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Integration of the subsurface and the surface sectors for a more holistic approach for sustainable redevelopment of urban brownfields

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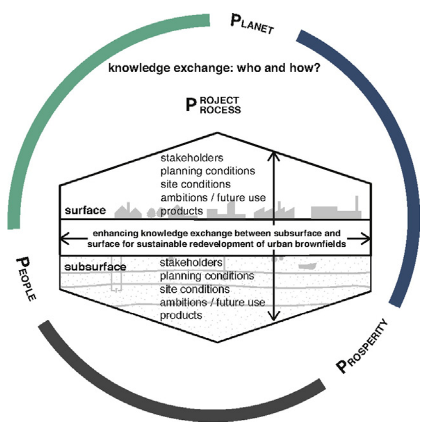
HIGHLIGHTS

- An approach to integrate sustainability and subsurface in urban redevelopment
- A framework to support knowledge exchange between the surface and subsurface sector
- An inventory of sustainability assessment instruments

GRAPHICAL ABSTRACT



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ABSTRACT

This paper presents a holistic approach to sustainable urban brownfield redevelopment where specific focus is put on the integration of a multitude of subsurface qualities in the early phases of the urban redevelopment process, i.e. in the initiative and plan phases. Achieving sustainability in brownfield redevelopment projects may be constrained by a failure of engagement between two key expert constituencies: urban planners/designers and subsurface engineers, leading to missed opportunities and unintended outcomes in the plan realisation phase. A more integrated approach delivers greater benefits. Three case studies in the Netherlands, Belgium and Sweden were used to test different sustainability assessment instruments in terms of the possibility for knowledge exchange between the subsurface and the surface sectors and in terms of cooperative learning among experts and stakeholders. Based on the lessons learned from the case studies, a generic decision process framework is suggested that supports holistic decision making. The suggested framework focuses on stakeholder involvement, communication, knowledge exchange and learning and provides an inventory of instruments that can support these processes.

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1. Introduction

1.1. Background

Land take as a result of urbanization is one of the major soil threats in Europe and the reason why European policy aims for a net zero land take by the year 2050.[1] This global trend of urbanization increases the importance of careful spatial planning in cities (OECD and CDRF, 2010) and one of the key measures to prevent further urban sprawl and additional land take, is redevelopment of urban brownfields (Pediaditi et al., 2010; Chakrapani and Hernandez, 2012; Bartke and Schwarze, 2015). Brownfields are underused areas with, in many cases, real or perceived, soil and groundwater pollution. Brownfield pollution is a barrier to redevelopment in terms of investment risks, ownership constraints, risk of future liability claims and public stigma (Bartke and Schwarze, 2009; Schädler et al., 2011; Davison and Legacy, 2014).

An additional difficulty for urban brownfield redevelopment is that urban planning/design and subsurface engineering, are carried out in isolation from one another, although the practical site restoration outcome depends heavily on both (Hooimeijer and Maring, 2013; Lackin et al., 2014; Maring et al., 2015). The urban planner/designer usually deals with opportunities for socio-economic benefits while the subsurface engineer deals with the technical challenges of e.g. remediating the site. Urban planning/design decisions are made prior to subsurface engineering decisions, which are usually not considered until implementation of the plan. Consequently, opportunities for more sustainable technical solutions in the realisation phase of the redevelopment process tend to be limited by already approved urban plans and designs.

In the remediation sector, which is one of many subsurface considerations, there is broad on-going work to develop guidelines and instruments that support sustainable remediation (e.g. SuRF-UK, 2010; ISO, 2015; Bartke and Schwarze, 2015). In accordance with Bardos et al. (2011), there are several attempts to incorporate sustainability thinking in early phases of projects, because the largest gains can be achieved early on in projects decision processes where there is still room for flexibility. Examples of such attempts are e.g. reviewed in Beames et al. (2014), who list generic sustainability appraisal decision support systems (DSSs) both for technology appraisal as well as for site redevelopment appraisal, with the latter gaining increasing interest in recent years. Sustainability assessment in site redevelopment has been operationalised through approaches that bridge the gap between the generic indicator systems and the diverse range of context specific community considerations (Hartmuth et al., 2008; Bleicher and Gross, 2010). Achieving sustainable development in the process of both site remediation and redevelopment is now widely regarded as a key measure of success (Edwards et al., 2005; Ferber et al., 2006; Schädler et al., 2011; Van Gaans and Ellen, 2014).

