Chapter 8
Sustainability Monitoring: Principles, Challenges, and Approaches

Abstract Because of the inherent complexity of urban brownfield regeneration projects, achieving sustainability objectives is not easy. It requires approaches adapted to the specificities of this type of operation, that allow for structured and regular follow-up, and that are integrated into the project dynamics. In this chapter, we argue that sustainability monitoring can help address this challenge. We start by defining the principles of sustainability evaluation and monitoring. Then, we look deeper at the challenges of an operational monitoring tool from the brownfield regeneration perspective. On this basis, we plead for the necessity of tailor-made operational monitoring tools for this type of operation and define, to this end, three general requirements for said tools. Finally, we make a critical analysis of existing certifications at the neighbourhood scale and different approaches developed for brownfield regeneration projects.

Keywords Sustainability monitoring · Indicators · Multi-criteria evaluation · Operational monitoring tools · Urban brownfield regeneration project · Tailor-made requirements

8.1 Sustainability and Urban Brownfield Regeneration Projects

We have seen so far that the regeneration of urban brownfields can be a relevant strategy to limit European metropolitan sprawl and, at the same time, to revitalize declining sectors. In a context marked by the imperatives of the sustainable city, we note that public authorities and developers—unduly—often praise urban brownfield regeneration as intrinsically sustainable.[1] This correlation is not automatic and appears to be unsatisfactory at the neighbourhood scale. In other words, even though the regeneration of brownfield sites is a sustainable land management solution at a territorial level, the projects are not in themselves inherently sustainable.

Three interconnected complexity factors can explain the difficulty of integrating sustainability objectives into the project dynamics. First, site complexity: brownfields

[1] "Any argument that all brownfields redevelopment is inherently sustainable is unjustified" (Eisen 1999).

E. Rey et al., *Neighbourhoods in Transition*, The Urban Book Series,
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are complicated sites covering an intermediate scale—the neighbourhood—with a building legacy of variable quality, often disconnected from its context, sometimes contaminated, and suffering from a poor public image (see Chap. 4). Second, the complexity of the regeneration project process: it involves multiple stakeholders and often lasts over a decade. Hence, chances are that the different stakeholders will change during the process, which makes it difficult to keep to the objectives that were set at the beginning (see Chap. 6). Finally, the complexity of the sustainability concept itself: it asks for the simultaneous consideration of a multitude of parameters that are not necessarily compatible. To strive for the overall quality of the future neighbourhood, holistic sustainability objectives must be shared as a common goal through genuine involvement of all stakeholders and assimilated to the different temporalities of the project from the very beginning (see Chap. 5).

Unsurprisingly, the integration of sustainability in an urban brownfield regeneration project is not a spontaneous process and goes far beyond the limits of intuition. To handle this complexity, it is fundamental to act on the basis of sound information and to put a system in place to collect this information appropriately (Pediaditi et al. 2010). In that respect, this chapter focuses on sustainability monitoring that demonstrates an overarching desire to promote integration as well as a structured and continuous follow-up of sustainability objectives (see Chaps. 6 and 7 for the interaction between monitoring practices and urban brownfield regeneration projects). Sustainability monitoring acts as an interface, simplifying the encounter between the urban brownfield regeneration project, marked by complexity, and the sustainability objectives, implying the consideration of multiple parameters. To account for this, we first give an overview of multi-criteria evaluation and monitoring principles. Then, we analyse monitoring challenges from an operational angle. This allows us to define the requirements for an operational monitoring tool. Finally, we look at a series of approaches available at the neighbourhood scale and, more specifically, for brownfield regeneration projects.

8.2 Principles of Sustainability Evaluation and Monitoring

8.2.1 Multi-criteria Evaluation Principles

We witness today a strong trend: the practice of evaluation using indicators is increasing in urban projects, notably in new neighbourhoods wanting to participate in the sustainability of the built environment, projects which are themselves more and more common (Adewumi 2020; Sharifi et al. 2021). Indeed, the last few decades have seen the emergence of an abundance of tools and frameworks aiming to assess urban

sustainability (Pedro et al. 2019). This trend is emphasized by Sustainable Development Goal (SDG) 11, "Sustainable cities and communities", of United Nations 2030 Agenda for Sustainable Development[2] (Klopp and Petretta 2017; Eurostat 2019).

Stating a sustainability goal leads to its measurement—i.e., its evaluation—which is essential to understand sustainable development in the making (Bossel 1999). Hence, sustainable development indicators are used to show, measure, or assess a phenomenon. Indicators are both derived from values and create value: "we measure what we care about and care about what we measure" (Meadows 1998). At the urban level, they are markers towards which the interest of generations of urbanites, present and future, is supposed to tend (Voituriez 2013). However, a simple list of indicators cannot be considered sufficient to support sustainable development decision-making. To achieve this purpose, multi-criteria evaluation approaches must be adopted, allowing actors to deal with the multiple parameters inherent in a sustainable city vision.

Multi-criteria evaluations are, therefore, at the heart of an informed decision-making process and an overall high-quality approach (Sala et al. 2015). They make it possible to carry out, to the best of knowledge, the essential trade-offs related to the pillars of sustainability (see Chap. 5). When integrated into project processes, multi-criteria evaluations also have the advantage of providing a framework for action and support for sustainability objectives. The evaluation results are a way to promote the human, technical, and financial efforts made in terms of sustainability, to demonstrate that they bring added value, and to encourage best practices. They prove to be an excellent tool for communicating with a specialized or wider audience. In this vein, multi-criteria evaluations are also a means of establishing a shared vision for the project, towards which the involved stakeholders agree to orient themselves.

To meet these expectations, a multi-criteria evaluation must, therefore, take into account a set of parameters, such as the appropriate choice of indicators or the context (Ramos 2019). In this regard, we like to refer to the eight Bellagio STAMP principles,[3] which serve as a benchmark for measuring progress towards sustainable development (Pintér et al. 2012).

Multi-criteria evaluations can take various forms, with a highly variable degree of applicability and exhaustiveness: certifications, checklists, technical guides, evaluation frameworks, rating tools, classification systems, life cycle analysis tools (LCA), etc. Coming from an "Eco-Label" trend, certification methods today tend to prevail over other approaches. They are standardized, reproducible, encourage benchmarking, and offer market visibility of the finished or current operation. However, on the scale of a sustainable neighbourhood, certification methods like LEED-ND, BREEAM communities, or Label EcoQuartier also present their share of blindspots:

[2] As a reminder, Goal 11 aims "to renew and plan cities and other human settlements in a way that offers opportunities for all, with access to basic services, energy, housing, transportation, and green public spaces while reducing resource use and environmental impact".

