



What's the point? The contribution of a sustainability view in contaminated site remediation



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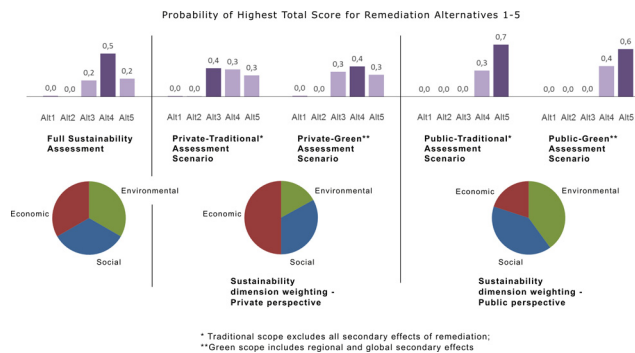
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HIGHLIGHTS

- The contribution of a sustainability view compared to other decision support approaches is analyzed.
- Four alternative assessment scenarios, representing more limited assessment views, were analyzed using the SCORE tool.
- The analysis is based on four case study sites in Sweden.
- The full sustainability assessment leads to decision support outcomes which balance trade-offs.
- Sustainability assessment accounts for key aspects that may be missed with other assessment approaches.

GRAPHICAL ABSTRACT



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ABSTRACT

Decision support tools (DST) are often used in remediation projects to aid in the complex decision on how best to remediate a contaminated site. In recent years, the sustainable remediation concept has brought increased attention to the often-overlooked contradictory effects of site remediation, with a number of sustainability assessment tools now available. The aim of the present study is twofold: (1) to demonstrate how and when different assessment views affect the decision support outcome on remediation alternatives in a DST, and (2) to demonstrate the contribution of a full sustainability assessment. The SCORE tool was used in the analysis; it is based on a holistic multi-criteria decision analysis (MCDA) approach, assessing sustainability in three dimensions: environmental, social, and economic. Four assessment scenarios, compared to a full sustainability assessment, were considered to reflect different possible assessment views; considering public and private problem owner perspectives, as well as green and traditional assessment scopes. Four real case study sites in Sweden were analyzed. The results show that the decision support outcome from a full sustainability assessment most often differs to that of other assessment views, and results in remediation alternatives which balance trade-offs in most of the scenarios. In relation to the public perspective and traditional scope, which is seen to lead to the most extensive and expensive remediation alternatives, the trade-off is related to less contaminant removal in favour of reduced negative secondary effects such as emissions and waste disposal. Compared to the private perspective, associated with the lowest cost alternatives, the trade-off is higher costs, but more positive environmental and social effects. Generally, both the green and traditional assessment scopes miss out on relevant social and local environmental secondary effects which may ultimately be very important for the actual decision in a remediation project.

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1. Introduction

1.1. Background

The Swedish Environmental Protection Agency (SEPA) estimates that there are 80,000 potentially contaminated sites in Sweden, where approximately 1300 are considered to pose substantial risk to human health and the environment (SEPA, 2014). So far only a fraction of these sites has been remediated, at an average cost of 40 million SEK¹ (WSP, 2013) for those publicly funded. This soil contamination problem is not limited to Sweden, as similar situations in many other industrialized countries worldwide can be seen. For example, a review by Panagos et al. (2013) estimates the number of potentially contaminated sites in Europe to 2.5 million, with 342,000 confirmed to be contaminated. In 2004, the United States Environmental Protection Agency (USEPA, 2004) estimated there to be 217,000 potentially contaminated sites in the US with 77,000 of those sites needing clean up.

Site remediation reduces risks from contaminants to humans and ecosystems, but the process itself may result in other negative effects, such as large environmental footprints and high costs to society. The most common remediation technique used in Sweden, as well as in many other countries, is excavation and disposal, so called “dig and dump”. The technique is often used due to the wish for a quick and simple solution, but it is associated with high costs, large emission of greenhouse gases, substantial waste production, use of non-renewable natural resources, and significant noise and dust on-site; see e.g. Kuppusamy et al. (2016), and USEPA (2008a).

As a result of the known contradictory effects of remediation, increased focus on implementing sustainable remediation solutions has been seen in the past decade (e.g. Bardos et al., 2011; Bardos, 2014; US Sustainable Remediation Forum, 2009; ISO, 2017). Internationally, different frameworks, methods and tools have been proposed to assess remediation projects, typically assessing sustainability within three dimensions: environmental, social, and economic. The Sustainable Remediation Forum United Kingdom (SuRF-UK) proposes a set of sustainability indicators as a basis to support sustainability assessment of brownfield redevelopment and remediation projects (SuRF-UK, 2011). In the US, the green remediation concept has been adopted, with primary focus on minimizing negative effects of remediation on the environment (USEPA, 2008b; Hadley and Harclerode, 2015). While sustainability indicators are suggested for consideration by the Swedish EPA (SEPA, 2009), traditional assessment of remediation alternatives in Sweden, prior to the year 2000, was commonly limited to addressing positive environmental effects, effects on human health, and remediation costs.

