THE VISION & STRATEGY?

Process evaluation and monitoring, periodically asking the fundamental questions: where are we now? and where do we want to be?

Annual progress reports can be used to demonstrate the transparency of the evaluation process, using performance indicators, multi-criteria factors or other. One common used method is the SMART approach.

FINAL REMARKS

The **main guidelines** for a strategic planning process are:

- Who are we: delineate the sphere of control and influence of the utility; consider which parties need to be involved in the various steps; set stakeholders involvement and manage their expectations; consider issues that may be communicated with wider audience;
- Where are we now: define the current state of the internal system including physical assets and resources and social conditions;
- Where do we want to be: on the first iteration of a vision, remember that “will” is prior to “necessity” and “capacity”; set short- medium- and long-term objectives;
- How might our environment change: consider a broad palette of trends and their interdependencies; select a method that matches the time horizon of the plan;
- Is our vision robust: consider approaches that match local situation, regarding resilience;
- What are the issues and our strategic options / How do we select and design a strategy: consider methods that match the level of stakeholder development, the variance between options, and the complexity of the system;
- How can we implement and iteratively adapt the vision and strategy: assume that the plan will be continuously optimised, learning through evaluation.

ADDITIONAL INFORMATION

The described deliverable can be accessed at the following URL:

www.trust-i.net/project/d.php?wa=1&wp=2&d=1

Further information can be found in the additional links:

- “Global Environment Outlook (GEO) scenarios, UNEP“
  http://www.unep.org/geo/
- “EU FP6 project SCENES and EU FP7 project PREPARED“, for scenario development”
  http://www.peer.eu/projects/peer-flagship-projects/scenes/
  http://www.prepared-fp7.eu/
- “EU projects HARMONICOP, NEWATER, SWITCH and CONVERGE”
  http://www.harmonicop.uni-osnabrueck.de/
  http://www.newater.uni-osnabrueck.de/
  http://www.switchurbanwater.eu/
  http://www.ict-convergence.eu/

D13.1

Roadmap guideline: a manual to organise transition planning in urban water cycle systems

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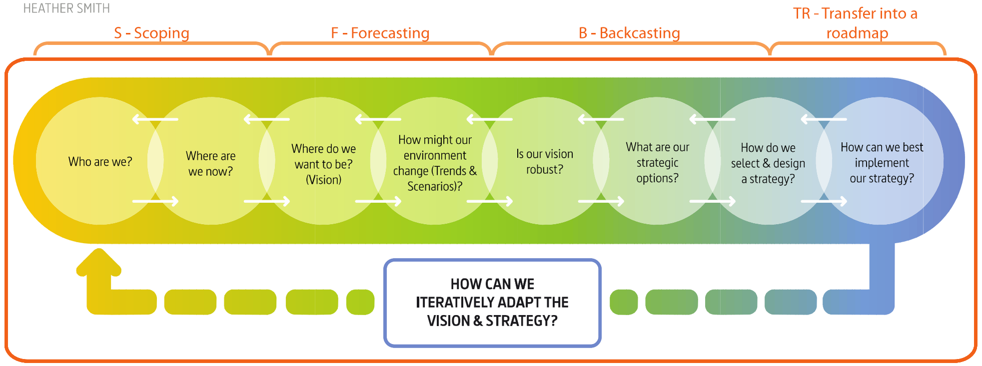
HEATHER SMITH



SCOPE

This manual intends to be a supporting instrument for urban water cycle planning, serving also as a valuable communication tool that organises a collaborative strategic development for sustainable USWC in the future. A roadmap enables decision makers to plan and implement a pathway to achieve desired objectives, linking strategy to future actions. The process sets out a creative methodology for establishing an interdisciplinary planning procedure, facilitating expert discussions. The guideline describes the roadmap stages and provides supporting templates, which will be tested in WA 6 of TRUST project with three demonstration clusters: scarcity, green city and urban /peri-urban.

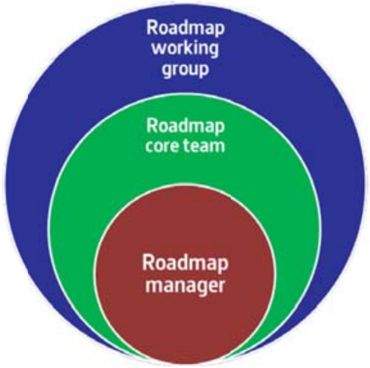
Furthermore, the whole concept will be available for adaptation to any city/region outside of TRUST.

SUMMARY DESCRIPTION

TRUST Roadmap Approach

The organisation of the roadmap is directed by a roadmap core team, consisting of 3 to 6 members, managed by a project leader who acts as roadmap manager. The roadmap core team has the task of applying and demonstrating the roadmap exercise in very close collaboration with the city/ utility. The roadmap core team plus the actors from the cities comprise the roadmap working group.

The TRUST roadmap guideline considers the four classical stages of the roadmapping process: Scoping (S), Forecasting (F), Backcasting (B) and Transfer (TR), as follows:



Roadmap manager, roadmap core team and roadmap working group

Scoping defines the extent of analysis in terms of system descriptions and boundaries. It provides a baseline understanding of the UWCS *status quo* and elements. This stage identifies relevant actors, asset structures, today's status and the impact of existing pressures and trends on the individual UWCS.

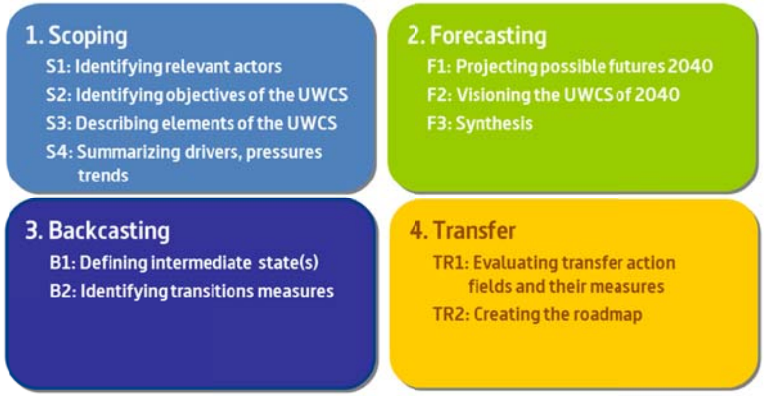
Forecasting creates a vision of the sustainable UWCS of the future (in the TRUST project the reference year is in 2040), that should develop realistic but still ambitious expectations. It also projects future scenario(s) of the external system and its potential impact on the UWCS. The rationale of forecasting is to project current trends into the future, to anticipate potential barriers and to obtain a perspective for a future scenario.

Backcasting looks iteratively back from the envisioned future state of the UWCS and works backwards via (at least one) intermediate state(s). Backcasting identifies the needs for a multi-step transition from today's status quo to intermediate state(s) and from intermediate state(s) to achieve the future desired state (vision 2040).

The stage of **Transfer** translates the identified measures into transfer action fields. This includes chronological information, recommendations with milestones, responsible actors, range of cost and so on. Identified transfer action fields and associated transition measures will be documented in the final document called "roadmap".

Working steps

The four main stages, previously presented, are structured into different of working steps as illustrated in the next figure.



Main stages and working steps in the TRUST roadmap process

The following table presents possible methods to use in each working step.

STEP	USED METHODS
S1	Establishment of contacts (identify and contact relevant actors, motivating them to participate in the roadmap work by sending template S1_1: Factsheet); contact details in a contact management document (see template S1_2: Actors management document); kickoff-workshop (optional) to launch the roadmap working group and explain the roadmap concept to city representatives– see template S1_3: Pool of slides
S2	(Internet) research, analysis of official documents, studies etc.; one-to-one interviews with actors from S1 (and others if needed) – see Template S2_2: One-to-one-interviews
S3	Agree on confidentiality rules (template S3_1: Confidentiality Agreement and Code of Conduct); collect data (template S3_2: City profile, a questionnaire based on IWA Performance Indicators)
S4	Scoping-/Forecasting-workshop, involving the roadmap working group; results from WP 12 (report on general pressures and trends) should be discussed
F1	Joint workshop with S4 (Scoping-/Forecasting-Workshop); estimate future Performance Indicators; down-scaling and transfer of national or regional scenarios; own scenario building
F2	Visioning and projecting exercise in expert workshop; survey to elucidate customer and stakeholder expectations of water services; Delphi surveys (with the actors)
F3	Internal evaluation round; public consultation, hearing
B1	Initial description of intermediate states using qualitative information, data/performance indicators of the template S3_2 that are consistent with the future scenarios identified in the Forecasting stage; feedback from a wider range of actors, using a cyclical (Delphi-style) consultation approach
B2	Circulate an initial set of measures (both short/medium-term and longer-term); organize a Transitioning- Workshop (optional); use the Roadmap Workshop to discuss the proposed measures
TR1	Use the output from B2 (measures and all available information); collect data from previous stages, chronological information, first recommendations for milestones and prioritization of transfer actions
TR2	Organisation of a Roadmap-Workshop, involving external participants from relevant actors of the pilot city; graphical representation and writing the roadmap; review of the final roadmap document

FINAL REMARKS

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. In this subject, workshops represent communicative platforms to involve different actors from the cities into the roadmap work. A minimum of three workshops is recommended, scheduled according to the stages and milestones. They are expected to provide valuable results to be incorporated in the next stage/working step.

ADDITIONAL INFORMATION

The described deliverable can be accessed at the following URL:

http://www.trust-.net/downloads/index.php?iddesc=32

The main document also contains the relevant templates to assist in the Roadmaping process.

D21.1
Carbon sensitive urban water futures

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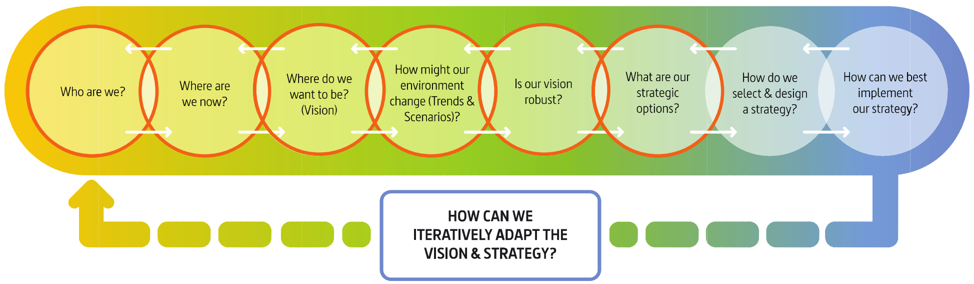


SCOPE

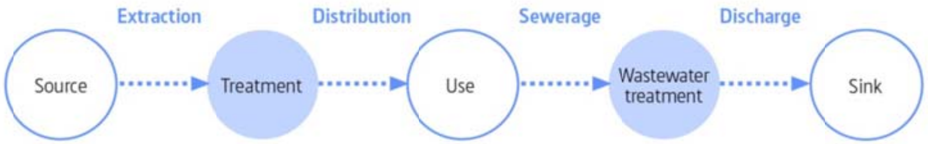
Water, energy, greenhouse gas emissions and climate change are interlinked through a series of relationships. One effect of climate change in many parts of the world is likely to be a change in rainfall patterns, which may further restrict the supply of groundwater and surface water in areas where it is already limited and even reduce availability in comparatively water-rich countries. At the same time, many countries have increasing populations and demands for water. This could create positive feedback by driving the use of others sources, such as desalination of sea water, which may have higher energy demands and greenhouse gas emissions. The challenge of supplying water and energy required for food production and development while mitigating climate change and adapting to its consequences has been termed the **Energy Water Nexus**. The great challenge is to improve resources (water and energy) efficiency.

The main purpose of the report is to characterise current energy and carbon use profiles in the water industry and explore the potential of new technologies and innovations to deliver on the ambition of a low carbon future. This report is primarily of interest to practitioners seeking to develop strategies and schemes to reduce energy/carbon use in urban water services.

SUMMARY DESCRIPTION

Energy consumption and GHG emissions in the water industry

There are five main stages in the water and wastewater systems, linked by transport steps.



Water is collected and extracted from its source, treated to appropriate chemical and biological standards, used by consumers, returned in part to the sewerage system, which also collects drainage water from buildings, roads and other surfaces, treated to further chemical and biological standards, and discharged, usually to surface water bodies or the sea. The two treatment stages consume energy, as do the transport steps connecting them. There are many different treatment processes applied to both water and wastewater treatment, with different energy intensities and levels of GHG emissions. Regarding wastewater sector, it is stressed that increasingly high standards for discharges from wastewater treatment works have led to increasing energy use.

Strategies for energy efficiency and for low emissions

i) Energy efficiency in water and wastewater sector

Demand reduction, through the reduction of waste and increasing water efficiency at the point of use should be part of the solution to both problems. Savings of up to 10% should be achievable by 2020 and at least 20% by 2050. These will have a proportional effect on energy and emissions for the water supply, but a much smaller effect on wastewater treatment, where they will only reduce the relatively small pumping requirement. Construction and decommissioning were fairly small components of the total carbon footprint (5–15%) due to the long lifetime of capital assets. Progressive improvements in the efficiency of conveyance and distribution should be able to reduce these components, which are about 40% of the total energy requirement for supply. Long distance conveyance and distribution is energy intensive so it should be avoided wherever possible.

Providing a separate supply of potable water and water treated to a lower standard (**dual supply**) has been proposed as a method of reducing total energy use and GHG emissions.

Other strategies can be considered in order to promote energy efficiency: optimization of water transport, reducing the volumes of water being treated and transferred to the supply network and water reuse. Operational improvements such as improvements in pumping efficiency and replacement of GHG intensive treatment processes, such as GAC filtration, can also contribute to reduce GHG emissions.

In wastewater treatment, improvements to the efficiency of pumps and other motors could provide 10–40% efficiency gains. Other general operational improvements may be capable of saving up to 25% of total plant energy. Aerobic treatments, especially the activated sludge process, are major energy consumers and the focus for substantial reductions. Better process control and other efficiency measures should enable 20% reductions of total emissions in the short to medium term.

ii) Energy recovery in water and wastewater sector

Although the process improvements could substantially reduce the energy consumption of water and wastewater treatment, energy recovery enhacements have the potential to reduce it to zero, or even to turn the plant in a net producer of sustainable energy, namely:

- larger-scale electricity generation is possible by the use of **turbines within gravity-fed flows**, for example from reservoirs prior to treatment;
- as landowners, water companies have also the opportunity to **exploit wind and solar electric generation**. In the case of wind generation, public opposition can be a problem where there is nearby housing or the site has a high amenity value for leisure activities or has a beauty spot;
- dewatered or dried sludge can also be used as a fuel. Sending sludge to landfill should be avoided, because it has high direct GHG emissions and provides no benefits. Agricultural use is preferable, as it can displace some chemical fertilisers, but still results in high emissions. So the preferred option should be **to use dewatered or dried sludge as fuel by co-firing or incineration with heat recovery**;
- biogas from anaerobic digestion of sewage sludge is an important source of renewable energy and should be maximized by ensuring that it is captured and used for **combined heat and power generation.** Indeed, if wastewater treatment plants were converted from aerobic to anaerobic treatment, the quantity of biogas available will increase while their demand for energy decreases, allowing them to become energy self-sufficient or net exporters of energy.

FINAL REMARKS

This report seeks to respond to and further develop the concepts, opportunities, and agendas needed to drive more energy and carbon sensitive water management from a European perspective, reviewing on these issues as they relate to municipal water supplies, and considering some of the options for sustainable water systems in the future.

ADDITIONAL INFORMATION

The described report can be accessed at the following URL:

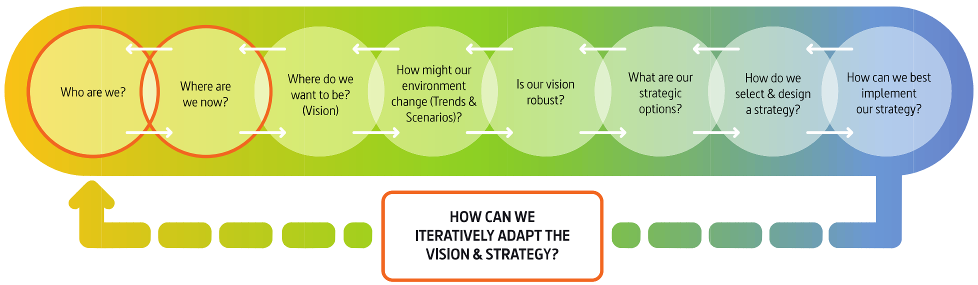
http://www.trust-i.net/downloads/index.php?iddesc=1

Further information can be found in the additional link of the TRUST project:

- "Policy Brief on Carbon sensitive urban water futures" http://www.trust-i.net/downloads/index.php?iddesc=52 "
- Energy Assessment of Pressurized Water Systems: http://ascelibrary.org/doi/abs/10.1061/%28ASCE%29WR.1943-5452.0000494

D21.2
Web based self-audit adaptive potential tool for urban water stakeholders

PAUL JEFREY, AINE GORMLEY, HEATHER SMITH
ENRIQUE CABRERA ROCHERA
RUI CUNHA MARQUES



SCOPE

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 requires organisations to be more adaptive - to adjust themselves according to changing circumstances.

In this context, the TRUST Adaptive Potential Self-Audit tool (APSA) for urban water sector organisations has been developed to help these organisations understand and improve their capacity to be adaptive. By doing so, an organisation can learn more from their experiences and as a result adjust management practices. This tool is geared towards teams and individuals working in the following business units in water sector organisations: strategic management, customer relations, R&D and/or operations.

SUMMARY DESCRIPTION

The APSA tool is web based, although a report was also been produced as a paper version. The tool guides users through a series of targeted questions, in which they are asked to assess particular practices within their organisation.

The purpose is to instigate thoughts about how their organisation operates and how practices might be improved. A suite of on-line resources is also given to the user, specifically tailored to help build on the strengths and reduce any weaknesses in their adaptive capacity.

