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Measuring the sustainability of urban water services

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ABSTRACT

This paper discusses the concept of 'sustainable water services' and suggests a multicriteria method to assess it. Although conceptual discussions around this notion are often confined to the triple bottom line (TBL) classification, it seems that the TBL approach does not provide the suitable framework to measure water services sustainability. It is argued that assets (or technical) and governance aspects are also indispensable dimensions. After revisiting the concept in broader terms, several criteria and metrics are suggested to operationalize and quantify the sustainability level of urban water services. To aggregate the numerous aspects that are relevant in this scope a multicriteria decision analysis approach is proposed. Furthermore, to illustrate the real-world application of the method, a multicriteria model applicable to the case of Portugal was developed and calibrated with the input of a decision-maker with extensive experience in the sector. With the suggested framework it is possible to assess the global sustainability level of the water services (e.g. of each utility) and also the performance in each particular dimension ('social', 'environmental', 'economic', 'governance' and 'assets').

1. Introduction

Although some recent efforts may be found in the literature (e.g. van der Steen, 2011; van Leeuwen et al., 2011), there is no widely accepted or established method to assess the sustainability level of urban water services (UWS). In fact, sustainability assessments face many obstacles. At the outset, the very definition of sustainability poses significant conceptual challenges. How can one operationalize such a wide-ranging notion? However, although there are many challenges towards achieving the sustainable urban water cycle (Brown et al., 2009), this pursuit is a major societal objective which therefore makes measurement important.

Sustainability is usually associated with the triple bottom line (TBL) framework, composed of social, environmental and economic dimensions or principles (Thornton et al., 2007). These dimensions find correspondence in the 'people, planet and profit' phrase of Shell or to the 'folk, place and work' of the planner Patrick Geddes in his definition of sustainability. The question is whether the TBL framework is suitable to deal with UWS sustainability. We, as some other authors, believe that the TBL approach is not sufficient in this regard (ASCE and UNESCO, 1998 or Ashley et al., 2003).

Taking into account the theoretical and practical difficulties, this paper proposes a framework and a method to assess the sustainability of UWS. To accomplish this, the research strategy encompasses three major steps: (1) the dimensions and objectives of UWS sustainability are defined along with the respective assessment criteria; (2) the quantitative and qualitative performance metrics are identified for each criterion; (3) a multicriteria decision analysis (MCDA) model is structured taking into account the Portuguese context (for illustrative purposes). Most of the conceptual work reported in this study (mainly corresponding to the abovementioned steps 1 and 2) was developed within the TRansitions to the Urban Water Services of Tomorrow (TRUST) research project. The current operationalization of the multicriteria model (step 3) was carried out through a participatory process involving an expert who acted as the decision-maker in the modelling process (a former Director of EPAL,[1] member of the board of ERSAR[2] and current Executive Director of PPA[3]).

[1] EPAL (Empresa Portuguesa das Águas Livres) is a major water utility serving the region of Lisbon (the capital of Portugal).
[2] ERSAR (The Water and Waste Regulation Authority) is the Portuguese sector-specific regulator.
[3] PPA (Portuguese Water Partnership) is an association that 'aims to develop synergies and maximize potential for the development of the water sector in the world, promoting the construction and consolidation of alliances and partnerships between national institutions and all nations engaged in sustainable water use and enhancement of water resources.'

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After this brief introduction the second section reviews some of the previous efforts to assess the sustainability level of urban water services. In the third section we discuss the concept of sustainability and argue for the addition of the 'assets' and 'governance' dimensions to the TBL framework. The fourth section demonstrates the suitability of MCDA modelling regarding the objective of assessing water services sustainability whereas the fifth section presents a real application of the procedure. Finally, the sixth section concludes the paper.

2. Sustainability assessments of urban water services

Sustainability is a trendy concept that is used in different contexts and with several aims. Sustainable practices are currently an objective that most organizations pursue; however, the question is often to know about what is not sustainable rather than what is sustainable (AWWARF and CSIRO, 2007). Considering the various stakeholders, the uncertainties, the numerous possible metrics and the trade-offs between them, it is difficult to know how to become sustainable and to measure to what extent a particular sector or activity is sustainable.

Nowadays, the success of a water (and wastewater) utility depends on the provision of drinking water supply or the collection of wastewater with the adequate quality levels but it also needs to take into account the impact of its actions and decisions on people, places and related resources, both in the short and long-term. Therefore, along with the economic performance, water utilities are now implementing new approaches to evaluate themselves. Some of these approaches are directly related to sustainability assessment through the TBL lenses, centred on financial, environmental and social performances (although other sustainability scorecards embrace further dimensions).