Anthropogenic activities in the subsurface include: abstraction of groundwater for multiple purposes, exploitation of raw materials, storage of e.g. heat, cold, radioactive waste and CO_2, underground constructions such as tunnels and garages, foundation of buildings, and remediation of contaminated soil and groundwater (Griffioen et al., 2014). A range of subsurface qualities are described in Ruimtexmilieu[2] and categorized into four different groups: carrying quality (e.g. basis for building activities, subsurface activities incl. road and rail infrastructure, aquifer thermal energy storage), *information quality* (e.g. cultural historical value, ecological diversity), *regulating quality* (e.g. clean and healthy soil, water filtering soil, water storing soil), and *production quality* (crop production capacity, drinking water, minerals, fossil and geothermal energy). Hooimeijer and Maring (2013) grouped the same qualities differently in order to relate better to the urban planning process, namely as *civil constructions*, *energy*, *water* and *soil*. The latter grouping is used in the System Exploration Environment and Subsurface (SEES) method developed by the same authors (Hooimeijer and Maring, 2012). Involving subsurface engineers in the early planning process in order to give advice on opportunities for sustainable redevelopment of urban brownfields by accounting for the existing subsurface qualities at a site and using those as part of the urban planning and design processes, is believed to improve the possibilities for identifying sustainable brownfield redevelopment strategies. For example, smarter locations of buildings and public spaces can create more cost-effective solutions with regard to remediation, foundations, cables and pipes, water management and energy solutions. Urban plans and designs that systematically consider the subsurface qualities may potentially be smarter as they can lead to increased climate security, to energy-saving, to higher degrees of sustainability and to more sound economic developments. Several projects have contributed to developing holistic approaches to brownfield redevelopment accounting for sustainability aspects, soil and groundwater quality and planning aspects (RESCUE, 2005; CABERNET, 2006; REVIT, 2007; HOMBRE, 2013), but, to the best of our knowledge, there is no published academic paper handling these key issues. The developed holistic approaches suggest considering subsurface and remediation issues earlier in the initiative and plan phases, but do not provide any guidance on the process of knowledge exchange between the surface and the subsurface sectors.

Subsurface qualities that sometimes compete or potentially exist in synergy, are complex. This paper is a first attempt to initiate a discussion in the academic community about integrating the subsurface qualities in the early planning phases of the brownfield redevelopment process. Although the majority of available information sources covering the topic and collated in this paper can be categorized as 'grey literature', these sources nevertheless provide valuable insights. The grey literature sources are thus used in this study alongside scarce and relevant peer-reviewed publications. We consequently use the term redevelopment in this paper as opposed to regeneration as we primary have a site perspective. Nevertheless, for redevelopment to be sustainable, it also needs to be related to the local and regional perspective, i.e. the political and societal visions and ambitions.

1.2. Aim and scope

The aim of this study has been to explore the possibilities of integrating subsurface considerations in the early planning phases and to develop a generic framework for supporting the decision process of sustainable redevelopment of urban brownfields. The suggested framework is developed based on the experiences of three case studies in the Netherlands, Belgium and Sweden, and builds upon the conceptualisation of a holistic approach to sustainable brownfield redevelopment. The outline of the paper is as follows. First, the urban redevelopment process is described in Section 2. Section 3 summarises opportunities identified for enhancing the subsurface in current planning systems, describes the concept of sustainability, and outlines what we envision as a holistic approach to sustainable brownfield redevelopment that includes integrating the subsurface qualities in the early planning phases of the redevelopment process. In Section 4, the various methods applied in the study are presented. The work on case studies and the main lessons learned are presented in Section 5. Section 6 provides a short discussion of the case study results. Section 7 describes a suggested generic framework based on the conceptualisation and the findings in the case studies, and summarises some concluding remarks.

[1] EC, 2011. Roadmap to a Resource Efficient Europe. COM (2011) 571 Final. European Commission, Brussels. http://ec.europa.eu/transparency/regdoc/rep/1/2011/EN/1-2011-571-EN-F1-1.Pdf. Accessed February 2016.

[2] Handreiking Plannen met de Ondergrond (2007), available at http://ruimtexmilieu.nl/. This website was developed under the auspices of the Dutch ministry of housing, spatial planning and the environment. Specific link to the subsurface qualities: http://ruimtexmilieu.nl/wiki/ondergrondlaag/ondergrondkwaliteiten-2 (In Dutch, accessed August 2015).

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