Conceptual basis for the tool

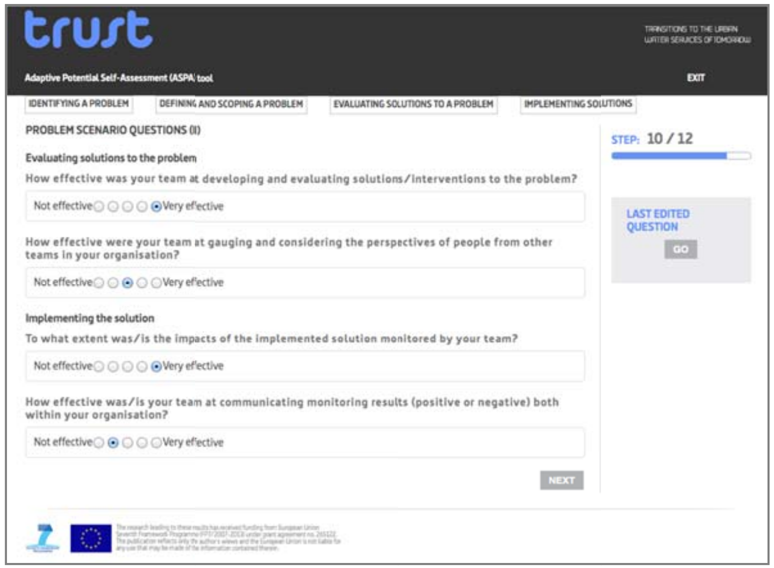
The basis of the tool stems from an adaptive capacity framework analysis that was carried out on the relevant literature. Ideal-type traits for accommodating long-term change or dealing with problems that are characterised by uncertainty, complexity and/or ambiguity were identified. The traits identified were not equal strategically nor were they used contemporaneously by an organisation. Rather, they could be characterised under the realm of four steps that an organisation takes in order to manage problems.

By aligning these attributes with operational behaviors in the water sector, traits that organisational actors can adopt to foster adaptive capacity were identified. From this, a framework was proposed for enabling water sector organisations to better understand and improve their capacity to be adaptive.

From concept to aplication

a) User input

The APSA tool requires an entry of introductory information based on the user's work and experience. It focuses on the adaptive capacity of the user's work team regarding four key management activities: identifying a problem; defining and scoping a

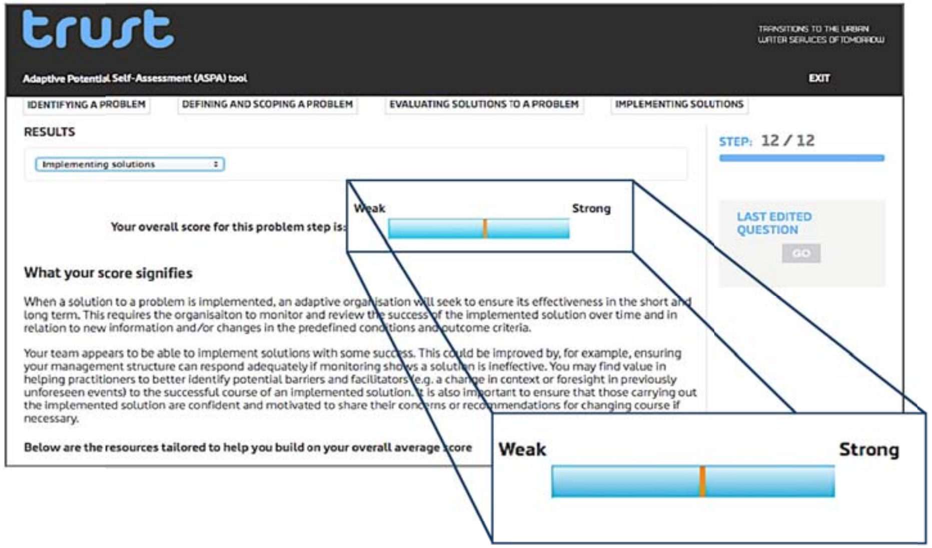


problem; evaluation solutions to a problem; and implementing solutions.

The scoring indicators associated with the questions were created with respect to the literature review. For the ‘identifying a problem’, ‘defining and scoping a problem’ and ‘implementing solutions’ stages, the tool considers 25 input variables, 50 for ‘evaluating solutions to a problem’ and a further 25 for the ‘problem scenario’ stage.

b) Tool output

Each indicator gets 1 to 5 points based on its contribution to adaptive capacity. For each problem step, the scores are averaged, and a description of what the score interval means is provided including the possible current status of adaptive potential in the users’ team and also recommendations of what they can do to improve (or retain) this. In addition, a suite of resources is provided to the user, tailored to the response for each question



(journal publications, training guidance material, educational videos, industry reports and handbooks).

FINAL REMARKS

The framework and APSA tool developed provides an aggregated speedy insight into the adaptive potential of a team working in the water sector, helping organisations understand and improve their capacity to be adaptive. However, it is important to note that the tailored improvement actions and resources are recommended from an adaptive capacity perspective and should be considered alongside other objectives, such as financial stability (e.g. by using the TRUST Financial Sustainability Rating Tool for Urban Water Systems).

Comparison with other teams’ and water sector organisations’ adaptive potential assessment and understanding is recommended. Benchmarking adaptive capacity projects offer an opportunity to see how adaptive potential has evolved, and where a team stands in comparison to others in the sector.

The APSA tool is considered to be a live tool where feedback from users will be collected and considered as possible improvements for action.

ADDITIONAL INFORMATION

The described on-line tool can be accessed at the following URL::

http://www.trust-i.net/downloads/index.php?iddesc=105

The TRUST report “Web based Adaptive Potential Self-assessment (APSA) tool for urban water stakeholders” is the paper version of this tool and is available at:

http://www.trust-i.net/downloads/index.php?iddesc=105

Further information can be found in the additional links:

- “Risk, vulnerability, resilience and adaptive management in the water sector”
  http://www.trust-i.net/downloads/index.php?iddesc=69
- TRUST Financial Sustainability Rating Tool for Urban Water Systems
  http://www.trust-i.net/downloads/index.php?iddesc=108

D22.1

Financial sustainability rating tool for urban water systems (FSRT)

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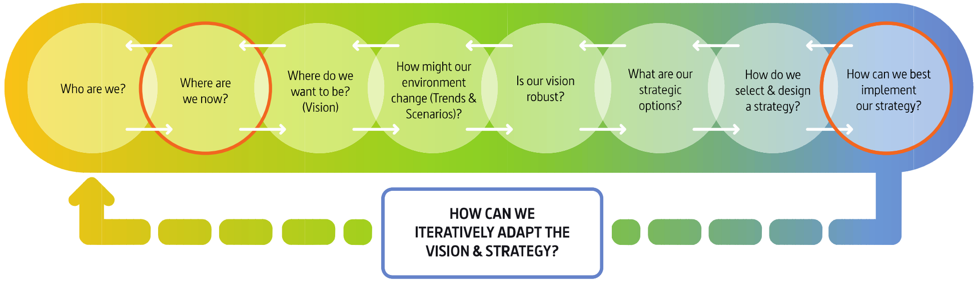
VITTORIO DI FEDERICO
NICOLE ANNETT MÜLLER



SCOPE

The FSRT is an online rating tool focused on financial sustainability in the urban water system, offering water supply and/or wastewater removal companies an opportunity to rate the utility's financial sustainability in a free and non-public way. It is directed at utilities, which provide either only one of the two services (water supply and wastewater disposal) or are able to split up the information and costs related to each service. Otherwise meaningful results cannot be achieved.

This factsheet focuses on the FSRT's characteristics, method and design incl. scoring/weighting methodology. The following information is not only considered important, but also necessary reading before a first run.

SUMMARY DESCRIPTION

The main target of the FSRT is to give a user an indication, which area from financial situation over asset management to business operation needs optimization. Further, the tool considers different forecasts and country specific characteristics to asses future challenges. A utility can use the tool once but also periodic (e.g. once a year) to have either a quick snap shot of the current

financial situation or to get a dynamic view on its financial position. Moreover, the FSRT considers historical data as well as forecasts to expand the observed time span.

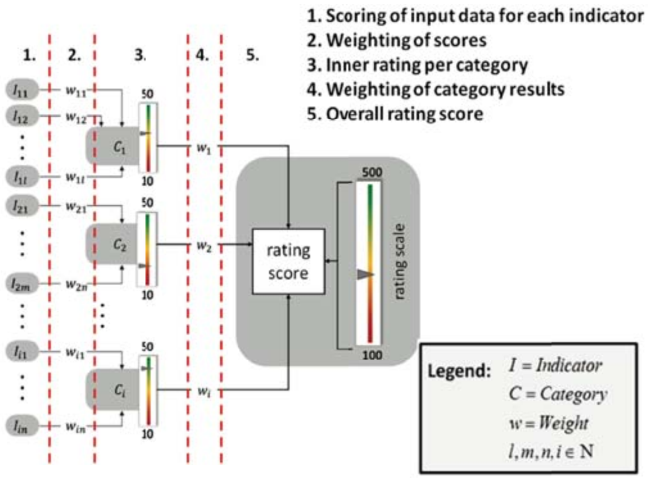
The Tool's conceptual design is based on a scoring model, which contains 4 categories and 21 indicators mainly based on the IWA performance indicators for water and/or wastewater (see figure beside).

FINANCIAL SITUATION	ASSET MANAGEMENT	BUSINESS ADMINISTRATION	FORECASTS
Liquidity indicator	Average mains/ sewer age	Economic regulation	Forecasted population growth rate
Equity ratio	Investments in tangible assets per capita	Inflation rate	Forecasted costs growth rate
Cash return on assets ratio	Annual mains/ sewer replacement rate	Gross domestic product per capita	Forecasted revenues growth rate
Cost recovery I: Revenue structure	Non-revenue water by volume	Late payments ratio	Expected cost recovery
Cost recovery II: Subsidies	Proportion of energy costs	Tariff policy	Planned tariff adaptations
			Planned price adaptations

Method and Design

The tool requires an entry of various performance indicators of a utility, some of which are used directly and some are used for further calculations within the tool. In the first step the indicators, which feed into the rating, get a score based on the utility's performance. In the second step the scores are weighted with respect to the importance of each indicator. In the third step the weighted scores of each indicator are summed up within all four areas from financial situation over asset management to business operation and forecasts. In step four the categories are weighted as well with respect to their importance (in the current version the weights are balanced), so that in step five the FSRT can generate an overall score (outer rating) in form of the summarized partial results.

Each indicator gets 1-5 points based on its contribution to financial sustainability, being 1 'less acceptable' and 5 'very good'The indicators within each category were weighted by several experts via paired comparison to generate adequate weights. Moreover, the weights were multiplied with the factor 10 for a better visualization of the results. In consequence, the scale for each category reaches from 10 to 50 points and the overall scale from 100 to 500 points (see figure above).



Application of the Tool

The accuracy of the input data is vital for the reliability of the results. Therefore, the deliverable gives a user some instructions before applying the Online-Tool:

- Each question needs to be answered.
- It is important to obtain all necessary data.
- Not to hurry helps to avoid input errors caused by time pressure.
- To check the input variables carefully avoids input errors, too.
- Approximations should be avoided if possible, because it might distort the results.

Recommendations for Improvement Actions

If the application of the Tool detects deficits in one of the evaluated areas, specific recommendations as well as further reading help to take the first step to improve financial sustainability. For further information on how to make use of the potential actions suggested by the tool and to define the next steps, the TRUST report "Funding alternatives for sustainable water services" (T22.4) is recommended..

FINAL REMARKS

The scoring model presented in this TRUST deliverable provides an aggregated quick insight into the utility's financial position.

However, the analysis of deviations usually stays in the task pane of a utility. The challenge here is to identify potential for further development as well as to take and prioritize necessary improvement actions. Since the main challenge of any rating is to break done a complex reality into a simple model, due to the need for aggregation, not all potential indicators and impacts could be considered. Focusing on one special objective, like financial sustainability, offered the possibility for more depth, but makes it very difficult to consider goal conflicts with other objectives.

Summarizing, the FSRT indicates deviations from a solid financial position ,shows in which particular area they occur and gives certain recommendations for improvement actions, but, however, the Tool cannot replace a detailed business analysis.

LINKS TO ADDITIONAL INFORMATION

The Financial Sustainability Rating Tool can be accessed at the following URL:

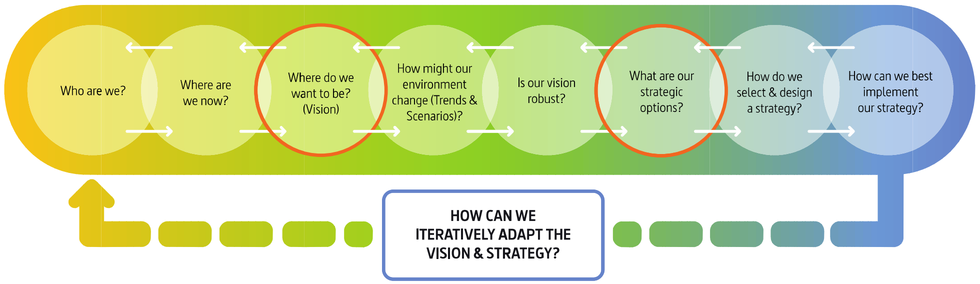
http://www.trust-i.net/downloads/index.php?iddesc=108

Further information can be found under the following additional link:

- Literature review WA2 http://wwww.trust-i.net/downloaads/index.php?iddesc ==54

D23.1
Set of policy briefs for water management practitioners

HEATHER SMITH



SCOPE

This report focuses on possible interventions towards a more sustainable future, presenting a set of briefs highlighting the key interventions that were discussed in the workshops.

The main propose is to expose the key challenges for urban water services as well as the benefits and weaknesses of potential interventions that might be used to help address those challenges. For this reason this document is useful for the stages '*where do we want to be*' and '*what are our strategic options*' phases of the TRUST roadmap presented in the framework.

There are seven briefs inside this report, discussing developing alternative water sources, demand management measures and general measures to strengthen the governance of the water sector. Each of the briefs provides a description and general context for the intervention, a summary of the responses towards each intervention that arose from the workshops, and a brief summary of the key factors that water service providers (or other governance bodies) should consider when developing and discussing these interventions. The documents are not intended to present a comprehensive guidance on each intervention but to work as a snapshot of the current thinking around urban water services. Next you can see a summary of each policy brief and some main concerns/advantages of each alternative practice.

SUMMARY DESCRIPTION

Wastewater re-use

In Europe wastewater re-use is an alternative for a set of different situations as for agricultural uses, cooling water and even as an artificial groundwater recharge (partly as a means of stemming saline intrusion in aquifers). However, this brief explains that it is still seen as a non-realistic or desirable intervention to address future challenges related to urban water services, being put as 'on the list' as a potential option but not one that could yet be seriously contemplated.

The main concern in relation to a reuse scheme, exposed during workshops, was cost including the cost of infrastructure and the cost of the water produced and the resulting impact on user tariffs. Also some concerns over water quality were exposed. Perhaps for these reasons only the more arid European countries are more likely to have already reuse and to treat it as a realistic option for the immediate future of urban water.

Desalination

Desalination has long been explored as a means of addressing water scarcity issues in Europe and around the world. In this brief there are exposed some drawbacks of this technology and why it has become an essential component of potable water supply in arid Mediterranean regions.

The main concerns stated in relation to desalination are once again related to costs, including the cost of the infrastructure, of the water produced (and the resulting impact on user tariffs) and the cost and reliability of the energy needed to supply the schemes. Also some concerns around the environmental impacts are mentioned.

Tarif reform

Tariffs are the charges that users pay, directly or indirectly, for access to water services, acting as economic signals. This third brief explains that there is many potential drives for reforming tariff systems, working in some areas as an economic incentive for water service customers to curb wasteful and inefficient practices or behaviors. Despite its potentials some concerns were exposed during the workshops, and presented inside the brief, regarding the long-term financial security of water service providers, and in particular, the need to cope with the rising costs of ageing infrastructure.

Customer Engagement

There is a wide range of mechanisms, beyond tariff payments, through which water service providers can communicate and engage with their customers. This brief exposes the concerns and validations, discussed in workshops, on different mechanisms of engagement used as a means of influencing customer behaviors and/or building support for proposed interventions.

Collaboration

Beyond water service customers there are a variety of stakeholders whose activities and responsibilities are related to the water sector. This is another brief inside where some attention is given in terms of collaboration and interaction between the water service providers and other relevant stakeholders, defining it as a key influence on the overall quality of water sector governance. Has the brief says, the workshops helped strengthen the water sector by allowing the various agencies to agree on resolutions to complex issues more quickly and effectively.

Supporting Research and Innovation

Although many acknowledge that research and innovation will be key to finding sustainable solutions for UWS, the implementation of new technologies or management approaches within the water service sector is often not straightforward. For this reason this brief is important by addressing the key challenges envolving this issue and referring some innovative technologies and work done in this area by the Water supply and sanitation Technology Platform (WssTP).

Understanding Responses to Innovation

This last policy brief discusses citizen responses to innovative technologies with the intended to help water service providers develop a clearer picture of potential responses to customer-focused technologies in order to better anticipate such responses. Many of the technologies that are currently of interest in the European water sector are those that could be used by customers themselves. With that said, this brief 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.

FINAL REMARKS

The set of policy briefs for water management practitioners report is essential for a first look on how water service providers and stakeholders see and objectify different possible interventions towards a more sustainable future within the urban water cycle.

Still, as it was mentioned, it does not work as guidance on each intervention, therefore for further information on how to apply any one of these 7 interventions the TRUST reports 'Guidelines for urban water strategic planning: The best European practices' and 'Template on roadmap structure and process, protocols and guidelines' (D12.1 and D13.1 respectively) are recommended.

LINKS TO ADDITIONAL INFORMATION

The Deliverable D23.1 can be accessed at the following URL:

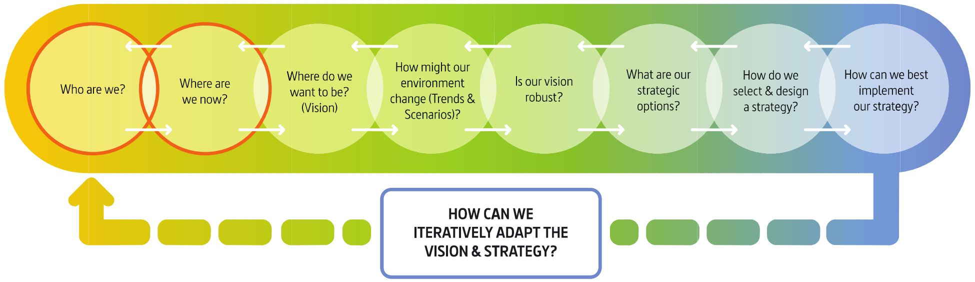
http://www.trust-i.net/downloads/index.php?iddesc=62

Further information can be found in the additional links:

- WssTP → http:///wsstp.eu/
- Deliverable D12.1 → http://www.trust-i.net/project/d.php?wa=1&wp=2&d=1
- Deliverable D13.1 → http://www.trust-i.net/downloads/index.php?iddesc=32

Framework for sustainability assessment of UWCS and development of a self-assessment tool

HELENA ALEGRE, HELGE BRATTEBØ
ENRIQUE CABRERA JR
ANDREAS HEIN



SCOPE

This report provides a comprehensive definition of sustainability aimed to provide a reference framework within the TRUST project. Sustainability for the Urban Water Cycle Services (UWCS) is defined in five dimensions (including the classical triple bottom line plus two additional enabling dimensions) and includes more detailed objectives and assessment criteria that should be used to perform such assessments within TRUST. A practical implementation of this approach is the development of the on-line self-assessment tool (SAT), which makes use of the TRUST sustainability framework developed for the whole project and develops it into a set of performance metrics to perform a quick and initial sustainability assessment of the system. The second part of this report provides details on how the self-assessment tool operates, the metrics used and how the assessment is provided.

