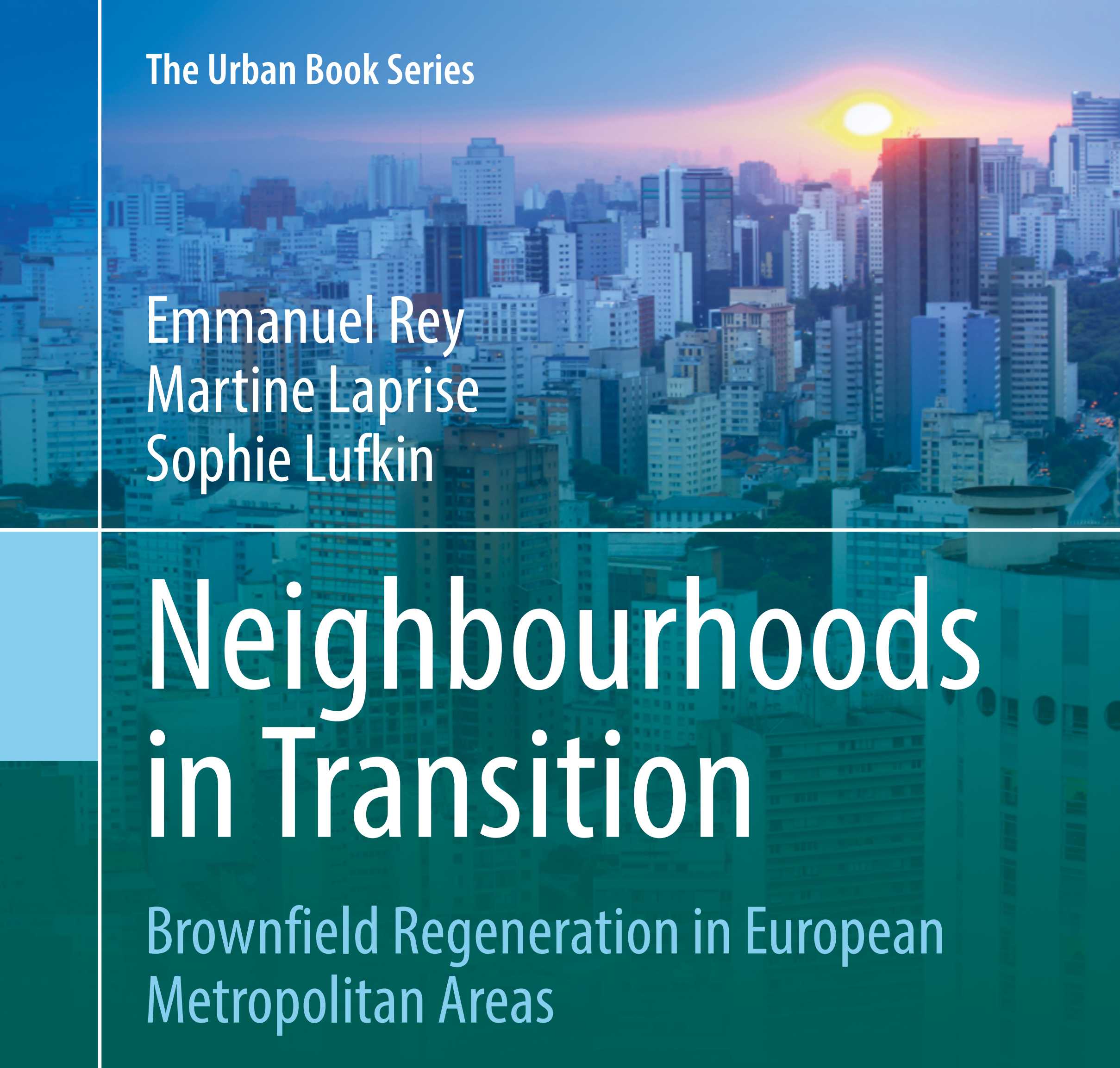

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Neighbourhoods in Transition

Brownfield Regeneration in European Metropolitan Areas

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Brownfield Regeneration in European Metropolitan Areas

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Foreword

The regeneration of urban brownfields to help controlling urban sprawl in cities and metropolitan areas has been a subject of interest for a while. Most examples and studies have focused on contaminated and degraded soil remediation, green infrastructures or heritage preservation. However, the integration of sustainability aspects during the regeneration process to deliver successful neighbourhoods in a holistic way with priority given to the quality of life of its inhabitants has had very little attention. The subject is complex, involves many actors and can be long enduring. Moreover, there is a lack of decision-making methodologies helping to integrate sustainability criteria.

This book addresses these issues and proposes a comprehensive approach in support to the regeneration of urban brownfield into liveable and enjoyable healthy urban neighbourhoods, contributing to the urban sustainability transition of metropolitan areas in Europe.

Sustainability can encompass a very broad scope. In this book sustainability addresses environmental, sociocultural, economic and quality issues, which include aspects dealing with the local context and the design project, but also with governance, such as management, processes, and participation. The contextual aspects include issues related to the local climate, air quality, accessibility and mobility, population density, proximity to essential facilities, green areas and outdoor spaces as well as the provision of local jobs. The aspects related to the design project address those linked to urban life qualities, such as health and well-being, social integration, security, good access to services and considerations with low-carbon construction, clean energy sources and operational costs, among other.

The book is carefully organized in eleven chapters. After a concise introduction, the following three chapters focus on urban brownfields, with discussions on its definition, origin and variety, on its potential, complexities and issues, as well as on the challenges to integrating sustainability considerations. The next three chapters deal with neighbourhoods and the regeneration strategies and processes at the architectural scale and also address issues related to inhabitants' awareness and participation. The last three chapters before the conclusion concentrate on sustainability assessment approaches and provide a useful and innovative multi-criteria evaluation and operational monitoring tool based on an indicator system to help with decision-making.

The application of this tool was tested in real case studies in three selected neighbourhoods in Liège (Belgium), Yverdon-les-Bains (Switzerland) and Besançon (France) and the outcomes of the latter case study are also presented and discussed.

In the current challenging scenario of a pandemic with continuous lockdowns people have been temporarily prevented from entering or leaving a restricted area. It is clear that our lives have been limited to our nearest neighbourhood and these have been more important now than ever before. Luckily, we were all well equipped to take on such a challenge; our mobiles, the internet, online storage, new digital ways of communication and meeting virtually, all these technologies allowed us to work, teach and learn, attend cultural events, socialize, and shop from home. However, the local urban realm was still fundamental for our healthy strolls, weekly exercise, daily dog walking and essential shopping. It has been the engagement of people in neighbourhoods and the spirit of local communities that have supported those most vulnerable living around us. As these scenarios may stay with us for a while, I think there is no better time to bring a subject like the one in this book and to disseminate a multi-criteria evaluation tool to help us making informed decisions as soon as possible when dealing with these projects.

I am certain "Neighbourhoods in Transition" will provide inspiration and advice to a wide variety of an audience, in particular those responsible for shaping our built environment. I am also confident that the decision-making tool here presented will be useful to all those involved in regeneration processes, including designers, researchers, students, public authorities, developers, investors, and local communities. I hope the valuable contribution of this book can steer the conversation on urban regeneration forward and help on the transformation of our cities and neighbourhoods into more sustainable and resilient, healthier and more attractive places to live, work, socialize and grow.

London, UK
Spring 2021

Dr. Paula Cadima

Dr. Paula Cadima author of the foreword, is Director of the MArch+MSc Sustainable Environmental Design, AA Ph.D. Supervisor and a Member of the AA Teaching Committee. She practiced in architecture and environmental design in various architectural offices and lived in Lisbon, Zurich, London, and Brussels. She chaired the Environment & Sustainable Architecture working group at the Architect's Council of Europe in 2009 and was the president of the International PLEA Network from 2011 to 2017, where she continues as advisor to the Director's Board.

Acknowledgements

The prime motivations underlying this book are rooted in the encounter of theoretical concerns—centred around issues related to the evolution of cities towards sustainability—and more concrete questions arising from field experiences. Its publication would not have been possible without the support of many people, whom we would like to thank warmly. Our thanks are especially addressed to the collaborators and partners involved in the research and teaching activities of the Laboratory of Architecture and Sustainable Technologies (LAST). The quality of the exchanges, the diversity of the interdisciplinary contributions, and the intensity of the reflections carried out within this framework are a precious source of motivation to pursue the development of knowledge on the transformation of the built environment. More broadly, our gratitude goes to the Ecole Polytechnique Fédérale de Lausanne (EPFL), the School of Architecture, Civil and Environmental Engineering (ENAC), and the Institute of Architecture (IA), which–thanks to the quality of their members and their infrastructure–provided a particularly favourable setting for the development of such a publication. Accordingly, we acknowledge the open access financial support from the EPFL Library. We also acknowledge the financial support from the Swiss National Science Foundation (within the framework of Project No 100013_143376) as well as the commitment and technical support from M. Alain Guye, Globalite Management, which led to the development of the operational monitoring tool presented in this book. We also wish to thank M. Olivier Govignaux, project manager at the Direction Urbanisme Projets et Planification, Grand Besançon Metropole for its collaboration during the monitoring of the Pôle Viotte neighbourhood and Emily Darrow for proofreading. Finally, we thank all those who accepted to share images of brownfield or regeneration projects to illustrate this book.

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Dr. Sophie Lufkin graduated as an architect from the Ecole polytechnique fédérale de Lausanne (EPFL) in 2005. She is the author of a doctoral thesis on the densification potential of railway brownfields in Switzerland. After an international practical experience at LAR-Fernando Romero (Mexico City), she is currently working as a senior scientist and lecturer at the Laboratory of Architecture and Sustainable Technologies (LAST) carrying out research and teaching activities. She is the author of several articles in scientific journals, conference proceedings, and books.

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Part I
Definition and Issues

Chapter 1
Introduction

Abstract The regeneration of brownfields in European metropolitan areas represents an important potential to mitigate urban sprawl by increasing density within the existing built fabric and to revitalize portions of cities at the neighbourhood scale. Although research and projects on urban brownfields are active, several issues still need to be overcome, especially regarding the sustainability transition challenge. Based on this observation, we introduce the present book, which proposes an integrated and theoretically grounded approach to highlight how urban brownfield regeneration projects—and the neighbourhood scale that they entail—can effectively contribute to the urban sustainability transitions of metropolitan areas. It is structured in two parts that are both distinct and complementary: the first part aims to clarify the framework of the investigations with definition and analysis and the second part presents a deep analysis of processes, project dynamics, and sustainability assessment approaches of urban brownfield regeneration.

Keywords European metropolitan areas · Urban brownfield regeneration · Neighbourhood scale · Sustainability transitions · Urban sprawl · Urban design · Architectural design

Observation of post-industrial European metropolitan areas reveals a singular paradox spanning decades. While planning politics seek to limit urban sprawl in order to slow the occupation of space, pressure on the landscape and its impacts on the environment, a considerable stock of land in the heart of urban territories still remains neglected or underutilized (Rey 2014).

Emblematic of a post-industrial era, their widespread appearance can be explained by the significant reduction or technological change in certain activities within the European territories. The disappearance of obsolete activities, the relocation of certain functions, the automation of production, or other changes in needs have locally imbalanced the relationships between functional needs and their spatial extent. Going beyond the sole question of industrial sectors, these urban brownfields may also have previously hosted activities such as railway, military, port, logistics, infrastructural, commercial, or energy concerns. Yet, these urban brownfields represent an important potential: their regeneration allows the mitigation of urban sprawl by increasing

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density within the existing built fabric—in particular when located near public transport—and to revitalize portions of metropolitan areas at the neighbourhood scale (Rey 2012).

