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# Definition and use of Solution-focused Sustainability Assessment: A novel approach to generate, explore and decide on sustainable solutions for wicked problems

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ABSTRACT

This paper introduces Solution-focused Sustainability Assessment (SfSA), provides practical guidance formatted as a versatile process framework, and illustrates its utility for solving a wicked environmental management problem.

Society faces complex and increasingly wicked environmental problems for which sustainable solutions are sought. Wicked problems are multi-faceted, and deriving of a management solution requires an approach that is participative, iterative, innovative, and transparent in its definition of sustainability and translation to sustainability metrics. We suggest to add the use of a solution-focused approach. The SfSA framework is collated from elements from risk assessment, risk governance, adaptive management and sustainability assessment frameworks, expanded with the 'solution-focused' paradigm as recently proposed in the context of risk assessment. The main innovation of this approach is the broad exploration of solutions upfront in assessment projects. The case study concerns the sustainable management of slightly contaminated sediments continuously formed in ditches in rural, agricultural areas. This problem is wicked, as disposal of contaminated sediment on adjacent land is potentially hazardous to humans, ecosystems and agricultural products. Non-removal would however reduce drainage capacity followed by increased risks of flooding, while contaminated sediment removal followed by offsite treatment implies high budget costs and soil subsidence. Application of the steps in the SfSA-framework served in solving this problem. Important elements were early exploration of a wide 'solution-space', stakeholder involvement from the onset of the assessment, clear agreements on the risk and sustainability metrics of the problem and on the interpretation and decision procedures, and adaptive management. Application of the key elements of the SfSA approach eventually resulted in adoption of a novel sediment management policy. The stakeholder participation and the intensive communication throughout the project resulted in broad support for both the scientific approaches and results, as well as for policy implementation.



## 1. Introduction

Risk assessment can be defined as scientific support for decision making under uncertainty (Yoe, 2011), with risk reduction as ultimate management goal. Recently, the novel concept of Solution-focused Risk assessment (SfRA) was introduced, to improve the utility of risk assessments (Abt et al., 2010; Finkel, 2011; U.S. NAS, 2009). The classical approach (U.S. NAS, 1983) aims to provide insights in current risks and its uncertainty, and suggests refined risk assessment loops to reduce uncertainties, until the results are considered sufficient for transfer to the risk management phase. The solution-focused approach however, explores risk reduction scenarios before, rather than after, the risk assessment. It yields comparative risk levels of the current situation and alternative solution scenarios in a single assessment round. The comparative risk assessment of risk reduction scenarios is followed by selecting the most promising solution scenario and adaptive management loops when needed.

Major jurisdictions support the development and use of solution-focused approaches: (1) Commissioned by the U.S.-Environmental Protection Agency, the National Academy of Sciences of the United States, (U.S. NAS, 2009) proposed the approach. (2) The European Commission (EC) hints at using a solution-focus for sustainability optimization via 'nature-based solutions' (EC, 2015) and finances a major European research project that is based on the solution-focused approach, addressing solutions to chemical pollution of water resources (Brack et al.,

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2015). And (3) the United Nations launched the Sustainability Development Solutions Network to invite research institutes and universities to contribute in finding solutions for reaching the Sustainability Development Goals (UN, 2015).

Expanding the use of the 'solution-focused' idea from the realm of risk assessment into that of sustainability assessment logically yields the concept of Solution-focused Sustainability Assessment (SfSA), which we introduce and illustrate in this paper. Risk and sustainability assessments have similarities (Sexton and Linder, 2014; U.S. NAS, 2011), but there are differences. Sustainability assessments usually address multiple metrics, covering the classical sustainability domains of 'people', 'planet' and 'profit/prosperity'. Sustainability science has been proposed as a new discipline in 2001 (Kates et al., 2001). It is considered a solution-focused discipline (Clark and Dickson, 2003; Sala et al., 2012), geared to support decision-making. Sustainability science further tends to address wicked problems (Stahl and Cimorelli, 2013), for which the main characteristics and coping strategies are summarized in Table 1. Contributing to solutions for these problems requires the involvement of multiple disciplines and stakeholders (Pooley et al., 2013; Sala et al., 2012; Thabrew et al., 2009) and a clear role for scientists in the decision pathways (De Ridder et al., 2007; Sala et al., 2013; Spruijt et al., 2014; Thabrew et al., 2009). Just like risk assessments, however, sustainability assessments in practice rather tend to focus on the identification of the type and magnitude of a (risk) problem than on exploring low-risk or high-sustainability solutions (Clark and Dickson, 2003; Waas et al., 2014).