SUMMARY DESCRIPTION

Sustainability definition

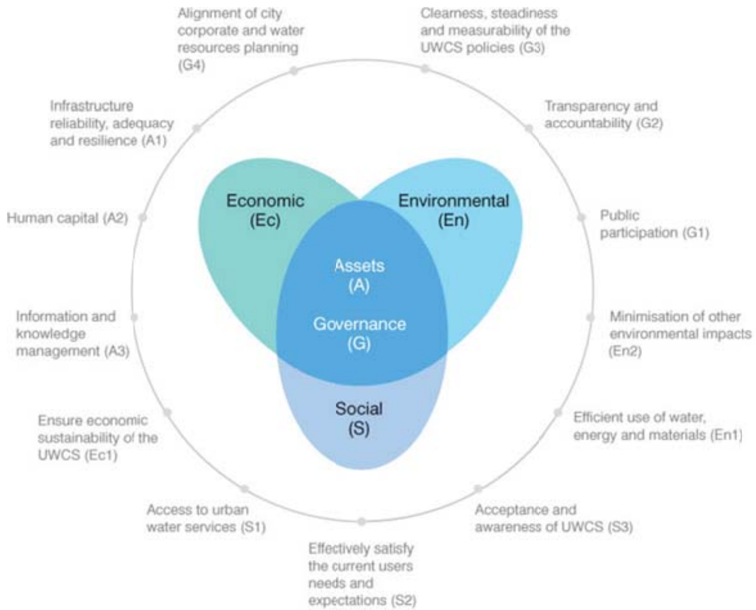
The proposed sustainability definition for use within the TRUST project is the following: "Sustainability in urban water cycle services (UWCS) is met when the quality of assets and governance of the services is sufficient to actively secure the water sector's needed contributions to urban social, environmental 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."

UWCS sustainability assessment

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 assessment should in particular provide insights in how to improve the assets and governance of UWCS in a strategic transition process towards 2040, to positively influence the end dimensions of social, environmental and economic sustainability.

The assessment is made operational by carefully examining a chosen set of performance metrics/indicators and how they comply with a predefined set of sustainability criteria. The performance metrics/indicators may be quantitative and/or qualitative, and are chosen to take account of the particular context and medium- and long-term challenges of a given urban water cycle system.



The table below gives the objectives and criteria of sustainability dimensions.

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 impacts	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)
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

The UWCS sustainability assessment method must be transparent, valid and holistic, and should take a systems metabolism and life-cycle assessment perspective when this is needed. 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.

Implementation. The TRUST self-assessment tool - SAT

The TRUST self-assessment tool represents the online version of the approach presented in this document. It represents a live system that will be updated throughout the project and will be maintained online for at least 5 years after the end of TRUST. The system collects all information required by the assessment method described above and calculates the corresponding score.

FINAL REMARKS

This document was developed outlining a common definition of sustainability and a common set of dimensions, objectives and criteria that should be taken into account to assess the sustainability of UWCS. It should be noted that this is not considered as the only "orthodox" definition of sustainability and its assessment, but as a common framework that is needed within TRUST project in order to ensure compatibility and consistency of activities and outcomes.

In the case of the self-assessment tool developed within TRUST, no information on data quality is explicitly gathered, aiming to reduce the time resources necessary to complete an assessment. In practical terms, the lack of data quality information limits the usefulness of the tool for making decisions as well as the quality of the assessment. For this reason, the self-assessment tool should be used as guidance and not as a final assessment. In any case, most of the performance metrics have been chosen to avoid data quality problems and should not present a problem for the average European utility.

ADDITIONAL INFORMATION

The TRUST **report** “Framework for Sustainability Assessment of UWCS and development of a self-assessment tool” is available at:

http://www.trust-i.net/downloads/index.php?iddesc=48

The TRUST self-assessment **tool** can be accessed at the following URL: https://self-assessment.trust-i.net/

Further information can be found in the following link of the TRUST project:

- “A Master Framework for UWCS Sustainability“ :http://www.trust-i.net/downloads/index.php?iddesc=40

D31.2
Urban Water Cycle Services (UWCS) performance self-assessment tool

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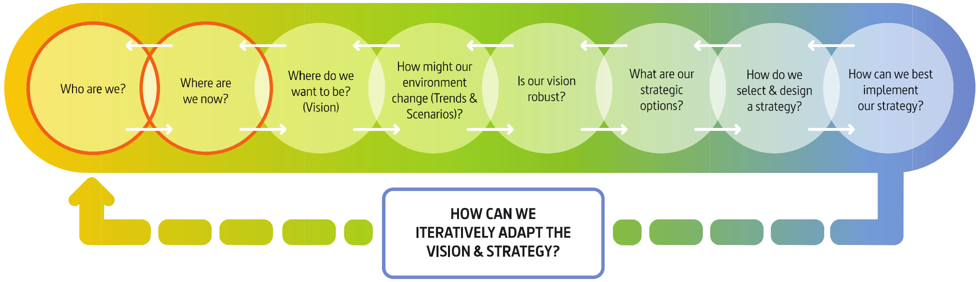
ENRIQUE CABRERA JR
ANDREAS HEIN



SCOPE

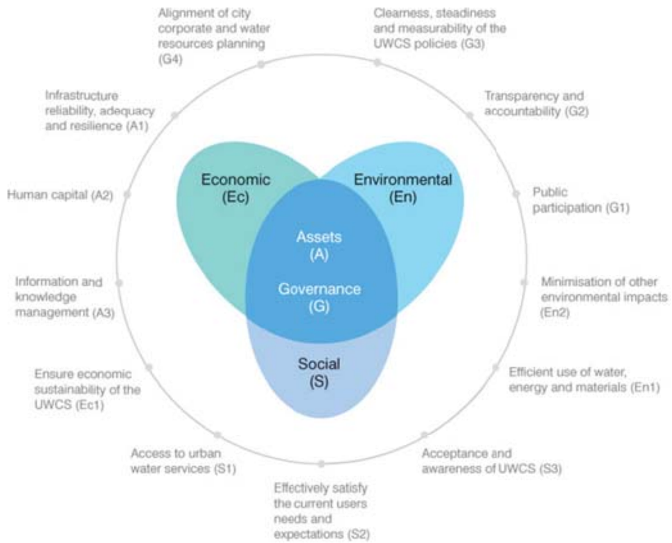
The proposed sustainability definition for use within the TRUST project is the following: "Sustainability in urban water cycle services (UWCS) is met when the quality of assets and governance of the services is sufficient to actively secure the water sector's needed contributions to urban social, environmental 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." Sustainability for the UWCS is defined in five dimensions (including the classical triple bottom line plus two additional enabling dimensions) and includes the details of objectives and assessment criteria that should be used to define assessment systems within TRUST.

As a practical implementation of this approach, an online tool was developed within the TRUST project for self-assessment by the UWCS utilities, making use of the framework developed for the whole project and developing it into a set of performance metrics to perform a quick and initial assessment of the sustainability of the system.

SUMMARY DESCRIPTION

UWCS sustainability assessment

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, as presented in the next figure. The TRUST report "Framework for Sustainability Assessment of UWCS and development of a self-assessment tool" should be seen as the document providing the technical insight on the self-assessment tool, including the details on how the tool operates, the metrics used and how the assessment is provided.

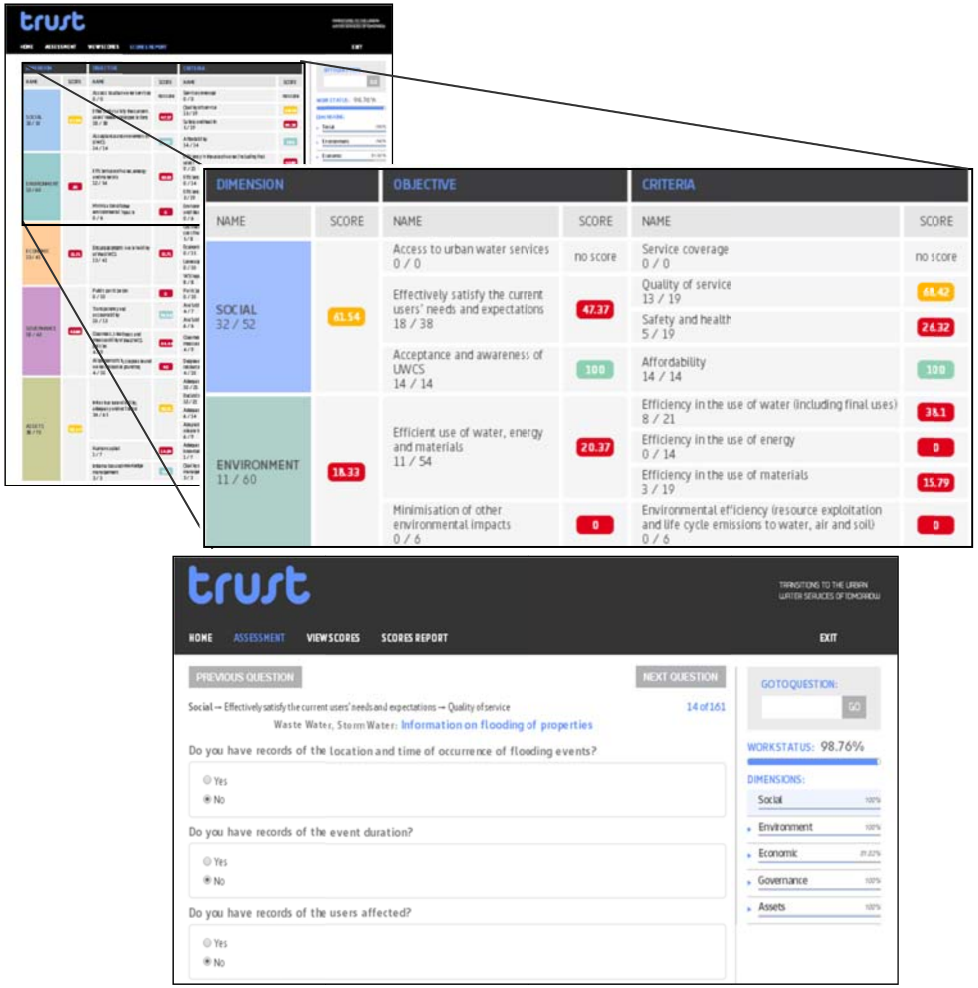


The TRUST self-assessment tool

It represents a live system that will be updated throughout the project and will be maintained online for at least 5 years after the end of TRUST. The system collects all the information required by the performance assessment metrics described above, and calculates the corresponding score

The self-assessment tool is a self-explanatory software that allows an easy interaction from the user. Visitors can create an account in the tool, so progress is saved allowing returning later to complete the questionnaire. Users can check their progress and intermediate assessment at any time providing real time feedback to encourage a complete assessment of the city. The tool was developed considering that all the data entry should not exceed three hours for a regular utility with some sort of information management procedures.

The Graphic user interface has been designed to facilitate the understanding of the tool's structure, and questions, as exemplify in the figure below.



Data input in the self-assessment tool

The above figure present the results screen of the self-assessment tool, detailing by dimension the scores obtained regarding each objective and assessment criteria.

The figure below presents the tool visualization of the final scores for each of the five dimensions considered for the UCWS sustainability assessment.

FINAL REMARKS

In the case of this self-assessment tool developed within TRUST, no information on data quality is explicitly gathered. There is a practical reason behind this omission, and it is related to the objective of reducing the time resources necessary to complete an assessment. In practical terms, the lack of data quality information limits the usefulness of the tool for making decisions as well as the quality of the assessment. For this reason, the self-assessment tool should only be used as guidance and not as a final assessment. In any case, most of the performance metrics have been chosen to avoid data quality problems and should not present a problem for the average European utility.

ADDITIONAL INFORMATION

The TRUST self-assessment **tool** can be accessed at the following URL:

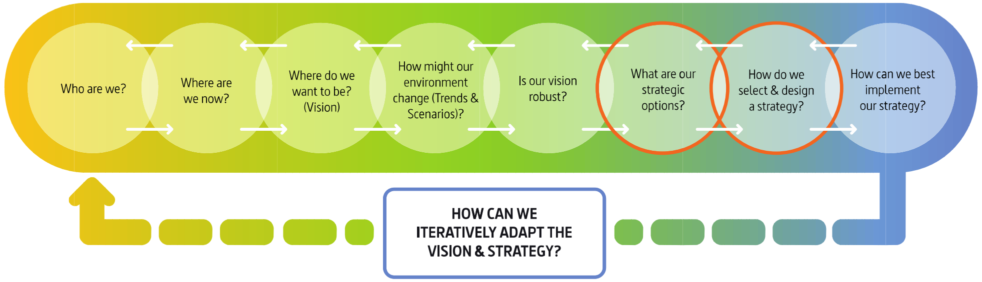
https://self-assessment.trust-i.net/

The TRUST **report** "Framework for Sustainability Assessment of UWCS and development of a self-assessment tool" can be found in the following URL:

- http://www.trust-i.net/downloads/index.php?iddesc=48

D32.1
Metabolism risk-controlled model

RITA UGARELLI, MARIA CÉU ALMEIDA
TONINO LISERRA
PATRIC SMEETS



SCOPE

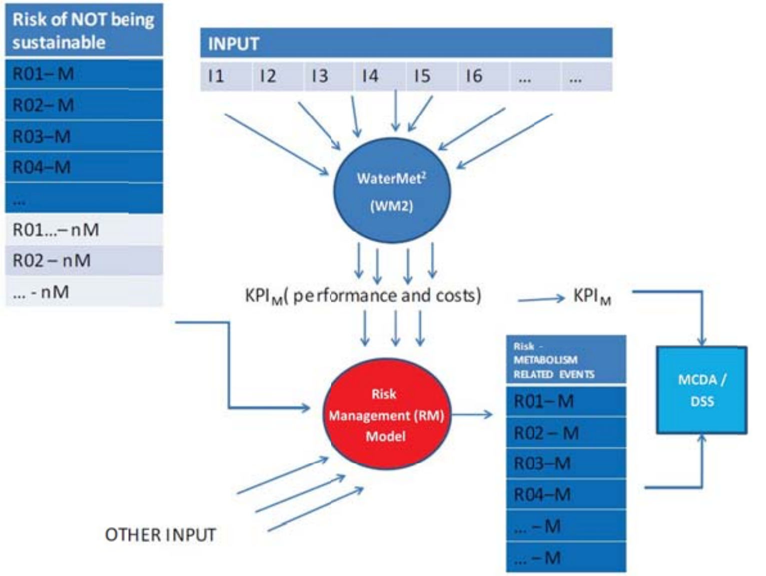
This document outlines the methodology developed for risk analysis in TRUST project. The report describes the conceptual model developed for the definition and identification of the risk events related to the metabolism of the urban water system at strategic level. The risk methodology has been developed parallel to the WaterMet[2] and it was tested on the case study of the city of Oslo in Norway. The report also characterizes the theoretical background for the risk management module that is going to be incorporated in the TRUST Decision-Support System (DSS), a "prototype" that will include the methodology here presented. The target audience for this report is the scientific community that deals with risk, sustainability and urban water management and also water professionals, at strategic decision levels.

SUMMARY DESCRIPTION

Scope of risk analysis in the metabolism model context

Risk analysis presented in this report deals only with the metabolism model context. The adopted methodology essentially follows the standard steps of a risk management process (ISO 31 000:2009), but adjusted to be used at strategic level.

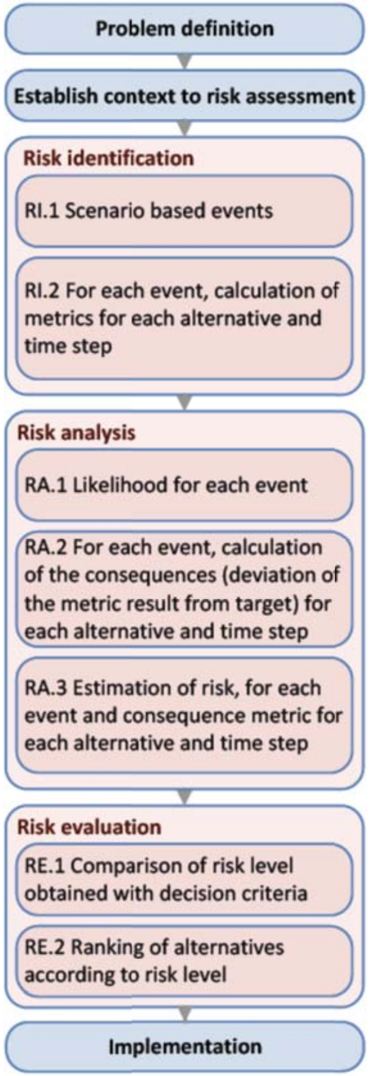
The figure below shows the interaction between the proposed methodology, the metabolism model (WM2) and the TRUST Decision-Support System (DSS) and Multi - Criteria Decision Assessment model (MDCA).



From an overall list of risks (indicated with R01, R02, R0x in Figure) that could be identified for a system at different levels of analysis (operational, tactical and strategic), and different spatial and temporal scales, only some of them are related to the metabolism model (indicated as R0x- M in Figure). The metabolism model (WM2) requires a list of inputs (I_i in Figure) to provide performance and costs indicators, which are further used together with other data ("other input" in Figure) by the Risk Management (RM) model to provide the MCDA/DSS with a full assessment of the risk-metabolism related events.

Methodology for strategic approach

At strategic level the usual approach of using a detailed analysis based on representative risk events (accidents or incidents) is not considered appropriate. Herein, the events should correspond to changes of a particular set of circumstances (ISO Guide 73:2009), evaluated in a given period. In the scope of TRUST, the risk assessment theoretical methodology includes the steps presented in the following Figure.



Problem definition – prior to risk assessment, an overall problem definition is carried out;

Establish the context – methods and criteria to be used need to be established, either using a qualitative or a quantitative approach;

Risk identification (RI) – definition of a comprehensive list of risks, expressed by events that can impact the achievement of organization objectives:

RI.1 – risk identification, in order to confine the subsequent steps to the aspects of interest and to reduce the number of possible events to be analysed;

RI.2 – calculation of the values of the metrics, for each alternative and time step;

Risk analysis (RA):

RA.1 – likelihood estimation, resulting from the estimated probability of the base scenario eventually modified using additional information for the specific circumstances that characterise the event;

RA.2 – calculation, using results from RI.2;

RA.3 – levels of probability (P), consequence (C) and estimated risk (R) for each event and metric are estimated, using qualitative and quantitative methods (e.g. risk matrix – see Figure);

Risk Evaluation – involves comparing the levels of risk estimated during the analysis with the criteria established;

Implementation – risk reduction measures are identified.