Among the pioneering examples of urban regeneration, we can cite in particular the Internationale Bauausstellung Emscher Park (IBA Emscher Park), which constituted an ambitious programme for structural changes in the so-called German Ruhr region from 1989 to 1993 (Nordrhein-Westfalen Minister für Stadtentwicklung 1988). In a context of strong industrial decline, this approach consisted of a kind of laboratory for the implementation of new concepts in brownfield transformation processes, integrating diverse sociocultural and ecologic dimensions. In the spirit of these first experiences, a growing number of urban brownfield regeneration projects have emerged in Europe over the past twenty years. The projects already carried out and the many sites still in the study phase are not limited to regions with a strong industrial past, but today concern a particularly large number of European metropolitan areas.

Arousing the interest of the various players in regional planning, these achievements have helped to overcome certain negative perceptions traditionally associated with declining sites and to recognize their development potential. However, they did not reduce the importance of the phenomenon, which remains more relevant than ever at a time of climate crisis. Many abandoned or underused sites are still waiting for new programmes, whether by hosting emblematic public institutions or, more broadly, by integrating a functional mix allowing links with the surrounding urban fabric to be re-established.

Although research and projects on urban brownfields are active, several issues still need to be overcome, especially regarding the sustainability transition challenge. With this in mind, the question is not limited solely to considerations of location and building densification. If density is an inescapable challenge, it ought to be considered as a necessary but not sufficient condition. Our observation of multiple regeneration projects highlighted that they do not automatically contribute to the sustainability of urban areas. To achieve sustainability, the integration of a proactive and continuous search for global quality into the dynamics of the project is essential (Rey et al. 2015). This involves taking into account multiple environmental, sociocultural, and economic dimensions from the first steps of the project, then careful monitoring of the sustainability objectives during the various stages of the design process until the commissioning of the new neighbourhoods.

It is in this spirit that this book proposes an integrated and theoretically grounded approach to highlight how urban brownfield regeneration projects—and the neighbourhood scale that they entail—can effectively contribute to the urban sustainability transitions of metropolitan areas. The challenge is undeniably significant and its accomplishment requires planning, conscience, and a mastery of complex processes. In terms of practice and usage, such an evolution must be accompanied by a true reappraisal of urban lifestyles. This requires the emergence of a habitat offering an increased quality of life to an increased number of inhabitants, while simultaneously promoting a sparse use of resources, a move towards carbon neutrality, and a minimization of environmental impacts. The health crisis induced by the COVID-19 pandemic has further heightened awareness of the necessary conditions for ensuring well-being within dwellings and to meet the need for services and amenities in a perimeter easily accessible on foot or by bicycle.

This search for quality and proximity, understood broadly, finds at the neighbourhood level a framework of actions and experiments that are particularly adapted in operational terms. This makes it possible to grasp the urban reality in a dimension vast enough to touch on sustainability criteria that go beyond the size of a single building, but circumscribed enough to be able to visualize concrete interventions. The neighbourhoods thus lend themselves well to a tangible realization of sustainability transitions, for example, by the increase in sustainable mobility, development of public spaces, development of local services, energy renovation of existing buildings, construction of new low-carbon buildings, promotion of the circular economy, and the realization of true sociocultural and intergenerational diversity.

Such projects should be understood as a dynamic process which involves many actors and underpins a common learning of how sustainability can be transposed in each operation. This subject is important because urban brownfield regeneration projects are not inherently sustainable. That is explained by the complexity of the nature of urban brownfields and their scale, the project process, and the holistic concept of sustainability itself. To overcome these complexities, a good understanding of the nature of urban brownfields and regeneration projects' process is required. Moreover, evaluation and monitoring are necessary approaches to ensure the integration of sustainability objectives into these operations.

Based on these findings and multiple works carried out within the Laboratory of Architecture and Sustainable Technologies (LAST) of the Ecole polytechnique fédérale de Lausanne (EPFL), the present book is structured in two parts that are both distinct and complementary. The first part aims to clarify the framework of the investigations presented by an effort to define the polysemic concept of brownfield and by an analysis of the different risks of their regeneration in regard to their potential contribution to the sustainability transition of European metropolitan areas. Highlighting the heterogeneity of situations, our presentation of a number of examples allows us to illustrate the phenomenon of urban brownfields and certain characteristics of their regeneration.

The second part of the book next presents a deep analysis of processes, project dynamics, and sustainability assessment approaches of urban brownfield regeneration. It highlights that the optimizations of the project are part of an iterative search for improvement and that all key players must be involved in this complex process. For this to happen, it is necessary to have an increased knowledge of the initial situation, and to define common objectives with the various actors, then assess whether they have been reached in order to draw concrete conclusions in the form of changes to the project and targeted adaptations of operational actions. It is for this reason that the book also provides an operational monitoring tool specifically focusing on issues raised by urban brownfield regeneration projects, whose method and principles can be concretely transferred as tools for supporting decision-making in professional practice (Laprise et al. 2018). The application of this tool was tested in real case studies in three selected neighbourhoods in Liège (Belgium), Yverdon-les-Bains

(Switzerland) and Besançon (France), and the outcomes of the latter case study are also presented and discussed.

Thus, these two complementary parts constitute a theoretical and practical reference book that provides detailed information on urban brownfield regeneration projects as contributions—at their own scale—to the evolution of European metropolitan areas. Faced with the current ecological and climate crises, urban areas represent both a huge challenge and a formidable potential. Among the multitude of actions to be undertaken and taking into account the long timeframe which characterizes urban projects, sustainable brownfield regeneration remains an unmissable issue, and a relevant operational strategy. In other words, at the beginning of the twenty-first century, a regeneration project constitutes a neighbourhood in transition that turns urban brownfield potential into opportunities for sustainability. In this light, this book attempts to highlight that rethinking urban territories through the prism of the neighbourhood scale gives the advantage of sufficient circumscription to be tangible, yet large enough to have an impact.

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Chapter 2
Urban Brownfields: Origin, Definition, and Diversity

Abstract Brownfield is a polysemic notion that encompasses a whole range of diverse spaces. Although there is no official definition at the European level, an emerging consensus has arisen around the urban character of brownfields and the need for intervention. Indeed, their location within metropolitan areas represents a strategic opportunity to densify and rejuvenate the urban fabric at the neighbourhood scale. Hence, we propose a definition of urban brownfields that is flexible enough to optimize the potential development of abandoned sites and precise enough to enable framing the discussion. Then, we take a look at the diversity of urban brownfields in European metropolitan areas by briefly explaining the factors that cause a site to become a brownfield and then attempting to classify different types of urban brownfields. The proposed classification aims to create a non-exhaustive reference framework by offering in-depth knowledge of the urban brownfield and regeneration projects phenomenon across Europe, without setting its meaning in stone.

Keywords Urban brownfield definition · Urban brownfield classification · Industrial brownfields · Railway brownfields · Military brownfields · Waterfront brownfields · Infrastructural brownfields · Commercial brownfields · Energy brownfields

2.1 Determining the Notion of Urban Brownfield

Initially confined to urban planning specialists, the notion of urban brownfields is now frequently discussed within politics, the media, and associations professional. However, brownfields encompass a whole range of diverse spaces. In order to provide a satisfactory meaning, it is worthwhile not only to define the coverage of the notion of brownfields, but also to clarify the characteristics of their localization, which formally determines its belonging to urban and, more broadly, metropolitan areas.

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2.2 The Origin of the Word Brownfield and Its Polysemous Nature

2.2.1 An Agricultural Etymology

It is worth pointing that the origins of the French word for brownfield, *friche*, are to be found in agriculture. Etymologically, the term comes from an evolution of the medieval Dutch word *versch*, which meant "fresh soil" (Dubois et al. 2001). More broadly, it refers to uncultivated agricultural land, disused due to low soil fertility, excess land available, or transitory fallow situation. The English word brownfield, which comes from a combination of the adjective "brown" and the noun "field", started being commonly used within urban planning circles at the beginning of the nineties to generically qualify abandoned land (Merlin and Choay 2010). The United States Environmental Protection Agency (EPA), for instance, established its Brownfields Redevelopment Initiative as early as 1993 to encourage and support local governments in their efforts to inventory and assess brownfields (Environmental Protection Agency (EPA) 2006).

According to the generic Merriam-Webster[1] dictionary, a brownfield refers to "a tract of land that has been developed for industrial purposes, polluted, and then abandoned". More specifically, urban brownfields are characterized by

- a state of imbalance, which reflects an inadequacy between the site's occupation potential and the activities performed (dysfunction, escheat, obsolescence);
- an extended period without investments, which tends to significantly reduce the site's value in use—or even its exchange value—in the foreseeable future.

2.2.2 A Polysemic Notion

Brownfields can be found to different extents within industrialized countries around the world. However, there is no such thing as a common, official definition of a brownfield, either on the European or American continents (Oliver et al. 2005). The formulation of criteria to precisely describe the state of "brownfield" varies among the institutions concerned. As a matter of fact, the study by Oliver et al. identifies as many as 19 different definitions and variations for the term brownfield in Europe alone.

Several cultural or geographical tendencies, however, can be identified, such as the idea that the term, in the American and Canadian understandings, mainly refers to land affected (or potentially affected) by contaminations due to former activities (Nathanail et al. 2003). For the government of Canada, for instance, brownfields are defined as "abandoned, idle or underutilized commercial or industrial properties

[1] https://www.merriam-webster.com/dictionary/brownfield.

where past actions have caused environmental contamination".[2] In the United States of America, a brownfield is a "property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant".[3]

But to reduce our understanding of brownfields to the sole issue of contamination would clearly be an over-simplification. Furthermore, some definitions, such as the Spanish or Dutch ones, tend to limit the scope to former industrial activities (Oliver et al. 2005). Analogously, the entry for brownfield in the Brownfields Center's glossary exclusively refers to an "industrial or commercial property".[4] In reality, a multiplicity of factors, which we will further develop below, can potentially lead to the creation of a brownfield. Field observations show that the term covers a rather heterogeneous reality of vast spaces crowded with obsolete infrastructures, mid-sized areas bearing witness to forgotten activities, and vacant lots at the heart of urban fabrics.

Therefore, in view of the diversity of origins and situations, it is worth keeping in mind that the term itself, as well as its resulting definition, has an inherent polysemous nature (Rey and Lufkin 2015). In that sense, the concept of *tiers paysage* introduced by Clément (2020) seems able to embrace the many meanings of the term. According to the French philosopher, brownfield refers primarily to something "abandoned", but also, more rarely, to something "reserved". The first category includes abandoned lands, formerly used for multiple purposes, such as agricultural, industrial, urban, or touristic, whereas the second designates an unexploited site, whose existence may be either coincidental or due to lack of access, which makes it impossible or expensive to run.

Stemming from the American context, the concept of *drosscape*, developed by A. Berger, is another inspiring approach to inclusively accommodate the diverse nature of brownfields, which he regards as "waste landscapes" within urbanized territories (Berger 2007). European metropolitan areas, as we will see in the next sections, are reservoirs of such sites. In this sense, brownfield sites can be considered as an integral part of the Horizontal Metropolis phenomenon (Viganò et al. 2018) and require full attention from urban space professionals.

2.3 The Emerging Consensus Around a Definition

2.3.1 A Broad-Spectrum Definition

These observations underline the fact that there is no precise or unambiguous parameter to designate a specific site as brownfield land. Rather, it is a situation that can

[2] https://www.canada.ca/en/environment-climate-change/services/federal-contaminated-sites/about.html.

[3] https://www.epa.gov/brownfields/overview-epas-brownfields-program.

