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No perfect tools: Trade-offs of sustainability principles and user requirements in designing support tools for land-use decisions between greenfields and brownfields

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ABSTRACT

The EU Soil Thematic Strategy calls for the application of sustainability concepts and methods as part of an integrated policy to prevent soil degradation and to increase the re-use of brownfields. Although certain general principles have been proposed for the evaluation of sustainable development, the practical application of sustainability assessment tools (SATs) is contingent on the actual requirements of tool users, e.g. planners or investors, to pick up such instruments in actual decision making. We examine the normative sustainability principles that need to be taken into account in order to make sound land-use decisions between new development on greenfield sites and the regeneration of brownfields – and relate these principles to empirically observed user requirements and the properties of available SATs. In this way we provide an overview of approaches to sustainability assessment. Three stylized approaches, represented in each case by a typical tool selected from the literature, are presented and contrasted with (1) the norm-oriented Bellagio sustainability principles and (2) the requirements of three different stakeholder groups: decision makers, scientists/experts and representatives of the general public. The paper disentangles some of the inevitable trade-offs involved in seeking to implement sustainable land-use planning, i.e. between norm orientation and holism, broad participation and effective communication. It concludes with the controversial assessment that there are no perfect tools and that to be meaningful the user requirements of decision makers must take precedence over those of other interest groups in the design of SATs.

1. Introduction

Soils support a range of fundamental ecosystem and societal services (Gardi et al., online first; Robinson et al., 2014). Their holistic management is essential for sustainable development because of their multifunctional role in preserving biodiversity, achieving food security, enabling climate change adaptation or, last but not least, providing a foundation for buildings and infrastructure developments. Anthropogenic land-use has progressively compromised the quality and availability of land. Urbanisation and growing global demand for biofuels, food and feed are causing conflicts over land use to occur at the expense of healthy soils and the ecosystem services deriving from them (cf. Bringezu et al., 2012; UNEP, 2014). Often taking place on the most fertile and productive land, urbanisation is a particularly disruptive form of land transformation (Imhoff et al., 2004). Land take on intact natural or arable areas (often referred to as *greenfields*) that involves sealing these areas for residential or commercial developments is in stark contrast to sustainable land management practice. As key instrument of sustainable environmental management, the aim of land-use planning must be to assess the diverse benefits and costs of the different land-use requirements and achieve a balance between them.

Soil sealing has been increasingly seen as a major cause of soil degradation (cf. EC, 2012b; Kovalick and Montgomery, 2014; Pediaditi et al., 2010). A growing awareness of the problem is evident at high political levels, as exemplified by the 68th United Nations General Assembly having declared *2015 the International Year of Soils* (UN, 2013) and by the efforts undertaken to introduce a European *Soil Thematic Strategy* (EC, 2012a). The *Roadmap to a*

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Resource Efficient Europe (EC, 2011) calls member states' national policies to account for their impacts on land use, the goal being to achieve zero net land take by 2050. The European Commission has defined "soil sealing [as] the permanent covering of an area and its soil by impermeable artificial material […]" (EC, 2012b, 39) and reports that in the European Union alone about 1,000 km^2 of soil were lost annually during the 1990s (ibid). At the same time, so-called *brownfields* exist – land that in many cases has been densely sealed for production, infrastructure or military purposes but no longer serves these purposes and has become underutilized. There are different definitions of *brownfields* (cf. Alker et al., 2000; Schädler et al., 2011). Put simply, they can be characterised as derelict and underused sites that are often contaminated. These sites regularly contain remains of buildings and other facilities reflecting their previous uses and offer no immediate prospect of re-development. Revitalisation normally requires coordinated intervention by stakeholders (cf. EC, 2012b). Brownfields' revitalization is considered to offer a sustainable alternative to soil sealing (Bartke, 2013). This article discusses the potentials of designing assessment tools to support decisions between greenfields and brownfields in the urban development context.