[3] On an indicative basis, the principles coming from the well-known Bellagio principles are: Principle 1: Guiding vision, Principle 2: Essential considerations, Principle 3: Adequate scope, Principle 4: Framework and indicators, Principle 5: Transparency, Principle 6: Effective communications, Principle 7: Broad participation, and Principle 8: Continuity and capacity.

significant labelling costs, indicators sometimes poorly suited to the local context, the imposition of means instead of the objective to be achieved, limited and unbalanced coverage of sustainability dimensions, a separation between the project process and the evaluation, or even use of the label for "greenwashing" purposes (Sharifi and Murayama 2013; Adewumi et al. 2019; Pedro et al. 2019; Sharifi et al. 2021). According to some researchers: "Altogether, this means that an area can be certified without being sustainable" (Wangel et al. 2016). The following sections will discuss complementary principles and alternative approaches to certification methods.

In any case, in Europe, the use of a multi-criteria evaluation approach is achieved on a voluntary basis, that is to say non-regulatory. At the neighbourhood scale, nonetheless, multi-criteria evaluations have more chances to be adopted when supported by the public sector and local government (funding programmes, tax abatement, public-private partnerships, or other incentives) (Cease et al. 2019). They are also one of the means to implement and measure the performance of an urban sustainability policy within a project or its management. This implies integrating the evaluation into the project dynamics and going beyond a simple communication of the results. In other words, multi-criteria evaluations must migrate to operational tools, including the principles of monitoring.

8.2.2 Monitoring Principles

Neighbourhoods in a transition towards sustainability follow a long process. Likewise, urban brownfield regeneration projects also span an extended timeframe. In that context, ensuring the pursuit of sustainability objectives or their improvement is a daunting challenge. Those responsible for evaluation have every interest in remembering that multi-criteria evaluations cannot guarantee results on their own, although it is, conversely, impossible to obtain good results without them (Meadows 1998). So, it is not enough to report on a sustainability status; it is also necessary to follow it up and know how to communicate it (Levett & Therivel 2004). Taking this stand and adopting the monitoring principles could promote the integration of multi-criteria evaluations within project dynamics.

Monitoring is a management tool already well established in the fields of management of private and public organizations, where the abbreviation M&E (monitoring and evaluation) is widely used. It is frequently reported that it is difficult to draw a clear line between the roles of each concept since any evaluation proves unproductive without the contributions of monitoring; the two are complementary (Moore and Spires 2000).

Monitoring, like evaluation, is primarily a means of gathering information, but with the aim to track the evolution methodically over time for early detection of problematic changes (Eurostat and Boesch 2014). The OECD defines monitoring as "continuing function that uses systematic collection of data on specified indicators

to provide management and the main stakeholders of an ongoing development intervention with indications of the extent of progress and achievement of objectives and progress in the use of allocated funds" (OECD 2010).

The idea behind this definition is the use of monitoring to communicate a message carried by indicators. In other words, this is essential feedback to assess the achievement of objectives and take action accordingly; monitoring provides information on changing aspects of a project depending on their direction, pace, and magnitude (Kusek and Rist 2004).

When reconciling these definitions with the concept of urban sustainability as a transition process, the notion of temporality adds to that of communication. Indeed, sustainability is neither static in time nor does it imply a fixed spatial perspective. "It cannot be seen as a destination but rather as a never-ending journey—at least on the timescale at which human society operates" (Franz et al. 2006). The evaluation of sustainability, and all the more, its monitoring, is therefore directly linked to notions of time and open-ended outcomes. In this sense, it is ideal to follow up all of the project processes: the evaluation must evolve from being static, carried out at a precise moment of a project, towards being more dynamic.[4] From an operational point of view, we explain in Chap. 6 that evaluation must be done at the early stages (prospective evaluation), checked during and at the end of construction (supporting evaluation), and continuously updated during the life of a neighbourhood (synthetic evaluation).

If one adopts the idea that sustainability is a transition process, open-ended, and more than an idealized outcome, then the juxtaposition of monitoring principles with a multi-criteria evaluation turns out to be an effective implementation and management tool. It can facilitate decision-making linked to the integration of objectives into the project dynamics. Besides, regular evaluation is central to a continuous improvement process, thanks to the feedback it provides. It thus fosters an iterative approach that will allow the different temporalities of multiple sustainability objectives to converge.

In the same vein, the first step towards collaboration between the different stakeholders is the exchange of updated information. Only accurate data concerning the sustainability objectives will be usable and will trigger clear commitments and agreements between these partners (Van Noordt and De Mulder 2015).

Ultimately, monitoring allows the creation of evaluation reports, which can play different roles and be put to different uses (Kusek and Rist 2004):

- To convince, using evidence from findings;
- To educate, reporting findings;
- To explore and investigate what works, what does not, and why;
- To demonstrate accountability, delivering on promises made to citizens and other stakeholders;
- To document, recording and creating a memory of the project;
- To involve, engaging stakeholders through a participatory process;

[4] It is customary to categorize the evaluation approaches according to the time of action: ex-ante, in-itinere, or ex-post.

- To gain support among stakeholders, demonstrating results;
- To promote understanding, reporting results to enhance understanding of the projects.

For all these reasons, it seems justified to recommend a complementary combination of multi-criteria evaluation approaches and monitoring principles to encourage the integration of sustainability in urban brownfield regeneration projects. To do this, sustainability monitoring tools are required. This can contribute to ensuring the pursuit of sustainability objectives within neighbourhoods in transition.

8.3 Operational Monitoring Tool Challenges

As we have just seen, a monitoring tool can facilitate taking into account sustainability objectives. To achieve this, the tool must be operational, that is to say, an efficient management device, adapted to the professional practice, and user-friendly. We consider an operational monitoring tool to be a digital tool that makes complementary use of multi-criteria evaluation and monitoring principles (see Fig. 8.1). Despite the obvious advantages of sustainability monitoring tools, their integration into the dynamics of urban projects often meets with reluctance. As recent research says, "practice has not yet reached a situation where particular methods or approaches are proven to work well" (Ramos 2019). Evaluation, per se, is said to be time-consuming and its cost–benefit ratio is often underestimated (Wedding and Crawford-Brown 2007; Sharifi and Murayama 2013). Besides, multi-criteria sustainability evaluation methodologies often require a large volume of data, ask for the participation of several experts, and provide complex results, which make them difficult to apply in practice (Sharifi et al. 2021).

Furthermore, as we will explain in Sect. 8.5, analysis of several evaluation methods at the neighbourhood scale, and in particular those adapted to brownfield sites, reveals that their development is mainly from the context of scientific research; they are generally not adapted to the context of practice and have often not gone beyond case studies (Laprise et al. 2015).

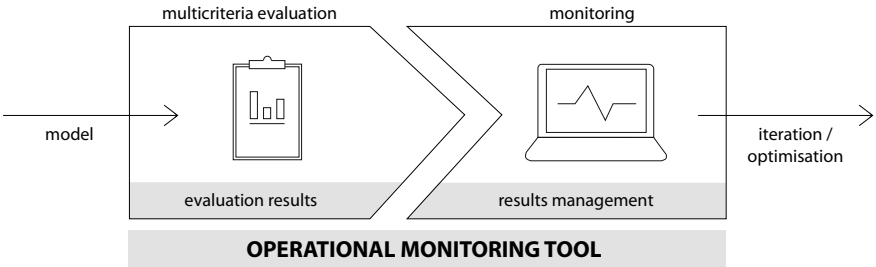

Fig. 8.1 Schematic representation of the constituent elements of an operational monitoring tool

Between theory and practice, the ideal monitoring tool does not seem to exist (Bartke and Schwarze 2015). Nevertheless, some evidence allows us to define what may be optimal for a monitoring tool to be operational. We will next explore the limitations and requirements used in the design of monitoring tools that can play a role in their integration into the dynamics of urban brownfield regeneration projects so that they are accepted and used or, in other words, operational.