[4] https://web.archive.org/web/20150226001245/.

present many different faces. Following this broad-spectrum perspective, the definition established by the CABERNET network is one of the most commonly adopted within scientific and research circles: “Brownfields are sites that have been affected by the former uses of the site and surrounding land; are derelict and underused; may have real or perceived contamination problems; are mainly in developed urban areas; and require intervention to bring them back to beneficial use” (CABERNET 2006). Apart from the fact that contamination is not identified as a determining stake per se, three aspects are worth mentioning in the framework of this publication. The two first are the urban character of brownfields and the need for intervention. We will have the opportunity to further both aspects in the following chapters. The third one is the term beneficial use. In today’s context looking towards the sustainable city, “beneficial use” implies that a brownfield regeneration project includes environmental, social, and economic considerations (Laprise et al. 2018). This will be considered in depth in Chap. 5.

Furthermore, besides the great variety of definitions, the common thread is a certain degradation of the urban fabric, as well as a loss of social and economic vitality. Since there is no single definition criterion, it is possible to assume that each urban land reserve represents a positive opportunity to densify and rejuvenate the urban fabric at the neighbourhood scale. For this publication, we propose a definition that is flexible enough to optimise the potential development of abandoned sites and precise enough to enable framing the discussion. This definition is largely inspired by that of the Institut d’aménagement et d’urbanisme de la region d’Île-de-France (IAURIF), which revolves around three major principles (IAURIF 1999):

1. *Dimension*

   The dimension is greater than half a hectare (i.e., 5,000 m^2), whilst acknowledging that smaller sized abandoned lands might be of significant importance in terms of urban continuity.

2. *Type*

   The nature and quality may be many and varied, according to the type of activities performed and the level of impairment of existing infrastructures.

3. *Activity*

   The vacancy time is more than one year, considering that the longer the site remains abandoned, the more negative the impacts on the surroundings will be.

It is worth noting that brownfields may also accommodate temporary or transitional uses (Oswalt et al. 2013), such as cultural events (artists’ workshops, exhibitions, festivals, or performances), or simple uses such as storage locations or parking places. More on temporary uses in Chap. 6, “Key Steps of a Regeneration Process”.

2.3.2 Urban and Metropolitan Brownfields

The localization of brownfields can be very heterogeneous. However, as the title suggests, the present publication focuses more specifically on brownfields located within metropolitan areas, which are often referred to as *urban* brownfields, if not *metropolitan* brownfields. Indeed, the phenomenon of metropolization, which can be interpreted as the advent of urbanization on a global scale, exists within each European country (EU 2019).

Broadly speaking, we can define urban or metropolitan areas as territories with a rather high density of population and a continuous built fabric. They can be characterized by a two-fold dynamic, namely the extension of suburban and peri-urban areas, which tends to merge the main agglomerations and the concentration of activities within urban polarities. At this stage, it seems important to underline that although metropolization processes exist throughout Europe (and throughout the world), they remain very specific to each region and continent. Therefore, as is the case for the notion of brownfield, there is no precise, single definition of what is considered an urban or metropolitan area at European level.

This being said, it should be clarified that urban densification strategies developed within the compact and polycentric city perspective are clearly not limited to city centres (see Chap. 5). Our reflections, therefore, include a large number of brownfields located within surrounding suburban rings and peri-urban areas, which represent particularly strategic opportunities for the sustainability transition of metropolitan territories as a whole. The commonly accepted wording *urban brownfield* is therefore adopted for this work.

2.4 The Diversity of Urban Brownfields in Europe

2.4.1 A Multiplicity of Causes

In an ideal perspective, any city or urban region should offer at each moment of its history a total coherence between its "container" (the urban fabric) and its "content" (the activities carried out thereon). However, it appears that these two essential components of the urban identity are governed by different logics. Whereas socio-economic data move in relatively short-term cycles, answers in terms of construction, infrastructure, and networks are most often based on long-term dynamics. This fundamental discrepancy causes urban brownfields to appear (Rey 2012).

If the evolution of urban activities is spread over a long period of time, the progressive shift from one point of equilibrium to the next is possible through converting, transforming, and adapting buildings, public spaces, and infrastructures. Such spontaneous regulating processes have persisted to the present day, in particular in stages of economic growth, during which urban spaces are rapidly converted to new uses. If the evolution instead occurs within short-term cycles and the economic climate is rather stagnant, the micro-processes of reallocation prove unable to catch up with the emerging flow of abandoned lands and constructions. In case the situation extends, a stock of brownfields inevitably appears, progressively carving the active urban fabric. Several specific causes for their appearance can be identified and are described below.

Land use is strongly impacted by a society's technological developments, principally in terms of energy sources, modes of transportation, and industrial innovations. The latter, whose objectives are to increase productivity, generally tend to decrease the surface area required for their operation. From a historical perspective, the risk that a large stock of urban brownfields is created concerns primarily metropolitan regions where a dominant activity, company, or institution occupies a particularly significant proportion of urban space. Indeed, an important mutation of the industry in question could abruptly free up surfaces clearly exceeding the requirements of other activities.

The creation of a stock of urban brownfields is accentuated by the accelerated change of location of many activities. While some of them are moved towards the outskirts of cities for logistical reasons, others are relocated in emerging countries for economic purposes. As an integral part of the increased territorial competition, these phenomena tend to amplify along with the multiple restructuring processes associated with financial globalization. The rapid pace of these mutations often prevents ensuring the transfer of workforce from one company to another, or even from branch to another, even though the service, high-technology, tourism, and health sectors have now taken over from more traditional production sectors in the European context.

In most industrialized countries, the modifications of economic activities lead to relatively different spatial needs, which tends to prevent fluid and harmonious succession of change of uses. In other words, the flow of cessation of activities and vacation of premises exceeds that of reuse in many European metropolitan territories, hence the creation of a stock of vacant lands, infrastructures, and buildings.

2.4.2 *Classification Attempts*

After the definition of brownfields based on CABERNET and IAURIF, their identification and description, the next important phase of our reflection focuses on the classification of brownfields—that is, their sorting into distinct categories. While some European authors, such as (Ferber et al. 2006) or, more recently, (Dolezelová et al. 2014), propose classification systems that tend to prioritize brownfields' economic viability (namely, the A-B-C classification approach), others focus primarily on the technical or environmental dimensions (Schädler et al. 2012). Other kinds of categorizations may refer to localization (rural, peri-urban, urban), type (under-utilized, vacant, derelict, dangerous), development phase (urgent need of action, in planning, etc.) (Ferber et al. 2006), ownership situation (multiple or single landowner, private or public), and size of the site (Clarinet 2002).

In the framework of this publication, however, we have opted to conduct an urban brownfields' classification by referring in the first instance to the activity performed on the site before its abandonment. Referring to authors such as (ACUF 2010; Lotz-Coll 2018), this approach based on the brownfield's previous use not only allows us to estimate the type and extent of potential soil contamination—and therefore roughly predict remediation costs (more on this important issue in Chap. 4)—but it may also help us focus on different reuse options (Clarinet 2002) and regeneration strategies (Dolezelová et al. 2014).

Classifications based on brownfields' origins typically include categories such as industrial, railway, military, institutional, commercial, cultural, and leisure (Yakhlef and Abed 2019). Based on our previous experience (Rey and Lufkin 2015) and with a view to update the list of categories according to society's recent evolutions, in particular the energy transition, we propose a classification based on the following eight categories: industrial, railway, military, waterfront, infrastructural, commercial, energy, and diverse.

However, due to the highly variable nature of brownfield land, establishing a strict typological classification is a complicated—and probably doomed—enterprise. Therefore, the eight categories of urban brownfields proposed within the present publication remain flexible. They are neither fully tight nor exclusive. Indeed, an abandoned site may, for instance, be considered simultaneously as an industrial and railway brownfield, these two activities having been intimately linked in the past. Likewise, it can happen that a currently abandoned parcel of land had previously experienced a change of use without having transited through a state of brownfield, that is, without a period of cessation of activities. By that we mean, for example, the case of a munitions factory that, due to decreasing demand in the armaments sector, may have been converted into a traditional mechanical manufacturing factory. The site in question might well belong to the categories of military and industrial brownfields.

Finally, the idea, here, is not to establish an exhaustive list of urban brownfield and regeneration projects across Europe, but rather to highlight the diversity and richness of situations. Moreover, recent brownfield regeneration projects aim at integrating explicitly sustainability-related considerations, in particular, its environmental dimension. This section will not focus specifically on these aspects, as they will be the object of Chap. 5.

These considerations make it possible to put the proposed classification in perspective, all while acknowledging its potential to create a reference framework. It is our hope that this classification offers in-depth knowledge of the brownfields phenomenon without setting our understanding of it in stone.

2.4.2.1 Industrial Brownfields

At the European level, the lack of clear definition for the general notion of brownfield also extends to the concept of industrial brownfield. There is no such thing as a unique, shared definition of the term. In France, for example, an industrial brownfield is considered as a "space, built or unbuilt, that has participated or still marginally participates to an industrial activity and whose state of deterioration is such that any new use of the land or built structure is possible only after a significant rehabilitation" (Lusso 2013). In Germany, more radically, industrial brownfields are "abandoned spaces that have been used for production but can no longer host any economic activity" (Güthling 2009). In Switzerland, the term designates "empty lands after the demolition of industrial constructions" and "disused industrial buildings". In an evolutive perspective, the definition also includes sites that "have been the subject of a reconversion plan" (ARE 2008).

Our concern here is to maintain a broad-spectrum definition of industrial brownfields. Therefore, sites that hosted artisanal, handicraft or small manufacturing activities, lightly mechanized, medium in size and production scale, are also included within the "industrial brownfields" category. In reality, across the European territory, it is often impossible to establish a clear distinction between industrial and artisanal brownfields. Therefore, these types of brownfields are mostly accounted for jointly. More on this topic in the section is dedicated to inventories and quantitative potential, Chap. 3.

The first industrial or artisanal brownfields essentially appeared from the 1950s, following both the creation of new industrial areas on the outskirts of urban regions and significant cessations of activities in the fields of energy and industrial production. At first, this phenomenon seemed to concern mainly coalfield regions in Northern Europe, the so-called *noirs* areas of Lorraine or Nord-Pas-de-Calais in France, or the Ruhr in Germany (Lusso 2014). Great Britain, of course, is deeply affected by the effects of deindustrialization, especially the counties of Staffordshire, Lancashire, West Yorkshire, Northumberland, and Durham, as well as the Great Manchester, South of Wales, and central Scotland regions (Beaver 1971; Lusso 2010). It is interesting to note here that the question of the recuperation of these early industrial brownfields started being seen as a problem as early as the 1960s (Oxenham 1966).

In Switzerland, where land is a scarce resource due to a combination of small territory and limited possibilities of urbanization in the mountains, industrial decline started to be integrated into specialized studies on land use only from the beginning of the 1990s, noticeably later than in Great Britain. At that time, however, derelict industrial zones were only seen in terms of an opportunity to create new workplaces, and not as a potential for new housing.

Progressively, industrial decline has spread across nearly all European metropolitan areas, all types of industrial and artisanal activities included (Raffestin 1988). Peripheral regions in Europe, albeit to a lesser extent, have also been touched by this development. In the Alps, for instance, where the phenomenon has manifested with considerable delay in comparison to the surrounding lowlands, deindustrialization has been accelerated by the economic crisis of 2008, turning Alpine regions into an interesting field of study for researchers and professionals concerned with the management of industrial brownfields (Modica 2019).

More often than not, the emergence of a new industrial brownfield site is the direct consequence of the dynamics of offshoring enterprises. The decision to relocate is generally taken for economic reasons by an industrial company or group's management. The offshoring may take place at highly variable distances, from a relocation towards the outskirts of the same urban region to the complete export of a production sector to another metropolitan region, country, or even continent. In a globalized economy, issues related to this type of situations go clearly beyond the physical limits of the concerned urban region.

