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Research Paper

Amenity proximity analysis for sustainable brownfield redevelopment planning

Alistair Beames[a,b,*], Steven Broekx[a], Uwe Schneidewind[c], Dries Landuyt[d], Maarten van der Meulen[a], Reinout Heijungs[e], Piet Seuntjens[a,b]

[a] Environmental Modeling Unit, VITO, Boeretang 200, 2400 Mol, Belgium
[b] Department of Soil Management, Ghent University, Coupure Links 653, 9000 Ghent, Belgium
[c] Department of Engineering Geology and Hydrogeology, RWTH Aachen University, Lochnerstr. 4-20, 52064 Aachen, Germany
[d] Department of Forest and Water Management, Forest & Nature Lab, Ghent University, Coupure Links 653, 9000 Ghent, Belgium
[e] Department of Econometrics and Operations Research, Faculty of Economics and Business Administration, VU Amsterdam, De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands

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ABSTRACT

Idle brownfields in urban settings are potential resources that could be put to productive use, meeting the goals of urban intensification, helping to curb urban sprawl on the periphery and benefiting communities living around sites. Various decision support tools exist in order to evaluate redevelopment scenarios. Spatial decision support systems have recently been developed to aid in evaluating the implications of the physical attributes of redevelopment scenarios, with a limited focus on the proximity of essential amenities to the local community. The application of proximity analysis in this context supports stakeholders in determining which social amenities are furthest from the local community and the extent to which including such amenities on-site would benefit the local community. A geographic information system based proximity analysis approach is presented specifically for this purpose. The distribution of walking distances for local households is compared to scenarios in which specific social amenities are included on-site. The approach is demonstrated using an abandoned brownfield case study in the Flemish region of Belgium. The local community would benefit most from having a doctor and pharmacy on-site in terms reduced walking distance. The inclusion of other amenities on-site such as employment, schools, green space, meeting places and shops also shortens walking distances for the local community but to a limited extent in comparison to a doctor and a pharmacy. 'Walking distance' is an indicator that is easily understood by stakeholders and the approach lays the foundation for more detailed analyses that would include frequency of visits.

1. Introduction

The definition of brownfields most commonly used in scientific literature is derived from the United States Environmental Protection Agency's *Brownfields Economic Redevelopment Initiative*. The definition refers to brownfields as "abandoned, idle or underused industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination" (USEPA, 1996; Thornton, Franz, Edwards, Pahlen, & Nathanail, 2007). A commonly accepted definition does not yet exist within the European Union and what constitutes a brownfield varies between Member States. In some states the term is extended to include abandoned sites that are not necessarily contaminated (Hartmann, Török, Börcsök, & Oláhné Groma, 2014; Oliver, Ferber, Grimski, Millar, & Nathanail, 2005; Ramsdem, 2010). Nevertheless, there is a consensus in the European Union that the redevelopment of abandoned urban sites serves the objective of sustainable urban development (European Commission Directorate-General for Regional Policy, 2009). The approach described here is intended to assist stakeholders in deciding upon a use for the site and can be applied to both contaminated and uncontaminated abandoned sites.

In general, brownfield redevelopment depends on (i) the demand for anticipated land-use determining current and future value of land at the site, (ii) the current and future value of land at potential alternative sites, (iii) legal requirements and liability issues, (iv) available remediation and clean-up options defined by the physical and biochemical parameters at the site as well as available technologies and resources, and (v) socio-economic necessities and preferences (Thornton

* Corresponding author at: Department of Soil Management, Ghent University, Coupure Links 653, 9000 Ghent, Belgium.
E-mail address: alistair.beames@gmail.com (A. Beames).

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et al., 2007; Bardos et al., 2016). The scale of abandoned areas in urban centres and the potential benefit of utilising these spaces highlight the need for decision support systems for brownfield redevelopment.

In the Flemish region of Belgium, the number of brownfield sites is estimated to be around 53,000 and is equivalent to a total area of 55 square kilometres (Oliver et al., 2005). Redeveloping such sites is beneficial in terms of the regional context by adding to the supply of available urban land and by allowing for more compact concentric and poly-centric urban zones (Laprise, Lufkin, & Rey, 2015). Brownfield redevelopment may also benefit local communities around such sites in terms of increasing local property values and generally improved liveability, as well as reducing the dependence on transport networks (Talen et al., 2013). The important questions that need to be addressed are (i) the services and amenities to include on-site to best serve the local community, (ii) how the feasible alternatives can best be communicated to local stakeholders and (iii) to what extent the alternatives are sustainable (Norrman et al., 2016).