The Swedish Foundation for Strategic Environment Research is responsible for one of the first studies referred to in the literature. The project adopted the metabolism model and 'health and hygiene', 'social and cultural', 'environmental', 'economic', 'functional', and 'technical' categories where the criteria adopted for assessing UWS sustainability were arranged according to their influence on the water and wastewater systems (Hellström et al., 2000). At that time the authors concluded that the tools to evaluate the socio-cultural and functional aspects were not suitable. The criteria used in the water sector were also analysed by Balkema et al. (2002) in 15 publications to compare technologies relating to sustainability and concluded that adequate attention was not given to the socio and cultural aspects.

A set of sustainability indicators was developed by Lundin (2003) to assess progress of water and wastewater systems as far as sustainability is concerned. Those indicators comprise environmental and technical factors and their choice took into account a number of principles. The International Hydrological Programme alongside the American Society of Civil Engineers (ASCE and UNESCO, 1998) defined criteria and set guidelines for the sustainability of water resource systems. By including economic, environmental, ecological, social and physical objectives the authors acknowledged the multidisciplinary, multi-objective and multi-participatory characteristics of water resource sustainability.

In view of the need for new actions to achieve sustainable management of the urban water systems, Bertrand-Krajewski et al. (2000) came across methodological issues related to definition of objectives, modelling, decision-making tools, metrology and multidisciplinarity. According to the authors these are essential conditions to develop the knowledge on the indicators and criteria used in the methodologies of sustainability assessment. Two integrated approaches were followed: one related to time and space scales and the other in the scope of multidisciplinarity. Three groups of methodological problems that get in the way of a suitable assessment of the indicators and criteria were identified by these authors, particularly the clear definition of objectives and operational objectives, the concerted and multidisciplinary measurements and the quality of the metrology.

Mitchell (2006) studied the concept of 'integrated urban water management' (IUWM) as a central pillar of sustainability. A full process of urban water services, whose components of an integrated 'physical system' are the drinking water supply and the wastewater collection systems, also comprises the organizational framework and the surrounding environment. It was shown that it was possible to successfully put into effect the IUWM approach, while being technically reasonable and acceptable to stakeholders. Some of the available IUWM tools that must be combined to result in the integrated total system solutions required by urban communities are water recycling, water efficiency programmes, and water sensitive stormwater management. According to this author, the IUWM approach considers that: (a) all components of the water cycle make part of an integrated system; (b) all dimensions of sustainability are well-adjusted; (c) all stakeholders are involved, including all water users; (d) all water uses are addressed and (e) all idiosyncrasies of the local context are taken into account.

A typology of five organizational development phases in sustainable urban water management (including the project, outsider, growth, insider, and integrated development phases) was proposed by Brown (2008) as a heuristic model and/or a capacity benchmarking tool for stakeholders. The results proved that the political institutionalization of environmental matters along with the commitment to local leadership and organizational learning 'are key corporate attributes for enabling sustainable management'.

In the UK, the industry umbrella in the water sector built a set of 25 indicators to measure the water utilities progress concerning environmental sustainability (Water UK, 2000). Since then this organization has been computing a set of sustainable water indicators yearly (see Water UK, 2010). Afterwards, a research project known as SWARD produced a sustainable water services procedural guide (Ashley et al., 2003, 2004). The aim of this tool is to help water utilities to make sustainable decisions. It makes a distinction between principles, criteria and indicators of sustainability and sorts the criteria (or dimensions) into economic, environmental, social and technical and each one of these into performance indicators.

In the U.S., Monsma et al. (2009) put emphasis on the role of integrated water resources management to improve the sustainability in water systems. The sustainable path for the U.S. water infrastructure found support in a set of 20 performance metrics which includes the following components: affordability, advanced procurement and project delivery methods, asset management, climate change mitigations and adaptation, conservation and water efficiency, costs of development, energy management, environmental impacts, full cost pricing, good governance, modernized plant operations, network optimization, public outreach and stakeholder investment, regulatory optimization, security and emergency preparedness, stewardship, transparency, watershed and regional optimization, workforce management and research, and technological and managerial innovation.

Recently, an indicator approach called City Blueprint was developed by the KWR Watercycle Research Institute and Deltares to assess the sustainability of the urban water cycle. The City Blueprint includes elements of water footprints, urban metabolism, ecosystem services and indicators (van Leeuwen et al., 2011, 2012; van Leeuwen and Chandy, 2013). The research uses 24 indicators from eight broad categories, namely (1) water security following the water footprint approach as developed by Hoekstra (2003), (2) water quality, which includes surface and