More concretely, the abandonment of a production sector follows the convergence of varied conditions, among which we can cite the more or less sudden emergence of a technological obsolescence context, the failure to respond adequately to international competition—in particular in relation to so-called "emerging" countries (for instance, steel factories or manufactured products)—or the closure of certain production sectors due to government decision, which is part of the political evolution of some nations' global context (for instance, ammunition factories).

Industrial Sites from the Nineteenth and the First Half of the Twentieth Centuries

Because many parameters can lead to the creation of an industrial or artisanal urban brownfield, the spatial settings of these sites have many different aspects. A part of industrial brownfields is constituted by groups of buildings built in the nineteenth and the first half of the twentieth centuries, usually located within or close to historical city centres, which were abandoned by the industries that had been their *raison d'être*. From the 1990s, a large portion of these sectors has been the subject of requalification projects that have, in particular, enabled actors to make industrial heritage preservation a design principle (Bertrand 2018). Indeed, many of these constructions are well embedded in the urban fabric and have a considerable historic interest, often the driving force of intense heritage enhancement processes, sometimes called patrimonialization processes (more on heritage in Chaps. 3 and 5).

Culture tends to play a major role in these requalification processes, which seek to offer abandoned buildings or groups of buildings a second life. Indeed, the transformation of a brownfield into a cultural space represents a new opportunity for industrial sites. Not only does it help to reintroduce life to a derelict place, but it also provides the surrounding neighbourhood with a new space for sharing sociocultural activities (Bertrand 2018; Fiori et al. 2020). Artists' squats have often initiated regeneration processes of industrial brownfields into cultural spaces. Frequently, the latter are subsequently the object of institutional recuperation, turning a temporary use into a permanent one (Bosák et al. 2020). Other typical requalification functions include educational or administrative programmes—for instance, companies looking for representative head offices—or, more recently, activities related to the digital and informational revolution such as co-working spaces, digital campuses, or start-up incubators (Aoudjhane 2019).

Most European metropolitan areas host several such emblematic examples of reallocated industrial brownfield sites from the nineteenth and beginning of twentieth centuries, which provide unique opportunities to stimulate the local economy and promote a new identity for the urban region as a whole. In addition to heritage preservation, many more recent regeneration projects attempt to integrate sustainability and environmental issues more prominently (more in Chap. 5).

In France, we can point to several examples, for instance, the Friche La Belle de Mai in Marseille, located in the former Manufacture des tabacs, which today includes artistic, cultural, exhibition, and theatre spaces (Rodrigues-Malta 2001). The Belle de Mai brownfield, occupied as early as 1992 by the SFT cultural association, later became part of the Euroméditerranée plan—we will further develop this project in the section dedicated to railway brownfields—with French architects Jean Nouvel and Patrick Bouchain actively participating in its urban and architectural development (Bertrand 2018). Another interesting example, also located in Marseille, is the building of Rizeries Indochinoises, originally built in 1885 to transform and package rice imported from Indochina. Abandoned since 1968, the building was completely transformed in 2000 to host the headquarters of a telecommunications company. Other recent industrial brownfield regeneration projects include EuraTechnologies in Lille (see Fig. 3.2, Chap. 3), established within an 8-ha digital campus, the redevelopment of the ancient factories of the Dollfus-Mieg et Compagnie (DMC) and the KMØ in the former casting foundry of the Société Alsacienne de construction mécanique (SACM), both located in Mulhouse, or the Lab'o digital incubator installed within a 4-ha industrial brownfield in the city centre of Orléans (Aoudjhane 2019).

We can also cite several famous cases in Central Europe, in Switzerland for instance: the emblematic transformations of the Sulzer industrial areas in Winterthur, or those of previously derelict sites in Zurich West, such as the Hürlimann Areal, an ancient brewery that now hosts a spa, shops, and restaurants in the midst of the city, the Löwenbräu Areal, which has become an important contemporary arts centre, or the Maag Areal, the headquarters of the Prime Tower, the highest skyscraper in the country, which embodies the mutation of an industrial district into a lively alternative, then economic centre. Belgian examples include the impressive Kanal Pompidou museum, installed in a former Citroën factory in the city centre of Brussels built in 1934 or the recent LaVallée in Molenbeek, a co-working space for creatives established in a former laundry facility, which hosts more than 100 art and innovation-oriented entrepreneurs (Bertrand 2018). Many examples can also be found in Poland, such as the Manufaktura shopping centre, established within the former Poznanski factory in the city of Lodz (Kozlowska, 2007).

Northern and Baltic countries such as the Netherlands, Sweden, Denmark, Finland, Estonia, Latvia, and Lithuania also have a rather high—sometimes extremely high—number of abandoned industrial sites from the nineteenth century and the first half of the twentieth century located in the heart of their cities (Qureshi and Leal Filho 2007). Hence, there is a very long list of successful industrial brownfield regeneration projects, among which we have made a selection aiming at illustrating the diversity of approaches. Werkspoor District in Utrecht, the Netherlands, an immense former industrial warehouse with a length of 175 m, is now a symbol for the circular economy. It houses a range of businesses, from creative independent entrepreneurs to a large beer brewery (see Figs. 2.1 and 2.2). In the centre of Riga, Latvia, we can cite the Kimmel Quarter, a nineteenth century beer brewery to be redeveloped into office buildings and a hotel with public facilities on the ground floor (gym, child care, café, spa, food court, etc.) (Luca 2019). Estonia also has a certain number of examples, such as the Rotermanni Quarter and the Telliskivi Creative City, both in the city of Tallinn, or the former Widget Factory in Tartu, transformed into

Fig. 2.1 Werkspoor Fabriek, Utrecht (NL). Transformation of an industrial warehouse into a mixed-use office building in the Werkspoor District. Zecc Architecten, 2016–2019 (photo: © Zecc Architecten and Stijn Poelstra, 2019)

Fig. 2.2 Werkspoor Fabriek, Utrecht (NL). Transformation of an industrial warehouse into a mixed-use office building in the Werkspoor District. Interior view. Zecc Architecten, 2016–2019 (photo: © Zecc Architecten and Stijn Poelstra, 2019)

a "culture factory", which has housed creative entrepreneurs, artists and designer studios, commerce and entertainment and a flea market since 2014 (Luca 2019).

Large Sub- or Peri-Urban Industrial Sites

Other sectors, generally located outside city centres, within the suburban or peri-urban areas of a metropolitan territory, may be characterized by the presence of industrial installations covering large areas (such as steel plants or metal factories), or heterogeneous ensembles of production-related and auxiliary structures (such as office buildings, warehouses, or depots). Considering these sites' substantial size and specific territorial location within intermediary or "in-between" territories (Ruegg and Deschenaux 2003; Sieverts 2004), it can frequently happen that their redevelopment is caried out with the contribution of landscape architects or artists who develop a thought process aiming at rebuilding a new landscape that is likely to offer an attractive and innovative environment.

In Germany, we can cite the famous example of the Internationale Bauausstellung Emscher Park (IBA Emscher Park), in the conurbation of the Ruhr, which experienced a profound economic decline from the 1960s due to the gradual cessation of the textile industry and coal mining, its major industrial activities (Lusso 2010). The urban regeneration project developed by the Land of the Rhineland of North-Westphalia proposes a highly ecological, cultural, and patrimonial approach, aiming at reconstructing the landscape and restoring the river Emscher system while highlighting the industrial cultural heritage. The regional landscaped park, which covers approximately 45,000 ha, was designed by renown landscape architects, among whom was Peter Latz, author of the Landschaftspark in Duisburg-Nord. The industrial structures were preserved and participate in creating new, striking aesthetics of the site.

Eternitten in Aalborg, Denmark, is another interesting Northern Europe reference. Located 1.5 km southeast of the city centre, the 36-ha former industrial area (which housed Danish Eternit since 1927) has become a resolutely mixed-use urban district with residential units (in particular youth and student housing), workplaces, stores, cafes, and amenities.

Another emblematic European example is the Belval project in Grand Duché du Luxembourg, close to the French border, whose redevelopment project has allowed the preservation of approximately 550 ha of greenfield sites, that is, the equivalent of 3 years of urbanization (Cenci 2018; Glumac and Decoville 2020). The Queen Elisabeth Olympic Park in east London, England, which was built and regenerated for the 2012 Summer Olympics and Paralympics, can also be cited as one of the major European operations of this kind (Hou et al. 2015). The Entrepôt Macdonald in Paris, France, is another impressive example: the former 617-m-long concrete building, built in the 1970s and located between the exterior boulevards and the Parisian ring road, has become the centrepiece within the wider urban transformation of north-east Paris. The project realized between 2007 and 2015 by OMA consisted in building a new piece of the city atop an existing one, including more than 1,100 residential units (among which 50% is social housing), retail spaces, cafés and restaurants, offices, a business incubator, and amenities (Rambert 2015).

Southern Europe, Italy in particular, also hosts an important number of examples of huge industrial complexes that have been the subject of regeneration projects. The ILVA steel plant in Bagnoli, in the Western periphery of Naples, is one of them. Closed at the end of the 1980s after the relocation of its activities in Asia, the industrial site, rebranded “Bagnoli Futura”, today hosts a more or less successful multifunctional complex dedicated to tourism (Parisi 2011; Manceau 2014). Parco Dora in Torino, Northern Italy, designed by landscape architects LATZ + PARTNER, is another successful example of the transformation of a former metallurgical plant into an urban park (see Fig. 2.3).

In Switzerland, the Attisholz-Areals, a 110-ha former cellulose factory, is the country’s largest industrial brownfield undertaking a regeneration process. The site of the ancient Briqueterie et Tuilerie de Renens (BTR), located in West Lausanne, offers another interesting example of suburban industrial brownfields awaiting new uses—albeit at a smaller scale than the previous examples. A new mixed-use neighbourhood including housing and activities is expected to be built on this 25-ha site. Like the above-mentioned Emscher Park project, the suburban character is predominant: the confluence of heterogenous sceneries reveals specific landscaping issues, which resonate with the emergence of a metropolitan region on the entire Swiss Plateau (Rey 2017).

Beyond these stimulating examples of successfully regenerated industrial sites, it is important to stress that there is still an important number of sites awaiting a redevelopment project (Qureshi and Leal Filho 2007). Indeed, many European

Fig. 2.3 Parco Dora, Torino (IT). Transformation of a former metallurgical plant into an urban park. LATZ + PARTNER, 2012 (photo: Uccio “Uccio2” D’Agostino, 2015)

industrial sites still have the status of brownfield, that is, they have not yet been regenerated. The cities of Turku (Finland), Livani (Latvia), or Kohtla-Järve (Estonia), for instance, are sadly famous for their large industrial brownfields. In Romania too, brownfield sites are still very common, especially in big cities like Timisoara and in former industrial cities (Moscovici et al. 2017). But it would be wrong to think that the topicality of the industrial brownfield subject is restricted to Baltic or Eastern European countries. As the section dedicated to inventories will demonstrate (see Chap. 3), Western European countries also remain largely affected by the brownfield phenomenon, both in terms of qualitative and quantitative potentials.

2.4.2.2 Railway Brownfields

In most European countries, railway companies—and armies—are among the largest urban landowners. Their property, both land and buildings, is of considerable significance in terms of urban development—although it is not exclusively located within metropolitan areas and is often characterized by relatively linear configurations, which tend to be sub-optimal for traditional urban forms.

