OPEN ACCESS

2nd International Electronic Conference on Sensors and Applications
15–30 November 2015

www.mdpi.com/journal/sensors

Conference Proceedings Paper – Sensors and Applications

Standards-based methodology for the design and implementation of a water management system

Thomas Messervey [1,*], Domenico Perfido [1], Louise Hannon [2] and Sander Smit [3]

[1] R2M Solution s.r.l, Piazza Della Vittoria, 2, 27100 Pavia, Italy; E-Mails: thomas.messervey@r2msolution.com (T.M.); domenico.perfido@r2msolution.com (D.P.)

[2] Department of Civil Engineering, National University of Ireland Galway, University Road, Ireland; E-Mail: LOUISE.HANNON@nuigalway.ie (L.H)

[3] BM-Change, Torenallee 20, 5617 BC, Eindhoven, The Netherlands; E-Mail: sander@bm-change.nu (S.S.)

* Author to whom correspondence should be addressed; E-Mail: thomas.messervey@r2msolution.com; Tel.: +39-0382 1726596

Published: 11 November 2015

Abstract: A lack of water information, expansive and difficult to access aging infrastructure, and a lack of information of how to tackle water management problems hinder efforts by stakeholders at all levels to manage water as a resource. Into this challenge, WATERNOMICS is an EU-funded research project that uses innovative information and communication technologies (ICT) to develop management and decision support tools that present meaningful and personalized information about usage, price, and availability of water to end users with the aim to facilitate the management of water as a resource, increase end-user conservation awareness, affect behavioral changes, and avoid waste through leak detection and diagnosis. This paper describes the first version of a standards-based methodology for the development and implementation of ICT-enabled water management programs. This methodology will, given constraints, standards, corporate preferences, and KPIs, provide decision makers and designers with a systematic way to select technologies, measurement points, data collection methods, and data management techniques for ICT-based water management systems.

Keywords: Water resource management; standards-based methodology; tools and methods; water sensing systems

1. Introduction

In developed countries, water has generally not been adequately considered as a resource and as a result our water infrastructure, business models and consumption behaviors reflect this fact. This is despite some dire warnings from global think tanks such as the World Economic Forum who in 2015 ranked water scarcity as the number one risk to global prosperity in terms of impact [1]. Other attention grabbing information bullets taken from the Europe 2020 Flagship Initiative Union, the Commission's initiative on Smart Cities and Communities and the European Innovation Partnership on Water include:

- 20-40% of Europe's water is being wasted
- Global energy and water demand is expected to rise 40% over the next 20 years
- By 2025, 1.8 billion people will live in water scarce regions and two thirds subjected to water stress
- Water supply and sanitation is a large energy consumer. In the water stressed area of California (for example), it represents 19% of electricity and 30% of natural gas consumption
- Current water consumptions and behaviors are not sustainable and we are almost crossing the global sustainable environmental threshold (tipping point)

Into this challenge, Waternomics "ICT for Water Resource Management" is a 3-year co-funded research project within the EU Seventh Framework Programme (FP7) under the Information and Communication Technologies (ICT) Directorate. The project involves 10 partners from Ireland, Italy, Greece and the Netherlands and has a total cost of 4.2 million euro. The goal of the Waternomics project, through the development of ICT platforms, sensors and services, is to provide personalized and actionable information about water consumption and water availability to individual households, companies and cities in an intuitive and effective manner at a time-scale relevant for decision making. From the Waternomics project webpage [2],

> *"The Waternomics project aims to reduce water consumption of municipalities, corporations and domestic users by providing water managers and consumers with timely information about water usage and water availability. The project makes information about the water services system available to stakeholders in real-time in order to stimulate water saving. By employing smart water technology, the project (i) enables the detailed and real-time measurement of water flows and usage, (ii) supports analyses of water consumption patterns and (iii) provides key recommendations on how to increase water efficiency."*

A dominant theme of the project is that there is the significant opportunity to accelerate the development and implementation of ICT-based water awareness, management and conservation solutions by following best practices and lessons learned from the energy markets. These include monitoring devices and services, dashboard interfaces, decision support tools, energy passports, energy labelling schemes, smart meters, variable pricing schemes, demand response, demand management, peak clipping, and peak shifting amongst others [3].

Within the project, the authors of this paper have led the development of a standards-based methodology for the design and implementation of water management programs. The rationale for such a framework is to provide visibility and to give confidence to each of the involved stakeholders and primarily the decision makers, end users, service providers and investors surrounding water efficiency measures. After its initial development, the methodology is currently being implemented across four pilots each having unique characteristics. They are a domestic scenario in the water stressed area of Thermi, Greece, a corporate scenario at the airport of Linate which also parallels the needs of small cities due to the nature and complexity of the airport infrastructure and environment, a university scenario in Galway, Ireland and a municipal scenario via a public school in Galway, Ireland. Through these pilots, the methodology will be validated and iterated for a final publication near project completion in 2016.