8.3.1 Operational Limitations

To be concretely manageable and integrated into project dynamics, a monitoring tool should not be overloaded with indicators, otherwise, too much time will be spent on data collection and not enough on its analysis (Kusek and Rist 2004). However, research highlights a lack of consensus on the selection and the optimal number of indicators (Tanguay et al. 2010). For instance, the theoretical requirements of completeness or transparency deriving from the BellagioSTAMP (see Sect. 8.2.1) inevitably lead to a system with specific indicators answering specific questions. In other words, pushing towards a holistic indicator system, which covers the sustainability concept, involves a large number of indicators.

In daily practice, the resources required to use such a system are limited (time, budget, skills, and capacities). For example, obtaining neighbourhood-wide data for an adequate assessment can be a problem: many aspects are relatively detailed or of a qualitative nature and difficult to assess. When these aspects can be quantified, the necessary data for a fine degree of analysis is both cumbersome and costly to obtain (Larco 2015). From a technical point of view, some indicators are deemed icebergs: they require a disproportionate workload compared to other indicators to obtain the desired final data (simulations, analyses, calculations, etc.) (Riera Pérez 2016). Furthermore, as urban brownfield regeneration projects change and develop in a context that is also changing, some indicators may lose their relevance. They may have to be replaced by indicators that are more adequate under the current conditions.

The challenge is, therefore, to condense and simplify the indicator system, and by extension the monitoring tool, without losing the essential elements. Indeed, how an indicator system is simplified can be critical and lead to simplistic and misleading conclusions (Bell and Morse 2006). In that respect, recent research identifies risks of indicator overuse (the use of indicators whose value is negligible for decision-making), non-use (the potential of the information provided by the indicators is not fully utilized), or misuse (the indicators are used to distort or create false impressions or the information they provide is interpreted erroneously) (Lyytimäki et al. 2020).

The recurring question thus concerns the time spent on the assessment, although our investigation indicates little by way of the ideal compromise. As a rule of thumb, we measure the effectiveness of a monitoring tool and its embedded evaluation approach by the amount of time and effort required to carry out an evaluation, which must be proportional to the benefits that it brings. As argued in Chap. 7, to convince actors of urban projects to spend time on data collection and monitoring, they must

take part in the process in order to be able to use and relate to the information generated.

Nowadays, certifications such as LEED-ND, BREEAM communities or Label EcoQuartier can be an attractive means for implementing an evaluation process and compensating for the additional costs generated by the market visibility they provide, even if they are said to be complex, time-consuming, and bureaucratic.[5] Another way to encourage this practice is through incentive or mandatory measures within policies supporting evaluation and monitoring (see Chap. 7). Finally, public awareness of the importance of including sustainability objectives added to market demand for eco-friendly projects can influence the choice of whether to monitor the transition of an urban brownfield towards a sustainable neighbourhood.

8.3.2 Target Audience

The challenge for monitoring tool designers is to incorporate not only the heterogeneous sustainability aspects but also the very different end-users requirements. However, requirements such as completeness, thoroughness, transparency, user-friendliness, flexibility, and affordability in terms of investment can be contradictory. According to research on the matter, "tool designers have to give up a certain degree of scientific and normative rigour in order to achieve practicability and long-term implementation" (Bartke and Schwarze 2015). The latter research suggests that no tool is capable of meeting all the requirements of different potential users. So instead of trying to develop the "perfect tool", developers should focus on identifying the target audience of the monitoring tool and their specific needs. Putting a priority on one aspect thus depends on the end-user's expectations (decision-makers, representatives of the public, scientists, and experts).

Hence, the aim is to find a balance between the normative principles of sustainability evaluation and the practical requirements of users (see Fig. 8.2). In other words, a monitoring tool can be operational when it is accepted and adopted by relevant end-users and, at the same time, helps to make informed decisions that support sustainability goals. As discussed in Chap. 7, defining the right target audience for the monitoring tool is crucial to ensure its credibility and duration over time (Kusek and Rist 2004):

- Ownership: Who are the users willing to invest time and resources in the tool?
- Management: Who, how and where will the tool be installed and operated?
- Maintenance: Who will be responsible for problem solving and updates, in particular on long-term operations?

[5] Certifications provide a multi-criteria evaluation approach but not necessarily structured and continuous follow-up required by monitoring principles.

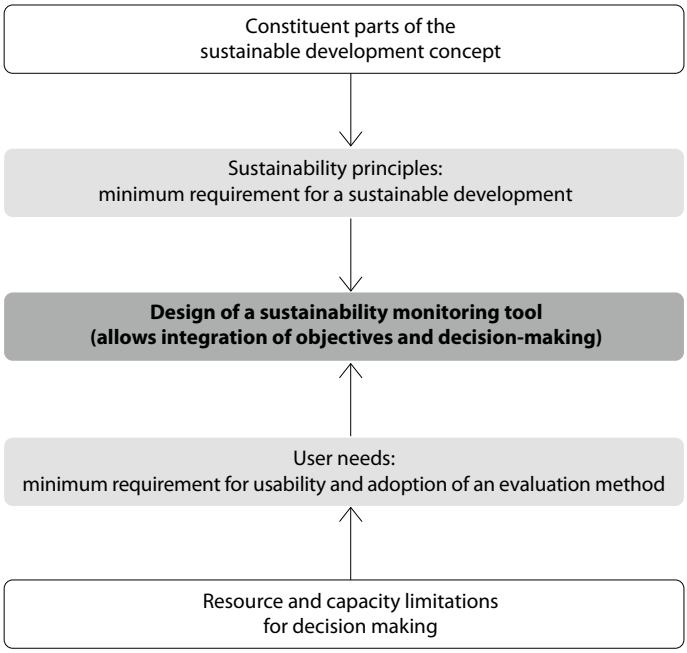

Fig. 8.2 Balance between normative principles of sustainability evaluation and practical user requirements for the design of an operational monitoring tool (Laprise 2017)

8.3.3 Results Reporting

An operational monitoring tool, when properly used, constitutes a database on the sustainability objective and performance of a project that allows sharing regular feedback on the operation. It can thus act as an exchange platform between many stakeholders from different spheres of action. In this sense, the communication of results is essential: the main challenge is to deliver a message. It should ideally be part of a larger communication strategy.

Regular communication of the results brings up some questions: Who will receive the information, in what format, and when? Who will prepare the information and who will present it, whether it gives good or bad results? Here too, the target audience must be identified and reflected in the data collection, analysis of the evaluation, and reporting of the results.