**Table 1**
(A) Features of wicked problems (Rittel and Webber (1973); Stahl and Cimorelli (2013)), and (B) strategies to cope with them (Roberts, 2000).

| A) Wicked problem features | Characteristics |
|---|---|
| Multidimensional context | The problem context cannot be easily defined and agreed on by all stakeholders.<br>The problem issue allows using and selecting multiple metrics. |
| Multiple stakeholder perspectives | The problem can be defined in many ways, including variation in the spatial and temporal scales.<br>The problem requires complex judgments about the level of abstraction at which to define the problem. |
| Reflects non-optimality | There are no clear rules to finalize a multi-metric assessment.<br>There is no single optimum. |
| Trade-offs among conflicting goals | There are better or worse conditions, not right or wrong ones. |
| Subjective, values-driven | There is no objective measure of success. |
| Learning-driven | Solving the problem requires iteration – every trial counts. |
| Stakeholder-driven learning | There are no given alternative solutions – these must be discovered. |
| Multidimensional legitimacy | The problem often has strong moral, political, or professional dimensions. |
| B) Coping strategies | Characteristics and (dis)advantages |
| Authoritative | A selection of people is asked to solve the problem; they get the necessary means.<br>*Advantage*: reducing # of stakeholders reduces process complexity as (some) competing points of view are eliminated from the start.<br>*Disadvantage*: relevant perspectives on problem and solutions may lack. |
| Competitive | Focus on contrasting points of view; best solution 'wins'.<br>*Advantage*: weighing of wide variety of alternatives.<br>*Disadvantage*: confrontational setting; discouraged knowledge sharing. |
| Collaborative | Engaging all stakeholders to find the most supported solution; iterative exploration towards a common, agreed approach.<br>*Advantage*: final output can be implemented with broad support.<br>*Disadvantage*: process management complex; final management choice may be consensus based and sub-optimal from different stakeholder's perspectives. |

Sustainability-oriented management solutions are especially needed when a ban on an activity is based on the evaluation of a single risk metric, whilst the same activity would be allowed or even stimulated from a multi-metric sustainability assessment. As one example, Riding et al. (2015) analyzed scientific, regulatory and socioeconomic barriers to the re-use of the waste streams from energy production from biomass. They confronted risk-based barriers with the opportunities of using the remains as soil fertilisers under clear standards of sustainability.

SfRA and SfSA are innovative by the exploration of alternative management solutions upfront in the risk- or sustainability assessment process. Perceived benefits are that assessors become actively involved in defining the key societal questions and in finding realistic approaches to minimize risk and optimize sustainability. As a result, the assessment results might be closer to (or better applicable for) management decision support. To our knowledge, practical applications of SfRA have not been published thus far. Given the utility-improvement argument that triggered the solution-focused approach, and the wider need for practical and societally important multi-metric sustainability evaluations such as those described by Riding et al. (2015), there is a momentum to re-consider some environmental problems currently addressed as single-metric risk problems, to redefine them in the wider context of sustainability assessments, and to apply the solution-focused paradigm for finding sustainable solutions to those problems. Therefore, the goal of this paper is to forward sustainability science by introducing a versatile and operational solution-focused approach for solving complex environmental problems, through the following activities:

1) defining Solution-focused Sustainability Assessment (SfSA) as the complement of SfRA;
2) providing practical though versatile guidance (both procedural as technical) for performing a SfSA for wicked problems;
3) illustrating the application of SfSA to solve a wicked environmental assessment and management problem: the disposal of slightly contaminated sediments from ditches in rural areas.

Note that the versatile framework is illustrated with one case study, and that this was done to show a practical application of the framework in solving a wicked problem. However, due to the highly variable nature of wicked environmental problems, the case study should not be interpreted as to be representative for all possible cases.

## 2. Methods: defining Solution-focused Sustainability Assessment (SfSA)

### 2.1. Principles for SfSA

The SfSA framework has been designed to be specifically suitable to cope with wicked problems. It is therefore a versatile framework (Fig. 1), defined by six main steps, which can be followed sequentially but also – as needed given outcomes of the central communication interface step –iteratively. In essence, this implies that all steps have a key role in the process, co-determining the success of the process. It also implies that the pitfall of defining a fixed-process for a highly variable set of problems is avoided. Table 2 lists the basic principles for and characteristics of a SfSA approach and refers to the frameworks in which the basic principles have been operationalized earlier.

### 2.2. Versatile and stepwise approach

We designed the stepwise Solution-focused Sustainability Assessment (SfSA) framework by combining the 'solution-focused' paradigm as designed in the risk assessment context with key elements of existing frameworks for especially risk assessment, sustainability assessment and risk management and -governance (Fig. 1).

The SfSA framework is primarily based on the merger of two classical frameworks, viz. those for risk assessment (U.S. NAS, 1983) and for risk governance (IRGC, 2008; Renn, 2008; Renn et al., 2011). The risk