Apart from the methodology, innovative aspects of Waternomics include the use of linked data to provide water information, the development of personalized applications and a water information platform, the development of low cost ultrasonic sensing systems, acoustic leak sensing systems, fault detection and diagnosis applied to water systems and the implementation of various water efficiency measures based on data, training or strategic decisions [4]. Publications and reports surrounding these developments can be found on the publications section of the Waternomics webpage [2].

2. The Waternomics Methodology

3.1. Overview & Considered Standards

Figure 1 shows an overview of the Waternomics methodology. Although it is new for the water sector, energy managers will immediately recognize the correlation to Plan-Do-Check-Act (PDCA) cycle of ISO50001 (Energy Management Systems). Paralleling ISO50001 is deliberate and is intended to foster familiarity and acceptance in the crossover from energy to water efficiency concepts.

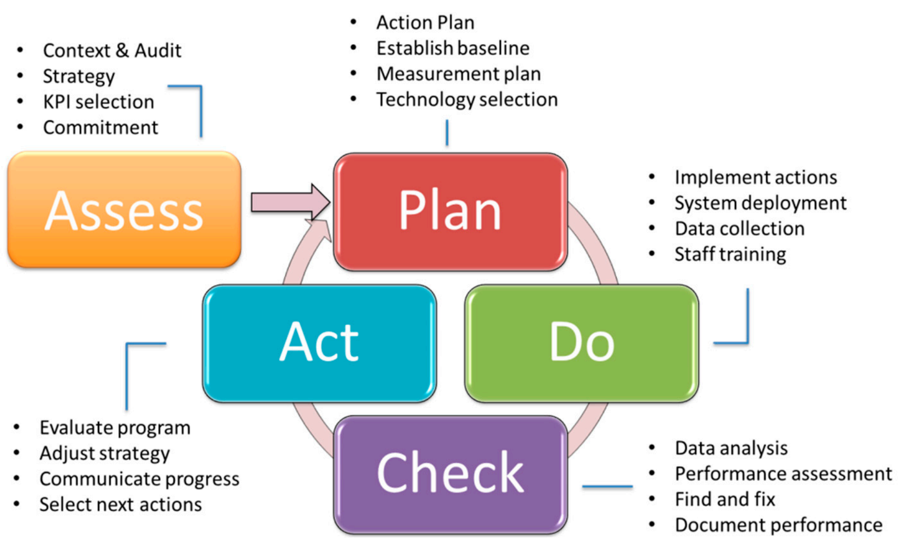

Figure 1. Overview of the Waternomics Methodology.

Added to the PDCA cycle is an initial "Assess" phase. Because end users may be less aware of water efficiency, water scarcity and how/why it affects them, the Assess Phase is a deliberate attempt to engage and educate the end user but still contain activities robust enough to to support complex and large organization water management program development. Other standards central to the methodology that many stakeholders will recognize include ISO50002 (Energy Audit), IPMVP (International Performance Measurement and Verification Protocol), and the recently released ISO14046 (Water Footprint). By assembling these standards in a non-redundant way and by customizing them to water where applicable, a holistic framework for the design and implementation of a water management program is constructed.

3.2. Methodology Expanded

Figure 2 shows the full view of the Waternomics Methodology in which the phases, activities, desired outcomes and the related standards are shown in a holistic manner.