At the local planning level, where there is pressure to attract new developers with the aim of generating tax revenues and creating jobs, *greenfields* are often perceived as being more attractive to investors and are therefore willingly earmarked for development. Indirect impacts on local people's health or on the ability of future generations to utilise limited soil resources are often neglected in the course of practical decision making based on simple business accountancy rules. Ensuring that there is an adequate appreciation at high levels of the need for soil protection and of the general desirability to revitalise even potentially contaminated sites hinges on whether the full benefits and costs of land-use decisions – including their negative impacts on society through the overexploitation of nature – are communicated in a way that influences local land-use planning and investment decisions. Several sustainability assessment tools (SATs) and approaches have been elaborated in an effort to inform and foster brownfield regeneration and sustainable land management (Bartke et al., 2013; Morio et al., 2013; Pediaditi et al., 2010; Stezar et al., 2013). Following on the recent attempt to better understand decision-making approaches including experts and stakeholders (Árvai et al., 2014), the potential limits of SATs' design and application are analysed in this paper.

2. Aim and scope

The aim in this paper is to understand the potential of SATs to support sustainable land-use decisions relating to *greenfields* and *brownfields* by proposing a structured approach for assessing the quality of SATs – and to demonstrate how this approach can inform future SAT design. By '*quality*' we mean the property of a SAT to account for both normative sustainability principles and practical user requirements; in other words, a SAT is of high quality if it is accepted and embraced by relevant end-users and, at the same time, if it contributes toward reaching well-founded decisions that support sustainable development.

To accomplish this aim, this article will first provide information about the sustainability challenges posed by land-use management, introducing an integrated normative and user driven approach to SAT design (Section 3). Second, the materials and methods are described to conceptualize the top-down normative approach to distil constitutive elements of sustainable development into principles suited to determine the potential of SATs to contribute to sustainability (Section 4). Section 5 introduces background information on the key user groups of SATs identified in empirical research and on their bottom-up recognized requirements regarding proper SAT design. Some interim results regarding the specific trade-offs involved in sustainable urban land-use management are discussed in Section 6. Following this, three conventional approaches are introduced, represented in each case by a typical assessment tool selected from the literature, and their performance with regard to addressing the trade-offs identified is judged (Section 7). Section 8 presents a discussion of the results relating to SAT design vis-à-vis user requirements. The final section concludes with a number of controversial recommendations for designing land-use management decision support tools.

The novelty of this work consists in conceptualizing the connections between sustainability principles and different SAT user groups and their distinct tool requirements. These connections are related to three typical SAT approaches. This makes it possible to formulate recommendations to SAT designers and specific stakeholder groups – in particular scientists and experts – for how to express their needs. The intention of this paper is not to judge the absolute quality of selected SATs but to identify and illustrate the inevitable trade-offs involved in designing SATs. By thus informing the general design of SATs, it is possible to establish a basis for making better informed decisions that facilitate the efficient management of land and safeguard the limited resource of soil.

3. Sustainability assessment tools: the case of land-use decisions about brownfields and greenfields

Although there cannot be a fixed rule that *brownfield* regeneration is to be preferred per se over *greenfield* sealing and development, there is some common ground that allows us to take this order of preference as a valid assumption from a sustainable land-use perspective. This has to do partly with the range of people who advocate *brownfield* regeneration instead of urbanisation and soil sealing (e.g., Bagaeen, 2006; Bartke, 2013; EC, 2012b; Pediaditi et al., 2010; Schädler et al., 2013; Thornton et al., 2007a, b) and partly with the distinct attributes of *greenfield* and *brownfield* development.

Greenfield sealing jeopardizes different types of sustainable soil functions which satisfy various needs and yet are not reflected in real estate prices; such functions are often ignored in decision making processes. For example, natural unsealed areas generally contribute to the stability of the socio-ecological system by (1) performing vital services such as providing groundwater and drinking water, producing oxygen and regulating the climate, (2) acting as a natural supplier of raw materials, including unique plants, types of wood and animals, (3) functioning as the basis of genetic information, analyses of which can be used to optimise crops or develop new medicines, and (4) being used for human recreation thanks to their cultural or aesthetic value (Baumgärtner, 2006). When they are sealed, the ability of such areas to perform these functions is diminished.

Brownfield regeneration has been defined as sustainable if it involves the "management, rehabilitation and return to beneficial use of brownfields in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations in environmentally sensitive, economically viable, institutionally robust and socially acceptable ways within the particular regional context" (Dixon, 2007, 91). Based on the Brundtland report's definition "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, 43), Thornton et al. (2007a, 118) ask "does the competent public authority, when enacting new incentives, consider the needs of the present and the future when using methods to redevelop brownfields?" – to which we would add "when deciding about *brownfield* regeneration and