On an indicative basis, the total French railway heritage is estimated at 110,000 ha, which correspond to approximately 4% of the total urbanized surface (Coutellier 2003; Giraud 2006). If the French railway brownfields are mainly sites linked with 4,000 km of disused railroads, they also include a certain amount of technical or functional buildings that no longer serve rail operation purposes (Lotz-Coll 2018). In England, the land property of the railway sector is also significant. It represents approximately 70,000 ha, or around 2.6% of the total urbanized surface (DEFRA 2003). In Switzerland, one of the European countries with the densest rail networks—together with Germany and the Czech Republic—the railway property proportionally has a large surface: approximately 13,000 ha, which represents almost 5% of the total urbanized surface (OFS 2003). By way of comparison, the German railway company Deutsche Bahn (DB) owns 120,000 ha, which also represent approximately 5% of the country's overall built-up areas (OECD 2014).

However, if it is relatively easy to determine the surface of railway companies' land holdings, it is extremely difficult to estimate the exact extent of areas located within metropolitan areas that are no longer needed for rail operation. At the end of the 1990s, diverse sources estimated that 5–10% of the impressive amount of surfaces owned by rail companies could be considered as brownfields (Chaline 1999). Today, in most European countries, these disused railway brownfields have been acknowledged as a strategic asset: as land reserves located in urban, suburban, or peri-urban territories, situated in close connection to public transport systems, they offer particularly interesting features for metropolitan areas in a transition towards sustainability (Merzaghi and Wyss 2009).

Recognizing this, and aware of the valuation gains achievable through obtaining building rights, several European railway companies have created dedicated real estate management divisions. It is for instance the case of SBB Real Estate, responsible for the operational direction and development of the Swiss Federal Railways's land property (Lufkin 2010). In France, the initiative Espace Ferroviaire, a subsidiary of the Société nationale des chemins de fer français SNCF (the French National Railway Company), plays the role of urban planner and real estate developer on behalf of the latter (SNCF 2021). In Great Britain, Network Rail Property specializes, among others, in property and land development for Network Rail, the owner, operator, and developer of Britain's railway infrastructure. Its activities include releasing land for development through partnerships with public and private sectors (Network Rail 2021).

Indeed, the specific interest of railway brownfields—versus industrial brownfields in general—is the ability to engage in a joint reflection with a single stakeholder (Jaccaud et al. 2009). With that in mind, it is possible to identify different types of railway brownfields; each has particular qualitative potentials that require specific development strategies.

Abandoned Railway Stations

The first type of railway brownfield includes former railway stations dedicated either to passengers, freight or yard, totally or partially abandoned due to the evolution of demand. In many cases, similarly to railway brownfields, because of their symbolic and heritage dimensions, these buildings have been the subject of ambitious regeneration projects revolving around cultural activities.

Several iconic examples can be cited across Europe, such as the Gare d'Orsay in Paris, which became a museum after forty years of abandonment, or the Hamburger Bahnhof in Berlin, which eventually shared the same evolution. Heavily bombed during World War II, the latter building situated in the no man's land between East and West Berlin remained abandoned for several decades. Finally, after a long reconstruction work, the building hosts a contemporary art museum since 1996. More recent examples include Station F, established in the former Halle Freyssinet of Gare d'Austerlitz in Paris, inaugurated in 2017 (see Fig. 2.4). The former freight hall, measuring 34,000 square metres and built in 1920 by French engineer Eugène Freyssinet, was transformed into the world's biggest start-up campus (Aoudjhane 2019). Another interesting reference in Paris is Ground Control, in close proximity to Gare de Lyon. This former mail sorting hall belonging to SNCF has become an independent cultural space including cafés, restaurants, stores, a photo studio, and an art gallery.

There are of course several examples of still derelict train stations across Europe. We can cite the Berlin-Pankow-Heinersdorf station in Berlin or the Estación Internacional de Canfranc, in the Spanish Pyrenees, probably one of the most emblematic buildings of this category although not in a metropolitan area.

Obsolete Railway Areas

The second type of railway brownfield includes railway areas that are no longer useful due to certain technological evolutions. Significant sectors are thus suddenly derelict, either because line sections are abandoned in favour of new ones or because space requirements decrease. Furthermore, freight transport activities follow this trend: globally, the amount of goods carried by rail decreases, and (un)loading is

Fig. 2.4 Station F, Paris (FR). Transformation of the former Halle Freyssinet of Gare d'Austerlitz into a start-up campus. Wilmotte & Associés SAS, 2017 (photo: Patrick Tourneboeuf, 2017)

concentrated to a limited number of sites. This polarization of areas dedicated to goods transhipment has liberated significant surfaces of land that used to host this kind of activities.

Here again, several examples can be cited across Europe, such as the logistic sectors of King's Cross station in north London (approx. 54 ha), those of the Sagrera station in Barcelona (approx. 74 ha), or the smaller but strategic Nyugati Grund in Budapest (approx. 2 ha) (see Fig. 2.5). In Neuchâtel, Switzerland, the Ecoparc Neighbourhood is a pioneering regeneration started in 1994 and completed in 2004 of a 4-ha obsolete railway area into a new mixed-use neighbourhood integrating high-performance sustainability criteria (see Figs. 2.6 and 2.7). Several interesting regeneration projects of obsolete railway areas can also be found in France, such as the remarkable Euroméditerranée project in Marseille, an operation of national interest covering approximately 169 ha, although this surface is not strictly speaking a railway brownfield since industrial, waterfront, and infrastructural brownfields are also involved. We can also cite the Ordener-Poissonniers project in Paris, which is about the rehabilitation of the La Chapelle storage site into a low-carbon neighbourhood, the Cité Fertile, also in Paris, a temporary living and working space dedicated to various sustainability-related issues, which aims at making the transition from former freight station to the new Pantin eco-neighbourhood, and the Viotte sector in Besançon, which is in a transition towards a new sustainable neighbourhood. The latter will be analysed in-depth as a case study in Chap. 10.

Fig. 2.5 Nyugati Grund, Budapest (HU). Regeneration of a disused railway area. Ongoing regeneration project (photo: © István Keresztes for KÉK-Hungarian Contemporary Architecture Centre, 2014)

Industrial Railway Sites

The third type of railway brownfield includes all areas equipped with rails that are directly linked to industrial brownfields. Historically, for logistical reasons, most production sites are directly connected to the rail network. Hence, the abandonment of the industrial site typically leads to the deactivation of the concerning railways. However, as already mentioned, it is not always possible to make a clear distinction between strictly railway brownfields and other types of brownfields.

Compared to the two previous types of railway brownfields, this type is somewhat singular in the sense that the national railway company is not necessarily the single landowner, or does not even own the majority of the land. On the contrary, in most cases, the land is owned by a multitude of private landowners, which tends to complexify land management issues.

The Pasila neighbourhood in Helsinki is definitely a remarkable European reference of a recent regeneration operation of such industrial railway sites. Undergoing a profound metamorphosis, the 90-ha brownfield located at the heart of the Finnish capital will become an essential transport hub by 2040, generating 50,000 jobs and accommodating 30,000 new inhabitants (Sarthou 2020). Ülemiste City in Tallinn, Estonia, is another impressive example in terms of dimensions and ambitions. This former railway-related manufacturing plant, built in 1899 and dedicated to the mass production of nuclear equipment in the 1980s, was transformed in 2005 into an attractive area for real estate development, well connected to public transport

Fig. 2.6 Ecoparc Neighbourhood, Neuchâtel (CH). Aerial view on the pioneering regeneration project of an obsolete railway area into a sustainable neighbourhood. Bauart Architects and Planners, 2000–2011 (photo: © Yves André, 2013)

Fig. 2.7 Ecoparc Neighbourhood, Neuchâtel (CH). An open public space in the heart of the sustainable neighbourhood. Bauart Architects and Planners, 2000–2011 (photo: © Yves André, 2013)

and perfectly adapted for smart-city-related activities (Luca 2019). The 35-ha area hosts approximately 400 businesses, a park, and cafes. In order to make the place lively outside working hours—one of the improvement potentials of the regeneration project—residential surfaces are expected to be included by 2025.

There are also examples of smaller-scale hybrid, largely industrial railway sites, such as the derelict industrial railway of Fribourg, Switzerland. Originally stretching between the main station and the sawmill plant located at the end of the Pérolles plateau, the ancient railway built in 1871 contributed considerably to the zone's industrial development. From the 1960s, following the creation of new industrial areas on the outskirts of the urban region, companies started to leave the plateau. This progressive deindustrialization liberated an important number of structures, including the former Cardinal brewery, which eventually closed in 2011. The cantonal and municipal authorities took this opportunity to create a new innovation-based neighbourhood meeting high environmental standards. Entitled blueFACTORY, the project includes the creation of the Smart Living Lab, a research centre bringing together scientists from Ecole Polytechnique fédérale de Lausanne (EPFL), the University of Fribourg (UNIFR), and the Haute école d'ingénierie et d'architecture de Fribourg (HEIA-FR).

2.4.2.3 Military Brownfields

From the eighteenth century and until the middle of the twentieth century, the recurrence of armed conflicts resulted in the establishment of multiple military installations within metropolitan territories on the European continent as a whole. Hence, armies have become among the largest landowners. For illustrative purposes, we can stress that the French military sector owns about 268,000 ha, which represent close to 10% of the country's total urbanized surfaces (Coutellier 2003). In the UK, the military owns over 450,000 ha—or the equivalent of up to 32% of total built-up areas—which makes them the third biggest owner in the country (ABC Finance 2018). In Switzerland, the army is resolutely the biggest landowner in the country. The military owns 24,000 ha of land—or the equivalent of the entire Canton of Zoug, i.e., approximately 12% of total urbanized land (Rey and Lufkin 2015).

After a long period of stability, a substantial decrease of military budgets occurred from the 1980s. This reduction, as well as other factors such as enhancing military technology, led in the 1990s to the emergence of huge military brownfields around the world in general, and in Europe in particular (Jauhiainen 2007). Several European countries made efforts to streamline the size of their military heritage, by way of selling the sites that no longer had a true operational or strategic *raison d'être* (Jaques 2004). Therefore, throughout the decade of 1990, successive reforms and restructurings of the military led to the progressive liberation of many surfaces likely to be rehabilitated for civil uses.

If this phenomenon is significant in European countries in general, it is particularly the case in Central Europe, where troops from the NATO and the Warsaw Pact had been stationed. After their departure, disused military bases are progressively restituted to central public authorities, who more often than not dispose of them for the benefit of local and regional authorities (Beyer 2006). In Poland, for instance, 76,000 ha of post-military land were liberated after 1990 due to the surrendering of the Russian Federation Army and the reduction of the number and sizes of the Polish Army bases (Jarczewski and Kuryło 2010). Although only a relatively small part of this surface (11,861 ha) is located within urban areas, this nevertheless represents a considerable land resource for the country.

Similarly, in the Balkan region, and notably in Croatia, the reorganization of the defence system has led to an increasing number of abandoned military sites, especially within major cities. A recent inventory identified more than 325 ha of military brownfields in the Zagreb Urban Agglomeration alone (Matković and Jakovčić 2020).

Another typical example of the phenomenon of the liberation of military bases is the Baltic region (Jauhiainen 2007). Latvia, for instance, is particularly affected, with approximately 850 sites abandoned after the withdrawal of the Soviet forces. Furthermore, it is estimated that 300 sites among the latter, covering an area of approximately 95,000 ha, are contaminated due to the presence of unexploded mines, bomb residues, heavy metals, residues from waste incineration, fuel contamination in former missile bases, and sediment contamination at marine bases (Qureshi and Leal Filho 2007).

Yet, for obvious confidentiality issues, the national competence centres responsible for managing military land have been the subject of far less detailed studies than their corresponding divisions in the railway sector. Some of these surfaces liberated for civil reconversion purposes were not necessarily qualified as urban or metropolitan when they were established as military areas, but they progressively became integrated into such territorial contexts due to urban sprawl. Inherited from multiple evolutions in terms of defence strategies, the spatial configuration of these military sites may vary from one brownfield to the next.