The perspective adopted here presumes the location under consideration is "fixed". Unlike decision support system that compare alternative sites as potential siting locations (Huff, 1963; Thomas, 2002) for a business venture or real estate development project, the appraoch presented here evaluates the potential for different redevelopment alternatives for a specific site. Compact urban development planning is supported by evaluating how walking distances to essential amenities can be shortened for those living around abandoned brownfields. The proximity to essential amenities is determined for the local community living around the site for the current situation, i.e. 'before redevelopment'. The current situation is compared to scenarios in which additional amenities are provided on-site. The social indicator concept and existing approaches are briefly described in order to show how the approach presented here contributes to the current state-of-the-practice.

1.1. Social indicators

The term "social indicator" was coined by Raymond Bauer in the mid-1960s in work performed for NASA on the anticipated societal impacts in the US Space Program (Bauer, 1967). The concept later evolved through the work of the OECD and Social and Economic Council of the United Nations (Bulmer, 1978), into welfare and well-being based statistics that could be used as alternative measures of progress to that of indicators based on economic growth and material prosperity. This alternative conception of progress reflected the political agenda of the "Social Indicator Movement" (Noll, 2004). Social indicators became the means of determining the "quality of life" of a given society encompassing measures of living conditions and areas of social concern. Social indicators could then be used to monitor change and to assist in policy agenda setting on regional and national scales. The advent of the concept of "sustainable development" during the early 1990′s extended the conception of "quality of life" to include the consideration of future generations (UNWCED, 1987). Social indicators were originally intended to gauge progress on regional and national levels but at present are also applied at city, community and household levels. The European Environment Agency defines social indicators as measures of progress in terms of the following objectives: promoting employment, combating poverty, improving living and working conditions, combating exclusion and developing human resources (EEA, 2015). This scale is commonly used in urban planning research and particularly for urban renewal planning (Colantonio, Dixon, Ganser, Carpenter, & Ngombe, 2009; Hayek et al., 2015; Rall & Haase, 2011).

The decision support systems for brownfield redevelopment discussed here, have applied the concept to the community spatial and functional scale in considering people living on or in the immediate vicinity of a brownfield. The social indicators (also referred to liveability indicators) in these tools value physical facets of the built environment, such as zonation (residential, commercial, industrial), availability of green spaces, accessibility to roads, percentage of sealed soil, historic or landmark buildings or local amenities in walking distance (see e.g. Schädler, Finkel, Bleicher, Morio, & Gross, 2013; Wedding & Crawford-Brown, 2007). The unit of analysis is the landscape itself and this is aside from perceptual analysis included in other approaches (Pediaditi, Doick, & Moffatt, 2010; Ryan, 2011). Pediaditi et al. (2010), focused on how stakeholders perceive the effectiveness of certain sustainability assessment tools and based their conclusions on meta-data from applying different tools. Ryan (2011), proposes a combination of landscape assessment and how the landscape is perceived by stakeholder (Ryan, 2011). The approach presented here attempts to measure the extent to which including different amenities on-site reduces the walking distance of residents to such amenities.

1.2. Existing decision support systems specifically for brownfield redevelopment

Two broad categories of *decision support systems for brownfield redevelopment* exist; indicator based multi-criteria analysis (MCA) tools and stakeholder participation frameworks. The indicator based MCA tools can be further categorized into tools that include spatially explicit indicators and those that do not. The tools that include spatially explicit indicators differ slightly by relying on automated computational processes in translating spatial data into indicator values. None of the tools to date are exclusively focused on determining the proximity of amenities to the local community, and instead, each of the tools includes at least a few proximity based indicators. Table 1 shows the indicators included in the existing tools. The selection reflects tools described in scientific literature, which focus on brownfields and include spatial based social indicators.

The Sustainable Brownfields Redevelopment (SBR) Tool and *SIPRIUS*, were designed to compare alternative redevelopment scenarios *ex post*, although it would be possible to apply them as *ex ante*. SBR is a retrospective tool for evaluating the success of completed brownfield redevelopments (Wedding & Crawford-Brown, 2007). All 40 indicators in the tool, including the proximity indicators, are normalized to a percentage by dividing the indicator values for the redeveloped site by the values of the site prior to redevelopment. The results are then weighted using an analytical hierarchy process (AHP). The internal normalization

Table 1
Proximity based indicators included in decision support systems for brownfield redevelopment.

Tool	Authors	Indicators
Smart Places	Thomas (2002)	Percentage of work force within 30 min of site
SBR	Wedding and Crawford-Brown (2007)	Percentage of new employees who live in the local region Net jobs created per acre Walking distance to green space in minutes Walking distance to cultural amenity in minutes Walking distance to restaurant/ grocery store in minutes
MMT	Schädler et al. (2011, 2012,2013	Primary school in walking distance Local amenities in walking distance
LEED-ND	Talen et al. (2013)	Housing and jobs proximity Neighbourhood schools Access to civic public spaces Access to recreation facilities
SIPRIUS	Laprise et al. (2015)	Net employment density Proximity of school facilities Proximity of commercial facilities Proximity of recreational facilities