The next figure shows an example of risk matrix for qualitative risk estimation.

		Consequence level				
		E	D	C	B	A
Likelihood level	5	5E - Medium	5D - Medium	5C - High	5B – High	5A - High
	4	4E - Medium	4D - Medium	4C - Medium	4B – High	4A - High
	3	3E - Low	3D - Medium	3C - Medium	3B – Medium	3A - High
	2	2E - Low	2D - Low	2C - Medium	2B – Medium	2A - Medium
	1	1E - Low	1D - Low	1C - Low	1B – Low	1A - Low

FINAL REMARKS

This report presents the application of the developed approach to the assessment of intervention strategies for the water supply systems of Oslo city in Norway, over a 30-year planning horizon. The system description builds on the water cycle safety plan (WCSP) developed from 2009 to 2011 and the establishment of the context for risk assessment included the following steps: (a) selection of scenarios and alternatives; (b) determination of the sustainability dimensions, objectives, assessment criteria metrics and relevant variables for the scenario; (c) definition of scales for expressing the likelihood and the consequence levels. Fault Tree Analysis proved to be a powerful tool for identifying critical events and was also used for evaluating different risk-reduction measures.

As previously mentioned, the approach is incorporated in the TRUST DSS, although some steps are estimated outside the system (e.g. probability values). This DSS tool develops the decision-making module in the AWARE-P software platform “PLAN”, as a front-end.

ADDITIONAL INFORMATION

The described deliverable can be accessed at the following URL:

https://project.trust-i.net/readdownload.php?id=99

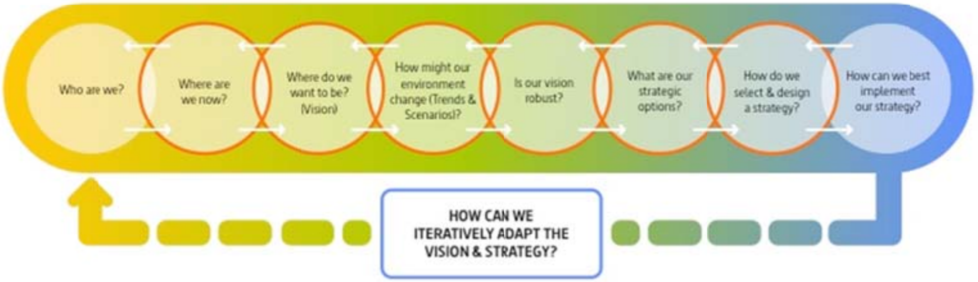
Further information can be found in the additional links:

- “PLAN – Infrastructure asset management planning (AWARE-P)“ http://baseform.org/np4/tools/planTool.html

“Risk, vulnerability, resilience and adaptive management - concepts“ http://www.trust-i.net/downloads/index.php?iddesc=69

D33.1
Conceptual UWCS metabolism model

KOUROSH BEHZADIAN, ZORAN KAPELAN
EVANGELOS ROZOS
CHRISTOS MAKROPOULOS



SCOPE

The aim of this report is to outline the key concepts used to develop the WaterMet^2 (WM2) simulation model a software tool that will enable assessing the performance of an integrated urban water system (UWS), covering the full water cycle (note: 'Met' stands for both metabolism and metropolitan hence '^{2}'). The model is mass balance based and focusses on sustainability related issues, such as supply/demand balance, greenhouse gas emissions, life cycle analysis. Once developed, WM2 is be part of the strategic Decision Support System (DSS) developed in WP54 of the TRUST project.

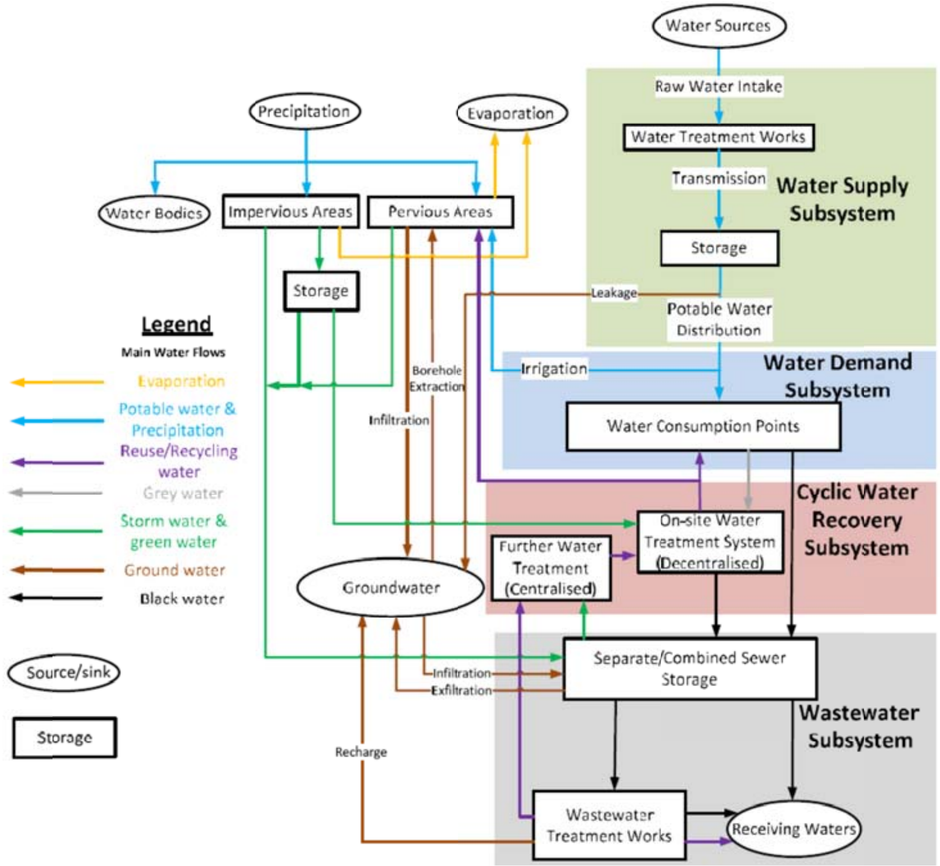
Two main aspects of WM2 model are addressed: main modelling concepts and detailed description of components and processes in the model: (1) water supply and distribution; (2) water demand; (3) wastewater and (4) cyclic water recovery and resource recovery.

This report is of particular interest to the TRUST project researchers. Once the model is fully tested, it will be available to scientific community and water professionals (technical staff and decision makers).

SUMMARY DESCRIPTION

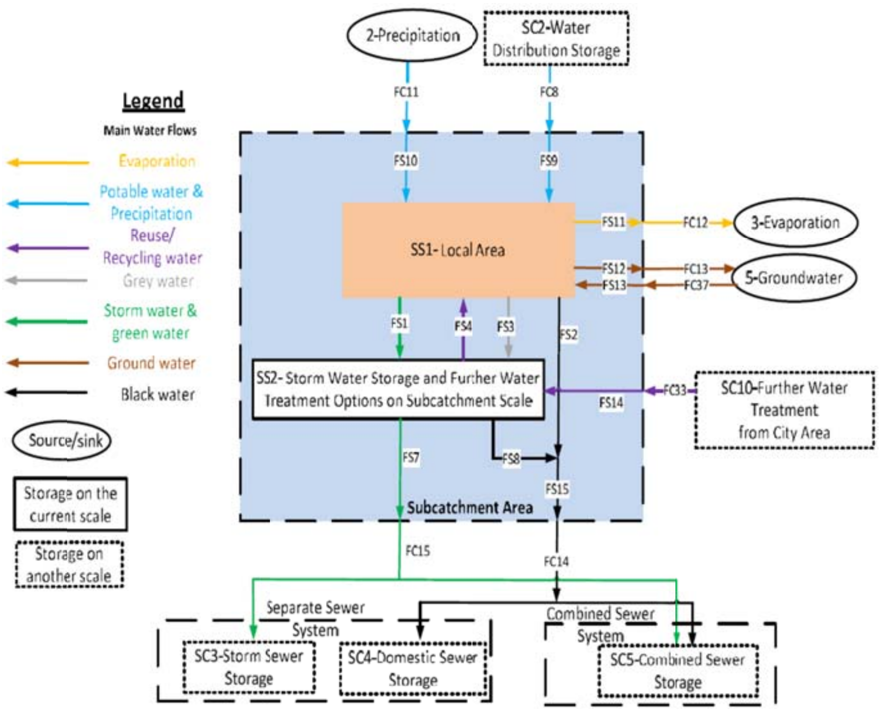
WaterMet2 Modelling Concept

The integrated modelling of the UWS implies the whole processes and components in an urban area related to water flows as a complex and interrelated system. A mass balance approach of water is followed within the system. The next figure illustrates the main flows and storages modelled in the WaterMet^2 which comprises four main subsystems.



Main flows and storages in the WaterMet^2 metabolism model

The water sources and sinks are the water boundaries which supply and receive water respectively; the water storages stand for any physical assets storing water in which some water related processes may take place; the water flows represent any physical assets conveying water flows between different water storages. For the representation of the urban water system components, the WaterMet^2 model recognises four spatial scales: indoor; local; subcatchment; and city. For each scale, the report presents main components, flows and storage interrelations, as the following example.



Water flows and storages on subcatchment level in the WaterMet^2 model

The WaterMet^2 model analyses several principal flows in the UWS components as: (1) water flows (e.g. potable water, stormwater, grey water, green water, recycling (reuse) water, groundwater, wastewater), (2) energy flows (such as energy required for raw water transmission to WTWs, operation of WTWs, WWTWs and on-site water treatment options); (3) greenhouse gas emission (GHG) flows, released to the atmosphere directly from fossil fuel consumption or indirectly from electricity consumption in water pumping, WTWs, water treatment facilities and WWTWs (and also those resulted from material flows); (4) material flows (which are linked to urban water system assets and their characteristics with focus on the water distribution and sewer pipes; (5) chemical fluxes (used in different UWS components, as WTWs, WWTWs, water distribution system); (6) pollutant flows (e.g. BOD, TSS, Tot-P, Tot-N).

Modelling Components and Processes

Next Table presents the modelling main components, under each of the four subsystems.

WATER SUPPLY AND DISTRIBUTION	WATER DEMAND	CYCLIC WATER RECOVERY	WASTEWATER
Raw water sources (surface, groundwater and saline sources) Raw Water Supply (aqueducts - trunk mains or channels) Water Treatment Works (WTW) Water distribution system (reservoirs and flow routes)	Outdoor water demand (irrigation, etc) Indoor water demand (inside a property such as household, industrial and commercial use)	Rainwater harvesting tank On-site water treatment systems Septic disposal Further water treatment for water reuse	- Rainfall-runoff (storage types: snow, impervious area, pervious area) - Sewer system - Wastewater Treatment Works (WWTW)

FINAL REMARKS

Since hydraulic modelling is outside the scope of a mass balance type modelling with a daily time step such as the WaterMet^2, true water quality modelling (such advection-dispersion equations) is considered unnecessary for this model. The WaterMet^2 model will generally be developed as a generic UWS for the application to any city through the TRUST project partners although it is first applied to Oslo case study.

ADDITIONAL INFORMATI ON

The described deliverable can be accessed at the following URL:

http://www.trust-i.net/project/d.php?wa=3&wp=3&d=1

D33.2
Quantitative UWS performance model: Watermet²

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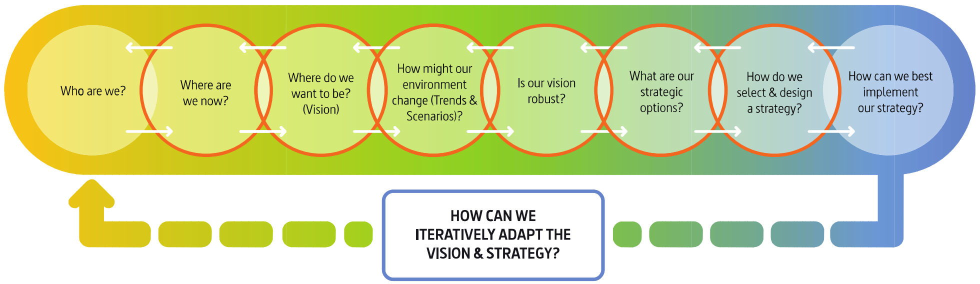
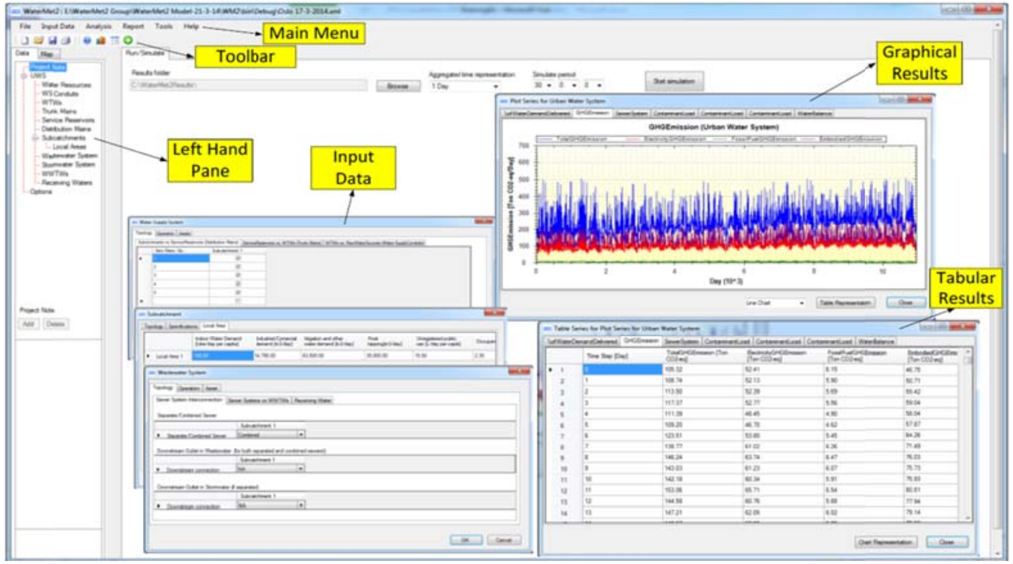
EVANGELOS ROZOS, CHRISTOS MAKROPOULOS



This deliverable presents a detailed description of the WaterMet² (WM2) methodology and tool as a quantitative urban water system (UWS) performance model (note: 'Met' stands for both metabolism and metropolitan hence '2'). It includes three parts: WM2 modelling concepts of different components in four subsystems (water supply, sub-catchment, wastewater and water resource recovery); description of the WM2 software tool; and illustration of the model using the UWS of Oslo city for long-term planning horizon. The target audience for this report is the scientific community and water professionals, technical staff and decision makers.

SUMMARY DESCRIPTION

WM2 follows other recently-developed approaches, such as CWB (City Water Balance) which is a scoping tool for the rapid assessment of urban water management strategies, Aquacycle and UVQ which focuses on water flows and contaminant balance through the urban water supply, storm water, and wastewater subsystems and the interactions between them, and UWOT which is a decision support tool to facilitate the selection of combinations of water-saving technologies as sustainable water management options.



The focus of all of the aforementioned models is mainly based on the quantification of water flows and their final destinations in different parts of the UWS. WM2, however, is a metabolism model which quantifies water flows plus other main fluxes of sustainability-related issues such as all types of direct and indirect (embodied) energy, material flows and greenhouse gas emissions resulting from the entire urban water cycle.

WaterMet² Methodology

The report provides an overview of the main flows/fluxes considered in spatial and temporal scales in WaterMet² and how they are framed within mass balance equations in four subsystems: water supply, subcatchment, wastewater and water resource recovery. This description has been prepared using the contents of deliverable "WaterMet² Conceptual Model Report" (consult corresponding SAF of this deliverable to see synthetic information about WM2 methodology).

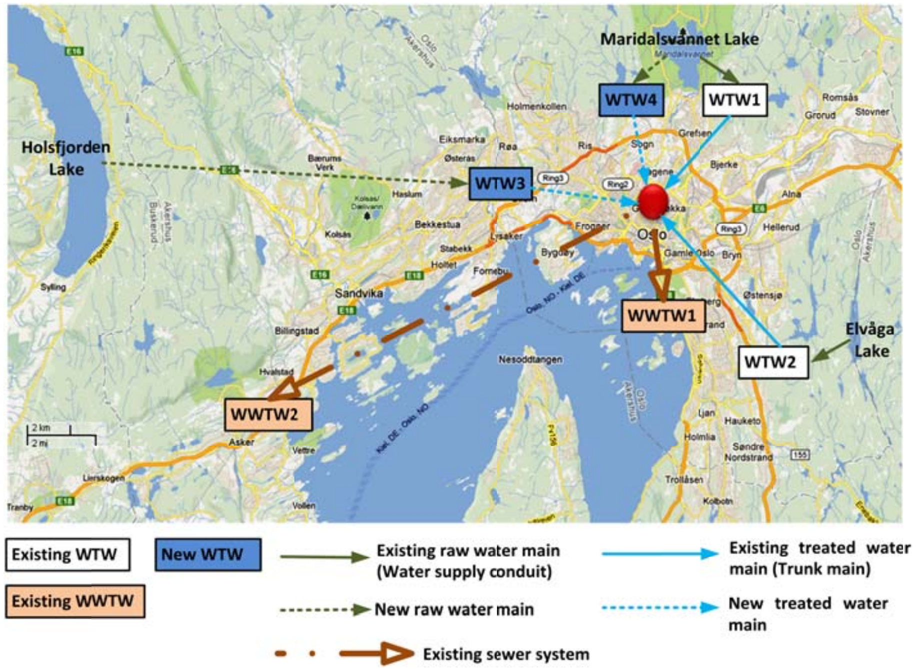
WaterMet² Software Tool

WM2 software tool is described under several sections as follows: software preparation including system requirements, installation procedures; main user interface elements or input data forms; running a simulation and results forms. The figure bellow shows the WM2 main window along with the main forms.

Regarding the input data forms, the model includes three sections: 1) Water Supply, (including tabs Topology, Operation and Assets); 2) Subcatchment (including tabs Topology, Specifications and Local Area); and 3) Wastewater (including tabs Topology, Operation and Assets). If the user wants to model only water supply subsystem, the first two forms (i.e. "Water Supply" and "Subcatchment") need to be filled out. For modelling an integrated UWS including both water supply and storm water/wastewater subsystems, all three forms must be populated. In addition to these forms, the input data for two additional sections need to be prepared: forms "Option" and "Time Series". It is also possible to model water resource recovery, through Rainwater harvesting (RWH) and Grey water recycling (GWR) schemes.