In the city centres, it is mostly about command buildings, such as, for instance, the French Ecole Militaire, which covers around ten hectares in Paris. These buildings, which often represent a considerable heritage value, are frequently rehabilitated for other types of institutional uses or may also be converted into residential units. Another relevant Swiss example is that of the former army barracks in Geneva, built at the end of the eighteenth century, which now accommodate chic apartments in the heart of the old town. It is worth noting here that this type of rehabilitation of military constructions located in historical centres is not new or unusual. It has been part of the transformation processes of European cities for centuries.

In metropolitan sectors located in close proximity to the city centre, military brownfield sites usually include former military garrisons, with barracks, arsenals, hospitals, warehouses, fuel stations, etc. They often create urban enclaves that may cover significant surfaces. Several examples can be cited, in Italy to start with, such as the Caserna Sani (11 ha) in the city centre of Bologna, the Artillery Arsenal Franz Josef (13 ha) in the city centre of Verona and the Pertite area (28 ha) in the city centre of Piacenza (Ponzini and Vani 2014). In France, we can also mention several successful rehabilitation projects, mostly steered by "Sociétés d'Economie mixte" (SEM), such as the Plateau des Capucins in Brest, a former 11 ha-site military area in the city now dedicated to housing, economy, leisure, culture, and tourism (see Figs. 2.8 and 2.9), the Bosquet barracks in Mont-de-Marsan, in the Landes department, now an administrative and residential pole, or the quite famous former barracks in Albi, transformed into a new university campus hosting around 2,800 students (Cros 2008, 2011; AFP 2014). Another emblematic example of this type of mutation is the progressive transformation of the arsenal of Sion, Switzerland, into a cultural centre including a media library, cantonal archives, the municipal library, and the "Culture Valais" platform.

Military brownfields can also include sites located in more peripheral metropolitan areas, hosting defence facilities, fortification works, airbases, or submarine bases. The size of these sites can be rather impressive, such as the 230-ha innovation park planned on the former Dübendorf airfield, located near Zurich, Switzerland, or the 166-ha masterplan for the transformation of the old army barracks of Aldershot, United Kingdom, into a new district (Bagaeen and Celia 2018). The Estonian National Museum in Tartu, Estonia, also provides a striking example. Located in the former Raadi Manor, built in 1783, the museum was established in 1922. Heavily damaged in 1944 during the fighting between German and Soviet forces, it was subsequently transformed into a Soviet military airbase. Hence, access was restricted for fifty years and the site became a "closed city". Officially inaugurated in 2016, the actual museum building, located on the abandoned military land, is designed as a brand-new entity symbolically built over the "ruins" of history.

Fig. 2.8 Plateau des Capucins, Brest (FR). Regeneration of a former military area into a mixed-use neighbourhood dedicated to housing, economy, leisure, culture, and tourism. Public space and urban cable car, 2017 (photo: Emmanuel Rey, 2019)

Fig. 2.9 Plateau des Capucins, Brest (FR). Regeneration of a former military area into a mixed-use neighbourhood dedicated to housing, economy, leisure, culture, and tourism. Interior view. Atelier de l'île, 2017 (photo: Emmanuel Rey, 2019)

Ultimately, each disused military site is unique. In that sense, each site is likely to present interesting architectural features, sometimes with buildings that are symbolic for the history of the entire metropolitan area. Their rehabilitation can therefore significantly contribute to the development of the city or region. To wrap up this section on military brownfields, we can cite several inspiring references, such as the city of Cherbourg, France, which created a new campus for the International Film School of Paris (French: École Internationale de Création Audiovisuelle et de Réalisation, EICAR) by transforming the 10-ha site of a former army hospital complex; the Herzogenaurach former German military site, which was gradually developed into the current 59-ha sports campus of Adidas, whose global headquarters is located in this Bavarian city (Beyer 2006); or the implementation of a solar park in the abandoned Tutow air base, also in Germany. And last but not least, one of the most spectacular transformations is probably the creation of the Tropical Island theme park, the world's largest indoor tropical swimming pool, in the huge airship hangar of the former Brand-Briesen airfield in Halbe, near Berlin (Beyer 2006).

However, although several military sites are already being or have already been regenerated—sometimes with a lot of creativity, as the above-cited references illustrate—there is still an important stock of military brownfields awaiting new uses. Indeed, the conversion of military sites into new pieces of the city is far from easy, but rather a complex and multidimensional process (Ponzini and Vani 2014; Bagaeen and Celia 2018). Furthermore, the former activity of these sites often causes misconception or even mistrust in their regard (Lotz-Coll 2018). Among the considerable number of still abandoned, disused or underused military areas, we can cite, as most renowned examples, the Ma.C.Ri.Co. (the acronym of Magazzino Centrale Ricambi Mezzi Corazzati) in Caserta, Italy (32.5 ha) (Di Pinto 2020), the Artillery Arsenal Franz Josef in Verona, Italy, the Metz-Frescaty military airbase in the Metz metropolitan area, France (AFP 2014), or the Željava airbase, situated on the border between Croatia and Bosnia and Herzegovina, one of the largest underground airport and military airbases in Europe.

2.4.2.4 Waterfront Brownfields

The naval field has always been a stimulus for the development of cities: rivers and seas have often been a driver in the choice of a site. Until the middle of the twentieth century, waterfront sectors were places dedicated to multiple commercial activities that combined storage, handling, and production. Due to the significance of fluvio-maritime transport during the early industrialization era, a large number of factories were indeed created along the shores of rivers, lakes, and seas (Urban Vestbro 2007). Often located in the centre of urban regions, they represented their economic base, whether as a simple river port (such as Paris, Frankfurt or Prague), as an estuary site (such as London, Hamburg, Nantes or Lisbon) or as installations in proximity to the open sea, like most Mediterranean harbours (such as Barcelona, Marseille or Genoa).

However, while ensuring substantial sources of income, these mostly industrial harbour sectors also contributed to making these waterfronts inaccessible and, therefore, unattractive to civil society. From the 1970s, these sites started undergoing radical reconsideration in most fluvio-maritime metropolitan regions across the world, including Europe, resulting in a multiplication of abandoned waterfront areas. Due to competition with land transportation, and even more so under the effect of new logistical requirements (shift to container technology, new constraints in terms of handling, storage and access), the storage function of these areas has been considerably reduced (IRSIT 2004).

Today, waterfront brownfields include loading and unloading docks, piers and wharves, basins, warehouses and storage buildings, production facilities, and shipyards, sometimes located beyond the original borders of industrial cities, which were later included within the territories of fluvio-maritime metropolitan regions with the advent of urban sprawl. They are often characterized by a sectorial organization that tends to separate urban and harbour spaces from their associated industrial zone. Therefore, the reconversion of such waterfront areas is a rather slow and complex process. It requires a decompartmentalization or re-permeabilization of the urban-harbour interface, which is to become a new public space shared among the diverse stakeholders of the metropolitan region (Tiano 2010; Lotz-Coll 2018).

We can cite, to illustrate these waterfront liberation processes, the case of the harbours situated along the riverbanks of the Parisian Seine, which underwent a radical decrease of their port activities, in particular following the removal of warehouses in Bercy, Tolbiac and the reduction of the business sectors along the Saint-Martin canal. Dunkerque (180 ha), La Seyne-sur-Mer near Toulon (40 ha), and La Ciotat near Marseille (40 ha) are other well-known French examples of shipyards abandoned due to the economic crisis faced by the shipbuilding industry (Lelogeais 2005; Prelorenzo 2010). Bilbao, Spain, an ancient industrial city dedicated to ironworks and chemistry, also hosts considerable surfaces of waterfront brownfields resulting from deindustrialization processes that drastically affected the region (Bertrand 2018). The city of Prague, which presents a particularly large surface of waterfront brownfields (approximately 160 ha of abandoned factories and warehouses), is another typical European example (Chaline 1999; Vantorre 2018).

Several inspiring examples of beautifully regenerated harbour brownfields can be found in Europe. In Northern Europe, to start with, we can cite the Frøsilo project by MVRDV, a radical waterfront conversion of an ancient silo into a residential building in the old harbour area of Copenhagen, or the impressive Paper Island project by Cobe architects, also situated in the Danish capital, which consists of the rehabilitation of former maritime paper storage facilities into a new district with street food halls, art exhibitions, fashion shows, concerts, and flea markets (see Fig. 2.10). Other interesting examples in Northern European countries include, in a non-exhaustive list, the NDSM Wharf in North Amsterdam, a former shipyard that hosts festivals, fairs, exhibitions, and even Europe's largest flea market (Luca 2019), and the emblematic expansion of the Port Authority Building in Antwerp, by world-famous architect Zaha Hadid. Telakkaranta is another harbour regeneration project in Helsinki, Finland (see Fig. 2.11). The historic shipyard is planned to open to the citizens as a dense, lively,

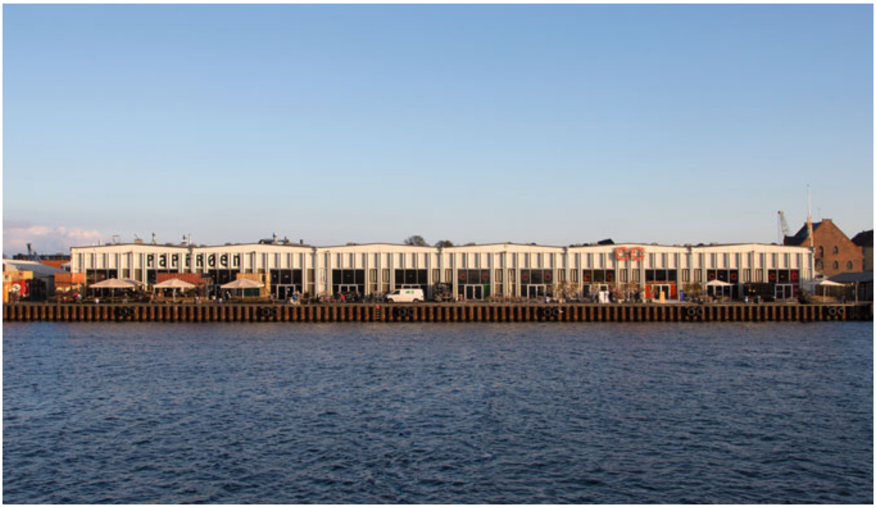

Fig. 2.10 Paper Island, Copenhagen (DK). Rehabilitation of former maritime paper storage facilities into a new district with street food halls, art exhibitions, fashion shows, concerts, and flea markets. Cobe architects, ongoing project (photo: News Øresund – Jenny Andersson, 2016)

Fig. 2.11 Telakkaranta, Helsinki (FI). Regeneration of a historic shipyard into an urban waterfront neighbourhood. Lundgaard & Tranberg Arkitekter, ongoing project (image: © Skanska, Huttunen-Lipasti Arkkitehdit and Lundgaard & Tranberg Arkitekter A/S, 2021)

urban waterfront neighbourhood, offering a promenade with cafes, restaurants and a jetty, but also apartments for about 300 people, as well as business and cultural facilities (Luca 2019).

In Western Europe, we can cite the Bassin à flot project, a 160-ha site at the heart of urban development strategies of the metropolitan region of Bordeaux, France, the Neptune project in Dunkerque, also in France, a former 180-ha shipyard in close proximity to the city centre. The Baltic Sea region cities are also rich in waterfront brownfields and regeneration projects, such as—to name but one—Spīķeri Quarter in Riga, Latvia. This former port warehouse area from the nineteenth century, used for cargo loading and unloading, is an inspiring example in terms of heritage (13 warehouses out of 58 have been preserved and included in the UNESCO World Heritage list) and public space design and activation: the project, which includes a new promenade along the Daugava embankment and hosts flea markets, fairs, and a modern culture forum (Luca 2019).