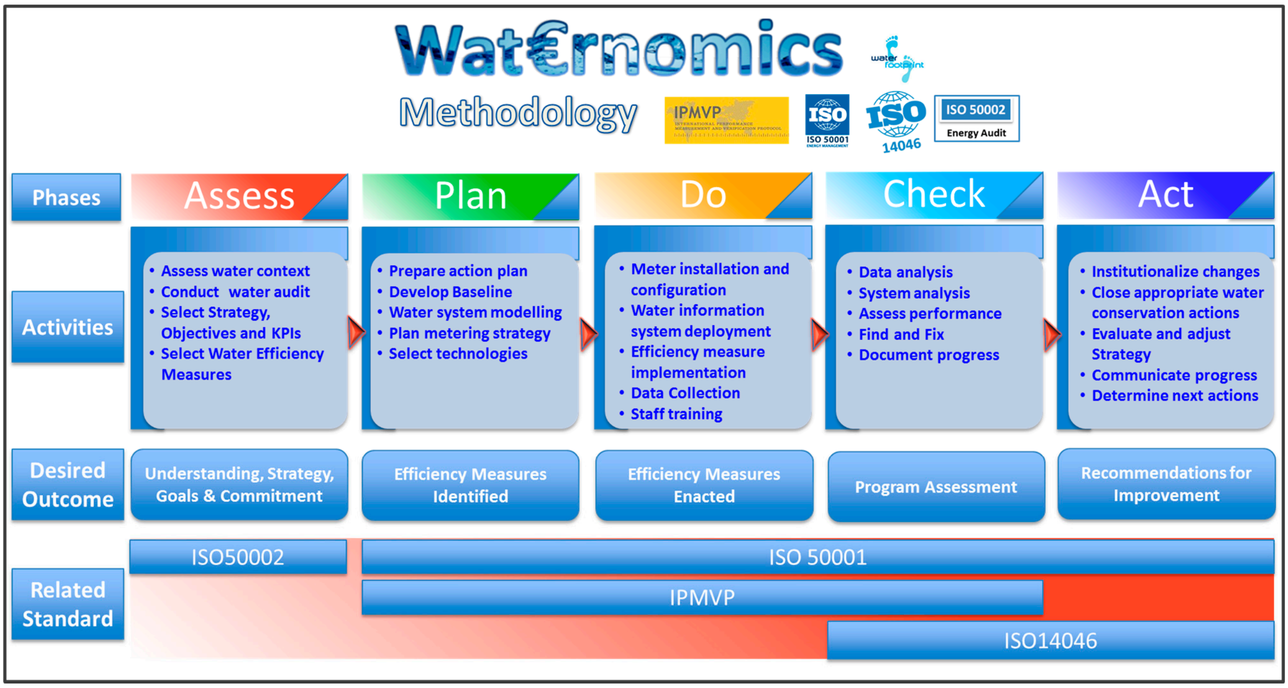

Figure 2. Waternomics Methodology – Expanded View.

Each of the five phases has four or five activities which constitute the steps and methods associated with each phase. The approach is intended to be general enough to be applicable to the different targeted stakeholders (domestic, municipal, and corporate) but also detailed enough to be useful and actionable in all scenarios. Within each activity, various methods (e.g. ways to carry out an activity) are possible. For example, IPMVP offers four unique methods to calculate a water consumption baseline (which is an activity under the Plan Phase). Another example is that three different levels (or types) of water audits are provided in the description of the methodology (an activity within the Assess Phase). As such, in using the methodology, the end user has the flexibility to determine what method and level of detail is appropriate for them. A domestic user may appropriately employ only the higher level concepts (phases and select activities). Instead, the manager of a large and complex organization may apply the phases, activities, and methods with more rigor. A full description of the methodology is documented in a project report (deliverable) titled "D2.1 – Waternomics Methodology." This report is public and available for download at the Waternomics webpage [2].

3. Tools and Methods

One desired outcome of the Waternomics project and methodology is that decision makers and end users at the community, corporate or home levels have a framework, set of tools, and references that enable them to take action towards water efficiency measures and to enact water management programs. To this end, in developing the methodology, six tools were created to facilitate carrying out the activities of the various phases. They are a methodology visualization method (via a Trello Board), a water auditing method, a strategy selection tool, a method for the specification of minimal data sets, a technology selection tool and a water value map.

Figure 3 shows the water value map tool which is part of Phase 1 (Assess) activities. By providing easy to understand symbols and terminology, it seeks to develop a shared understanding of water usage and water related activities amongst stakeholders such that people with different backgrounds and knowledge levels, can quickly start discussing water related issues and exchanging knowledge, without being hindered by lingual obstacles.