Case Study – Oslo Urban Water System

This section first presents the details of building and calibrating steps in the WM2 model for the existing UWS of Oslo City as the case study, as shown in the figure below. Then, it examines two types of alternative intervention options: (i.e. adding new water resource and water treatment options) which are supported by the WM2 model.



FINAL REMARKS

WM2 as an integrated modelling tool in UWS enables the planners to track down the long-term impact of intervention options on both water supply and wastewater subsystems simultaneously. This would result in recognising not only the shortcomings of the existing conditions but also the intervention options which improves the overall performance of both water supply and wastewater subsystems. Therefore, it is important to model the full urban water cycle in an integrated fashion as the resulting best long-term intervention strategy(ies) can be quite different when compared to the corresponding best intervention strategies identified by considering only part of the urban water cycle (e.g. WSS here).

Concerning the Oslo case study, the authors emphasize that results obtained in this report do not reflect the views of the Oslo VAV and have been used only to demonstrate possible application and functionality of the WaterMet^2 simulation model and software tool.

ADDITIONAL INFORMATION

The described deliverable can be accessed at the following URL:

http://www.trust-i.net/project/d.php?wa=3&wp=3&d=2

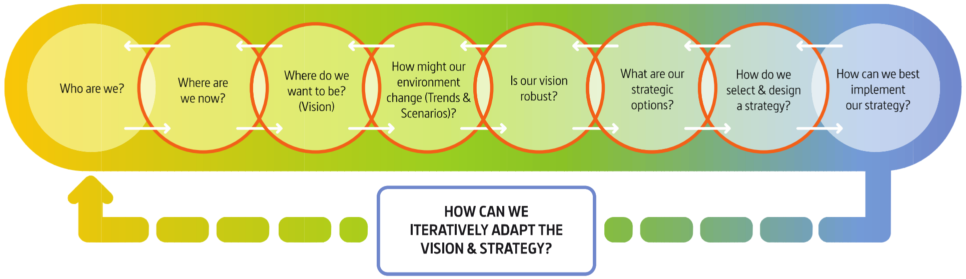
Further information can be found in the additional links:

- "UVQ: The Urban Volume and Quality Model"
  http://www.clw.csiro.au/products/uvq/download.html
- "UWOT: The Urban Water Optioneering Tool "
  http://www.switchurbanwater.eu/outputs/pdfs/w1-2_1-4_gen_prs_urbanwater_optioneering_tool.pdf
- "City Water Balance (CWB) and other software produce under SWITCH project"
  http://www.switchurbanwater.eu/res_software.php

D34.1

Performance analysis of model city - Watermet² & dynaminc metabolism model - testing on Oslo's water and wastewater system

HELGE BRATTEBØ, SVEINUNG SÆGROV
G VENKATESH
RITA UGARELLI



SCOPE

This report describes the contents, structure and applications of two models developed within the TRUST Project WaterMet² (WM2), developed at Exeter (United Kingdom) and the Dynamic Metabolism Model (DMM), developed at NTNU (Norway). Both models were tested on a holistic decision-making study of impacts resulting from interventions planned by the Oslo water and wastewater authority (Oslo VAV), for the time period between 2013 and 2040.

The target audience for this report is the scientific community and water professionals, technical staff and decision-makers.

SUMMARY DESCRIPTION

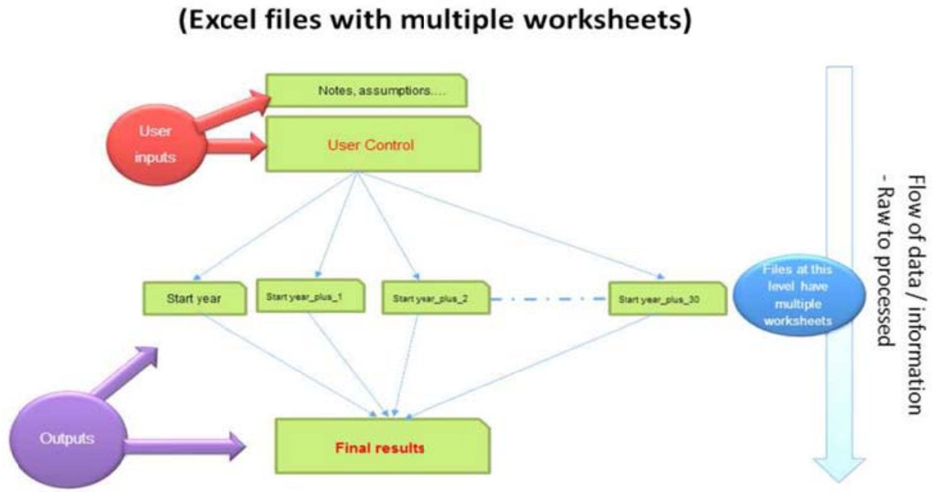
WaterMet²

WaterMet² is explained in detailed in other deliverables of the TRUST Project, such as "WaterMet² Conceptual Model Report" and "Quantitative UWS Performance Model: WaterMet²", including its application in Oslo's Water and Wastewater System. To see summarized contents of those deliverables, consult corresponding SAFs.

The principal metabolism fluxes quantified in the components of the WaterMet² UWS model include water flows, and the fluxes of energy, chemicals, greenhouse gases and pollutants. Through quantification of these metabolism fluxes in UWS, numerous key performance indicators (KPIs) can be derived and evaluated by WaterMet² (the end-user can actually select from 265 different and predefined KPIs).

Dynamic Metabolism Model (DMM)

DMM is a simple, user-friendly Excel-based model, structured as shown in the next figure.



File structure and data/information flow in the Dynamic Metabolism Model

The related MS Excel files in the DMM include the following: 1) Notes, assumptions and guidelines; 2) User control; 3) Annual files named as 'Start year.xls', 'Start_year_plus_1.xls' and so on; and 4) Final results_comparison. Results are presented both as absolute values as well as values normalised with reference to the start-year (against which comparisons are made). DMM provides values for 31 different key performance indicators. The table below presents a snapshot of a few results generated by the DMM.

SOME KEY INDICATORS OF THE WATER-WASTEWATER SYSTEM OF **Oslo, Norway** FOR YEAR **2023**

PER-CAPITA BASIS;
WHEREVER APPLICABLE

ECONOMIC DIM.	Value	Unit	ENVIRONMENTAL DIM.	Value	Unit	PHYSICAL DIM.	Value	Unit	FUNCTIONAL DIM.	Value	Unit
O&M expenses	89,57	Euros per cap/y	GHG emissions	178,32	kg CO_2-eq per cap/y	Pipeline material mass per capita	614	kg per cap	Rehabilitation rate in water pipeline network	0,25	%
Capital expenditure	88,82	Euros per cap/y	Acidification impacts	0,36	kg SO_2-eq per cap/y	Length of pipelines per capita	5,28	kg per cap	Rehabilitation rate in wastewater pipeline network	1,28	%
Income for water supply services from consumers with access	109,27	Euros per cap with access/y	Eutrophication impacts	12,2	kg PO_4-eq per cap/y	Coverage of water supply	100,00	%	Leakage percentage	23,34	%
Income for sanitation services from consumers with access	64,12	Euros per cap with access/y	Electricity consumption	166,5	kWh per cap/y	Coverage of wastewater collection	100,00	%	Nitrogen removal from the wastewater	69,3	%
			Total energy consumption	284,2	kWh per cap/y	Water supplied per cap per year	161,6	Cubic metres per cap	Phosphorus removal from the wastewater	93,1	%
			Total treatment chemicals consumption	25,4	kg per cap/y	Wastewater treated per cap per year	183,8	Cubic metres per cap			
			Biogas utilisation in WWTPs	100	%						
			Rate of recycling of wastewater	0	%						

DMM: Snapshot of results from one of the annual files – a sample extract

Comparing and contrasting between the two models

The following table presents the main differences between the two models.

DYNAMIC METABOLISM MODEL (DMM)	WATERMET^2 (WM2)
Excel-based model	Software-based model (wider range of processing and providing outputs)
Model inspired by industrial ecology, with focus on flows and environmental impacts	Started as a hydraulic model, which has evolved to metabolic aspects of utilities
Results are presented as annual snapshots / trends; individual Excel files (annual) can be accessed to get a sub-systemic perspective	Results are presented at higher temporal resolution; sub-system behavior over time can be assessed
Interventions can be tested by entering data into the 'User Control.xlsx' file.	Intervention modeling is defined on a separate sub-module
Easily 'reprogrammable' by anyone with an understanding of MS Excel	Changing user needs requires programming expertise to modify background software
Capital costs are calculated as a sum of depreciation and interest rates	Capital investments allocated to the specific years in which they are committed
Climate change effects are not assessed (current version); environmental impacts of biogas are modeled in detail	Climate change effects are partly modeled, assessing future availability of water; simple biogas generation is estimated
PIs are expressed in per-capita or per-unit volume-water-treated terms	PIs are expressed in per-day, per-week, per-month, or per-year terms

FINAL REMARKS

For a general 'systemic' overview of the estimated future performance of the UWS system, on a year-to-year basis, which strategic managers could benefit from and use as decision-input at the strategic level, the DMM with its systemic outlook is suitable. On the other hand, if tactical decisions on a quotidian basis are to be taken, and utilities seek a tool to guide them onward on a more detailed level, taking into account spatial or temporal aspects, the WM2 is apt. Thus, the two models complement each other, but for a different context of use.

Further work would be needed, as the authors intend to interact with the officials at Oslo VAV in the time to come, discuss more closely the usefulness / suitability of both models to problem-solving and decision-making.

ADDITIONAL INFORMATION

The described deliverable can be accessed at the following URL:

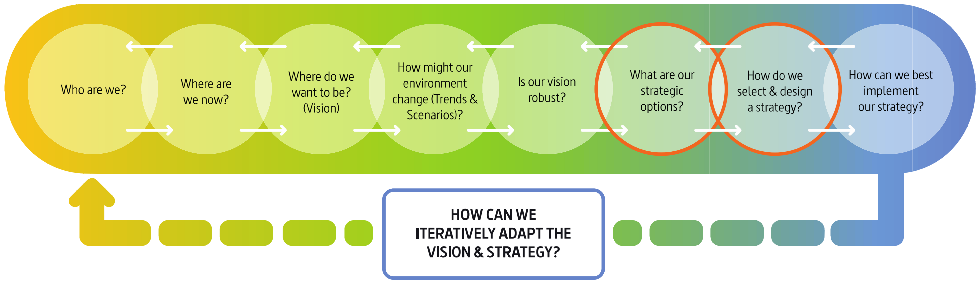
http://www.trust-i.net/project/d.php?wa=3&wp=4&d=1

Further information can be found in the additional link of the TRUST project:

- "Metabolism modelling of urban water cycle systems - System definition and scoping report" https://project.trust-i.net/task.php?wa=3&wp=3&t=1&subt=1

D42.1
Guidance on evaluation and selection of sustainable water demand management technologies

AISHA BELLO-DAMBATTA, ZORAN KAPELAN, DAVID BUTLER
EMMANUEL OERTLÉ, THOMAS WINTGENS
EVANGELOS ROZOS, CHRISTOS MAKROPOULOS



SCOPE

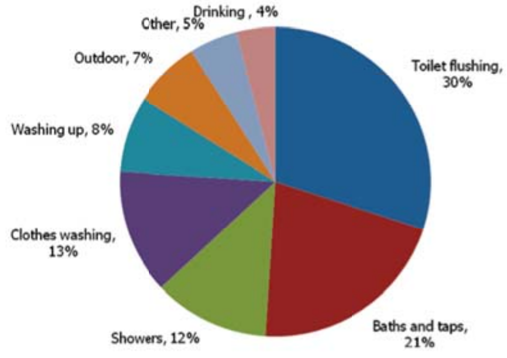
Climate change, population growth, migration/urbanization, and ageing infrastructure will all impose significant strains on urban water services in Europe, and cities across Europe will experience increasingly frequent shortfalls in supply/demand balance. With the global demand for water continuing to rise at a pace that is double the rate of population growth water service providers must manage the available supply in an efficient way to ensure the sustainability of future supplies.

With that in mind, this TRUST report presents guidance for the evaluation and selection of household and industrial water demand management (WDM) options (i.e. interventions) for the effective and sustainable reduction of water consumption for different water stakeholders. The considered WDM interventions have been evaluated largely based on the water saving potential, cost-effectiveness, water-related energy use, as well as impact on the reliability of supply/demand balance.

These WDM strategies typically search for cost-effective measures to reduce water use by increasing efficiency through technical fixes, process and operational improvements, economic incentives, and consumer education. The strategies offer an alternative to conventional water supply but have so far often been considered as temporary options subject to their social acceptance. However, in the face of ever growing demand, current climate change, urbanization and other uncertainties it is increasingly evident that reducing the specific demand for water is our best 'source' of 'new' water.

SUMMARY DESCRIPTION

Demand management: households



On average, 85 percent of European urban water use is used by households to satisfy basic needs (drinking, sanitation) and other needs (such as house cleaning, laundry, dishwashing and outdoor water use). However, around 1/3 of this volume is being flushed down the toilet and only about 4 percent is used for drinking (see figure above).

Different types WDM interventions and technologies such as efficient household micro-component appliances and fittings and alternative water system can be used to reduce household water consumption. In this chapter, the TRUST report presents different household micro-component appliances and fittings design to encourage water and/or energy efficiency such as:

- WCs – Represent the largest single consumption of water in households, particularly in older properties
- Baths and Showers – Although WC flushing volumes have fallen, bathing habits have changed, increasing the volume of water used.
- Taps – Up to a quarter of domestic water use flows through taps, and a good deal of it flows down the drain without any useful purpose.
- White goods – Washing machines and dishwashers account for around 16 percent of the total volume of water used in a typical household.
- Outdoor water use – The average amount of water used outdoors in Europe accounts for about six percent of the amount of total household water used each year.

Adding to this type of measures, the document also presents some alternative water systems that by limiting the amount of potable water use for non-potable uses, such as WC flushing, can reduce water consumption and therefore reduce the dependence on mains supply:

- Grey water recycling systems (GWR) – This type of systems uses treated wastewater from showers, baths and washbasins for non-potable water use.
- Rainwater harvesting systems (RWH) – Rainwater harvesting is the process of collecting, diverting, and storing rainwater from an area (usually roofs or another surface catchment area) for direct or future use. Although it doesn't necessarily reduce water demand, it can reduce water abstraction needs, the demand for mains water and relieve pressure on available supplies.
- Combined grey water and rainwater harvesting systems – Where one or the other of the non-potable sources is insufficient to meet the intended demand on its own, a possible solution is to combined this two types of systems.
- Sustainable drainage systems (SuDS) – As a result of development, impermeable cover is constantly increasing, resulting in less water being available for infiltration into the ground, disrupting natural drainage patterns. SuDS addresses this issue by managing stormwater locally to mimic natural drainage and encourage its filtration, retention and passive treatment.

Several methodologies have been developed for assessment of WDM interventions, being some of them presented and compared within the document. Also, the report includes a scenario assessment of hypothetical household water savings under two different EU climatic conditions (Oceanic and Mediterranean) carried out using some of this referred tools.

Demand management: water service providers (WSPs)

Not all water produced reaches customers, limiting the extend of saving that can be made from customer-side WDM interventions like water efficiency. Reducing water losses from WDS can also significantly lower water demand as well as result in a decrease in the cost of production and distributing of water as well as in the capacity requirements for storage systems, treatment works, and mains sizing. It is then imperative to reduce these types of losses along with other WDM interventions that WSPs can use to reduce/manage water loss between the source of production and the customer meters that are explored in this report's chapter:

- Water pricing, metering and tariff structures
- Soft interventions
- Leakage reduction – Pressure management, Energy management

Adding to these WDM interventions, the document also explores a case study of leakage reduction in Reggio Emilia (Italy).

Evaluation and selection of water demand management interventions

Both householders and WSPs have an important role to play in reduction water consumption, and different WDM interventions can be used to enable the different water stakeholders to reduce waste and achieve more sustainable WDM practices. However, when selecting WDM intervention to implement, trade-offs have to be considered between competing and often conflicting technical, social, economic, and/or environmental objectives and evaluation criteria. Therefore the report explores the application of different WDM interventions with two case studies and presents some guidelines for evaluation and selection of WDM interventions with reference to various tools.

FINAL REMARKS

Historically, efforts to satisfy water demand have involved augmenting supply by developing new infrastructure. However, this is now considered too costly as it tends to be unresponsive to economic, environmental, social, and political constrains. In that sense, WDM has an important role to play in balancing supply/demand and as a potential means of aiding the security of future water supplies. This TRUST report explores numerous types of WDM interventions and combinations that can help WSPs achieve a better water-energy sustainable future.

LINKS TO ADDITIONAL INFORMATION

The Deliverable D42.1 can be accessed at the following URL:

http://www.trust-i.net/downloads/index.php?iddesc=84

Further information can be found in the additional links:

- TRUST reports:
  - Assessment of various water saving technologies in a pilot city (Athens)
  - Priorities of current and emerging water demand management technologies and approaches
  - Impact assessment of water demand management technologies

D43.1
Curative actions in wastewater treatment systems. Part 1

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CYNTHIA HALLE, ANA GALVÃO, RITA AMARAL
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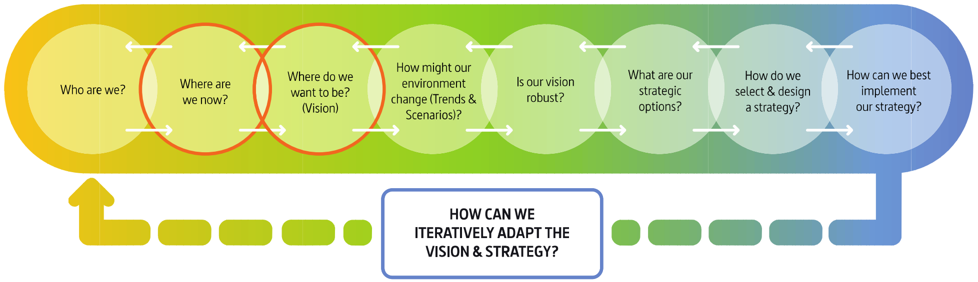


SCOPE

This part I of the report D43, entitled Pilot-city specific, new technological options for stormwater separation and optimized WWTP, introduces a performance assessment system (PAS) developed by LNEC (Portuguese National Civil Engineering Laboratory) to improve the performance of wastewater treatment plants (WWTPs) and a case study of combined sewer overflow (CSO) treatment through constructed wetlands (CWs) located in a Portuguese WWTP.

It provides results and analysis of WWTPs in Portugal and Norway, and is divided in four main chapters: 1.Performance assessment of WWTPs, 2.PAS application in Portugal, 3. PAS application in Norway and 4. CWs as a low carbon footprint option for CSO treatment.

