This is a pre-publication author-version of a manuscript which has been published in
Science of the Total Environment
https://doi.org/10.1016/j.scitotenv.2017.11.168

The manuscript did undergo copyediting, typesetting, and review of the resulting proof before it was published in its final form. To find or request access to the final version, please see:
https://www.sciencedirect.com/science/article/pii/S0048969717332266

Limasset, E., Pizzol, L., Merly, C., Gatchett, A. M., Le Guern, C., Martinat, S., Klusacek, P., & Bartke, S. (2018). Points of attention in designing tools for regional brownfield prioritization. Science of The Total Environment, 622, 997-1008.

Points of attention in designing tools for regional brownfield prioritization

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Abstract
The regeneration of brownfields has been increasingly recognized as a key instrument in sustainable land management, since free developable land (or so called "greenfields") has become a scare and more expensive resource, especially in densely populated areas. However, the complexity of these sites requires considerable efforts to successfully complete their revitalization projects, thus requiring the development and application of appropriate tools to support decision makers in the selection of promising sites where efficiently allocate the limited financial resources. The design of effective prioritization tools is a complex process, which requires the analysis and consideration of critical points of attention (PoAs) which has been identified considering the state of the art in literature, and lessons learned from previous developments of regional brownfield (BF) prioritization processes, frameworks and tools. Accordingly, we identified 5 PoAs, namely 1) Assessing end user needs and orientation discussions, 2) Availability and quality of the data needed for the BF prioritization tool, 3)

Communication and stakeholder engagement 4) Drivers of regeneration success, and 5) Financing and application costs. To deepen and collate the most recent knowledge on the topics from scientists and practitioners, we organized a focus group discussion within a special session at the AquaConSoil (ACS) conference 2017, where participants were asked to add their experience and thoughts to the discussion in order to identify the most significant and urgent points of attention in BF prioritization tool design. The result of this assessment is a comprehensive table (Table 2), which can support problem owners, investors, service providers, regulators, public and private land managers, decision makers etc. in the identification of the main aspects (sub-topics) to be considered and their relative influences and in the comprehension of the general patterns and challenges to be faced when dealing with the development of BF prioritization tools.

Keywords
Brownfield inventory database, Brownfield prioritization tool, Sustainable brownfield regeneration, Stakeholders, Tool designing

Points of Attention in Designing Tools for Regional Brownfield Prioritization

1. Introduction

Over recent decades, the reuse of brownfield (BF) sites in cities has been seen as one of the solutions to fight urban sprawl. In this context, BF regeneration is understood as a means to safeguard natural ecosystems and fertile soils from new urban development (cf. CEN, 2014). The reuse of the BF land that are underused or have lost their original functions can fulfill redevelopment needs such as industrial or residential. Regeneration has been increasingly recognized as a key instrument in sustainable land management and in the reduction of environmental hazards. It can make municipalities safer and more attractive places, supports the local and regional economy by creating jobs and increasing tax revenues (Krzysztofik et al. 2016). It is typically more sustainable than new development on greenfields—agricultural and natural land (Bartke & Schwarze 2015; EC, 2012, Pediaditi et al., 2010; Stezar et al., 2013).

Despite this degree of appreciation (e.g., found on the political agendas in the form of land degradation neutrality and soil sealing limitation goals; see EC, 2011 and SGD 15.3 of UN, 2014), more work needs to be done to encourage brownfield regeneration activities. Urbanization, migration, climate change, and the competition between cities and municipalities to increase tax revenues by attracting more citizens and businesses to additional living areas/business parks, have led to increased and partly unnecessary use of greenfield land and fertile soils. This inefficiency is particularly true if land use is assessed on a national or global level, rather than on a site-specific or municipal level. Soils are a limited and important resource (Amundson et al., 2015; Gardi et al., 2014); therefore, the efficient (re-)use of land with particular attention on the soil resources is demanded internationally to achieve a land degradation-neutral world (Dooley et al., 2015). For example, in Europe the severity of the problem is striking; the extent of new land development equals more than the city of Berlin each year (>1,000 km² per year), whereas about 300,000 underutilized BF sites exist (EC, 2012). In Germany alone, an estimated 120,000 BF sites await reuse and cover an area sufficient to meet the average land development in the country for the next 5 years (Bartke, 2013; Schiller et al., 2013).

The situation at the national level is different from that at a more regional level where there is still a claim for soil protection, but the players (e.g., companies or municipalities) look for the most economical site for a new company or residential area, as highlighted by the CABERNET A-B-C Model on funding drivers for BF (CABERNET, 2006). In the direct comparison of BF regeneration options versus investing in greenfield land, the obstacles to regenerate formerly used and possibly contaminated land become obvious. In many cases, BF sites need considerable investigation and improvement/regeneration investments to be reused. Particular challenges arise from (1) site-specific risk assessment of contaminants, which may be very costly; (2) deconstruction/revitalization of existing buildings and (infra)structures; (3) the economics of the redevelopment, which are mainly market driven; (4) critical environmental problems that may require remediation; (5) uncertainties in terms of decontamination costs, high rehabilitation costs, and reduced real estate value preventing investments; and (6) the stigma of being considered non-attractive or having no market value, especially when being in competition with greenfield developments designated by municipalities for attracting new businesses (Bartke, 2011; Schädler et al., 2011, CABERNET 2006). BF redevelopment, especially sustainable regeneration will inevitably be the result of an economic, environmental and social compromise. (RESCUE, 2005).

To overcome these obstacles, prioritization methodologies and tools have been developed based on factors determining a successful BF site regeneration (so called "success factors") (Meyer and Lyons, 2000; Thornton et al., 2007; Dixon et al., 2011; Frantal et al., 2013, 2015a, Pizzol et al. 2016). It is also vital that conflicts between priorities for BF regeneration are managed (RESCUE 2005). Prioritization of BF sites is a process that supports the "evaluation and classification and, where appropriate, their ranking, in order to assist the allocation of limited resources (funding, staff, time and energy) to those BF sites that turn out to be the most critical, practical or profitable to be revitalized" (Pizzol et al., 2016).

Brownfield prioritization tools help identify the most worthwhile investments in BF regeneration options for efficient land recycling. The strategy is to start where the intervention results in the greatest benefit. These benefits can be economical, environmental (e.g., hazard prevention), or social (e.g., crime reduction). The prioritization tools that have been developed so far are directed towards decision makers (urban planners, regional development agencies, state and regional authorities, grant agencies, etc.) who are responsible for wide territories (cities, regions, or states) (Chrysochoou et al., 2012; Pizzol et al., 2016). Market driven end users are also expected (e.g. developers, site owners, service providers, …) as information on the short-term availability of BFs for future development may of strong interest to them.