A number of decision support tools (DSTs), of varying type and scope, are currently available to evaluate and rank remediation alternatives of contaminated sites. These have been developed by e.g. government organizations, consortiums of remediation specialists, private consultancies, and research institutions, and with somewhat different purposes. Reviews of available tools have been provided by e.g. Brinkhoff (2011), Beames et al. (2014), Cappuyns (2013), and Huysegoms and Cappuyns (2017). The reviewed tools include CO₂ calculators and footprint analyses (e.g. CO₂ Calculator: Praamstra, 2009; SiteWise: US Navy, 2013), which focus on the environmental effects of the remediation process, as well as tools which provide a more holistic approach, considering sustainability of the three common sustainability dimensions, e.g. GoldSET (Golder Associates, 2017) and SCORE (Rosén et al., 2015). The focus of the latter tool type is to try to balance the usual positive effects of contaminant source removal with the potentially negative effects of the remedial action. Since different tools are developed in different legislative and practical settings, the aim and system boundaries of the tools differ. Beames et al. (2014) show how the ranking of alternatives for one case study changes between four

different tools, due to the different indicator sets and structures of the investigated tools.

The SCORE (Sustainable Choice Of REmediation) decision support tool is based on an MCDA (Multi-Criteria Decision Analysis) approach, assessing sustainability within three sustainability dimensions (environmental, social, economic) (Rosén et al., 2015). SCORE builds on a comparison of effects for each alternative relative to a reference alternative and includes cost-benefit analysis (CBA) (Söderqvist et al., 2015), economic project risk analysis (Brinkhoff et al., 2015), soil function assessment (Volchko et al., 2013; Volchko, 2013), uncertainty analysis, and allows for weighting of criteria and sustainability dimensions. The key criteria used in SCORE are in line with the SURF-UK framework and the tool was found to be one of the most complete in integrating critical sustainability criteria (Huysegoms and Cappuyns, 2017) and social indicators (Cappuyns, 2016). SCORE generates a total sustainability index, and gives indication of whether remediation alternatives lead to “strong or weak” sustainability (see Pearce et al., 2006). The SCORE tool is not yet publicly available, but is described and demonstrated in case studies in a number of publications (Volchko et al., 2014; Volchko et al., 2016; Rosén et al., 2016).

There is no standard method on how to assess the sustainability of remediation alternatives. The recent ISO standard on Sustainable Remediation is meant to be descriptive and informative about sustainable remediation, but is not prescriptive about method (ISO, 2017). SCORE, like many of the other assessment tools, is flexible, and allows the user to choose which criteria and indicators to include, and how weighting is performed. Different users may assign different weights to the different sustainability dimensions, e.g. a private problem owner could potentially assign a higher weight to the economic dimension, whereas a public problem owner would potentially think differently. Commonly, what is included in an assessment, and the importance of different effects, is dependent on the specific legislative setting or what is agreed upon in the specific project, with or without influence from a broad stakeholder group.

Though outcomes of different decision support tools have been studied and compared (Beames et al., 2014), it has not yet been explicitly studied how the outcome of a full sustainability approach compares with that of other, more limited, assessment approaches. Of interest is how a full sustainability assessment compares with a more basic assessment approach, what has traditionally been performed (i.e. not including secondary environmental effects and only limited social aspects), as well as to a somewhat more comprehensive approach regarding secondary environmental effects (green remediation, or a footprint assessment, but only limited consideration of social aspects). In addition, the effect that different problem owner perspectives on sustainability dimension weighting have on assessment outcomes is of interest. Sustainability assessments are believed to result in more balanced decisions and outcomes on remedial actions (see e.g. SuRF-UK, 2010), but what type of trade-offs are then made in practice in comparison to other types of assessments?

1.2. Aim

The SCORE tool is flexible enough to simulate different types of assessments compared to what would be included in a full sustainability assessment as developed in the SCORE method. In this study, significantly different assessment scopes are adopted in the SCORE tool by excluding criteria, and the weighting of sustainability dimensions is altered to reflect the perspectives of private or public problem owners. The aim of this paper is twofold. The first is to demonstrate how and when different assessment views affect the decision support outcome on remediation alternatives in the SCORE tool. The second aim is to demonstrate the contribution of a full sustainability assessment, i.e. what are the trade-offs being made for including all potential positive and negative effects of the remediation and considering equal sustainability dimension weighting.

¹ 40 million Swedish Kronor (SEK) is approximately equal to 4 million €.

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