SUMMARY DESCRIPTION

Performance Assessment of WWTPs

One of the TRUST's main objectives is to provide to the water industry tools and techniques for optimized operation of WWTPs. In this mindset, this report aims to provide a PAS able to assist the benchmarking of WWTPs, i.e. the continuous assessment and improvement of WWTP performance.

This tool was developed by LNEC team and the objectives behind it fall within the scope of TRUST's master framework for urban water cycle services (UWCS), namely in four of the five dimensions proposed. The developed PAS assumed two general objectives for any undertaking with regard to WWTP performance: 1. its effectiveness and reliability and 2. its efficiency and sustainability. It was therefore defined with the following assessment groups:

1. Treated (waste)water quality
2. Personnel
3. Removal efficiency and reliability
4. Economic and financial resources
5. Use of natural resources and raw materials
6. Planning and design
7. By-product management
8. Safety

For each assessment group, there is a portfolio of performance indicators (PIs) formulated according to the IWA approach. According to TRUST objectives, a set of PIs was selected from the assessment groups, comprising 42 PIs and 85 variables. For each assessment group, the report presents the related PIs.

There are also performance indices (PXs), which are obtained by applying a processing rule that converts state-variable data, expressing the relevant operational performance assessment aspects of the plant, into a dimensionless performance index. These indices range between 0 and 300, in which 300 corresponds to an excellent performance. This scale, unlike the usual 0-4 scale, provides a higher resolution and enables intuitive and easy-to-read "traffic light" graphing: red zone from 0 to 100, yellow for 100-200 and green for 200-300. For the operational indices there are three assessment criteria: treated wastewater quality, removal efficiencies and operating conditions.

Performance indices complement the performance indicators, since the PIs assess the overall performance of the WWTP in a given assessment period whereas the PXs assess the distance to the goal and identifies "when", "where" and "why" a type of performance was obtained. The comprehensive integrated analysis of PIs allows to diagnose and to identify opportunities for improving WWTP performance.

The 1st step of PAS application (Figure 1) is the definition of the objectives and the assessment criteria. The PIs must then be selected and calculated accordingly, and analyzed against the pre-established references. The next step is the selection and calculation of PXs of Treated water quality to complement the information provided by the homologous PIs. One may then select the parameters and unit operations or processes for which one intends to assess and optimize the removal efficiency to enhance the treatment reliability.

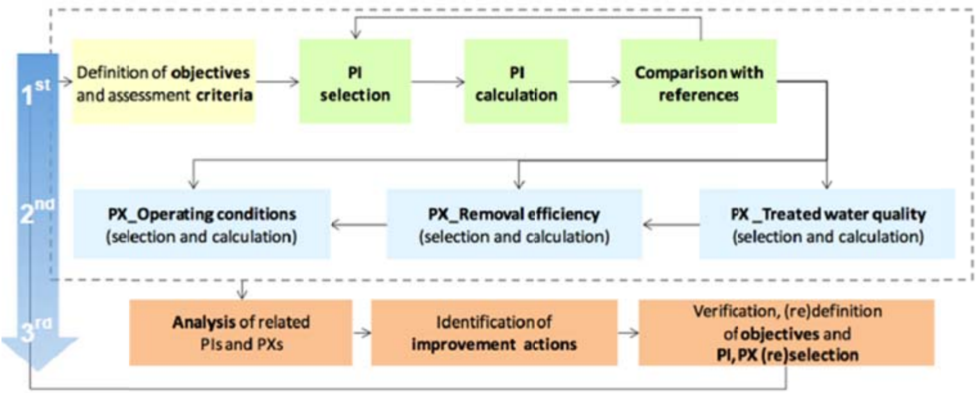


Figure 2 – A step by step Illustration of PAS application.

The continuous improvement of WWTP performance should be implemented through plan-do-check-act (PDCA) cycles, which requires the verification and, eventually, the (re)definition of objectives and (re)selection of the corresponding assessment measures (PIs and PXs).

PAS Application in Portugal

In this chapter, the report presents a demonstration of the PAS application in assessing and improving urban WWTP performance. For that, data from 17 Portuguese WWTPs was processed according to the objectives and the applicable metrics. For each objective the results of the 17 WWTPs (in a 5-year period 2006-2010) were analyzed in order to investigate the model (PAS) applicability to address the pre-established objectives and to calibrate the PIs and the reference values. The model was then validated for one WWTP, during a 5 year period 2008-2012. The report defines the selected PIs and PXs for each objective, and presents and analyzes the obtained results, overall and by clusters of treatment type and capacity.

PAS Application in Norway

Similarly to the previous chapter, the report presents the PAS application to the Norwegian reality. For that, relevant PIs were selected in collaboration with Oslo Kommune to evaluate the performance of Bekkelaget WWTP located in Oslo, in terms of the nutrients removal efficiency. The data were obtained for a period of 5 years (2008-2012) and processed for using the corresponding PIs of the earlier calibrated PAS.

CWs as a Low Carbon Footprint Option for CSO Treatment

The discharge of non-treated overflows during wet weather conditions is a problem being faced by many countries of Europe, due to the pollution introduced in the receiving waters. The use of low carbon footprint options, as constructed wetlands, to minimize this source of pollution can be considered a step forward in increasing the sustainability of urban water cycle services.

In this chapter the report presents a pilot-scale experimental setup located in a Portuguese WWTP that aims to analyze the response of this type of systems under real circumstances. The results showed a high treatment response in terms of COD removal efficiencies, TSS and Enterococcus.

FINAL REMARKS

This report, which represents the 1st part of the TRUST report 'Pilot-city specific, new technological options for stormwater separation and optimized WWTP', presents curative solutions in wastewater treatment systems. Although it presents a set of important solutions with relevant results, it cannot replace a wider research. For a more complete overview of possible solutions we recommend the reading of the reports and documents presented below.

LINKS TO ADDITIONAL INFORMATION

This TRUST report can be accessed at the following URL:

http://www.trust-i.net/downloads/index.php?iddesc=76

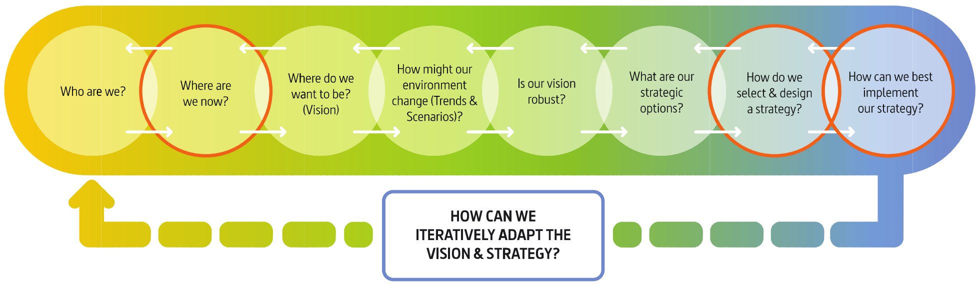
Further information can be found in the additional links:

- PAS articles → www.sciencedirect.com/science/article/pii/S0301479714003582
  www.sciencedirect.com/science/article/pii/S0043135414002152
  www.iwaponline.com/ws/01203/ws012030372.htm
- CWs article → www.iwaponline.com/wst/06712/wst067122739.htm
- Report D21.1 → www.trust-i.net/downloads/index.php?iddesc=1

D43.1

Pilot-city specific, new technological options for stormwater separation and optimized WWTP. Part 2

HEIKO SIEKER
STEPHAN BANDERMANN
JOANNA POTRAWIAK



SCOPE

This report presents treatment technologies, stormwater technologies, operation practices, and standalone software oriented to improve management of wastewater and stormwater in a municipal setting. Within the document the potentials of Sustainable Urban Drainage System (SUDS) and the effects on the sewer system are examined for the Oslo catchment in Hoffsvela. For that a GIS based method was applied to produce a 'stormwater management map'. In the process of identifying impervious areas, which can be disconnected from the sewer system in the most efficient and economical way, diverse criteria were considered. Finally, the possibilities of disconnecting the existing sewer network were determined for all sub-catchment.

Also, the effects of disconnection on the behaviour of rain water overflows (CSO) were calculated. Depending on the location of the CSOs within the sewer system, and the amount of disconnected impervious areas, the frequencies, volumes and peaks of the overflows were more or less reduced. Thus the main goals were to:

Identify spatial distribution of SUDS in the catchment Oslo Hoffsvela

1. Set up a run off model, that is calibrated to an existing runoff model (Mouse) and is able to implement SUDS
2. Calculate and simulate the effects of SUDS.

SUMMARY DESCRIPTION

Study Area: Catchment Oslo Hoffsvela

In this chapter the characteristics of the catchment and necessary data are presented. The studied area has approximately 9 km^2 and a sewer system of more or less 14 km long. The total area was divided into two sub-catchments that are dominated by forests in the northern part and urban areas in the south.

Oslo sewer system transports mainly stormwater runoff from streets, which is important regarding the methodology of identifying specific areas for SUDS. The following data were applied for the project:

- Water bodies
- Wastewater data
- Land use
- Catchments
- Property map
- Mike Urban Model
- Impervious areas
- Digital elevation Model
- Geology maps
- Soil maps
- Orthophotos

Create Maps of SUDS

In the process of identifying impervious areas, which can be disconnected from the sewer system in the most efficient and economical way, many different criteria have to be considered (Figure 3).

Especially natural factors affect the application of the types of SUDS technique. Other criteria, which are related to build-environment, influence the selection of possible location for SUDS.

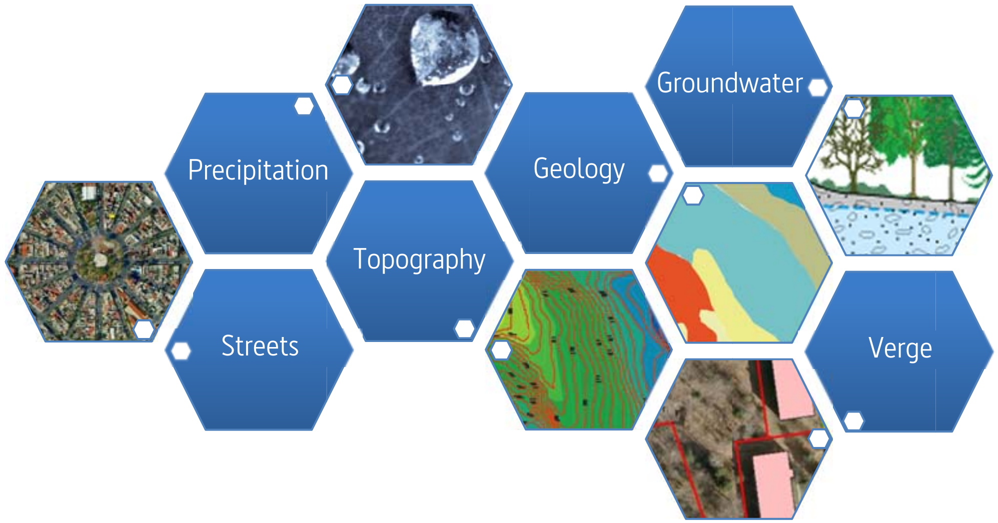


Figure 3 – Influencing criteria on planning SUDS

As a result of the applied method, two different maps were developed:

1. "Map of SUDS technique" – shows the spatial distribution of the best applicable SUDS technique, taking into account different influencing natural criteria.
2. "Disconnection potential" maps – These maps estimate the amount of impervious areas, which can be isolated from the sewer system and treated by SUDS.

In this section is also presented two different maps: (an infiltration capacity map and a soil thickness map) and the resulted map of SUDS technique for Oslo Hoffsvela followed by the disconnection potential map.

Building and Calibrating STORM Model

STORM is a hydrological runoff model, where all main components of the hydrological cycle are included. This model is able to set up runoff models for complete river catchments and to calculate both time series and design storm. Since it was originally programmed for the design of SUDS, it is presented as an ideal program to calculate the effects of SUDS to urban water hydrology.

In this section is presented the mike urban model (which was used as a base to the creation of a runoff model for the drainage system of the two sub-catchments), a STORM simulation of the base scenario and also the implementation of disconnection potential into STORM model.

Design of SUDS for Oslo Climate

The stormwater overflow frequency of SUDS should be comparable with manhole overflows of the sewer system. The given time series of rain data from Oslo were used for the calculation of the necessary size of SUDS in this region and the results of iterative simulations are presented in this chapter.

Simulation of Storm Model: SUDS Scenarios

After implementing the results of the disconnection potential maps into STORM, new simulations (long-term series and design storms; 2-year and 10-year events) were started. The effects of disconnection on the overflow behaviour of each rainwater overflow are shown in this section. Depending on the location of the CSOs within the sewer system and the amount of disconnected impervious areas, the frequencies, volumes and peaks of the overflows were more or less reduced.

FINAL REMARKS

SUDS are well known measures for stormwater management, but their application must be demonstrated and this depends on many different criteria (specially in already existing infrastructures). In Oslo Hoffsvela mainly the streets are connected to the sewer systems with rainwater from roofs often infiltrated on site. The created maps show that the disconnection potentials for streets vary widely, from less than 10% to 90%. The report also concludes that the CSO overflow frequency behaves in comparison to the disconnection potential disproportionately.

LINKS TO ADDITIONAL INFORMATION

The Deliverable D43.1 can be accessed at the following URL:

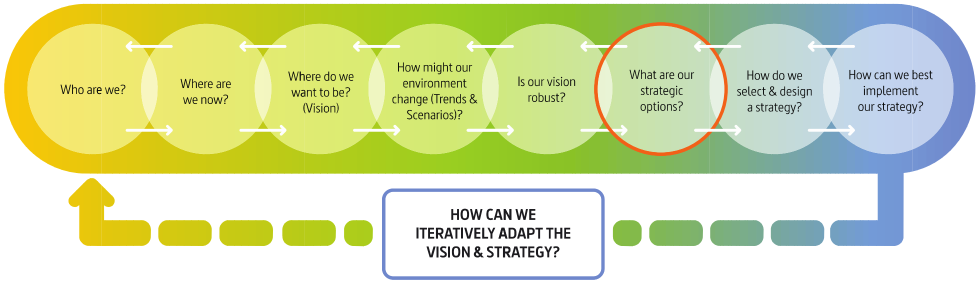
http://www.trust-i.net/downloads/index.php?iddesc=76

Further information can be found in the additional links:

- Images links:
  - Groundwater - http://water.usgs.gov/edu/earthgwaquifer.html
  - Streets - http://www.thepolisblog.org/2012/12/urban-morphology-in-mexico-city.html

D45.1
Intervention concepts for energy saving, recovery and generation from the urban water system

JOS FRIJNS



SCOPE

There are numerous options for energy measures in the water sector ranging from water conservation and process efficiency improvements to new technologies and redesigning water systems. Next to energy efficiency improvements, there is a need for new concepts in which water is viewed as a carrier of energy. This report presents intervention concepts for energy saving, recovery and generation from the urban water system. The following options for energy saving and alternative energy recovery and generation concepts in UWCS were selected and further investigated in selected pilot cities:

- Improving energy efficiency in water supply
- Heat and Power generation from wastewater
- Heat and cold recovery
- Micro-generation in water systems

SUMMARY DESCRIPTION

Potential for energy optimisation in the urban water cycle

The urban water cycle of production of drinking water from ground water or surface water, distribution, consumption, discharge in sewerage to wastewater treatment plants and finally discharge to surface water, consumes energy. Also, the energy consumption in this urban water cycle (UWCS) is increasing. In this chapter the report presents the carbon footprint concept, the potential for energy saving and recovering in UWCS, and also some examples of "best practices".

Improving Energy Efficiente in the Algarve Multi-Municipal Water Supply System

This chapter presents the energy-efficiency measures identified for multi-municipal water supply system for the Algarve region. Energy efficiency metrics based on a whole system energy audit are presented and applied to the Algarve's Beliche system. Main results, conclusions and future developments are also presented.

By performing an energy audit the most energy efficient operating scheme can be determined. In the case of Beliche, in terms of energy efficiency, it is best to have the water treatment plant of Beliche working the **whole year** and **not only at the high season**. The combined application of a new coating in the pumps and a new pumping schedule resulted in a reduction of **12,9% in the total energy consumption** of the pumping station.

Energy Audit of a Water Distribution Network – Alcoy Case Study

Energy assessment of water distribution networks is a key goal for water utilities. In a permanent energy crisis scenario and being sustainable water management becoming very energy consuming, to do more with less is crucial. Performing an energy audit of pressurised water networks, gives a good indication of the energy problems and possibilities and locations for energy saving. In the case of Alcoy, which is presented in this section, the energy audit revealed that energy embedded in leaks represent **19% of the total energy** supplied. Introducing a **PAT (pumps as turbines) could result in an energy recovery of 631 kWh/d.**

Heat Recovery From Water and Wastewater System in Oslo

In this chapter, the main focus lies on **energy recovery through the use of heat exchangers and heat pumps at different stages in the network and at the treatment plants**, focusing on effluent flows at Hias and BEVAS WWTPs, and the flow of raw water to Oset water treatment plant (WTP). Possibilities for heat recovery on small scales in households and point-recovery in the wastewater network are also mentioned.

Thermal Energy in the Water Cycle in Amsterdam

To achieve the new ambitious goals regarding CO_2 emissions, Amsterdam has an extensive program on reduction of energy consumption, increase of the use of sustainable energy sources, application of sustainable heating and cooling, clean public transportation etc. Feasibility studies in Amsterdam show that heat and cold recovery from both drinking water systems as well as wastewater systems coupled to aquifer thermal energy storage systems are technically and economically feasible.

Energy Optimization at Schiphol Airport Wastewater Treatment Plant

Examples of technology implementation for energy saving and generation at the water industry are available. New concepts and technology improvements are needed that view water as a carrier of thermal and organic energy. Examples of energy efficiency and heat and power generation from wastewater are presented in this section. The case study of Amsterdam Airport Schiphol WWTP is described, where the separate treatment of fecal deposit from airplanes, directly to the digester, will **increase the biogas** production from **17% to 27%** of COD influent load.

Energy Flow Review for Psyttalia WWTP, Athens – An approach to Optimisation

This chapter presents approaches for optimisations of the plant with regard to potential improvements in energy consumption and production at the WWTP on Psyttalia Island. Regarding the Psyttalia WWTP, **the biogas production can increase from 25.2 to 37.3 million m3/y** if the operational mode is changed from **mesophilic to thermophilic** conditions. Moreover, increasing biogas production, combined with energy recovery from exhaust gases and air blowers, implementation of a micro hydropower plant and utilisation of solar energy, would result in a energy self-sufficiency rate of **81.9%** at Psyttalia WWTP.