The starting points are the assessment of literature on success factors for BF regeneration (e.g., Frantal et al., 2012), stakeholders engagement (Rizzo et al. 2015, Alexandrescu et al. 2017), prioritization methodologies based on MCDA that are likely to be applied for prioritization of items in portfolios (Bartke et al., 2014), and approaches to the design of BF prioritization tools for regional portfolios of sites (Chrysochoou et al., 2012; Cheng et al., 2011; Thomas, 2002; City of Colorado, 2000; Pizzol et al., 2011; Zabeo et al., 2011; Agostini et al., 2012).

Based on our previous work in this area, we identify the critical points of attention for BF evaluation and prioritization tool design. Several obvious items that tool designers need to consider more carefully are:

- Discussions to assess end-user needs and orientation, e.g. need to organize discussions with all relevant stakeholders as early as possible in the tool developement process;
- Availability and quality of the data used to evaluate success factors and constraints of each BF , e.g. are there any suitable BF inventory dataset on which the BF prioritization tool could rely;
- Communication and stakeholder engagement during the tool development, e.g. would a bottom up approach be needed in the early stage so that stakeholders can express their interest;
- Drivers of regeneration success during the tool development, e.g. may success factors be relevant to address regional expectations and concerns; and
- Financing and application costs/transaction costs to run the tool, e.g. would sufficient funding be available for development and/or running the tool.

The paper focuses on discussing critical points of attention (PoAs) for designing regional BF evaluation and classification approaches towards prioritization tools. This contribution aims at a deeper understanding of these critical PoAs. The goal is to identify significant PoAs that shape the design of regional BF prioritization tools considering the state of the art in literature, and lessons learned from previous developments of regional brownfield (BF) prioritization processes, frameworks and tools. In addition, the paper elaborates on the meaning/extent/dimensions of identified PoAs and discusses how the PoAs are linked to one another to determine whether general patterns exist that can be considered in future tool design. The overall approach will assist in assessing the needs for a potential framework or systematic approach that identifies PoAs and the key research areas designed to address PoA challenges and reduce knowledge gaps to address PoA complexity.

2. Methods and Materials

To identify the most critical and relevant points for designing BF prioritization tools, we applied an expert-based focus group approach, which was cross-checked with a literature review.

To determine and collate the most recent knowledge on the topic for scientists and practitioners, we selected a deliberative method to collect materials and engaged in an exchange with experts in the BF regeneration field. We organized a special session at the AquaConSoil (ACS) conference 2017. ACS addresses experts interested in "beyond state-of-the-art in science, policy making and practice in the field of sustainable use and management of soil, sediment and water resources" (Rijnaart et al., 2017). The conference attracts from 600 to 800 participants every 2 years. Here, we could expect to find leading experts in BF regeneration from academia meeting policy and practice. We organized the session "Prioritization strategies & tools for regional brownfield redevelopment: Perspectives & feedback on existing tools and approaches" at the event. The 90-minutes session was structured to first introduce three different tools recently developed or currently in development (in different European countries) and reported on the challenges their designers have faced. Against this background – serving as state-of-the-art overview – a facilitated focus group discussion on specific topics in a World Café style (cf. Schieffer et al., 2004) followed.

In total, 30 experts participated in the session. Although we have no exact statistics on the specific background of each participant, we assume that they well-represent the expertise of ACS delegates and, moreover as a result of self-selection, are stakeholders who have a particular interest in BF regeneration tools. From individual discussions and after-session exchange of business cards we do know that stakeholders with diverse backgrounds took part, including representatives of municipal, regional and national agencies from economic development and environmental areas. Also scientists from PhD students to full professors joint the session next to policy makers and business representatives from industry and smaller consultants.

The group discussions were not according to professional backgrounds, but followed a bottom-up self-selection approach of delegates choosing topics of highest interest and concern. We offered 5 different groups, each facilitated by a moderator. The topics of the groups (cf. section 4.2) were selected by us, prior to the meetingbased on the experiences on recently or currently developed BF tools – those introduced to participants as part of the state-of-the-art background. The geographical focus of the discussion was not restricted specifically. The delegates were asked in each group to add their experience and thoughts to the discussion in order to identify the most significant and urgent points of attention in BF tool design. The discussions were interrupted every 15 minutes and delegates were asked to select another group to give their input. Thus in total, each participant could contribute to 3 self-selected topics. At the end of the session, we reported briefly back the key points of discussion to the full audience of the session and asked if any significant topic was not addressed so far. No such feedback was given. The results of the discussions were documented on flip-overs and personal notes and are reported in section 4.2 below.

To ensure that the group discussions would not miss an important topic discussed in the topical literature, we added a review by screening the Web of Knowledge for relevant keywords. We used the following search terms to identify potentially relevant scientific papers: (1) "region*" OR "portfolio" AND (2) "priority*" OR "rank*" AND (3) "brownfield*." We add as a supplementary material an overview of the papers identified and discuss their main insights in section 4.1.

3. Background

Regional BF prioritization methodologies and tools originated from the improvement of regional risk assessment procedures aimed at providing a quantitative and systematic way to estimate and compare the impacts of environmental problems that affect large geographic areas by considering multiple habitats and multiple sources releasing a multiplicity of stressors impacting multiple endpoints (Pizzol et al., 2011; Zabeo et al., 2011; Agostini et al., 2012; Landis, 2005; Hunsaker et al., 1990). In this context, a region is a spatially extended nonhomogeneous area, defined on the basis of physical, industrial, and socioeconomic characteristics, not necessarily on administrative boundaries. A region's boundaries depend on the dimension of the problems to be assessed, on the potential targets that can be directly affected, on the involved physical or biological processes, and on the strategic planning and management scale (Graham et al., 1991; Smith et al., 2000; Gheorghe et al., 2000; Hunsaker et al., 1990; Suter, 1990; Agostini et al., 2012).

The main objective of regional approaches is the classification and ranking of those BF sites (with a special interest in BFs with suspected contamination or actual contamination)on the basis of a specific objective (most critical, practical, or profitable to be revitalized), thus, implementing a relative assessment rather than an absolute estimation of their conditions(Carlon, 2007).

A review and analysis of the available relative risk assessment procedures for regional risk assessment of CS and BF sites was published by the European Environment Agency (EEA, 2004) for developing the Preliminary Risk Assessment Model (PRAMS), which identifies and assesses soil contamination problem areas in Europe (EEA, 2005), in which 27 existing and documented international methodologies were analyzed (Pizzol et al., 2011). However, in this paper, we focus on prioritization methodologies and tools that consider not only environmental aspects (i.e., human health and ecological risks) but also those that have a wider purpose and apply sustainability concepts by including socioeconomic aspects, stakeholders' perspectives, and success factors. The development of regional risk assessment approaches strongly depends on the availability of regional and spatial data integration methods (Smith, 2000; Locantore et al., 2004) and has been supported by the use of GIS tools for spatial data management. However, the huge amount of spatial data for such an assessment (i.e., environmental data, socioeconomic data, stakeholders' points of view, etc.) requires developing tools that can integrate GIS data and models for prioritization issues and management and communication actions (Patil et al. 2001; Smith, 2000).