So far, we have noted that the desire to create a monitoring tool representing the complexity of sustainability objectives can be contradictory to the expectations related to its usability, notably clear and simple communication of results. Nevertheless, methods such as aggregation or the selection of representative indicators can help simplify the communication of results.

Multiple aggregation methods are used, especially when the list of indicators is long. They raise the question of the transformation of qualitative and quantitative

indicators into homogeneous values, and that of their weighting. Aggregation feasibility and relevance, and more particularly weighting methods, are criticized for their subjective and ambiguous nature and their varying degrees of transparency (Haapio and Viitaniemi 2008; Tanguay et al. 2010). Indeed, weighting methods imply giving particular consideration to an indicator, while it is difficult to compare and prioritize one aspect of sustainability with another (Riera Pérez 2016).

Another strategy consists of selecting relevant flagship indicators, knowing that all sustainability dimensions must be covered in a sustainable neighbourhood project. The involved stakeholders can make this selection during specific workshops with varying degrees of participation. This approach can establish a collaborative culture with a positive social impact within sustainable neighbourhood projects: the assessment is designed by the actors themselves, based on their discussions, and adapted to the realities of the context (Ramos 2019).

Furthermore, identifying mandatory indicators can be a strategy to ensure the achievement of a certain level of performance. However, mandatory indicators should not mean that some sustainability aspects are more legitimate than others and should not undermine the indicator system's flexibility (Wangel et al. 2016).

Finally, how the evaluation results are reported, that is to say, their graphical representation, can have a significant impact on their usefulness in decision-making, the latter being the central issue in any monitoring tool. An evaluation report must offer a balanced representation of the sustainability dimensions, including both good and bad results, and be adapted to the right audience. The graphical representation of the results must be simple, clear, and in enough detail to allow some form of transparency. The ability of these results representations to track changes over time is also a question that is directly linked to the monitoring principles. For example, the transposition of evaluation results into a radar chart is easier to communicate than a simple list (see Fig. 8.3).

There are many requirements for operational monitoring tools: to be reliable and accessible, including, beyond environmental aspects, economic and social ones, while recognizing local particularities and, above all, capable of communicating, creating and enabling participation. This means more complex, precise, and demanding tools (GBCe 2014). We must, therefore, find an acceptable balance between this complexity and a sufficient level of accuracy; between theory and practice. Since an operational monitoring tool may prove to be relevant for ensuring the transition from urban brownfield sites to sustainable neighbourhoods, it must also meet this challenge. Hence, it is important to have in-depth knowledge of the subject to be evaluated—in our case, urban brownfield regeneration projects—and to adapt the monitoring tool to this specific subject.

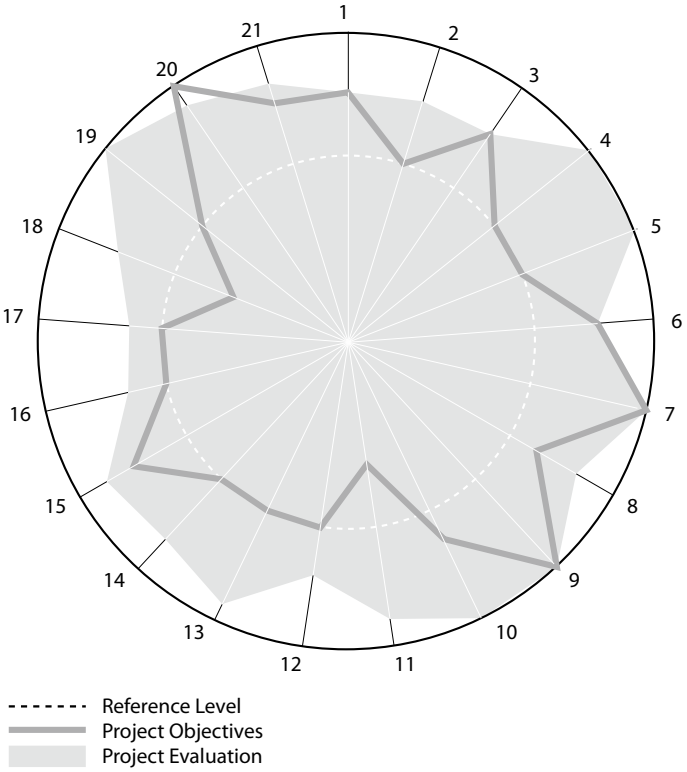

Fig. 8.3 Example of radar chart showing multi-criteria evaluation results and objectives simultaneously

8.4 The Need for Tailor-Made Operational Sustainability Monitoring

Since urban brownfield regeneration projects are inherently complex, the adoption of a monitoring tool seems necessary to encourage the pursuit of sustainability objectives and their improvement. To adequately respond to its role, the monitoring tool must be operational. It must strike a balance between theoretical and practical requirements, considering the specificities of this type of project. Indeed, a tailor-made tool sensitive to the type and context of the project appears to be the only way to face complexities, ensure a certain rigour and credibility of the results, and provide decision-makers with a real account of a given situation (Bleicher and Gross 2010).

According to the specific features of urban brownfield regeneration projects, we formulate three requirements so that such a tool can be integrated into project dynamics, adopted by the various project stakeholders, and bring real added value

compared to current practices. Further developed in Sect. 8.4.2, these three requirements are: a search for overall quality, adequacy with the specificities of urban brownfield regeneration projects, and integration into the project dynamics.

8.4.1 Consideration of Specific Features

The complexity of an urban brownfield regeneration project depends notably on its location and size, the nature of the regeneration, as well as the timeframe and involved stakeholders. Because the scale of the project corresponds to that of the neighbourhood, a suitable monitoring tool cannot only assess isolated objects within a defined perimeter. It must also address how the new neighbourhood influences—like a system—its context and vice versa (Wangel et al. 2016). Sustainability evaluation at this scale involves the consideration of factors, both qualitative and quantitative, that provide sensitive results to adapt the project to the changing needs of different stakeholders (Zheng et al. 2014).

To promote the integration—and continuation—of sustainability objectives, the decision-making support provided by the tool should focus on the regeneration project and its development and management, rather than policies to be evaluated. As discussed in Chap. 7, such a tool can also be used in collaboration with citizens and in this way gain social relevance (Ramos 2019). Communicating regularly on the monitoring results makes it possible to promote the future neighbourhood but also to mitigate expectations by explaining its limits. Because a neighbourhood in transition certainly produces not only winners but also losers, having an adapted monitoring tool facilitates project-related trade-offs in a search for sustainability optimization and contributes to the acceptability of these trade-offs. In other words, it can be used as a means to facilitate exchanges and constructive discussions between the various stakeholders and the citizens.

In a brownfield regeneration project characterized by temporal complexity, sustainable development is far from constituting a unifying element, but, on the contrary, brings different paces into play. By managing sustainability objectives, a tailor-made operational monitoring tool can mitigate this temporal complexity (Wangel et al. 2016).