Integrating Pressure and Energy Management and Microgeneration in Langhirano

The goal of this chapter was to develop a methodology for integrating pressure & energy management in water distribution systems, with the aim to save both water and energy resources. The Water System of Langhirano, described in this report, appears as a meaningful case study for the **water/energy nexus** under several different perspectives. Modelling results show that the inclusion of micro-turbines is not in contrast with the measures taken to save water and energy.

Hydro-generation in the Water Supply System of Athens

Currently, the five small hydropower plants in the Athens external water supply system generate 20.6 GWh/y. This chapter presents the **potential of micro-generation in the external aqueduct of the Athens water supply system**. The report describes proposed water-energy interventions and also presents simulations with a water-energy model and the main conclusions and results.

Micro-Hydro Generation in the Algarve Multi-Municipal Water Supply System

The current chapter aims at describing Ágguas do Algarve (AdA) water utility experience with **micro-hydro power generation in urban water services**, in particular in water supply systems, and carrying out a cost-benefit analysis of already implemented solutions. Within this section **micro-hydro generation solutions are identified and two case studies are presented.**

FINAL REMARKS

Although this report focuses on the technological aspects of energy saving and generation in the water system, in this final part emphasis is put on the opportunities that exist for the water sector in relation to other developments in cities. In fact**, collaboration with other sectors will be essential to achieve an energy neutral urban water cycle.** In the efforts of other sectors, such as building, energy, and urban planning, to become energy neutral, a large potential exist to incorporate energy efficient water initiatives as well. One can anticipate that the driving forces for change are stronger in these urban sectors than in the water sector itself**. There is a clear opportunity for the water sector to incorporate water-related energy use in sustainability transformations of other sectors, e.g. in urban renewal.**

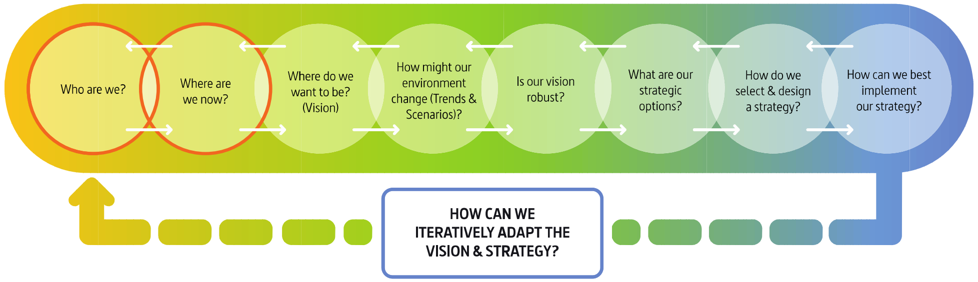
LINKS TO ADDITIONAL INFORMATION

The Deliverable D45.1 can be accessed at the following URL:

http://www.trust-i.net/downloads/index.php?iddesc=92

D46.2
Report on system development, method applicability and pipeline condition data for modeling purposes

ARNE CHRISTIAN VANGDAL, MATTHEW POULTON
LARS BRENNA, PER ARNOLD DYRKOREN
STIAN BRUASET



SCOPE

This report describes how and why Breivoll Inspection Technologies (BIT) provides condition assessment by inspection of buried water pipes. It then presents some scientific background, with a review of related work and literature, and discusses the advantages of condition assessment based on continuous in-line inspection compared to other approaches. Adding to this, the document presents a case study and discusses the applicability of the inspection method, its strengths and weaknesses, as well as its sustainability aspects.

SUMMARY DESCRIPTION

Acoustic Resonance Technology, ART

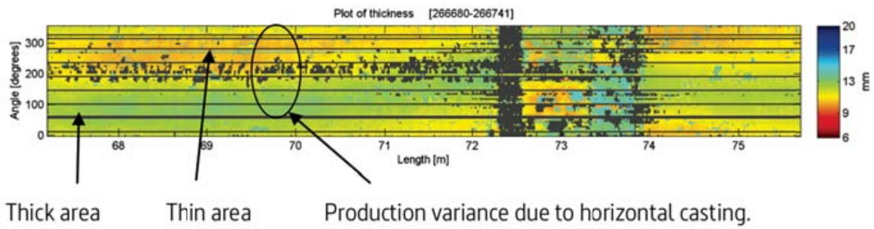
ART is an ultrasound technology used differently than the traditional "time of flight". It enables 360-degree measurement of metallic water pipes without need of pre-cleaning of the pipe. A *PipeScanner* was developed to bring ART into water networks for collecting condition data, enabling production of detailed reports and specifying the quality of the pipes by determining:

- Remaining wall thickness
- Metal loss caused by internal and/or external corrosion
- Internal topography like, joints, repairs, hydrologic capacity *etc.*

Inspection reports help asset managers by:

- Giving an overview of the need for pipe maintenance by finding weak spots in the network, thus reducing risk
- Localizing and prioritizing pipes needing maintenance and replacement, and deciding when to perform needed work – the right pipe at the right time with the right method, thus limiting the maintenance and repair work in both volume and time
- Classifying individual pipes in order to enable classification of whole network structures.

All measurements of thickness, distance and inner and outer corrosion are plotted in a color-coded plots. For example, when measuring thickness blue shows the thickest areas and red the thinnest (see figure below).



Water Infrastructure Challenges

The report exposes the main problems in terms of water infrastructure rehabilitation. Siemens AG and Fraunhofer Institute already in 2005 estimated the global need for maintenance and replacements of drinking water pipe infrastructure to be 6500 B€ over the next 20 years. Renewal has still not reached a satisfactory level and utilities are not keeping up with the increasing deterioration of their assets. Research reports shows that iron based pipes have the highest failure rate, and the percentage of metallic water pipes in European countries varies between 50-90%. The efficiency in water pipe asset management is poor, and the reason for this is, to a large degree, lack of relevant data. There is a common understanding in the industry that the way to meet the challenges is by developing and using new technologies and methods.

Pipeline Condition Data for Modeling Purposes

BIT has developed a pipeline database based on experience from many inspections around Europe and input from cooperating water utilities, especially Oslo Water and Sewage Works. Collected experience shows a high grade of heterogeneity of pipes. It has been shown that a pipeline is like a chain where each pipe is a link in the chain. Inspection finds the weakest link. This has led to the over-arching idea of identifying and diagnosing each individual pipe. This will be implemented in Oslo. Data from all inspections are stored in order to compare and do analysis of large quantities of data. In this database, the following entities will be stored:

1. Inspections – 'Recommendations', 'Severity levels' and 'Issue types'
2. Pipes – 'Standard pipe thicknesses', 'Pipe materials', 'Pipe types', 'Pipe linings', 'Manufacturing standards' and 'Pressure groups'
3. Findings – 'Finding types', 'Finding grades' and 'Finding texts'

All inspection results and aggregated findings can be implemented in existing models in order to bring these closer to reality. New models may be based on the findings and conclusion.

Method Applicability

Here we present the BIT method's strengths and weaknesses, followed by a case study showing the benefits of inspections.

Strengths:

- Scans water-filled pipes – the ART technology requires that the pipes are filled with water, reducing the time that a pipe has to be taken out of service for inspection.
- Robust to sediments and corrosion
- 360 degree scans of every pipe
- Distinguishes internal and external corrosion
- Exact positioning of findings
- Leak detection method implemented
- BIT data are implementable in all GIS tools.

Weaknesses:

- Pipe access – It requires cutting out 90-140 cm of the pipe and installing an entrance pipe or hatch box
- Water evacuation – In case the pipeline has a high operating pressure or if the entry point is lower than other sections of the pipeline, large amounts of water may have to be evacuated
- Limited range of pipes diameters (DN300-600)
- Limited range of pipe materials – metallic pipes

FINAL REMARKS

Based on close cooperation with utilities and within the framework of different R&D projects there is a constant development of technology, working process and reporting. Amongst others are development of new *PipeScanners* capable of inspecting both lower and higher diameter pipes, new propulsion units as well as making entrance into pipes easier. As it will be impossible to inspect all pipes, the development of new, as realistic as possible, models need to be improved, developed and used.

LINKS TO ADDITIONAL INFORMATION

The Deliverable D46.2 can be accessed at the following URL:

http://www.trust-i.net/downloads/index.php?iddesc=65

Further information can be found in the additional links:

- EPA. Condition assessment technologies for water transmission and distribution systems (March 2012) http://nepis.epa.gov/Adobe/PDF/P100E3Y5.pdf
- Ugarelli, R. 2009. Theoretical background of pipes condition assessment (Importance and limitations for the application of the *PipeScanner* in the asset management set of procedures). SINTEF report
- www.breivoll.no

D54.1
Integrated decision support framework

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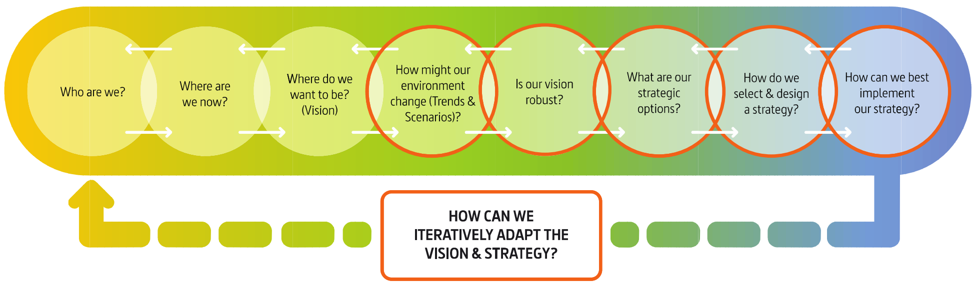


SCOPE

This report provides an overview of the proposed implementation of the Decision Support Framework to facilitate the development of an integrated Decision Support System (DSS). The DSS will use platform AWARE-P to support strategic level decisions related to long-term planning of urban water systems, with focus on sustainability related issues. A new methodology for comparing and selecting alternative solutions is presented employing Multi-Criteria Decision Analysis and multiple scenarios handling. DSS seeks to assist in all principal phases of the related decision-making process including problem definition, problem structuring/analysis and problem solving.

The report outlines the envisaged DSS concept, functionality and structure, including description of principal modules. It also describes the related DSS software architecture and related issues.

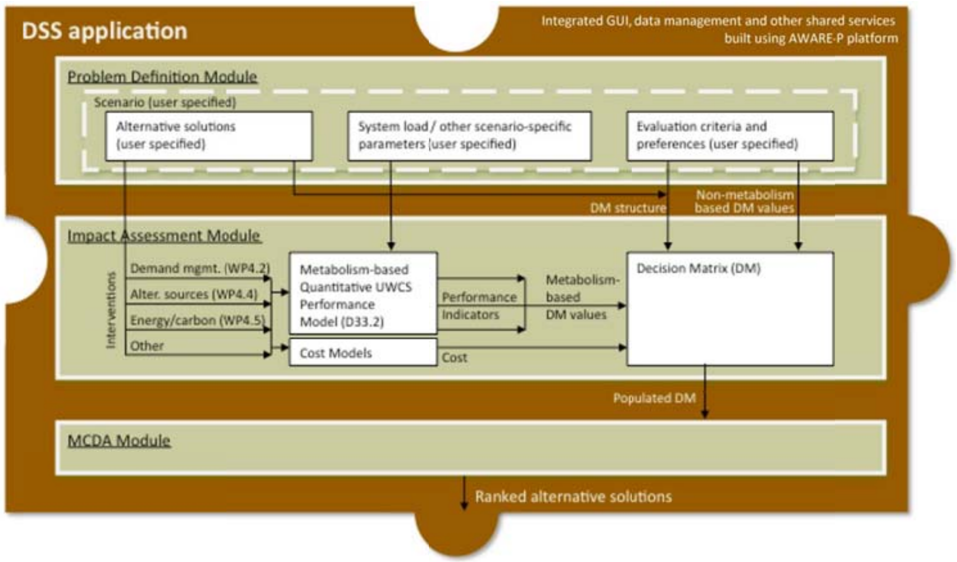
It is targeted to a wide range of professionals, interested in the long-term, strategic-level decision making related of urban water systems.

SUMMARY DESCRIPTION

DSS concept and components

DSS methodology is oriented to the generation and comparison of user-developed Intervention Strategies, allowing an interactive study of their effect on the Urban Water Systems.

As outlined original proposal of TRUST Project, the primary Graphical User Interface (GUI) to the DSS would be based on the AWARE-P platform, giving the unified look to the DSS and the other planning software developed under TRUST (see next Figure). In addition, a lightweight Microsoft Windows client will be implemented to complement the web-based AWARE-P approach. This client will allow for more complex DSS analysis to be undertaken locally.



DSS includes three "conceptual" modules shown in the previous Figure:

1. Problem definition module

Enables the user to define the strategic planning problem. More specifically, the module allows the user to define a number of alternative solutions (i.e. intervention strategies) to be analysed, together with the multiple criteria that will be used to evaluate them, all under a number of different, user-specified scenarios. The evaluation criteria will be based primarily on the outputs of WaterMet^2 model (to see more information about this model, consult deliverable "Quantitative UWS Performance Model: WaterMet^2").

2. Impact Assessment module

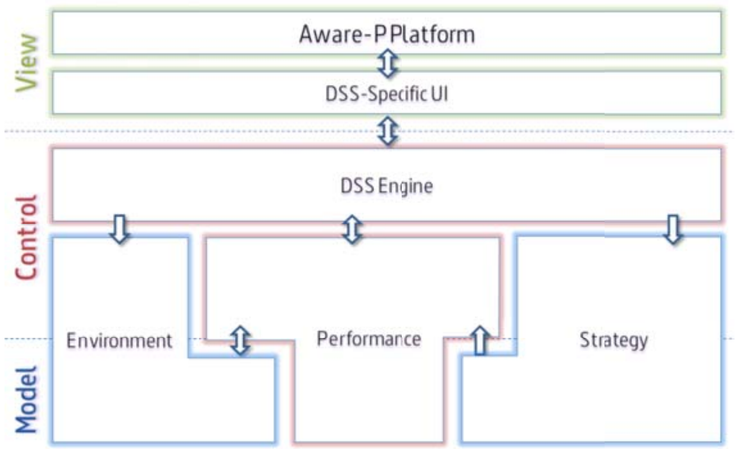
Enables the quantification of impacts for each optional intervention strategy on the future UWCS performance, using WaterMet^2 model. The database of individual interventions modelled will include different intervention types and the associated default cost models/parameters. The resulting UWCS performance and the corresponding intervention costs will then be used to populate the Decision Matrix, which will be defined based on the information provided in the Problem Definition module.

3. Multi-Criteria Decision Analysis module

Allows user selection of the best alternative solution, ranking the alternative solutions with Multi Criteria Decision Analysis (MCDA) method to the Decision Matrix data. Two MCDA methods can be implemented in the DSS for this purpose: the Compromise Programming (CP) method and the Analytical Hierarchy Process (AHP) method.

DSS Software Architecture

The software architecture is divided into three conceptual layers, Model, Control and View, which correspond to Modelling Functionality, Operations and User Interface respectively. An overview of the DSS software architecture is presented in the figure.



The View layer will be implemented on the AWARE-P and Microsoft Windows platforms and is subdivided into two conceptual units. The DSS-Specific UI comprises the dialogs and displays specific to modifying the inputs of the DSS and rendering the results as, for example, tables. The top-level "AWARE-P" platform element represents the advanced visualization services provided by the platform in terms of network display, charting etc. DSS Engine package is employed as the interface between the other procedural elements of the DSS – in the Control layer – and the user interface above. All function calls and data transfers are marshalled through this layer as a single point of contact

The remaining three packages transcend the Control/Model boundary, containing elements applicable to both domains. Environment and Strategy Packages form the Problem definition module, as outlined in the TRUST proposal description of work. Performance incorporates the Impact Assessment Module as well as the WaterMet^2 model as a self-contained entity.

FINAL REMARKS

The described application will be prepared for "standalone use" as well as being integrated in the TRUST software platform. Also, DSS framework will be "open-sourced" – license type.

The report contains a section ("Software Components") that describes each package and the key relationships between the concepts in that package. Where appropriate, the key public functions for each concept are described. Further functional description can also be seen in the individual package Conceptual Class Diagrams.

ADDITIONAL INFORMATION

The described deliverable can be accessed at the following URL:

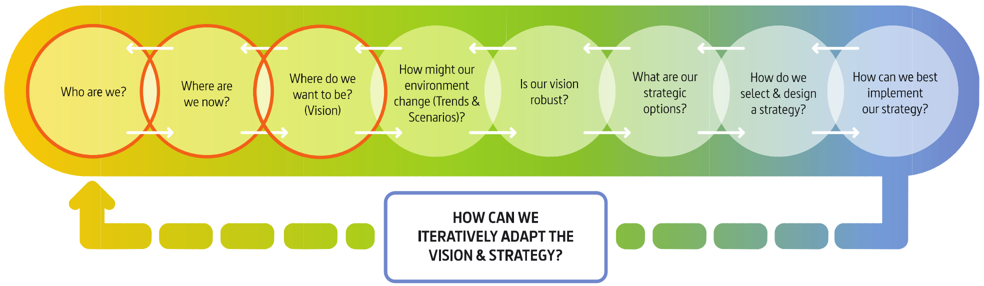
http://www.trust-i.net/downloads/index.php?iddesc=22

Further information can be found in the additional links:

- "AWARE-P Platform"
  http://www.aware-p.org

T22.1
Contemporary water market structure and regulatory framework

ANDREAS HOFFJAN
NICOLE ANNETT MÜLLER



SCOPE

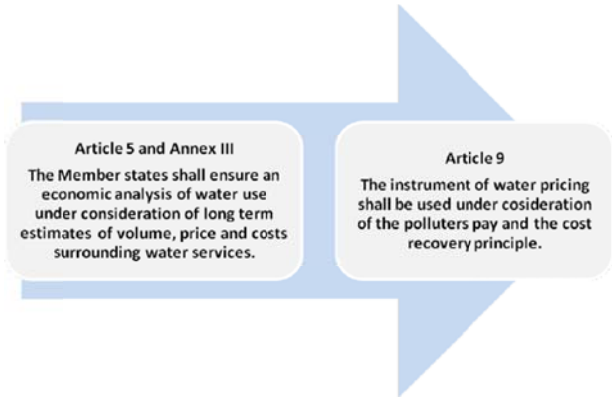
The main purpose of the report is to point out the status quo of the European water market and its regulatory framework. The report focuses, initially, on the economic aspects of the European Water Framework Directive, and after an overview of the European water market and its regulatory framework, it describes the situation of the water sectors in Scotland, Portugal, Norway and Germany, which are characterized by their differentiation.

SUMMARY DESCRIPTION

The UE Water Framework Directive

The Directive 2000/60/EC of the European Parliament and the Council, known as EU Water Framework Directive (WFD), came into force in October 2000 and became fully operational in 2012. The main target of WFD is to establish a framework for Community action in the field of water policy. Its primary requirements are to prevent any deterioration in water quality in any water body and to aim to achieve 'good status' in all water bodies except those designated as an artificial or heavily modified water bodies. Having a legislation concerning water management on EU level stresses the fact that water resources and environmental problems do not stop at national borders.