Only a few approaches and tools have been developed for regional prioritization of CS and BF sites. Chrysochoou et al. (2012) developed an indexing scheme that incorporates indicators for three dimensions (socioeconomic, environmental, and livability) to scan large areas and initially identify which BF sites should be considered for further assessment and ultimately redevelopment. Cheng et al. (2011) developed a framework for prioritizing identified potential BF sites according to a set of criteria, which were selected and weighed based on key interviews and the study of local reference cases. Thomas (2002) developed a Brownfield Site Ranking Model to select sites for potential redevelopment that included 11 siting criteria derived from the review of general siting factors that can be evaluated in locating a business on a formerly used site. Pizzol and colleagues developed two decision-support systems called SYRIADE (Pizzol et al., 2011; Zabeo et al., 2011; Agostini et al., 2012) and the Timbre Brownfield Prioritization Tool (TBPT) (Pizzol et al., 2016, Bartke et al. 2016; Frantal et al., 2015; Alexandrescu et al., 2017). SYRIADE has been developed to support regional authorities in the ranking of potentially contaminated sites and BFs for priority of investigation, when information on site-specific investigation and risk is not available. SYRIADE considers environmental impacts, economic aspects, and shareholders' perspectives. However, it does not include any reference to CS and BF site success factors. The inclusion of these factors in prioritization tools was the main objective in developing TBPT, which includes stakeholders' perspectives and success factors and provides an easily accessible web-based application.

Both SYRIADE and TBPT have been applied in different contexts, such as the City of New Haven, Connecticut; the Futian District in the city of Shenzhen, China; Jackson County, Michigan; the Upper Silesia region in Poland;

two large portfolios of BF sites in Germany; a local and a regional administrative body from the Czech Republic; and a portfolio of BF sites in Romania, thus, covering different areas in Europe, two in the United States, and one in China.

Two other tools are under development in France. The first is a BF evaluation prototype tool that aims to systematically evaluate and classify, on a large territory, individual environmental risks for a large number of potentially contaminated, industrial BFs. It is investigating how incorporating an evaluation of the best regeneration potential, attractiveness for each the sites. The tool is still under development by the French Bureau de Recherche Géologique et Minière (BRGM) for the Alsace territory and could ultimately be used by regional authorities in allocating funding in support of regeneration processes. It is also developed to be used by local authorities as an aid to better understand environmental risks and required actions in their municipalities (Limasset et al. 2016). The second project deals with the development of an observatory for the Auvergne-Rhône-Alpes region to accelerate and secure the redevelopment of BFs. BRGM in collaboration with the region undertook a preliminary study to define the end-user needs with respect to the BF observatory and to frame the future tool(s) to be developed. This work, which involved a wide range of stakeholders, identified two potential options for the tool: A BF prioritization module to be integrated in a wider planning tool and a methodological framework for alternative uses for off-market BFs (Merly, 2017).

4. Results: Identified Points of Attention

4.1. Insights based on literature review

Designing tools for prioritization of BF is a challenging task, whether it involves focusing on a systematic evaluation/classification of sites or going towards ultimate ranking. Existing tools address different aspects and phases of the regeneration process, including environmental and health risk assessment, remediation cost assessment, uncertainty assessment, evaluation of the sustainability of projects, and management of the negotiations and partnership among involved stakeholders. The models and tools can be divided into two groups (Chrysochoou et al., 2012):

- Tools designed to assess management options for a single BF (or “megasite”) or
- Tools intended to prioritize management options for clusters of sites (portfolios) or wide areas (states, regions, cities).

A majority of existing tools and manuals fall within the first category and are developed for a case-by-case approach. Only a few tools enable a comparison of sets (clusters) of different BF sites with the purpose of prioritizing them in the context of large areas or institutional portfolios (e.g., Bartke et al.,2016, Chrysochoou et al., 2012; Cheng, 2011; Thomas, 2002; Carlon et al., 2008; Pizzol et al., 2011; Pizzol et al., 2016; Agostini et al., 2012, Tonin et al. 2014). These “site prioritization and selection” tools are designed specifically for stakeholders (urban planners, regional development agencies, state and regional authorities, grant agencies, etc.) who are responsible for wider territories (cities, districts, regions, or states) and who need to identify which BF sites should be preferably considered for further investigation and ultimately redevelopment (Chrysochoou et al., 2012).

One key problem lies in defining the aim to which the prioritization is being developed (i.e., do we prioritize BFs for urgency in cleanup, for particular reuse option, or prioritize a set of BFs that occur in a particular region/city, or just take into account a portfolio of BFs that are owned by specific owner?). The key message that seems to be repeated in various papers on designing tools for BF prioritization is that various groups of stakeholders need to be involved in all evolving stages of the tools' design (e.g., Hartig et al., 2012; Sardinha et al., 2013; Rizzo et al., 2015; Pizzol et al., 2016).

Various methods are used to identify people's concerns about BFs. Burger (2005) used in-depth interviews to study perception of contaminated sites by tourists in Brookhaven, Long Island. He revealed that highest among a list of concerns were rate of accidents/spills, loss of public health, and loss of ecological health. Change in property values was rated as the lowest concern. On the other hand, it seems that local populations perceive BFs differently than tourists who do not live near these sites (De Sousa, 2006). Ruelle et al. (2013) suggested the importance of quality of landscape while discussing regeneration of BFs in communities.

Hartig et al., (2012) advise that applying practices of adaptive management could be useful in BF regeneration planning. Some authors discuss site-specific characteristics of individual BFs, which complicate assessment of multiple BF sites (e.g., McCarthy, 2002). The importance to shift to a regional scale is also highlighted as development of economically and socially feasible land-use plans of individual BF can be based on regional needs (Ishi et al. 2013, Raco 2003)

Lee and Mohai (2013) in an environmental justice study, analyzed prioritization of BFs to be cleaned up in the Detroit metropolitan area (prioritization was done by EPA). They found that BFs located near socioeconomically disadvantaged neighborhoods tend to be cleaned up first and BFs located far from major roads also tend to receive priority in EPA funding. They claim that developmental potential of neighborhoods is one of the main factors given in determining prioritization of BFs in case of private investments. They also warn that perceived lack of safety within inner cities could well be a deterrent to BF redevelopment.

4.2. Insights from stakeholder discussions

This section introduces the PoAs identified in the AquaConSoil (ACS) special session.

4.2.1. End-user needs and orientation

Despite the development of a few BF prioritization tools, hardly any of these tools are effectively and efficiently used for regional land redevelopment and land planning, mainly because end-user needs and expectations have not been properly addressed in the tools development process.

BF regeneration inherently **involves a multi-range of stakeholders** (e.g., problem owners, investors, service providers, regulators, public and private land managers, decision makers, and—not least—the general public affected by the site and its non/redevelopment). When considering a territorial dimension to BF management, an even wider set of stakeholders and potential end users are concerned who also raise various visions and interests for regional BF redevelopment. ACS experts particularly stressed that there is a difficulty due to the market-related complexity of having to consider multiple potential stakeholders.