As neighbourhoods are in transition, urban brownfield regeneration projects are continuously changing. Because their realization spans over 20 or even 30 years, they are unlikely to conform to their original design. Marked by uncertainties, the performances of these projects are only partially predictable and controllable: there will always be elements that will influence the project and appear over time. Even though predictive assessment provided by an adapted tool remains partial, it can contribute to maintaining a certain level of consistency over time with the sustainability objectives. Based on this observation, measuring sustainability challenges cannot be limited to ad hoc reviews. As shown in Fig. 8.4, it must participate fully in the project dynamics and be embodied in a reflective approach allowing continuous and iterative adjustment of its intents (Rey 2012). Hence, monitoring throughout an urban brownfield

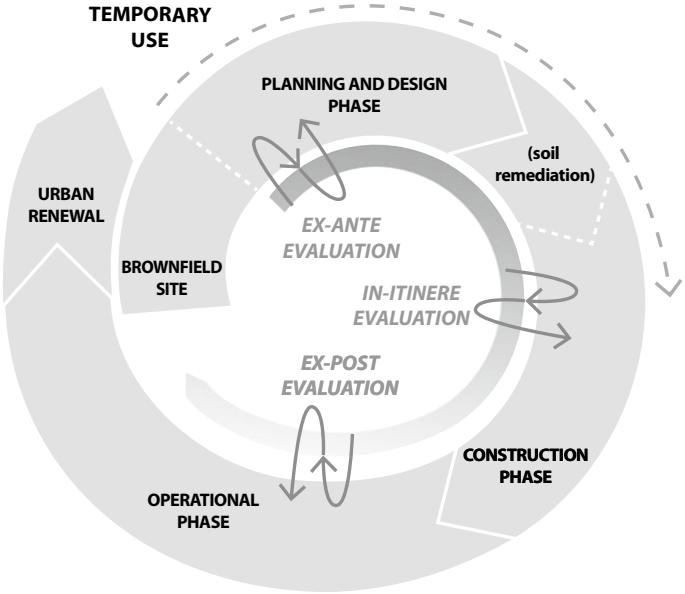

Fig. 8.4 Sustainability monitoring throughout an urban brownfield regeneration project's lifecycle

regeneration project's lifecycle can be a useful source of information and contributes to developing more accurate sustainability strategies (Cahantimur et al. 2010).

Already discussed in Sect. 6.6.2, the early integration of monitoring can be particularly crucial, as decisions made at this stage will affect the neighbourhood's sustainability throughout its lifecycle (Romm 1994). Indeed, early monitoring allows time for reflection and maturation of the sustainability objectives related to the neighbourhood's transition. The early days provide a window for the project to include flexibility, which may increase the possibilities for subsequent modification and delay unalterable decisions. The latter introduces the idea of taking into account aspects that can help prevent the regenerated site from returning to a state of neglect, or, in other words, becoming a brownfield site again (HOMBRE 2014).

An urban brownfield regeneration project may not be linear. On the contrary, the activities of each step of the process may overlap or merge; actors may move from different activities and steps, depending on the project's unique set of characteristics. Capturing the potential nonlinearity through monitoring is fundamental in terms of the optimization of sustainability objectives. An adapted tool can support this overall complexity, thanks to the creation of a shared image of the project. As discussed in Chap. 7, a person responsible for evaluating the sustainability objectives will promote this shared image and lead the monitoring process within the project.

8.4.2 Operational Monitoring Tool Requirements

The consideration of these specific features calls for the development of an operational monitoring tool that includes a continuous, engaging, and efficient evaluation approach, specially adapted to the needs of urban brownfield regeneration projects. To do this, it is necessary to encourage a proactive research for high-quality, integrated voluntarily into the project dynamics, and introduce structured and continuous monitoring of sustainability while taking into account the characteristics specific to urban brownfield regeneration projects. We identify the following requirements:

Search for overall quality

The tool must provide monitoring of sustainability objectives in a holistic manner. Consequently, the recurrent evaluation will have to examine, equally and concurrently, the environmental, sociocultural, and economic aspects of the project as well as the sound management of the project process, i.e., its governance.

- The tool must assess the three pillars of sustainability;
- The tool must assess the "fourth pillar" of sustainability (governance).

Adequacy with the specificities of urban brownfield regeneration projects

The tool must respond to the problems that are at the origin of the brownfield, as well as to the inherent characteristics of the urban brownfield site and regeneration project process, which brings challenges related to sustainability assessment.

- The tool must be specific to urban brownfield issues;
- The tool must be specific to the process of the regeneration project, notably, its multi-disciplinary aspect.

Integration into the project dynamics

The tool must ensure an operational evaluation that is integrated into the project dynamics. It allows easy monitoring throughout the site's transition from urban brownfield to a sustainable neighbourhood. It provides clear communication of the evaluation results that allows iterative and informed action to change performances.

- The tool must include ex-ante assessment and follow-up;
- The tool must include in-itinere assessment and follow-up;
- The tool must include ex-post assessment and follow-up;
- The tool must promote continuous improvement of the regeneration project.

Formulating these requirements is not trivial. It is deduced from the three complexity factors discussed at the beginning of this chapter. Thus, the "search for overall quality" refers to the definition of the sustainability of European metropolitan areas elaborated in Chap. 5. "Adequacy with the specificities of urban brownfield regeneration projects" relates to the analysis made of the potential and particularities of a neighbourhood in transition in Chap. 4. Finally, "integration into the

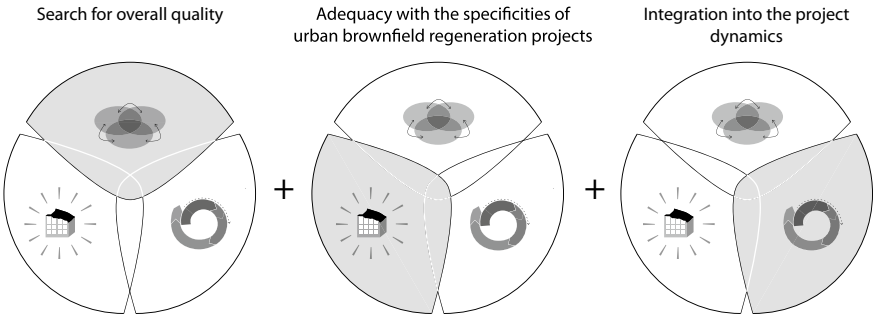

Fig. 8.5 Schematic representation of the three general requirements for a tailor-made operational monitoring tool

project dynamics" reflects concerns about project monitoring, as discussed in Chap. 6 as well as in the present chapter.

However, as illustrated in Fig. 8.5, these requirements are not independent of each other, but rather intersect. For instance, integration into the project dynamics can only be conclusive if the tool is in line with the specificities of urban brownfield regeneration projects. The same goes for this adequacy with the specificities of urban brownfield regeneration projects, which will only be complete if it responds to a search for overall quality. Hence, the operational monitoring tool must entirely and simultaneously embrace the three general requirements.