According to the WFD, cost recovery is a main factor to ensure sustainability and quality in the water sector. This Directive requires the polluter pays principle as a basic influence on the water pricing model to distribute the costs of water services more equitable. WFD proposes economic principles and provides an implementation framework (summarized in the next Figure), but does not set obligatory detailed guidelines on how to implement these economic principles.



The European Water Market

In general, the water and wastewater services across Europe require high investments for maintenance, repairs and renewal of assets and pipes to ensure sustainability. Whilst in the past the services of general interests were traditionally duties of the municipalities, now many countries enable a participation of private companies. In fact, because of the high investment and financing needs, private actors play an even greater role in Europe.

The organizational structures of water and wastewater services differ widely among the European countries. The occurring ownership models can be grossly divided into:

- Public,
- Private.
- Public-public partnership (different models),
- Public-private partnership (different models),

Regardless of the ownership structure, the natural monopoly as well as the according lack of competition leads to the risk that this provision is economically exploited by the serving companies.

The problem is handled differently among the European countries. The introduction of a regulatory body is one way to monitor and regulate the markets. Many countries have established a regulatory authority for water and wastewater services during the last years as illustrated in the following Figure. Nevertheless, the focus of regulation varies between the countries. Possible duties of regulatory entities are, among others:

- monitoring of drinking water quality
- supervision of market entries
- consultative role
- economic regulation (e.g. price caps, specification of investment budgets)
- contact for customer complaints.

Future perspectives and starting points

In order to contribute to the development of the water sector, the report shares the following starting points:

Population:

- scenario analysis;
- cost-benefit analysis (reconstruction vs. additional flushing).

Water consumption:

- leakage repair;
- consumption analysis – What affects the differences?

Regulatory framework: :

- influence of the degree of regulation on efficiency;
- costs and prices.

Structure:

- efficiency analysis regarding the companies' ownership structure;
- assessment of sufficient use of economies of Scope and Scale.

Competition:

- national benchmarks;
- transnational benchmarks;
- publication requirement;
- rating systems for water supplier and wastewater provider.

Finance:

- adequate tariff structures;
- earmarked revenues;
- improvement of the cost recovery ratio;
- long-term funding strategies.

Customer satisfaction:

- improvement of the drinking water quality;
- lower interruption frequency;
- transparency initiatives.

FINAL REMARKS

In summary, the organisation of the water and wastewater sector are not homogenous among Europe. Although rough guidelines apply to all Member States, there is further national scope for the regulatory and legal design. To reach the overall aim of sustainable urban water and wastewater sectors, there is still a lot of need for improvement.The report shares starting points aiming to contribute to address the technical and economic challenges in water supply and wastewater treatment sectors in Europe.

ADDITIONAL INFORMATION

The described report can be accessed at the following URL:

http://www.trust-i.net/downloads/index.php?iddesc=34

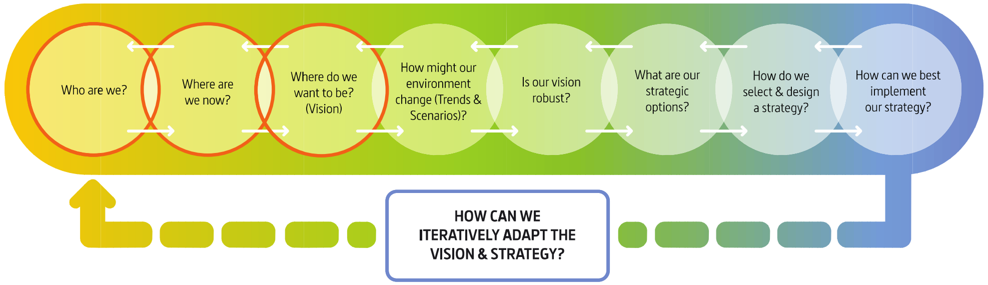
Further information can be found in the additional links of the TRUST project:

- "Customer perspectives on new urban water services" http://www.trust-i.net/downloads/index.php?iddesc=54
- "Financial sustainability rating tool for urban water systems" http://www.trust-i.net/downloads/index.php?iddesc=108

T22.2

Costumers perspectives on new urban water services

ELENA RIDOLFI, HEATHER SMITH
NICOLE ANNETT MÜLLER
ANDREAS HOFFJAN



SCOPE

Beyond the need to understand the value of water in a more holistic way, it is also recognized that the price of water is one of the main 'signals' that can help to shape how different groups of users bestow value on water services. In many parts of Europe, discussions around the reform of tariff structures are becoming increasingly prominent.

This report presents the results of an initial literature review, encompassing both academic and grey literature, which focused on understanding the 'customer perspective' – what they value and might be willing to pay for – around the future of urban water services.

It starts with a review exploring the concept of how different users bestow 'value' on water and water services, and how this value might be assessed. The report then shifts to examining the different costs associated with water services, along with different models for setting water tariff structures and discusses the factors that influence water users' recognition and acceptance of those costs and willingness to pay tariffs.

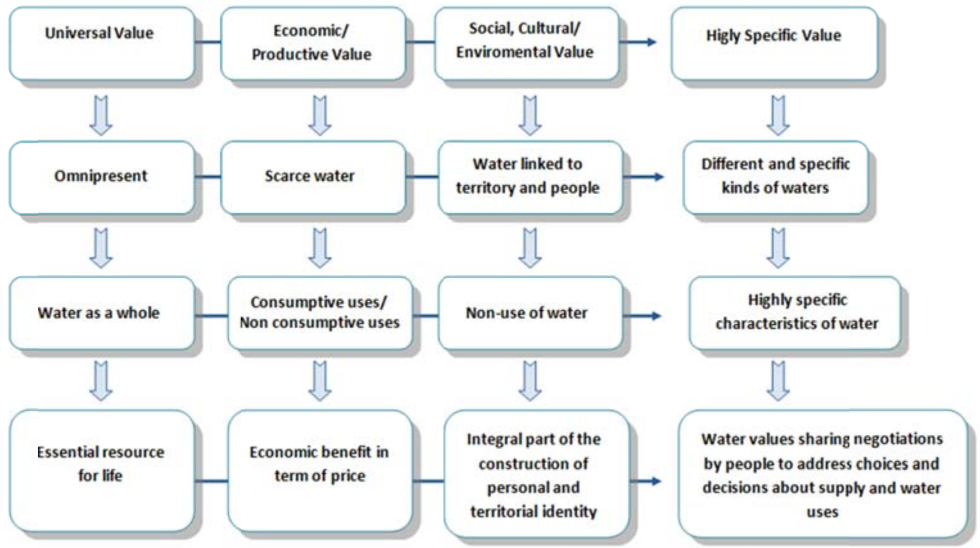
SUMMARY DESCRIPTION

The European Water Market

As water is becoming a more critical resource, more comprehensive management efforts with respect to water supply and availability are emerging. In keeping with this, there is a growing need to explore how different end-users of water – e.g. households, businesses, industry – bestow value on the resource, in order to better comprehend whether and how users might be encouraged to 'pay for the future'. Additionally, there has long been some recognition that different sources of water are better suited to different purposes, depending on their underlying quality. As pressures on water resources increase, particularly in highly populated areas, there is growing interest in exploring how to take advantage of alternative, lower-quality water sources to meet certain end uses. Understanding the range of end-uses, and how they are valued, is therefore key to understanding how lower quality sources might best be used and paid for.

Conceptual framework around the value of water

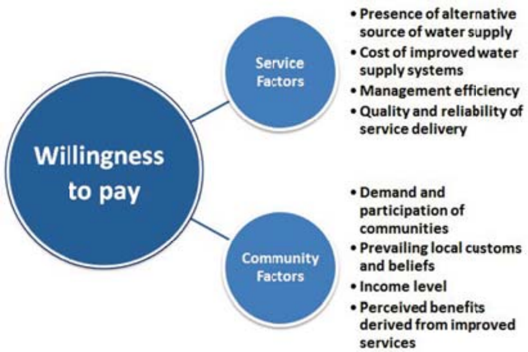
The literature highlights four broad perspectives from which the value of water can be characterized: in terms of its universal value, its economic/productive value, its social/cultural/environmental value, and its highly specific values.



Process of attribution of value for water

Acceptance of cost analysis

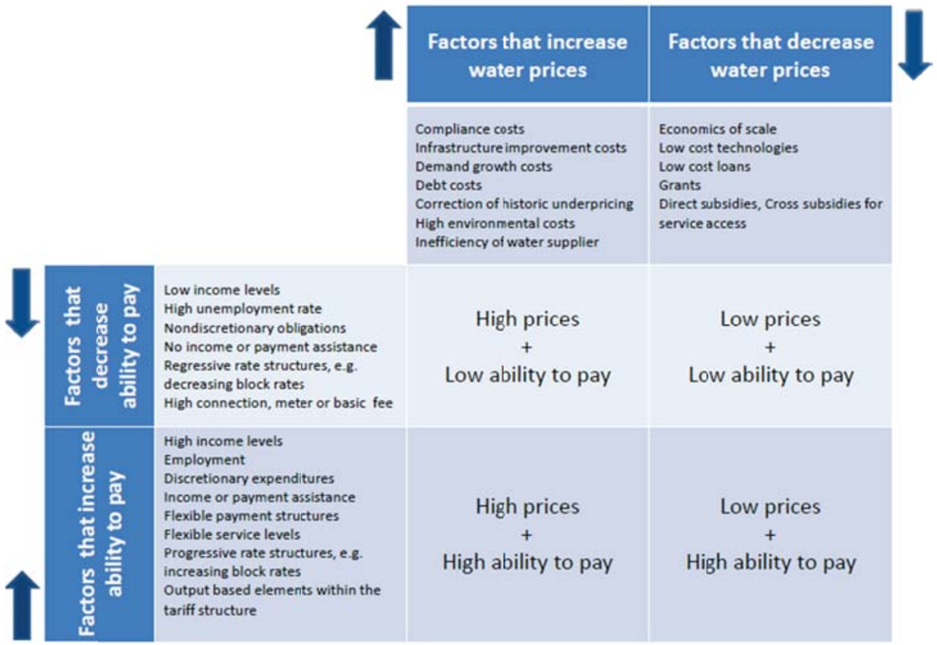
The next figure summarises partially correlated factors affecting the reservation price Regional variations in natural and demographic conditions as well as other characteristics of the supply area have a positive or negative impact on the supplier's costs.



Selected factors having influence on the customers' willingness to pay

Water pricing

The successful implementation and operation of a (new) tariff model is directly dependent on customers' acceptance of it. The following figure gives an overview of key factors, which influence the water prices and the ability to pay.



Selected factors influencing affordability and the level of the water price

The scenario of 'high prices plus low ability to pay' is particularly alarming, indicating that the tariff models and structures must be better adapted to the customers' circumstances.

In summary it can be stated that the acceptance of a tariff model is dependent on various factors. The priority of the household customers lies in the affordability of drinking water. Moreover, the prices should be fair and understandable. Nonetheless, there is still room for improvement especially with regard to an adequate provision and transparency of information. When the customers are informed of the relationship between the utilities' costs and the water prices, the acceptance of tariff models can be further developed.

FINAL REMARKS

Ultimately, this report seeks to inform how water service providers communicate and engage with their customers. Customers' views on how much they ought to pay for water services are a fundamental influence on the long-term sustainability of the water sector. If the sector wishes for customers to invest in the future of these services – e.g. through tariff reforms –then a much better understanding is needed around how different uses of water are valued by different users, and how these values ultimately shape what they are willing to pay for. This understanding should help service providers to craft mechanisms for communication and engagement with customers on the subject of costs and tariffs.

ADDITIONAL INFORMATION

The described report can be accessed at the following URL:

http://www.trust-i.net/downloads/index.php?iddesc=54

Further information can be found in the additional links of the TRUST project:

- "Contemporary water market report "
  http://www.trust-i.net/downloads/index.php?iddesc=34
- "Financial sustainability rating tool for urban water systems"
  http://www.trust-i.net/downloads/index.php?iddesc=108

T22.4
Funding alternatives for sustainable water services

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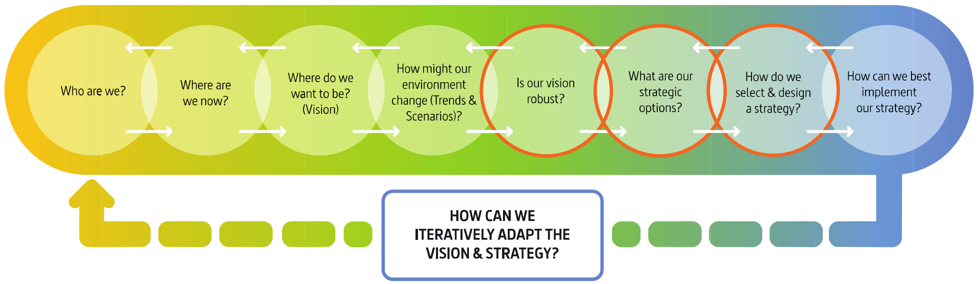


SCOPE

Due to several sector-specific characteristics, ensuring an adequate financing is a serious challenge in the drinking water and sanitation sector. This report focuses on funding alternatives for water services in an economic sustainable way.

There are high financial needs in the water sector, because the water and wastewater services are very capital intensive, making this TRUST report an essential document.. Most assets are tangible ones, with an eminently long lifetime, making investment decisions of today affect future generations. Moreover, an extremely high level of fixed costs characterizes the water sector, so most costs occur regardless of the actual water consumption respectively sewage production.

The main purpose of this report is to show options for sustainable financing of water infrastructures. It presents not only existing financing models but also considers economic measures and recommendations for utilities in order to help them to do more with the available capital.

SUMMARY DESCRIPTION

The Definition and Role of Sustainable Financing

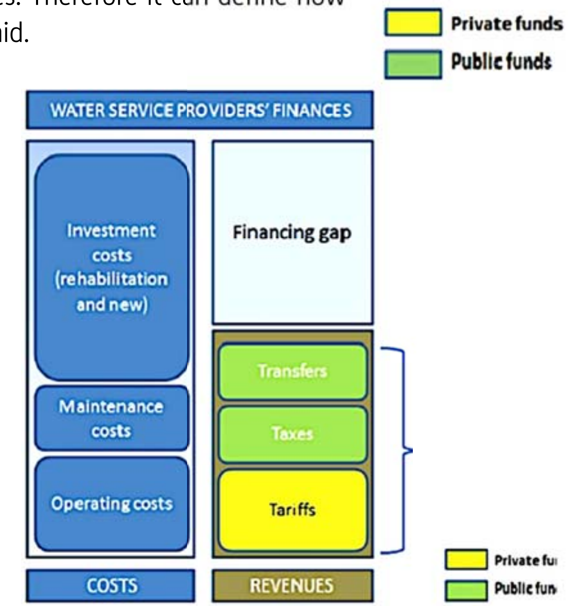
A central tension in water services financing is the conflict of objectives between capital investors, who want to recover their investments, and operators, who are ensuring a stable value of the infrastructure. A water company shall ensure service provision and asset maintenance with the help of financial stability, which means an adequate planning and management of financial resources. However, ensuring financial sustainability may affect certain sustainability dimensions, objectives and criteria for UWCS within the TRUST project. Due to their high importance, the following assessment criteria were considered within the report (however, it is striking that conflicts of objectives can occur):

- Ec11 – Cost recovery and reinvestment in UWCS
- Ec12 – Economic efficiency
- Ec13 – Leverage
- Ec14 – Affordability

Financing Strategies

Before actual financial decisions are taken, an appropriate strategic direction should be developed. It is important to note that financial policies determine the extend to what a utility will rely on various financial sources. Therefore it can define how long-term debt will be structured and repaid.

It can be deduced from the European Water framework directive (WFD) that the revenues from water pricing should be the main financial source for water utilities. Nonetheless, water pricing is mostly based on the recovery of basic operation and maintenance costs, which makes costs for major repairs, rehabilitation and replacement only rarely covered. Moreover, if the revenues are not sufficient to cover all costs, a financing gap occurs (see figure bellow).



If reducing costs or increasing revenues cannot close the financing gap, alternative-funding sources can be a solution:

- Existing community sources
- Private or corporate financing
- Specific funds
- Credit-loan mechanisms
- Grants

The use of repayable finance can help to bridge the financing gap, before it becomes an investment gap, which would conflict with the overall goal of sustainable service operation. 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).

Recommendations to ensure Financial Sustainability

Since most utilities already decided for a financial policy, the 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, giving the user an indication which area from financial situation over asset management to business operation needs optimization.

This rating tool also evaluates different forecasts (e.g. population development) and country specific characteristics (e.g. inflation rate) to assess future trends. FSRT cannot offer individual recommendations but identifies general suggestions, which are described and supplemented in this document. The given suggestions might help utilities to take the first step for improvement and to find tailored literature for further reading.

FINAL REMARKS

The TRUST report 'Funding alternatives for sustainable water services' can help utilities to reach financial sustainability by identifying certain areas of action and exploring different strategies and funding options. The document stresses certain questions that 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?

However, this analytical process should be supported by the use of special tools (e.g. the TRUST FSRT tool) or the participation in financial sustainability benchmarkings. After having identified certain problems, the options for sustainable financing and recommendations for improvement actions presented within the report shall encourage utilities to take the next step to reach financial sustainability. Nonetheless, if choosing between potential funding options the IRC-report 'Key factors for sustainable cost recovery' is recommended.

LINKS TO ADDITIONAL INFORMATION

The TRUST report T22.4 can be accessed at the following URL:

http://www.trust-i.net/project/t.php?wa=2&wp=2&t=4&subt=1

Further information can be found in the additional links:

- FSRT online tool → http://fsrt-trust.ing.unibo.it/fsrt/
- Corporate Finance:
  - Revsine, L., et al. (2012): Financial Reporting and Analysis, 5TH edition, Mc Graw-Hill, New York.
  - Ross, S. A., et al. (2010): Corporate Finance 9th Edition, Mc Graw-Hill, New York.
- Cost and management Accounting:
  - Bhimani, A., et al. (2012): Management and Cost Accounting, 5th Edition, Pearson, Essex.
  - The World Bank (2008): Accounting for Infrastructure Regulation.
- Financing in the Water Sector:
  - IRC (2001): Key Factors for Sustainable
  - Cost Recovery, URL:→http://www.ircwash.org/sites/default/files/Brikke-2001-Key.pdf
  - OECD – The Organisation for Economic Co-operation and Development (2009): Strategic Financial Planning for Water Supply and Sanitation.

Guidelines for assessment of UWSC current situation and future scenarios
D 51.2

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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