Assessing end-user needs should be the first consideration to **frame the orientation of BF redevelopment** prioritization tool by setting whom the tool will be really developed and designed (i.e., its final objectives and scale; depending on the end-user needs, the desired scale for a BF tool can range from the district to the regional level [including the city and the county scale]).

The experts agreed that assessing and defining end-user needs is a key step to collaboratively **define the functionalities** (boundaries and the characteristics) of BF prioritization tools. There will be different **tool formats and content** according to the end-user needs, and if multiple end users are foreseen, the tool will have to be **fully flexible** and modular to respond to each stakeholder's demands. In any case, the tool will need to be **user-friendly** to ensure its accessibility to end users (e.g., GIS-based interface, graphical user interfaces [GUI]).

The shared experience has shown that assessing end-user needs and defining orientation can be done at various stages of the development process, either at a very early stage in the process, before any tool development, or following initial prototype development. In any case, this is an iterative process.

4.2.2. Data availability and quality

The development of regional risk assessment approaches strongly depends on the availability of regional data and spatial data integration methods (Smith, 2000; Locantore et al., 2004). Therefore, a crucial component for developing and running a prioritization tool is availability and access to a BF inventory database, ideally one in which data are well georeferenced. The access to such a database will serve as input data to qualify or quantify the selected BF-regeneration success factors for running a BF prioritization tool. Input data usually come from data set extractions of BF-inventory databases that cover the area of interest and from complementary information sources (e.g., data sets from national statistics institutes, public national database). Some streamlining of the large amount of data may be necessary. In Europe, the existence or availability of these BF inventory databases differs from one country to the next, and in some countries, varies from one region to another. In some countries, BF databases are under strict protection and not publicly available. Therefore, the willingness of BF inventory database owners to provide input data or participate in tool development is not to be overlooked.

The expert group agreed that checking for the availability or prompting the creation of a new data set where none exists is a prerequisite to any tool development process. The experts emphasized that a BF-inventory database may be heterogeneous, that is, have different characteristics, for example, in terms of right of access, ownership (public/nonpublic), funding process, format, and update procedure, among others. This implies the need to adapt the development of the tool from one area to another, but also to ensure **interoperability** when several data sets of different construction are needed. Relying only on publicly available, easily accessible, and good quality data could, in some circumstances, limit success factors to those that may not be relevant to the overall objective, unless strategies are considered for collecting key complementary data (Limasset et al., 2016). Therefore, special attention should be given to data gaps, and complementary databases should be sought to fill in these gaps. Further, the experts distinguished matters of data availability and quality for two distinct phases: (1) developing and testing and (2) full operation. Rights of access to relevant data sets for developers or future end users may vary from one phase to another. BF database owners may question how **confidentiality of the input and dissemination** output data is dealt with during the full operation of a BF evaluation or prioritization tool.

4.2.3. Effective stakeholder engagement

BF regeneration is a challenging problem, requiring the involvement of the whole range of stakeholders (Solitare, 2005). Many studies, projects, and organizations have recognized the importance of stakeholder involvement and have promoted public participation (Rizzo et al., 2015; Azadi et al., 2011; Solitare, 2005; Cundy et al., 2011).

The ACS experts agreed that a **bottom-up approach** should be put in place during the orientation stage (i.e., as early as possible prior to BF prioritization tool development to ensure all stakeholders can express their interest, understand what is at stake, and get effectively engaged in the discussions). This early process will encourage discussions on legal, economic, social, and environmental pressures that the stakeholders' territory may face, as well as expected opportunities and mechanisms for regenerating the BF (available space, economic development, financial support, etc.). The importance of **the leadership, capacity building capabilities, and authoritative acceptance** from the initiators was highlighted as key to creating a dynamic engagement from interested stakeholders and initiating, when possible, co-development of the BF tool prioritization. Developing a common language is equally needed for effectively involving a wide range of stakeholders in these discussions. The experts also stressed the challenges of keeping stakeholders engaged over time beyond the development and initial operation stages. Incentives to keep them engaged can vary, from producing an initial prototype tool that could strongly develop stakeholder interest to exploring funding options. Emphasizing and identifying early the concerns (especially legal) of stakeholders may aid arguments to obtain funding for tool development.

4.2.4. Drivers of regeneration success during the tool development

The main objective of BF prioritization tools is to identify those BF sites that need to be revitalized first, either because they are the most critical or most profitable for a regeneration operation. Accordingly, the two main drivers for regeneration are **environmental impacts** (i.e., unacceptable risks for human health and ecosystems due to contamination) and **economic drivers** (i.e., the land value after regeneration, and the liability related to remediation of hazardous environmental impacts). However, these two aspects alone cannot predict whether the selected BF sites will undergo a successful regeneration process and allow a fruitful and permanent reuse of the derelict land. Thus, the identification of success factors for BF regeneration is a key aspect for prioritization. A list of success factors (i.e., conditions, circumstances, actors, and agencies that are determinants and contributors to successful BF regeneration) have been provided by Frantal et al. (2012) and include regeneration costs, specific localization, transport links, and price of the land and property, among others. These factors may be perceived and assessed differently based on stakeholders' personal or collective concerns, experiences, or values (Frantal et al., 2012), thus, requiring that the importance **(weight)** of each success factor be assessed case by case. Moreover, stakeholders' attitudes can influence or can be influenced by policies and planning strategies developed at the city or regional level.

During the ACS session, the experts differentiated the drivers of regeneration success acting at BF site level (i.e., specific location, proximity to road network, railway, airport, physical conditions of the area, economic status of the locality, etc.) from drivers of regeneration success acting at a wider scale, such as policies and planning strategies for (re)developing the city or region under assessment. The first class of drivers influence the ranking of BF sites within the same requalification objective (e.g., identifying the most suitable set of BF sites for building a shopping center), while the latter influence the objectives of the prioritization process (e.g., building a new shopping center, a new solar power plant, a new recreational area, etc.).

4.2.5. Financing and application costs

The expert group discussing financing and application costs agreed that this domain is of critical importance. However, the experts also stressed that political willingness is a major driver, which in turn depends on public and media awareness for the topic (cf. Bartke et al., unpublished). Furthermore, some key issues were pointed out that ought to be considered as a PoA in creating regional BF regeneration tools. In particular, it must be clarified from the beginning what the specific focus of the instrument is and what the **specific added value** will be. The benefits of using the tool need to be, as far as possible, expressed in tangible outcomes. This will help decision makers understand that the resources needed to create a BF prioritization tool actually translate into an investment and business opportunity. It was highlighted, that a designed BF tool can be a selling product for consultants. At the same time, it can be a selling point for a region to demonstrate to land investors that their potential sites have been evaluated in an overall regional assessment based on which the potential investor is provided with a shortlist of sites that best suit the requirements.

