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Research article

Method selection for sustainability assessments: The case of recovery of resources from waste water

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ABSTRACT

Sustainability assessments provide scientific support in decision procedures towards sustainable solutions. However, in order to contribute in identifying and choosing sustainable solutions, the sustainability assessment has to fit the decision context. Two complicating factors exist. First, different stakeholders tend to have different views on what a sustainability assessment should encompass. Second, a plethora of sustainability assessment methods exist, due to the multi-dimensional characteristic of the concept. Different methods provide other representations of sustainability. Based on a literature review, we present a protocol to facilitate method selection together with stakeholders. The protocol guides the exploration of i) the decision context, ii) the different views of stakeholders and iii) the selection of pertinent assessment methods. In addition, we present an online tool for method selection. This tool identifies assessment methods that meet the specifications obtained with the protocol, and currently contains characteristics of 30 sustainability assessment methods. The utility of the protocol and the tool are tested in a case study on the recovery of resources from domestic waste water. In several iterations, a combination of methods was selected, followed by execution of the selected sustainability assessment methods. The assessment results can be used in the first phase of the decision procedure that leads to a strategic choice for sustainable resource recovery from waste water in the Netherlands.

1. Introduction

Transition towards a circular economy has been proposed as one of the solutions for a future that supports the growing world population and welfare per capita within the environmental and social boundaries of our planet (Ellen MacArthur Foundation, 2013). Initiatives towards realizing a circular economy can be found from global to local levels (Bocken et al., 2016; European Commission, 2016; Geng et al., 2013; Linder and Williander, 2015; Ministerie van Infrastructuur en Milieu, 2016; Municipality Utrecht, 2015; UN, 2015). The transition process needs be supported by insights from different disciplines with respect to the economic, environmental and social costs and benefits, amongst which trade-offs may occur. In addition, decision makers have to deal with uncertainties and unknowns that are characteristic of investing in new business models (Linder and Williander, 2015), and with different stakeholders views on the current situation, the desired solution and on what sustainable choices should encompass (Zijp et al., 2015). The selection of sustainable solutions for a resource-efficient economy is a wicked problem *sensu* Rittel and Webber (1973).

An example of the need for such strategic choices in the realms of circularity is the recovery of resources from domestic waste water. We selected this as a case study to design and test an approach to support decision making with a sustainability assessment. We applied a solution focused sustainability assessment

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framework (Zijp et al., 2016), with specific focus on the translation of the sustainability question and its context into sustainability analysis methods selection (Zijp et al., 2015).

Currently, the use of waste water flows as a potentially valuable resource are evaluated in various pilot projects in the Netherlands and elsewhere. In order to invest in full-scale operations, water system managers need to make strategic choices. The choices involve technical issues (e.g. different solutions for resource recovery from waste streams are possible but can be mutually exclusive), political issues (e.g. the focus on climate change draws organizations towards low-energy cost solutions without considering the biomass value pyramid (Gavrilescu, 2014)), many unknowns (e.g. what will be the future quality of waste water) and many stakeholders.

A sustainability assessment (SA) provides scientific support in the decision making for selecting amongst competing sustainability-enhancing technologies. Its outcomes can be utilized in a decision-making process that is solution focused, participative, iterative and transparent in its definition of sustainability (Zijp et al., 2016). However, many SA methods can be utilized and the question arises: which (set of) SA methods is most suitable for the evaluation of a specific situation? In practice, assessment methods are often selected by an expert, with poor question articulation and with limited inclusion of stakeholders' views on sustainability (Zijp et al., 2015). This approach can lead results that are incomplete in their coverage of the sustainability metrics of relevance, and may furthermore not be supported by the stakeholders and decision makers, so that they are consequently of limited practical influence in the decision context.