8.5 Critical Analysis of Existing Approaches

The themes raised so far highlight the need for an operational monitoring tool with specific requirements. The identification of such a targeted need is confronted with the fact that the fields of multi-criteria evaluation as much as monitoring itself are already widely explored and that a real profusion of tools already exists. To close this chapter, we present a critical analysis of existing approaches (certifications at the neighbourhood scale and most relevant evaluation methods developed for brownfield sites). The objective is not to provide an exhaustive list of all approaches, but to highlight the most encountered limitations.[6] This critical analysis will lead us to the observation that—for several reasons—existing approaches do not entirely fulfil the general requirements identified in Sect. 8.4.2.

[6] For detailed analysis, refer to Laprise (2017).

8.5.1 Existing Certifications at the Neighbourhood Scale

As discussed above, certification methods such as LEED-ND, BREEAM communities, Label EcoQuartier, HQE Aménagement, DGNB System for districts or One Planet Living OPL, to name a few, are frequently used in current practice across Europe; much has been said about their benefits and pitfalls (Lützkendorf and Balouktsi 2019; Sharifi et al. 2021). We observe that, even if they are designed to assess sustainability at the neighbourhood scale, certifications do not meet the many specific challenges of urban brownfield regeneration projects.

Symptomatic of this mismatch, several of these certification methods consider the reclamation of brownfield in their indicator system as a separate condition contributing to the overall sustainability of a project. By way of example, in the case of LEED-ND, the Smart Location and Linkage (SLL) Credit: Brownfield remediation grants 1–2 points for projects taking place on contaminated sites (USGBC 2018). Similarly, BREEAM communities' indicator LE02-Land use aims to encourage the use of previously developed or contaminated land, offering 1–2 credits (BRE Global Limited 2013). While it is true that a thoughtful location on a brownfield site is a sustainable solution by reducing pressure on unexploited land, indicators of this kind can be misleading regarding the direct benefits that can be generated by regeneration projects on their own. In other words, it reduces the many specificities relating to these sites and confines them to the concepts of contamination or built density.

The criticism has been made that, regardless of the development site chosen (urban brownfield, allotment in outskirt area, or land which has not been previously disturbed), these tools generally use the same indicators and benchmarks (Sharifi and Murayama 2014). Because these certifications are specially designed for new developments, they are seen as ineffective in assessing issues relating to a brownfield site confronted with existing conditions and marked by the complexity of its regeneration. This calls into question the use of certifications for urban brownfield regeneration projects unless they are simply used as checklists (Wangel et al. 2016). In addition, certification consists generally of the one-off assessment of a project by a third party (external audit) to award a label. Thus, the evaluation intervenes indirectly and passively in the project process, which prevents it from integrating into the project dynamics (Schweber and Haroglu 2014).

However, it should be noted that most certifications include indicators regarding the governance of the project with varying levels of engagement from the main stakeholders. For instance, process quality is one of the five topics rated by the DGNB system for the district, accounting for 20% of the global score. It aims to increase planning and construction quality but leaves little room for bottom-up approaches. The Label EcoQuartier assesses the project's governance initiatives such as communication and inclusion of the population. It also adds to its list the criterion "implement evaluation and continuous improvement procedures", which demonstrates that a label is expressly a tool that excludes monitoring principles.

Ultimately, many evaluation approaches, such as the iiSBE SN Tool (Larsson 2020), offer generic performance assessment frameworks for rating the sustainable performances of neighbourhoods, although they are not certifications, per se. However, like the certification methods, these approaches are not designed specifically for brownfield regeneration. Moreover, as far as we could determine, they are not integrated into operational tools, further limiting their usefulness.

8.5.2 Existing Evaluation Methods for Brownfield Regeneration Projects

We also identify from the literature a number of sustainability evaluation methods that relate to the issues raised by brownfield regeneration projects. However, we observe from the outset that most of these methods remain at the theoretical level, or at best at the experimental level. They can be classified into three categories.

The first category consists of targeted methods. The latter aims at simplifying the complex brownfield regeneration process by shedding light on a single aspect. For example, many approaches focus on soil remediation (Rizzo et al. 2016; Huysegoms and Cappuyns 2017). In fact, within the larger context of sustainable land-use planning, urban brownfield redevelopments and sustainable soil remediations often interweave. It is worth mentioning—for the sustainable soil remediation guidance they provide—the qualitative impact assessment model developed by Nijkamp et al. (2002), the REFRINdd approach (ARTELIA et al. 2016), and the participatory decision support system for contaminated brownfield redevelopment elaborated by Tendero and Plottu (2019). Other targeted methods narrow the assessment on a single aspect of sustainability—quite often on the reduction of energy consumption, carbon emission, and motorized private transport—like the 2000-Watt Site certificate (SwissEnergy 2019). In short, we witness that targeted methods do not address all the specificities of an urban brownfield regeneration project and are not adapted to a structured and continuous follow-up integrated at every stage of the project dynamics.

The second category refers to ex-ante methods, which are designed to intervene at the early stage of project planning. Many of these predictive tools—using geographic information systems (GIS)—were developed to compare the sustainability of different scenarios on brownfield sites at a pre-design stage, predict optimal planning solutions, and/or identify sites for priority development at a territorial level. We can cite interesting works on GIS an indexing scheme (Chrysochoou et al. 2012), an integrated assessment model (Schädler et al. 2011), a definition on the points of attention in designing tools for regional brownfield prioritization (Limasset et al. 2018), and the TIMBRE project's brownfield prioritization tool (TBPT) (Pizzol et al. 2016). The work of HOMBRE (holistic framework for zero brownfield perspective) allowed the development of the so-called BFN (brownfield navigator) (HOMBRE 2013). It is a sophisticated spatial planning tool that helps identify at an early stage

how a brownfield site can be successfully regenerated. One of the tool's special features is the inclusion of "early indicators", which detect the risk of a given site becoming a brownfield and allows the parties concerned to watch over the sites at risk. Finally, RESCUE's work led to the creation of a checklist that focuses on the future functional use of brownfields and sustainable development-related impacts. The checklist was, however, limited to rating a project to obtain public funding (RESCUE 2004). If the early use of a monitoring tool is essential for integrating sustainability issues into brownfield regeneration projects, continuing the evaluation is just as important. Indeed, sustainability objectives risk being abandoned along the way of the project and falling into the trap of "Build and let's see what happens".