The experts also mentioned the ability of BF prioritization tools to inform about the costs of land use and property development to support more informed decisions of stakeholders, including planners, policy makers, or classic investors. For municipalities and regional authorities, such tools can support the efficient allocation of scarce tax dollars. Authorities, some experts argued, need to understand the public's need for such tools and, therefore, should support the design and application of these tools through sufficient funding.

Regarding the quality of the tools, it was critically emphasized that sufficient (financial) resources are needed also for tool application to get topical, precise, and reliable results. See the above discussions on sufficient data input as one example. The "communication" with stakeholders during the development phase, which is also resource demanding.

Finally, the expert group stressed that on designing and creating BF prioritization tools, an early-on and high-level involvement of the foreseen users of the tool is critical. In this regard, co-funding of tool development by the prospective "user" and the creator/researcher is recommended. This makes clear the investment character of the project and **enables co-ownership of the product**. From the start, scientists/developers should think about collaborating closely with consultants to bring their expertise and provide the basis for later usage of the tool.

5. Discussion: Linking the PoAs

5.1 Assessing the relevance and links of the different PoAs

This section aims at putting the PoAs into context by discussing the individual links among the five categories of PoAs presented in the previous section. The strength of the impact of one PoA on another is crucial to understanding whether certain PoAs need higher attention prior to a BF prioritization tool development (e.g., this is the case when solving one issue helps to alleviate or minimize a future issue). Following the ACS session, we assessed how these PoAs were linked to one another to see whether general patterns exist that can be considered in future tool design. For each of the PoAs we, as authors,identified what we perceived as the most relevant subtopics following the expert discussions (PoAs that were either highly stressed or most intensely discussed). These subtopics are presented in Table 1.

Table 1. Most relevant subtopics for each of the five proposed PoAs following the ACS expert discussions

PoA	**Subtopics of the PoA**
End-user needs	● Involvement of a wide range of stakeholders and potential end users ● Orientation and framing of a BF prioritization tool ● Expected BF tool functionalities and data outputs (i.e., format?) to ensure product is user-friendly and accessibility...
Data availability and quality	● Existence of BF inventory data set (understanding its characteristics/scale coverage) ● Willingness of BF inventory data set owners to provide input data/participate to tool development (conditions for confidentiality/dissemination of output data) ● Interoperability requirements to be considered for BF prioritization tool development (with BF inventory data sets and complementary data sets)
Effective stakeholder engagement	● Early stakeholder engagement towards a bottom-up approach/incentive for tool development ● Recognition of initiators' leadership, authority, and capacity building ● Common language among stakeholders
Drivers of regeneration	● Environmental drivers to be assessed by the tool (current environmental issues at a site/territory pushing for the BF regeneration process, i.e., aiming at reducing

success during the tool development	risks to acceptable levels with new intended use) ● Economic drivers to be assessed by the tool (pushing for the BF-regeneration process, e.g., land value) ● Allocating weight to each success factor within the BF tool (once in operation)
Financing and application costs	● Assessing specific added value of the tool (define tangible outcome) ● Having financial resources for tool application ● Co-funding of tool development to create ownership of the product

The assessment of whether one PoA influences another PoA is presented in Table 2. For each PoA subtopic, we assessed the relevance/linkage using a specific categorization following the approach used by Bartke et al. (unpublished) and Gausemeier et al. (1998), which is presented below:

- (0) = Negligible relevance—the PoA is not an important driver or inhibitor of the other PoA.
- (1) = Minor relevance—the PoA might have a limited but not very important effect.
- (2) = Considerable relevance—the PoA is likely to have a notable (indirect) effect.
- (3) = Key relevance—the PoA is of utmost importance for the other PoA.

A matrix highlighting the influence/relevance of the PoA has been developed as support to this mapping exercise. The influence matrix (based on Gausemeier et al., 1998) helps identify overall dominant PoAs that are "active" in influencing many other PoAs (most critical) and those that are more "passive" (i.e., being influenced by the other PoAs and, therefore, should be considered toward the end of the process/assessment because knowledge of the activePoAs before the passive is beneficial. We apply an overall scoring proposed by the categorization system to highlight the most influential or less influential PoA or subtopic. The overall matrix therefore reflects on the author's opinion on one PoA influence against another one.

According to Table 2, the PoA that has the higher influence is "effective stakeholder engagement," which accounts for the higher score (62 as sum of the scores allocated to each subtopic), followed by "end-user needs" (61). The PoA that seems to have the lower influence is "data availability and quality." The most influential subtopics are "orientation and framing of the BF prioritization tool" (30), "early stakeholder engagement towards a bottom-up approach" (28). "Involvement of a wide range of stakeholders and potential end users and "environmental and economic drivers" play and intermediate influence, each having scores of 24. The lower influence is posed by "expected BF tool functionalities" and "allocating weight to the success factors." This analysis underscores the strong influence that end users and stakeholders should play in developing prioritization tools able to provide tailored results according to the identified needs and expectations. More technical aspects, such as tool functionalities, attribution of weights to success factors, interoperability aspects, and common language do not strongly affect the prioritization tool development process, but are seen as aspects that can be included/evaluated in a second stage of the tool development. The "financing and application costs" PoA has an intermediate influence, which is also reflected in its subtopics.

5.2 Discussion over the most relevant influence/linkages

5.2.1 End-user needs and orientation influence on the other PoAs

As illustrated in the PoA matrix, all the subtopics of the PoA "end-user needs and orientation" are very closely linked. Defining the end-user needs and orientation is crucial because it involves a wide range of stakeholders and enables all involved to frame and describe the functionality of the tools to ensure that sustainable human and financial resources are allocated for the BF prioritization tool and to maximize the use of the tool.

Two categories of end users can be clearly distinguished, leading to different choices in framing and defining tool functionalities and serving two distinct objectives:

- **Market-driven end users** include developers, site owners, service providers, and others. Their overall aims are, at the site scale, to minimize risks and liabilities associated with the site while maximizing site value and best use. Their needs could be met by developing a tool such as a brownfield bank, which would enable access to information on the short-term availability of BFs for future development and would support the development of a BF by giving the best match between the BF characteristics and its future desired land use (site-by-site adequation and approach). In this case, the tool would have to be largely supported by private parties and might be run by consultants (the prioritization tool would then be seen as a selling product). Drivers of success will need to be designed according to the different types of activities/future land uses of interest to the market-driven end users. The challenges of designing and running such a tool lie in the availability (confidentiality) and the interpretation of the public data to economic and private ends. Moreover, the added value of such a tool with respect to site-by-site assessment needs to be clearly identified to attract private funders.
- **Not strictly market-driven end users** encompass public stakeholders, such as local and regional councils, policy makers, and society at large. Their overall goals are to promote sustainable land management by ensuring the protection of citizens with respect to potential human health and environmental risks originating from the site(s) while maximizing the benefits originating from the BF's regeneration at the site- and regional scale. Tools to support urban planning and operational BF redevelopment tool could be foreseen in this case. We can envisage that the prioritization tool will be a strategic tool mainly owned (and supported?) by land planners (and public parties). It will aim to compare various land uses with respect to various regional objectives (e.g., greener cities, denser cities, climate change, increase of well-being). Overall regional assessment, which will aim to assess all the benefits (even nonfinancial ones, using for example, an ecosystem services approach) associated with a wide range of land uses (even off-market sites that will perhaps require more public-money support).