2.4.2.5 Infrastructural Brownfields

In a similar manner to industrial sectors, many facilities and infrastructures are also subject to processes of technological change that can lead to the abandonment of some sites, which, in turn, leads to the creation of urban or metropolitan brownfields. Although it seems impossible to compile an exhaustive inventory of such multifaceted phenomena, several categories of infrastructures, relatively significant in terms of functional evolution and rehabilitation potential, can nevertheless be identified.

Transport-Related Infrastructures

Beyond railway and fluvio-maritime fields, the entire transport field has been subject to substantial mutations since the middle of the twentieth century. Following logistical evolutions, many transport infrastructures become obsolete and lose their primary function.

We can cite the case of airports that become too landlocked due to the urban extension of a metropolitan area, such as Croydon in London, or Tempelhof in Berlin, which became a huge 350-ha public park—that is, larger than Central Park in New York. Former tram depots, such as Kalkbreite in Zurich, Switzerland, also belong to this category. For this latter cooperative project, opened in 2014, the on-site tram depot was covered by a 2,500 m^2 terrace above the tracks, available to residents and the public as a green recreation area. This kind of infrastructural brownfield may also include sites related to road transport, such as ancient bus stations (for instance Bellevue, south of Saint-Etienne, France) or motorway viaducts. This is the case, for instance, for A8ernA in Koog aan de Zaan, a village near Amsterdam. In order to restore the connection between both sides of town, NL architects activated the area under the road with public space, a marina, a skateboard park, a basketball field, a supermarket, and various shops (Rambert 2015).

Agro-Food Facilities

Many agro-food-related facilities also tend to lose their purpose, due to technical evolutions, relocations or commercial strategies of geographical clustering. Municipal slaughterhouses occupy a key place in this category of agro-food infrastructural brownfield. Because of tighter hygiene rules and increased liberalization of the global meat market, these constructions—often considered troublesome—are progressively abandoned in favour of new facilities located on the outskirts of urban or metropolitan regions.

Gradually, thanks to the often monumental spatial, architectural, and aesthetic potential of these constructions, it has been possible to overcome the negative perceptions linked with these sites. In terms of soil contamination, these killing places are nevertheless qualified as "clean", in the sense that this industry doesn't generate any kind of pollutant—except for the carbon dioxide rejected by the furnace and the cremation oven during operation. In the past decades, several regeneration projects have thus been initiated and realized in Europe. We can certainly cite the French slaughterhouses of Toulouse, transformed into a contemporary art museum, and Lyon, which is now a modern concert hall (the Halle Tony Garnier, named after its original designer). Furthermore, not a lot of people know that the famous 55-ha Parc de la Villette in Paris, designed by French architect Bernard Tschumi, is established on the former site of the La Villette slaughterhouse, originally built in 1867. In Belgium, the former slaughterhouse of Mons hosts, since 2006, spaces dedicated to culture and exhibition. In Spain, the slaughterhouse of Valence has become a sports complex, and that of Madrid (see Fig. 2.12), which included a cattle market, was recently transformed into the Nave de la Música, a centre for multidisciplinary contemporary creation (Rambert 2015). In Switzerland, the Zurich slaughterhouse

Fig. 2.12 Matadero, Madrid (ES). Regeneration of a former slaughterhouse area into a new neighbourhood dedicated to culture. Ensamble Studio, A. Franco, Martin + Batanero, CH + QS arquitectos, 2006–2012 (photo: Fred Romero, 2017)

and its surrounding are currently undergoing a test planning process to develop a regeneration concept and strategy.

Considering their often-problematic rehabilitation, grain silos and their juxtaposed buildings (offices, depots, warehouses, etc.) may also belong to this sub-category of agro-food facilities. Several European examples can be cited, such as the ancient grain silo in Fribourg, Switzerland, transformed into a residential high-rise building, the Armani silos in Milan, where the famous Italian fashion designer Giorgio Armani opened a contemporary exhibition space, or Silo 13, a few metres away from Paris ring road, where the old industrial facility was literally transformed into an urban sculpture hosting a new, vibrant neighbourhood.

Tertiary Sector Facilities

Even though the phenomenon is more recent, and perhaps more modest in terms of surfaces, it is important to stress that some tertiary sector infrastructures may also be subject to functional obsolescence, which sometimes results in their abandonment. A wide variety of facilities related to communication or sports, administrative centres of companies undergoing restructuring or closure (for instance, postal companies), and public buildings that no longer serve a purpose are all types of constructions belonging to the category of tertiary sector infrastructural brownfields.

The emergence of postal brownfields is specifically linked to several substantial evolutions in the field of mail delivery, in particular the double impulse of increasingly digital exchanges and the proliferation of private actors in the sector. The results are significant impacts on logistical and spatial needs, in particular in terms of traditional mail sorting and management centres, which tend to lose their full or partial purpose.

We can cite several European references for stimulating tertiary sector regeneration projects. The Cité numérique in Bordeaux, France, a vibrant location for start-up companies and digital entrepreneurs redesigned by architect Alexandre Chemetov, is established in the former postal sorting centre of Bègles. Also in France, the National Dance Centre is hosted in the brutalist architecture of the former administrative centre of the city of Pantin, in north-eastern Paris, originally built in 1972 by architect Jacques Kalisz. The Carandá municipal market in Braga, Portugal, was also transformed into dance-related activities. The rehabilitation project by architect Eduardo Souto Moura includes exhibition and performance spaces.

Similarly to the other types of brownfields, the large number of infrastructural brownfields awaiting new uses demonstrates the topicality of the issue. We can cite, to name but one, the case of the Athens Olympic Sports Complex, restructured to host the 2004 Olympic games by Spanish architect Santiago Calatrava Valls. Due to its large size and the lack of funds to ensure adequate maintenance, the site is mostly abandoned since the international event and its general state is rapidly deteriorating (see Fig. 2.13).

Fig. 2.13 Hellinikon Olympic Hockey Centre, Athens (GR). Abandoned Athens Olympic 2004 venues since 2004 (photo: Arne Müseler, 2019)

2.4.2.6 Commercial Brownfields

Considering the increasingly changing economic activities and their constantly transforming logistical and spatial needs, it is likely that some unbalance between the built environment and the functions it accommodates will continue to manifest. Hence, new types of brownfields are continuously emerging. And although they probably won't reach industrial brownfields' proportions, these new species of brownfields are starting to find their niche in the specialized literature.

Commercial brownfields, to start with, are among these fresh fields of investigation. They could potentially represent a significant spatial impact. Indeed, the establishment of abundant commercial surfaces on the outskirts of most European metropolitan areas has led, in some regions, to an absolute explosion in the supply of commercial areas. Several authors stress that this proliferation of large shopping centres is based on a globally fragile financial logic (Capucin 2013). Changes in customers' behaviour, for instance, the significant increase in online shopping or the demand for local products emphasized by the pandemic situation, may thus lead to a heavy mutation of this field and to the brutal closure of commercial sites that will find no buyer.

The study of the American situation reveals a serious risk. As a consumerist icon of a flourishing America, the oversized suburban shopping mall seems to face the reconsidering of a societal model that prevailed for several decades. According to a study by Green Street Advisors, about 15% of shopping malls currently in operation in the United States are expected to either close or be converted into non-commercial spaces over the next years (Lekeu 2014). According to another source, up to one-third of American shopping malls—which represents several hundreds of centres—are practically dead (de Graffenried 2017). Furthermore, the recent publication of a series of photographs by American artist Seph Lawless, representing shopping malls abandoned following the last financial crisis of 2008, draws a particularly striking parallel with the aesthetic universe of industrial brownfields (Lawless 2014).

As shopping mall redevelopment projects appear both costly and perilous, the question of what to do with abandoned commercial centres remains open (Voien 2017). In order to go beyond processes of demolition/reconstruction, it may be useful to turn to less recent commercial centres to find inspiration. The Kunsthaus Tacheles, a large 1-ha building and sculpture park in the Mitte district of Berlin, is certainly among the most stimulating references in processes of urban regeneration—or urban recycling—involving commercial architecture. Originally named Friedrichstraßenpassage when it was built in 1907–1908, the five-story department store made of reinforced concrete is a typical example of early Modern architecture. After a first bankruptcy, the building was successively used as a new department store, showroom, and Nazi prison during World War II, before being occupied by the artists' collective Künstlerinitative Tacheles, which opened studios and workshops, a gallery, a nightclub and a cinema. After having experienced multiple uses, demolition and transformation works, the building is now expected to be renovated by Herzog & de Meuron in 2022 in order to host the Fotografiska contemporary Swedish photography museum.

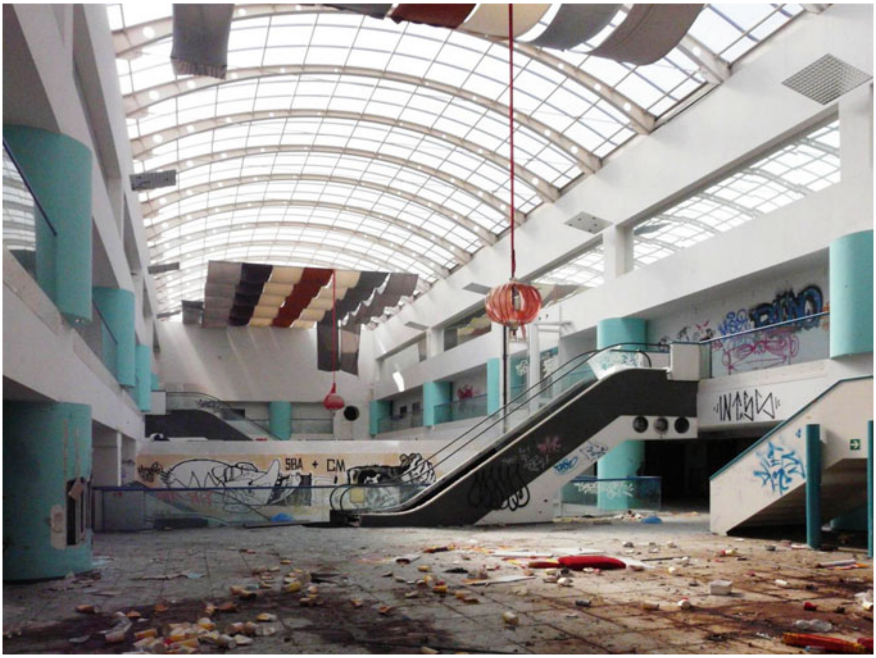

Fig. 2.14 Magic Movie Park, Muggiò (IT). 21,000 square metres multiplex and commercial centre in the outskirt of Milan, abandoned since 2006 (photo: Roberto Barbone, 2016)

Unlike industrial, railway, military, or waterfront brownfields, there are relatively few other examples of commercial brownfields in Europe. We can site for instance the Magic Movie Park, in Milan metropolitan area, Italy (see Fig. 2.14), or the Centro Ovale in Chiasso, Switzerland, both abandoned for several years. Testifying to the relevance and up-to-datedness of the topic, the web platform "Dead Malls Europe" provides a list of abandoned shopping centres across Europe. The online map identifies some twenty "debris" of "consumer society", mostly located in France, Belgium, and the United Kingdom (DeadMaller 2013). This attempt to establish an inventory, albeit partial, opens up encouraging perspectives towards greater acknowledgement of the acute question of the future of abandoned shopping malls.