In order to support the consistency and utility of SA, Zijp et al. (2015) proposed the idea of a sustainability assessment identification key, to identify case-specific requirements for a SA and use these requirements to make selections amongst the available SA methods. The key supports a transparent and well-considered choice for an SA method or combination of methods. Furthermore, it specifies what can and cannot be expected from the assessment. Since its publication, the proposed SA-methods identification key has been applied to studies that report transparently on method selection (e.g., Moreira et al. (2015)), but not yet in its inverse application: to first determine the specifications of a transition plan, and then select a method. This process, of setting the requirements for an SA, is further referred to as 'question articulation'. Ideally, question articulation is performed together with the stakeholders (Harder, 2015). Firstly, because every stakeholder can

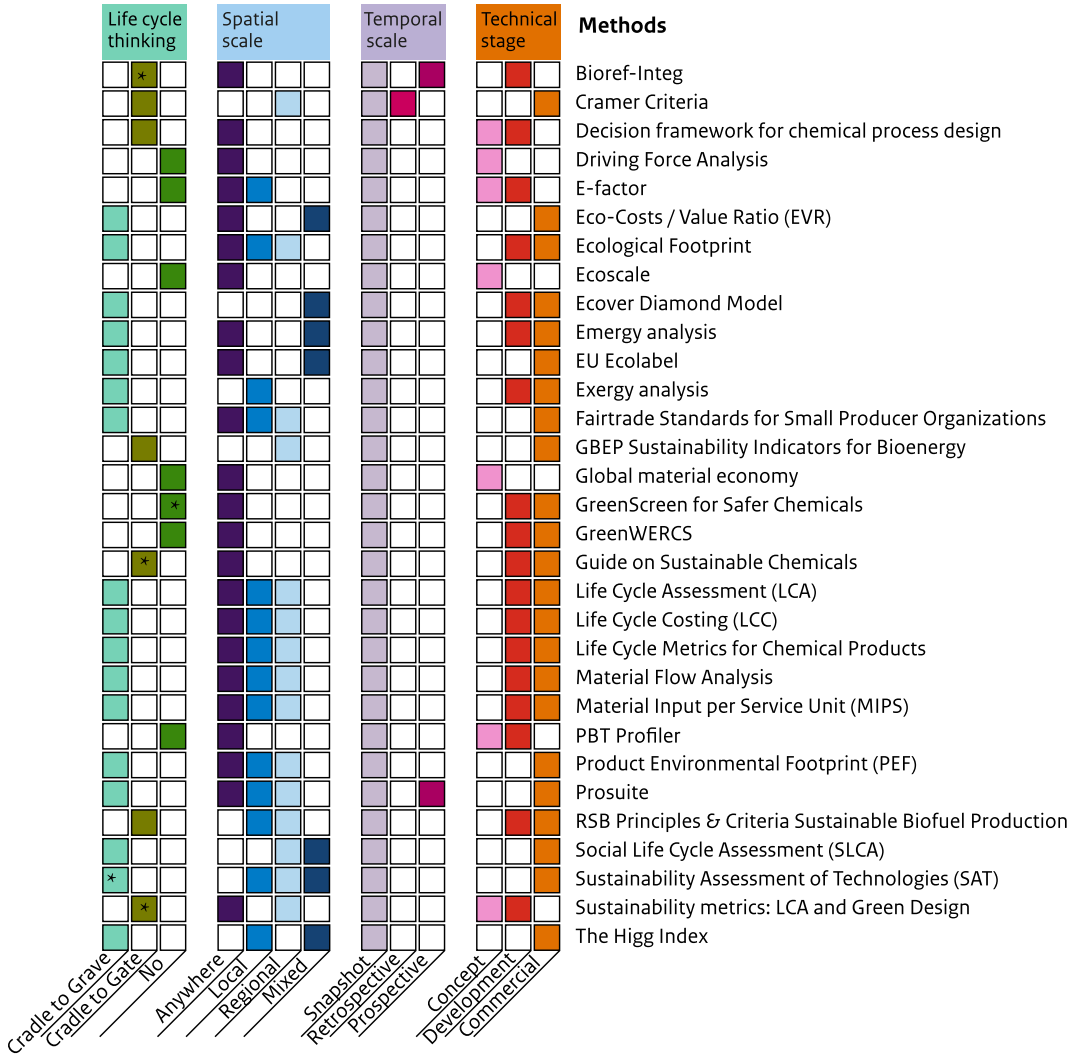

Fig. 1. Overview of the system boundaries of the methods collated in the review of this study; for references of the methods see SI, Table S5. The asterisk (*) shows that for this method life cycle perspective is taken into account for part of the themes (Bioref-Integ and Guide on Sustainable Chemicals only qualitative; Greenscreen only for the theme "Biodegradation"; SAT only for the themes "Climate Change" and "Economic Performance"; Sustainability metrics only for the theme "Energy efficiency").