The end-user needs and orientation PoA is also very strongly linked to the following PoAs:

- Data Availability and Quality: The involvement of a wide range of stakeholders promotes the willingness to share and provide existing data, which will be the basis for a sound BF-regeneration assessment. The expected functionalities of the BF tools set the conditions for the confidentiality of the input and output data.
- Stakeholder Engagement: ACS experts discussed that eventually **uptake** of the BF prioritization tool could be enhanced by developing **legal requirements or incentive** on urban development (large-scale vision, BF redevelopment obligation, etc.).
- Understanding Drivers and Regeneration Success: Assessment of end-user needs and orientation is of particular importance to define the geographical coverage of the tool and its application.
- Financing and Applications Costs: End-user needs and orientation must be sustainable and supportable by stakeholders and end users to guarantee appropriate construction and long-term running of the tool. This is why **needs and orientation** must be **well balanced with available human and financial supporting resources.** The end users and stakeholders must make choices according to their needs and their available resources.

5.2.2 Data availability and quality influence over the other PoAs

Table 2 indicates that the "data availability and quality" PoA is the least critical. But it is nevertheless shown as **considerably influencing the end-user needs,** and to a less extent, the other PoAs. Indeed, access to a BF inventory database and willingness of its owner to take part in the process are key for developing and running a BF prioritization tool.

Reflecting on the discrepancies in existing BF inventory coverage and characteristics that are known across Europe, the influencing factors for creating such data sets obviously lie outside the scope of the PoAs being discussed here. Such data sets are usually developed by authorities keen to have a better knowledge of the BF sites that lie within their territories for planning purposes. Authorities are usually constrained by the need to find appropriate funding for initial data set development and necessary regular updates (e.g., annual checks on BF status). When discussing the data availability and quality PoAs, it is important to distinguish in particular the development phase in which input data are needed to test any proposed tool framework, usually through research and development partnerships between initiators/experts and the running phase, which results in access to the fully developed tool for the end users. The input data are usually of a sensitive nature (i.e., information on ownership of individual sites, on future plans, or on the level of contamination, etc.) and require protection (usually data on privately owned sites) and avoidance of their misuse, which means that they are usually not available (or just partly available). Participation by the representatives of data owners in the tool development will help overcome this burden. For the full operational phase, the data owners may still be reluctant to provide straightforward access unless they fully understand and agree on input data confidentiality management and output dissemination data conditions.

The conducted PoA assessments focused on the tool development phase, where any **available BF inventory data set(s)** is believed by the experts to particularly influence the following items when a BF prioritization tool is considered:

- **involvement of a wide range of stakeholders**, especially when BF inventory do not exist yet. The development of such inventories may be considered in parallel with the discussion of the BF prioritization tool expected functionalities, leading to gathering all kinds of stakeholders with strong interest in both processes.

  interoperability requirements between the BF prioritization tool to be developed and any of the BF inventory data sets and complementary data set that will be needed to provide input data. In addition, these data sets may have different updating procedures and may not all be accessible in the same way from one stakeholder to another.

The existence of BF inventory data sets will influence, to a less extent, the **environmental drivers** to be assessed within the tool because some of the fields may be particularly relevant for providing input data on environmental matters. However, we stress that finding relevant input data that is publicly and easily accessible can be a challenge.

Willingness of data owners to provide relevant input data and fully support BF prioritization tool development will be highly influenced by how well they are engaged in **early discussions**; their presence in the early orientation and framing of the tool is crucial. Usually, the aim is to get as much access as possible to relevant and needed data sets that are of good quality (i.e., sources that can be trusted for the way the data is collected, checked, stored, and revised when necessary) and that is free to use if possible. Usually, for research and development purposes, data set owners of BF inventories that are financed by public funding will tend to agree to provide extractions of their database for developing and testing the tool. Unfortunately, in some countries like Germany or Romania, BF inventory databases are under strict protection and are not publicly available.

5.2.3 Effective stakeholders' engagement influence on the other PoAs

The "effective stakeholder engagement" PoA has the highest influence on the others, with its strongest influence on subtopics of the "end-user needs" PoA. This is particularly the case during any tool development phase. A bottom-up approach to engage stakeholders and the recognition of initiator's leadership also strongly influence the financing and application costs for a prioritization tool, and to a less extent, the willingness of BF inventory data set owners to participate to the development.

An early stakeholder engagement process is indeed crucial for the effective definition of needs for future tool end user(s) (e.g., market vs. nonmarket driven). Early engagement will influence directly the participation of a **wide range of stakeholder groups** in designing the prioritization tool. This demanding task is worth investing time in as early as possible because it might contribute to the better visibility of the tool among experts in the field. Indeed, feedback from experts outside the tool development team can, for example, help eliminate too sophisticated (and hardly understandable) ideas and include perspectives that might be omitted otherwise. To keep the stakeholders involved, a prototype tool may need to be developed that stakeholders can reference and adjust during the development process.

A bottom-up approach engaging as much as possible the wide range of stakeholders will strengthen **the orientation and framing** of the tool that is to be developed. For this end, proper communication and common language are also crucial. That is why **initiators with recognized authority** and capacity building are needed because they will be rapidly recognized among relevant stakeholders and will influence engagement. A dynamic approach makes it easier to have/keep the stakeholders engaged. A dynamic leader is of course needed in this iterative and long process. The overall approach that is, therefore, recommended will help discussions among stakeholders as early as possible and in a constructive manner, onimportant elements such as required data sets (BF inventory and/or complementary data sets), expected confidentiality conditions in input and output data, scale of application [local, regional] etc..

This early process is also of importance because it will influence how to **optimize incentives for financing and application costs,** as clearly shown in the PoA matrix. The identification of pressures on stakeholders (especially if legal) will facilitate the funding of the tool development. The financial support by the stakeholders themselves will naturally make them more engaged, as will their involvement/help in finding sources of financial support. Early engagement and recognition of the advantages of tool development will also encourage co-funding and co-development.

5.2.4 Drivers of regeneration success during the tool development influence on the other PoAs

The analysis of influences between subtopics of this PoA underlines that **environmental drivers** have strong influence on the other sub-topics. This is quite intuitive because the current environmental issues at a site/territory pushing for the BF regeneration process are real conditions that need to be assessed and solved/remediated, and their impacts cannot be affected/influenced by the tool development process. On the other hand, environmental drivers can affect the **economic drivers**, when one considers the loss in land value due to the liability of hazardous environmental impacts and the costs required to remediate unacceptable risks. The inclusion of methodologies/functionalities for allocating weights to success factors is a subtopic that cannot influence/modify the environmental and economic drivers to be assessed. However, these drivers can leverage the methodologies/functionalities to be developed to properly assess the identified drivers.