The third category consists of frameworks that were developed to help orient the transformation of urban brownfields into new neighbourhoods integrating sustainability principles. The framework created by Williams and Dair (2007) and the redevelopment assessment framework (RAF) developed by Pediaditi et al. (2005) are guidelines based on a participatory approach. They mainly consist of a list of sustainability objectives, within which users are free to define the most appropriate indicators to measure their goals. Without possible comparison or uniform measurement, these frameworks do not enable an informed choice among different iterations or variants of a project. For its part, the sustainable brownfield redevelopment (SBR) tool (Wedding and Crawford-Brown 2007) is a result-oriented framework that evaluates and communicates successes related to the sustainability of completed brownfield redevelopment projects. However, despite its project monitoring ambition, the tool provides only a list of weighted indicators and quantitative aggregation principles. The methodological framework for brownfield assessment developed by Cappai et al. (2019) includes a list of new criteria, resulting from crossing brownfield redevelopment issues with the parameters of project design. The evaluation must be performed during each phase of the lifecycle of the project. However, since it has not yet been validated in cases studies, this approach cannot be considered operational. Finally, we also identify the sustainability indicator system SIPRIUS, which is specifically adapted to issues raised by brownfield regeneration projects in the post-industrial European context and offers opportunities to follow the entire project process in detail (Rey 2012). Furthermore, a successful test application to a case study, the Ecoparc Neighbourhood in Neuchâtel, Switzerland (already mentioned in Chap. 2), was performed. However, the latter framework, taken in this version, is not yet operational. In all cases, these frameworks do not consider nor assess aspects related to the fourth pillar of sustainability.

8.5.3 Towards a Hybridization of Existing Approaches

The critical analysis shows that existing approaches do not entirely fulfil the general requirements for an operational monitoring tool previously elaborated in Sect. 8.4.2. Indeed, most methods are dissociated from the overall project dynamics. Therefore, they cannot be applied on a regular basis or do not address all the phases of a project.

This lack of structured and continuous follow-up limits the ability of actors to make informed choices and communicate the results and, as a consequence, reduces their ability to integrate holistic sustainability objectives into the regeneration project.

This chapter highlights a paradoxical situation: the importance of not only developing a tailor-made operational monitoring tool but also the presence of a multitude of approaches. The next chapter proposes, rather than starting from scratch, to rely on existing "know-how" in order to come up with an optimal tool. This hybridization strategy is inspired by the fact that often in the built environment, new ideas are formed by combining old ones (Glaeser 2011). Entitled SIPRIUS+, this tool is thus the hybridization of two existing approaches: SIPRIUS, the previously identified indicator system, and OKpilot, a user-friendly, web-based monitoring software designed to check and manage compliance with different frameworks and checklists.

References

Adewumi AS (2020) Enhancing urban regeneration at the neighbourhood level: the role of sustainability assessment frameworks. Emerald Open Res 2:1. https://doi.org/10.35241/emeraldopenres.13418.2

Adewumi AS, Onyango V, Moyo D, AlWaer H (2019) A review of selected neighbourhood sustainability assessment frameworks using the Bellagio STAMP. Int J Build Pathol Adapt 37:108–118. https://doi.org/10.1108/IJBPA-07-2018-0055

ARTELIA, Collet J-L, ARMINES (2016) REFRINdd Phase 2: REdéveloppement de FRiches INdustrielles prenant en considération le développement durable. BRGM

Bartke S, Schwarze R (2015) No perfect tools: trade-offs of sustainability principles and user requirements in designing support tools for land-use decisions between greenfields and brownfields. J Environ Manag 153:11–24. https://doi.org/10.1016/j.jenvman.2015.01.040

Bell S, Morse S (2006) Measuring sustainability: learning by doing. Earthscan Publications, London (reprint 2006)

Bleicher A, Gross M (2010) Sustainability assessment and the revitalization of contaminated sites: operationalizing sustainable development for local problems. Int J Sustain Dev Amp World Ecol 17:57–66. https://doi.org/10.1080/13504500903488263

Bossel H (1999) Indicators for sustainable development: theory, method, applications

BRE Global Limited (2013) BREEAM Communities Technical Manual: SD202. Version 0.1:2012. BRE Global. http://www.breeam.org/communities

Cahantimur AI, Öztürk RB, Öztürk AC (2010) Securing land for urban transformation through sustainable brownfield regeneration—the case of Eskişehir, Turkey. Environ Urban 22:241–258. https://doi.org/10.1177/0956247809362641

Cappai F, Forgues D, Glaus M (2019) A methodological approach for evaluating brownfield redevelopment projects. Urban Sci 3:45. https://doi.org/10.3390/urbansci3020045

Cease B, Kim H, Kim D et al (2019) Barriers and incentives for sustainable urban development: an analysis of the adoption of LEED-ND projects. J Environ Manag 244:304–312. https://doi.org/10.1016/j.jenvman.2019.04.020

Chrysochoou M, Brown K, Dahal G et al (2012) A GIS and indexing scheme to screen brownfields for area-wide redevelopment planning. Landsc Urban Plan 105:187–198. https://doi.org/10.1016/j.landurbplan.2011.12.010

Eisen JB (1999) Brownfield policies for sustainable cities. Duke Environ Law Policy Forum 9:187–229

Eurostat (2019) SDG 11—sustainable cities and communities—statistics explained. In: Eurostat Stat. Explain. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=SDG_11_-_Sustainable_cities_and_communities&oldid=439596. Accessed 2 June 2020

Eurostat, Boesch A (2014) Getting messages across using indicators. A handbook based on experiences from assessing sustainable development indicators. European Union (EU)

Franz M, Pahlen G, Nathanail P et al (2006) Sustainable development and brownfield regeneration. What defines the quality of derelict land recycling? Environ Sci 3:135–151. https://doi.org/10.1080/15693430600800873

GBCe (ed) (2014) WSB14 Barcelona—are we moving as quickly as we should? It's up to us! GBCe, Barcelona

Glaeser EL (2011) The triumph of the city. Macmillan, London

Haapio A, Viitaniemi P (2008) A critical review of building environmental assessment tools. Environ Impact Assess Rev 28:469–482. https://doi.org/10.1016/j.eiar.2008.01.002

HOMBRE (2013) Holistic management of brownfield regeneration. http://www.zerobrownfields.eu/index.aspx

HOMBRE (2014) HOMBRE's role in brownfield management and avoidance. http://www.zerobrownfield.eu

Huysegoms L, Cappuyns V (2017) Critical review of decision support tools for sustainability assessment of site remediation options. J Environ Manag 196:278–296. https://doi.org/10.1016/j.jenvman.2017.03.002

Klopp JM, Petretta DL (2017) The urban sustainable development goal: indicators, complexity and the politics of measuring cities. Cities 63:92–97. https://doi.org/10.1016/j.cities.2016.12.019

Kusek JZ, Rist RC (2004) Ten steps to a results-based monitoring and evaluation system: a handbook for development practitioners. World Bank Publications

Laprise M (2017) Monitoring opérationnel pour l'intégration des enjeux de durabilité aux projets de régénération de friches urbaines. Ecole polytechnique fédérale de Lausanne (EPFL)

Laprise M, Lufkin S, Rey E (2015) An indicator system for the assessment of sustainability integrated into the project dynamics of regeneration of disused urban areas. Build Environ 86:29–38. https://doi.org/10.1016/j.buildenv.2014.12.002

Larco N (2015) Sustainable urban design—a (draft) framework. J Urban Des 21(1):1–29. https://doi.org/10.1080/13574809.2015.1071649