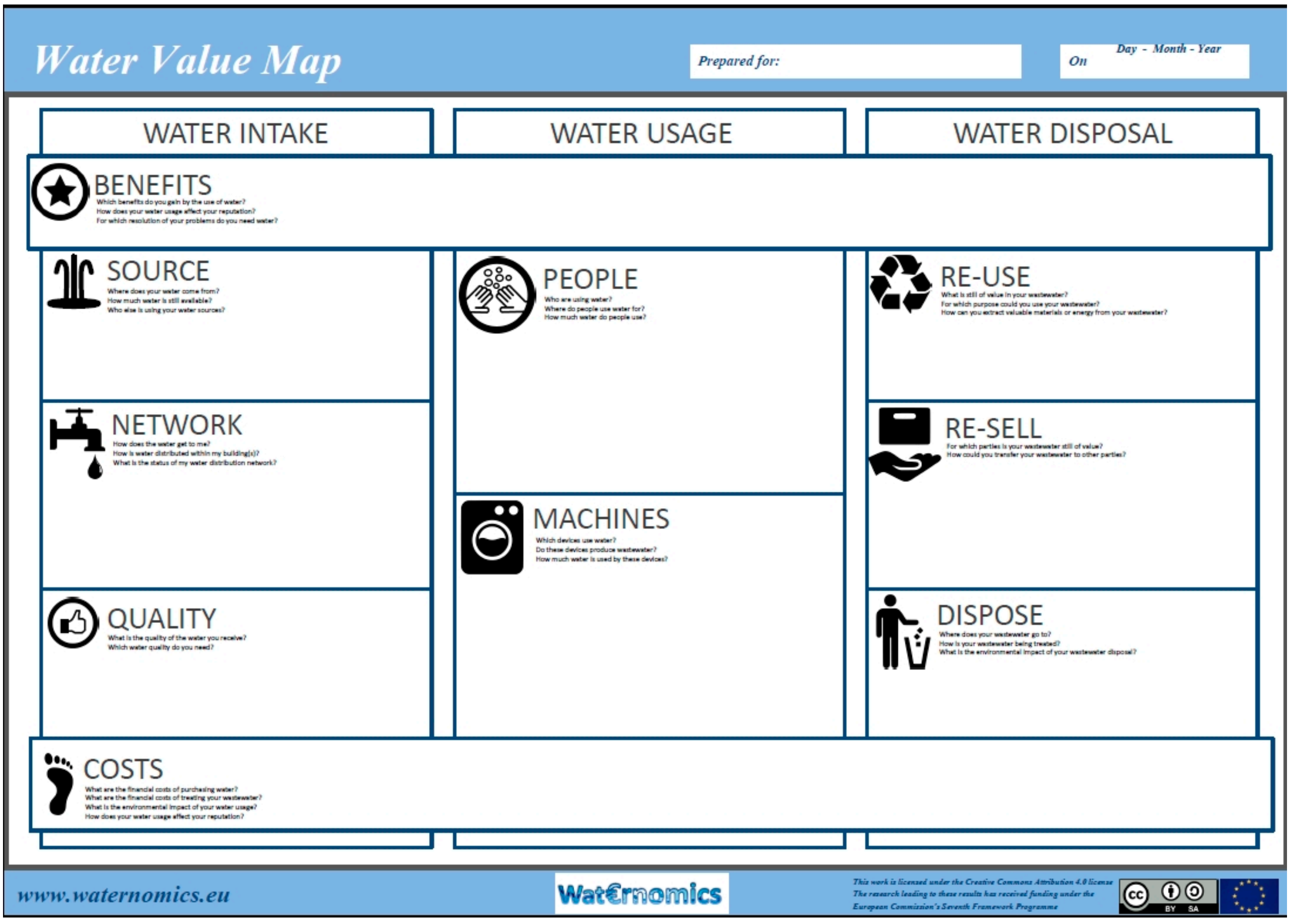

Figure 3. Waternomics Water Value Map.

Each of the six tool are detailed in in the D2.1 methodology report. The tools will also be available on the Waternomics information platform as clickable resources.

4. Conclusions/Outlook

This paper has provided a brief overview of the methodology developed in the FP7 Waternomics Project for the design and implementation of water management programs. It is standards-based, holistic and deliberately parallels best practices from the energy sector. Pointers to the full report and available tools to implement the methodology have been provided. The methodology is important for sensors, data analysis and water efficiency services in that it provides visibility, confidence and a framework to take action where inaction might otherwise prevail.

At the time of this writing, the methodology is currently being validated across four Waternomics pilots. Lessons learned will be folded back into the methodology and a final revision published in late 2016. Updates will be reflected on the Waternomics webpage to include publications in the project's technical activities. Readers interested in the topic area are also encouraged to visit the ICT4Water webpage [5]. The ICT4Water platform groups together 10 EU funded projects working on water related ICT research.

Acknowledgments

The research leading to these results has received funding under the European Commission's Seventh Framework Programme from ICT grant agreement WATERNOMICS no. 619660.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. World Economic Forum, Global Risks Report 2015, available at http://reports.weforum.org/global-risks-2015/ (accessed on 15 October 2015).
2. Waternomics project homepage. Available at http://waternomics.eu/ (accessed on 15 October 2015).
3. Clifford, E., Coakley, D., Curry, E., Degeler, V., Costa, A., Messervey, T., Smit, S. (2014). Interactive Water Services: The Waternomics Approach. In 16th Int. Conf. Water Distribution Systems Analysis (WSDA 2014). Bari, Italy.
4. Curry, E., Degeler, V., Clifford, E., Coakley, D., Costa, A., van Andel, S. J., Smit, S. (2014). Linked Water Data for Water Information Management. In B. Brodaric & M. Piasecki (Eds.), 11th Int. Conf. on Hydroinformatics (HIC). New York, USA.
5. ICT4Water cluster homepage. Available at http://www.ict4water.eu/ (accessed on 20 October 2015).