The importance of the drivers of regeneration success on the remaining set of PoAs is moderately relevant. **Environmental and economic drivers** can have a major influence on the **orientation and framing of the tools**, on the **expected tool functionalities,** and on **early bottom-up stakeholders' engagement** processes, considering that environmental drivers always lead the discussion among end users and decision makers who are pressed by public opinion to consider these factors when deciding how to prioritize remediation actions. Moreover, stakeholders are moved/involved in prioritization processes mainly to solve **environmental issues** that can affect them directly or indirectly, or to **attract and invest economic resources** and evaluate possible gains. Environmental drivers have considerable influence on **confidentiality issues** in light of the liability that can come from disclosing unacceptable risks that were not properly communicated to the involved stakeholders and the public. At the same time, functionalities to assess environmental impacts can grant specific **added value** to the developed tool and serve in funding adequate **financial resources for the tool application**. **Economic drivers** can have considerable influence in the involvement of a wide range of stakeholders and end users, who can be attracted by possible economic benefits. Simultaneously, economically attractive regeneration processes can be considerably relevant for all the subtopics under "financing and application costs," fostering added value of the tool, financial resources for its application, and stakeholder willingness to co-fund and co-own the product. When discussing drivers, it is always important to refer also to the **success factors** that characterize each driver and the geographical level they refer to or represent. Identifying, at the beginning of the tool development phase, the most relevant success factors and the **geographic level** at which they are acting (e.g., at the BF site level or at city or regional level) is a major task that strongly affects the **orientation and framing of the tool**, **the spatial functionalities** to be included in the tool, and the process for **allocating the weights** to each success factor.

The last subtopic (i.e., allocating weight to each success factor) has a lower influence on the other subtopics, and along with existence of BF inventory data sets and environmental drivers, it is only partially influenced by the other subtopics. These subtopics represent starting conditions that cannot be modified by the tool development process (i.e., availability of data, environmental issues that needs to be assessed, and stakeholders' perceptions, concerns, and values).

5.2.5 Financing and application costs' influence on the other PoAs

Considering the links between financial factors, the following picture emerges:

1) A clear description of the **added value** of the prioritization tool will be the precondition for finding the financial resources for tool development and any successful tool application. In turn, the consideration and availability of **budget for application** of a tool is not a meaningful determinant of the overall role a prioritization tool can gain. Even if the tool was inexpensive or even free, it would not be used if it did not also promise a tangible benefit.
2) There is a clear role of understanding the potential **added value** of the tool on the **ability to attract co-funding** for the tool development (and, thus, for enabling co-ownership of the product) because clear tangible outcomes make investments attractive (for both private and public investors). Conversely, a vision of co-ownership and co-funding can help identify a joint vision and derive required tangible outcomes. However, the relationship between added value and the ability to attract co-funding is not always obvious and may take considerable effort to resolve and explain .
3) The influence from **budgets** availability on the ability to create **co-funding** is likely only minor assuming that if resources are available from one funder it could increase the chances that they will be available from a co-sponsoring funder. On the other end, co-funding is influencing more considerably budget availability, the link is more considerable because co-funding will as it increases the chances of finding resources for the application of the tool.

Considering the importance of the financial factors on the remaining set of PoA points yields the following insights:

- The role of determining the specific objective in the form of **tangible outcomes and clear added value** of application is a considerable determinant for most factors and is a precondition to attract the target end-user group (but will not enable a wide range of indirectly affected stakeholders). It is the key to make concrete what the specific orientation and framing of the BF prioritization tool should be. Also, it determines many of the BF tool functionalities that ensure achieving the added value. The influence of data availability is less straightforward and likely considerable if only in increasing the willingness of BF inventory data set owner/managers to provide input data and participate in tool development because a specific added value can be made transparent to them. Effective stakeholder engagement will be certainly improved if tangible results of BF prioritization are clear, in particular if affectedness of several groups is addressed. A clearly determined outcome can also make it easier to recognize the initiators' leadership, if the initiator is the end user or co-owner. Regarding the understanding of drivers of regeneration success, there is a considerable link on the economic drivers to be assessed by the tool because it will be often these drivers that determine the added value, and the tool provides a kind of monitoring or proof for the return of investment made in the investigation.
- The influence of **available budgets to thoroughly apply the tool** is less strong. It is evident that more experts and stakeholders can be involved if budgets are available. The budget will also determine the tool functionalities that can be implemented—even if certain functionalities were demanded (e.g., high-resolution, real-time imaging of the site) but unaffordable. In the long run, the budget will determine whether the BF databases are created and provided. More significantly, whether current database owners will make available their data will have to be clarified. Budgets are key to enable early stakeholder engagement. They might also have a role in the extent of capacity building and establishing a common language (ability to interpreting). Minor influence is also debatable regarding the allocation of weights and the selection of the appropriate geographical scope because both decisions should be reflected and updated over time, and missing resources potentially hinder this.
- Finally, **co-funding and in particular co-ownership of the BF prioritization tool** is another rather active factor. Increased co-funding will increase the involvement of stakeholders, is key for orienting and framing the BF prioritization tool because it determines the "who" and "why," and consequently, influences the expected BF tool functionalities, which adjust to the funders' wishes. As argued above, funding will have a potential influence on the long-term establishment of databases. Moreover, if the data owners are also co-funders, they can be more confident in the tool results. Co-ownership can have a minor influence on all factors of effective stakeholder engagement because it demonstrates willingness to collaborate.

6. Conclusions

Tools and support for land management decisions are limited. This document discusses tools to support the prioritization of BF investments or actions on a regional scale, an important level of land-use management. Specifically, this paper focuses on discussing critical PoAs for the design, the development, and the running of such regional prioritization approaches. Significant PoAs that influence the design of tools are based on (1) a review of the state-of-the-art in literature and expert based focus groups, (2) the stakeholders' needs, (3) available tools, and (4) lessons learned from developing regional BF prioritization processes, frameworks, and tools. Our analysis yields a deeper understanding of critical PoAs, namely (1) the assessment of end-user needs and orientation, (2) the availability and quality of the data used to evaluate success factors and constraints of each BF within a BF prioritization tool, (3) the communication and stakeholder engagement during the tool development, (4) the drivers of regeneration success during the tool development, and (5) the financing and application costs/transaction costs to run the tool. We elaborate on each of these PoAs, discuss how the PoAs are linked to one another, and identify general patterns and challenges that can be considered in future tool design.