Larsson N (2020) Neighbourhoods and SNTool, iiSBE (The International Initiative for a Sustainable Built Environment). http://www.iisbe.org/node/295

Levett & Therivel (2004) Report to the sue-MOT consortium: sustainable urban environment—metrics, models and toolkits: analysis of sustainability-social tools

Limasset E, Pizzol L, Merly C et al (2018) Points of attention in designing tools for regional brownfield prioritization. Sci Total Environ 997–1008. https://doi.org/10.1016/j.scitotenv.2017.11.168

Lützkendorf T, Balouktsi M (2019) Sustainability assessment systems for new and existing neighbourhoods. In: Albiez M, Banse G, Lindeman KC, Quint A (eds) Designing sustainable urban futures: concepts and practices from different countries. KIT Scientific Publishing, Karlsruhe, pp 27–42

Lyytimäki J, Salo H, Lepenies R et al (2020) Risks of producing and using indicators of sustainable development goals. Sustain Dev. https://doi.org/10.1002/sd.2102

Meadows D (1998) Indicators and information systems for sustainable development—a report to the Balaton Group. In: Donella Meadows Institute, Hartland, USA. http://www.donellameadows.org/archives/indicators-and-information-systems-for-sustainable-development/. Accessed 4 June 2013

Moore B, Spires R (2000) Monitoring and evaluation. In: Roberts P (ed) Urban regeneration: a handbook. SAGE, London, pp 203–227

Nijkamp P, Rodenburg CA, Wagtendonk AJ (2002) Success factors for sustainable urban brownfield development: a comparative case study approach to polluted sites. In: Spatial aspects of environmental policy, pp 211–228

OECD (2010) Glossary of key terms in evaluation and results based management
Pediaditi K, Doick KJ, Moffat AJ (2010) Monitoring and evaluation practice for brownfield, regeneration to greenspace initiatives: a meta-evaluation of assessment and monitoring tools. Landsc Urban Plan 97:22–36. https://doi.org/10.1016/j.landurbplan.2010.04.007
Pediaditi KE, Wehrmeyer W, Chenoweth J (2005) Monitoring the sustainability of brownfield redevelopment projects: the Redevelopment Assessment Framework (RAF). Contam Land Reclam 13:173–183.
Pedro J, Reis A, Duarte Pinheiro M, Silva C (2019) A systematic review of the international assessment systems for urban sustainability. IOP Conf Ser Earth Environ Sci 323:012076. https://doi.org/10.1088/1755-1315/323/1/012076
Pintér L, Hardi P, Martinuzzi A, Hall J (2012) Bellagio STAMP: principles for sustainability assessment and measurement. Ecol Indic 17:20–28. https://doi.org/10.1016/j.ecolind.2011.07.001
Pizzol L, Zabeo A, Klusáček P et al (2016) Timbre Brownfield Prioritization Tool to support effective brownfield regeneration. J Environ Manag 166:178–192. https://doi.org/10.1016/j.jenvman.2015.09.030
Ramos TB (2019) Sustainability assessment: exploring the frontiers and paradigms of indicator approaches. Sustainability 11(3):824. https://doi.org/10.3390/su11030824
RESCUE (2004) Guidance on sustainable land use and urban design on brownfield sites—Workpackage 4
Rey E (2012) Régénération des friches urbaines et développement durable: vers une évaluation intégrée à la dynamique du projet. Presses Universitaires de Louvain, Louvain-La-Neuve
Riera Pérez MG (2016) Méthodologie multicritère d'aide à la décision pour le renouvellement urbain à l'échelle du quartier. EPFL (Ecole Polytechnique Fédérale de Lausanne)
Rizzo E, Bardos P, Pizzol L et al (2016) Comparison of international approaches to sustainable remediation. J Environ Manag. https://doi.org/10.1016/j.jenvman.2016.07.062
Romm JJ (1994) Lean and clean management: how to boost profits and productivity by reducing pollution. Kodansha International, New York
Sala S, Ciuffo B, Nijkamp P (2015) A systemic framework for sustainability assessment. Ecol Econ 119:314–325. https://doi.org/10.1016/j.ecolecon.2015.09.015
Schädler S, Morio M, Bartke S et al (2011) Designing sustainable and economically attractive brownfield revitalization options using an integrated assessment model. J Environ Manag 92:827–837. https://doi.org/10.1016/j.jenvman.2010.10.026
Schweber L, Haroglu H (2014) Comparing the fit between BREEAM assessment and design processes. Build Res Inf 42:300–317. https://doi.org/10.1080/09613218.2014.889490
Sharifi A, Dawodu A, Cheshmehzangi A (2021) Neighborhood sustainability assessment tools: a review of success factors. J Clean Prod 125912. https://doi.org/10.1016/j.jclepro.2021.125912
Sharifi A, Murayama A (2013) A critical review of seven selected neighborhood sustainability assessment tools. Environ Impact Assess Rev 38:73–87. https://doi.org/10.1016/j.eiar.2012.06.006
Sharifi A, Murayama A (2014) Neighborhood sustainability assessment in action: cross-evaluation of three assessment systems and their cases from the US, the UK, and Japan. Build Environ 72:243–258. https://doi.org/10.1016/j.buildenv.2013.11.006
SwissEnergy (2019) Catalogue of criteria for the 2000-Watt-Site certificate. https://www.2000watt.swiss/en/english.html
Tanguay GA, Rajaonson J, Lefebvre J-F, Lanoie P (2010) Measuring the sustainability of cities: an analysis of the use of local indicators. Ecol Indic 10:407–418. https://doi.org/10.1016/j.ecolind.2009.07.013
Tendero M, Plottu B (2019) A participatory decision support system for contaminated brownfield redevelopment: a case study from France. J Environ Plan Manag 62:1736–1760. https://doi.org/10.1080/09640568.2018.1512476
USGBC (2018) LEED v4 for neighborhood development

Van Noordt A, De Mulder S (2015) In: Schrenk M, Popovich VV, Zeile P, Elisei P, Beyer C (eds) Online territorial consultation tool. Gent, Belgium

Voituriez T (2013) What is the purpose of the sustainable development goals? IDDRI 18

Wangel J, Wallhagen M, Malmqvist T, Finnveden G (2016) Certification systems for sustainable neighbourhoods: what do they really certify? Environ Impact Assess Rev 56:200–213. https://doi.org/10.1016/j.eiar.2015.10.003

Wedding GC, Crawford-Brown D (2007) Measuring site-level success in brownfield redevelopments: a focus on sustainability and green building. J Environ Manag 85:483–495. https://doi.org/10.1016/j.jenvman.2006.10.018

Williams K, Dair C (2007) A framework for assessing the sustainability of brownfield developments. J Environ Plan Manag 50:23–40. https://doi.org/10.1080/09640560601048275

Zheng HW, Shen GQ, Wang H (2014) A review of recent studies on sustainable urban renewal. Habitat Int 41:272–279. https://doi.org/10.1016/j.habitatint.2013.08.006