Our analysis enables us to make conclusions on some key challenges. Considering the prioritization process as the first step in a BF regeneration process, we can identify several questions that must be addressed next: (1) What is the scale for consideration? (2) How are sites identified within the area? (3) How are scenarios compared? and (4) What services will the regenerated sites provide? Each of these questions present many challenges for all stakeholders involved in the process. No two site redevelopment plans will be the same because size and scale play an important role in the process and will often dictate the tools needed in a decision-making process. BF site redevelopment tools can help stakeholders make informed decisions and also protect and preserve greenspace. While this might appear to be straightforward, there are many PoAs that must be considered and integrated to meet challenges to land revitalization. Much like the initial redevelopment strategies, tool development comes with its own set of challenges. There are different interests depending on the stakeholder (i.e., neighborhood community vs. technical developer) yet all need to use the tool. Data format, comparability, quality, and data volume used in the tools can also present a challenge. In addition, data accessibility must be considered, and sensitive data and version control must be protected. Combinations of tools and interoperability of those tools need to be developed, tested, and applied. Stakeholders need tools that are flexible and easy to use when evaluating different reuse scenarios and comparing the benefits from each. Indicators or specific success measures need to be defined early in the process so adjustments can be made as the project progresses.

The focus of the BF redevelopment tool has been to address the different aspects for site-specific cleanup options. Fewer tools are either in development or in the testing phase for the broader region-wide scale. Most importantly, the process of tool development should start with a proper **framing** to guarantee clarity for whom and what the tool is applied. The framing will condition the attractiveness of the tool for end users and stakeholders (**tangible outcome and added value**). Early stakeholder involvement in defining the boundaries of the project (i.e., scale, type of land use) is key, as identified in the PoAs. Such tools will enhance **political willingness to support** projects by promoting legal and financial incentives. We conclude that a **mutual relationship** through data sharing, stakeholder trust and engagement, and co-ownership/co-funding through private and public partnerships needs careful consideration. To address PoAs, research is needed to expand on existing tools, develop new ones, and address operation maintenance and interoperability of the tools. Examples that would be of benefit include: (1) recommendation for a framework or stepwise approach on how regional prioritization tools should be applied (this would include identifying the project scope and tool selection to meet objective and success measures, which is particularly important for clusters of sites or wide areas such as states and regions); (2) application of the framework and approach through case studies, which would allow for documentation of lessons learned and assist in the tool enhancement or modification; and (3) development of tool integration and interoperability at various scales.

Additional specific challenges can be drawn depending on the orientation given for the tool framing and the type of end-user needs (i.e., market-driven or nonmarket-driven). For prioritization tools developed for market-driven end users, such as a brownfield bank, key research challenges to be tackled include (1) the transfer of the tool to commercial use, (2) the sharing and confidentiality of data, and (3) the tool and data updates for guaranteeing reliability. For prioritization tools developed for nonmarket-driven end users, such a BF management module in a wider urban planning tool, key research challenges may encompass (1) the scale of the tool and the amount of data, (2) a suitable financial scheme to support large-scale tool development and operation, and (3) the promotion of the development of off-market sites (deprived and low land-pressure BF) in providing methodological tools to assess full range of benefits from a wider panel of potential future land uses (e.g., nature-based solutions using the ecosystem services approach as an assessment framework).

Acknowledgements

The authors gratefully acknowledge the financial support backing the research for this article. This work was supported by the European Commission's Seventh Framework Programme project TIMBRE (an integrated framework of methods, technologies, tools, and policies for improvement of brownfield regeneration in Europe; www.timbre-project.eu; grant agreement 265364, 2012—2014); the Auvergne-Rhône-Alpes region and FEDER, which support the regional brownfield initiative, ID friche; and the brownfield prioritization prototype tool, Alsace territory in France supported by the DREAL Grand Est, the *Observatoire des friches du Haut Rhin* and ADEME. We thank Glenn Sutter, Lisa Walker, Linda Tackett, Tom Schaffner for their precisious time in editing the document. The sponsors did not influence the study design; collection, analysis, or interpretation of the data; writing of the report; or the decision to submit the report for publication.

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Table

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	End-user needs			Data availability and quality			Effective stakeholder engagement			Drivers of regeneration success during			financing and application costs			Scores		
	Involvement of a wide range of stakeholders and potential end-users	Orientation and framing of a BF prioritization tool	Expected BF tool functionalities, data outputs	Existence of BF inventory data set	Willingness of BF inventory data set owners to provide input data/participate to tool development	Interopeability requirements to be considered for BF prioritization tool developement	Early stakeholder engagement towards a bottom up approach/incentive for tool development	Recognition of initiators' leadership, authority and capacity building	Common language amongst stakeholders.	Environmental drivers to be assessed by the tool	Economic drivers to be assessed by the tool	Allocating weight to each success factor within the BF tool	assessing specific added value of the tool	Financial ressources for successful tool application	Co-Funding of tool developement and co-ownership of the product	Overall score	Number of interactions	Score for each PoA
Involvement of a wide range of stakeholders and potential end-users		3	3	n.a.	1	n.a.	2	n.a.	2	2	2	3	2	2	2	**24**	**11**	
Orientation and framing of the BF prioritization tool	3		3	1	3	2	3	1	3	1	1	0	3	3	3	**30**	**14**	61
Expected BF tool functionalities, data outputs	n.a.	n.a.		n.a.	3	2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2	n.a.	n.a.	*7*	*3*	
Existence of BF inventory data set	3	0	3		n.a.	3	1	n.a.	1	2	0	n.a.	2	2	2	19	11	
Willingness of BF inventory data set owners to provide input data/participate to tool development	3	3	2	n.a.		n.a.	1	n.a.	n.a.	1	1	n.a.	2	2	2	17	9	47
Interopeability requirements to be considered for BF prioritization tool developement	2	3	2	n.a.	1		1	n.a.	1	n.a.	n.a.	n.a.	1	n.a.	n.a.	11	7	
Early stakeholder engagement towards a bottom up approach/incentive for tool development	3	3	3	n.a.	3	1		1	3	1	1	n.a.	3	3	3	**28**	**12**	
Recognition of initiators' leadership, authority and capacity building	3	3	1	n.a.	3	n.a.	3		2	n.a.	n.a.	n.a.	2	2	2	21	9	62
Common language amongst stakeholders.	3	3	1	n.a.	1	1	2	2		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	13	7	
Environmental drivers to be assessed by the tool	1	3	3	n.a.	2	1	3	1	1		3	2	2	2	n.a.	24	12	
Economic drivers to be assessed by the tool	2	3	3	n.a.	1	1	3	1	1	n.a.		2	2	2	2	23	12	52
Allocating weight to each success factor within the BF tool	n.a.	n.a.	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.		2	n.a.	n.a.	*5*	*2*	
Assessing specific added value of the tool	2	3	2	n.a.	2	n.a.	1	1	n.a.	n.a.	2	n.a.		3	3	19	9	
Financial resources for successful tool application	2	n.a.	2	1	2	n.a.	3	1	1	n.a.	n.a.	1	n.a.		1	14	9	51
Co-funding of tool developement and ownership of the product	1	3	2	1	2	n.a.	1	1	1	n.a.	n.a.	2	2	2		18	11	