2.4.2.7 Energy Brownfields

Similarly to commercial brownfields, energy brownfields appear as a relatively new category, preidentified in (Rey and Lufkin 2015), and whose emergence is largely related to the energy transition. Indeed, the possibility of being confronted by energy brownfields is strongly linked with the evolution of energy consumption patterns over the next decades. The strategies developed for the energy transition—blending a search for sobriety and priority recourse to renewable energy—have already started to modify our current uses, and are expected to even more so in the near future. They also impact several infrastructures related to energy production and distribution.

The end of the dominance of oil, as well as the objectives of several European countries to phase out of nuclear energy, represent a real turnaround on the political and technological levels. Hence, this energy transition phase is generating unprecedented questions for several still fully and heavily exploited sites. In the evolving energy sector, which presents particularly challenging, major environmental and economic issues, several electrical installations (in particular those related to nuclear plants) or oil-related sites (refinery or storage) will, in turn, be facing obsolescence, dismantling, and remediation. In that case, these sites will most likely nourish the catalogue of metropolitan brownfields over the next decades. We can site as an example the Mühleberg Nuclear Power Plant in the Canton of Bern, Switzerland, which decommissioning began in January 2020 and is forecasted to be completed by 2034 (see Fig. 2.15) or the Mülheim-Kärlich nuclear power plant (DE), which dismantling work started in 2004 and is expected to be completed around 2029 (see Fig. 2.16).

However, while the energy transition induces the emergence of this new category per se, energy brownfields have certainly existed in the past, although not to the extent of creating a separate, clearly identified group. Abandoned urban network management areas like electricity conversion compounds, gasholder works, power stations, and coal-mining sites, for instance, were typically included in the industrial brownfield category.

Fig. 2.15 Mühleberg Nuclear Power Plant, Canton of Bern (CH). Decommissioning of buildings as part of the strategy of abandoning nuclear power in Switzerland started in 2020 and to be completed by 2034 (photo: Emmanuel Rey, 2021)

Fig. 2.16 Mülheim-Kärlich nuclear power plant, Mülheim-Kärlich (DE). Collapsed of the cooling tower of the decommissioned nuclear power plant in 2019 (photo: Phantom3Pix, 2019)

Several such European regeneration projects can be cited, such as the Battersea Power Station, a decommissioned coal-fired power station located on the south bank of the river Thames in London, United Kingdom, expected to host the new British headquarters of Apple (the project was interrupted due to the COVID-19 pandemics) (see Fig. 2.17). London has also various gasholders awaiting a regeneration project in order to prevent them from demolition, such as the Haggerston, Kensington, and Old Kent Road Gasworks or the Kennington, Wandsworth and Rotherhithe Gasholders (see Fig. 2.18). Similarly, the former Italgas Gazometro in the Ostiense district in Rome is worth mentioning. The Gasometers in Vienna, four former monumental gasholder houses rehabilitated for commercial and residential use, is an example of such a reconversion.

Finaly, we can cite the former mine of Beringen, a unique 10-ha heritage coal-mining site in Flanders, Belgium, redeveloped into the be-MINE integrated tourism and recreational project, the ancient power plant of Saint-Denis, north of Paris, commissioned in 1933 to power the Parisian metro and whose reconversion into the huge Cité du Cinema film complex was designed and supported by French director and producer Luc Besson (see Fig. 3.4, Chap. 3), or, last but not least, the mesmerizing Hlubina Mine in in the traditionally industrial post-socialist city of Ostrava, Czech Republic, an interesting example of cultural regeneration with temporary uses (Luca 2019; Bosák et al. 2020).

Fig. 2.17 Battersea Power Station, London (UK). Transformation of a former power station into a headquarters in the heart of a 7.6-ha new development. Masterplan by Rafael Viñoly Architects, ongoing project (photo: Aurelien Guichard, 2010)

Fig. 2.18 Haggerston Gasworks, London (UK). One of the few and oldest remaining abandoned gasworks structures (photo: © Alizé Soubeyran, 2020)

2.4.2.8 Diverse Derelict Sites

In parallel to the seven above-mentioned categories of urban or metropolitan brownfields, relatively clearly identified in terms of their initial activities, it should be noted that a significant number of derelict sites may also be taken into account. Indeed, since the 1950s, very few activities taking place within metropolitan regions have escaped being reconsidered due to their functionality or their localization.

These multi-layered situations often result in the liberation of unbuilt spaces, sometimes accompanied by the abandonment or even demolition of constructions. These sectors tend to turn into wastelands, that is, devitalized metropolitan enclaves that often suffer from a lack of identity. Countless circumstances, present throughout most European metropolitan areas, can lead to this type of situation.

This last category of diverse derelict sites includes, to start with, the residential or habitat brownfields (Lotz-Coll 2018). This sub-category is composed of neighbourhoods of housing buildings abandoned due to population migration (for jobs or better life conditions), changes in fertility rate, de-industrialization or post-socialism. It is important to stress that while this situation of shrinking cities may be found in Europe—in particular in Eastern and, to a lesser extent, Central European urban areas (Wolff et al. 2013)—it certainly doesn't reach the extent of some North-American metropolitan regions. The case of Detroit, for instance, is particularly representative of this phenomenon, with approximately 200,000 derelict housing units (Rey and Lufkin 2015).

Ultimately, this hybrid group comprises all other types of abandoned sites—whose list, in theory, can expand infinitely considering the proliferation of socio-economic mechanisms that impact activities in and uses of buildings. The non-exhaustive list of sub-categories includes

- Hospital or health brownfields, such as the former hospital area in Berlin-Kreuzberg, resulting from concentration or relocation strategies, which can create considerable enclaves within metropolitan territories (Pascal and Kostrzewa 2017);
- Religious brownfields, which includes numerous sites across Europe such as the Great Synagogue of Constanta in Romania abandoned in the 1990s, Buttevant Convent of Mercy in Ireland abandoned in 2012 or the Benedictine priory in Amay in Belgium abandoned in 2012, to name just a few;
- Educational brownfields, such as the Val-Benoît site in Belgium, former property of the University of Liège which housed the engineering faculty, completely abandoned by students and lecturers in 2006 (see Fig. 2.19);
- Prison brownfields, such as the former Sainte-Anne Prison in the centre of Avignon, France, which should be reconverted in a mixed-use residential and cultural centre, including notably a youth hostel;
- Recreational brownfields, such as the abandoned amusement parks of Fun Park Fyn in Denmark or Mirapolis and Parc Avenue France;
- Speculative brownfields, i.e., districts or blocks intentionally left abandoned for real estate development purposes, such as several neighbourhoods in Brussels;

Fig. 2.19 Val-Benoît, Liège (BE). Regeneration of the Liège university campus abandoned in 2005 into a new mixed-use neighbourhood including office spaces for start-ups and a diversity of housing. Baumans-Deffet Architecure et Urbanisme, ongoing project started in 2011 (photo: Jean Housen, 2017)

- and finally, the more rare, so-called strategic brownfields, for instance, buffer zones located in historically divided cities such as Berlin or Belfast.

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Chapter 3
The Multiple Potentials of Urban Brownfields

Abstract The phenomenon of urban brownfields is significant throughout European metropolitan areas. In this chapter, we assess, both in qualitative and quantitative terms, the inherent potential of urban brownfields to provide a relevant and substantial densification strategy for metropolitan areas. First, we explore the various opportunities for improvement of the built environment offered by urban brownfields in terms of environment, society, and economics, which are the core principles of sustainable development. This analysis is, inter alia, a juxtaposition between urban brownfields and the compact and polycentric city model, adapted to the metropolitan area. While brownfield regeneration appears to be a relevant densification strategy, it nevertheless implies that a sufficient reserve of land is available to engage policymakers. Thus, we attempt to estimate the urban brownfield stock in three countries: the United Kingdom, Switzerland, and France. The data subsequently serves as a basis for our calculation of the theoretical construction potential of brownfield sites.

Keywords Urban brownfield regeneration · Compact and polycentric city model · Densification strategies · Urban brownfields potential · Urban brownfield stock

3.1 Urban Brownfields as a Range of Opportunities

The different categories of urban brownfields presented in Chap. 2 highlighted the great diversity of this type of site. The multiplicity of former activities translates into not only a great variety of situations, but also significant spatial dissemination of the phenomenon within European metropolitan areas. Indeed, at the time of establishment, the choice of where to install the activity—and ergo buildings and facilities—was thoroughly studied particularly with regard to accessibility conditions and raw materials available onsite. As a result of this, many urban brownfields benefit from a strategic location.

The present chapter aims to assess, both in qualitative and quantitative terms, the inherent potential of urban brownfields to provide a relevant and substantial densification strategy for metropolitan areas. In other words, the regeneration of urban brownfields offers a range of opportunities to transform these territories by fostering their transition towards sustainability. Our purpose, in particular, is to raise

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awareness of policy makers and actors involved in regional and city planning on the importance of the issue.

3.2 The Qualitative Potential of Urban Brownfields (Environmental, Sociocultural, and Economic)

The definition adopted for urban brownfields reveals a great diversity of derelict sites which, mainly due to their abandonment, appear a priori to be unattractive or even dreary. It is therefore relevant to underline why urban brownfields can, on the reverse, be of interest for the sustainable transition of European metropolitan areas. To appreciate their qualitative potential, we propose a juxtaposition between urban brownfields and the reference model of the compact and polycentric city adapted to the metropolitan area (more on this reference model in Chap. 5), which is organized around three major principles: density, mobility, and functional mix. Subsequently, we will explore through a literature review various opportunity for the built environment's improvement offered by urban brownfields, in terms of environment, society, and economics, which represent the core principles of sustainable development.

3.2.1 Opportunities for Density, Mobility, and Functional Mix

In 2011, in its "Roadmap to a Resource Efficient Europe", the European Commission called on politicians from member states to be accountable for their land use, with the aim to put an end to the net increase in urbanized land by 2050 (European Commission 2011). In this context of reconsideration of urban sprawl, giving priority to projects located on urban brownfields appears to be a relevant strategy to reach these densification objectives. Indeed, urban brownfields enable greater compactness within cities and metropolitan areas, especially due to their localization within existing urban fabrics. In that sense, they offer a unique opportunity to participate in efforts towards limiting urban sprawl. This feature is probably one of the most obvious and spontaneous potentials offered by brownfield sites. It is acknowledged as such by a large number of territorial authorities (Thornton et al. 2007; Apparu 2011; ARE 2014; DGO4 2014).

In terms of public policy, one of the most notorious examples comes from the United Kingdom, where in 1998 the government introduced an ambitious target for the reuse of brownfields. The initial objective was to reach at least 60% of new residential housing built on brownfields by 2008. For the record, the objective was reached eight years earlier than the deadline (politics.co.uk 2011; Schulze Bäing and Wong 2012). Since 2010, the new political approach is to make local planning authorities responsible for establishing the level and localization of dwellings on their territory. More concrete rules concerning the redevelopment of brownfields, however, still need to be refined (Department for Communities and Local Government 2015). In 2016, a 1.2 billion £ special fund was created to support the purchase of and construction on abandoned land, thus encouraging the densification of urban regions (Carr 2016). It is, however, expected that the funding allocated to soil remediation will be withdrawn, which will most likely penalize such developments in the poorest regions of the country (Harvey 2016).

We have seen previously that the geographical definition of a metropolitan region is far from limited to the city centre (see Chap. 2). A large number of urban or metropolitan brownfields are located in the suburbs or on the peripheries of urban areas. Following the compact and polycentric city model adapted to the metropolitan area (see Fig. 3.1), the notion of urban brownfield finds its place among the multiplicity of territories waiting to be reconquered. Urban brownfields are likely to promote the creation of mixed-use, compact polarities or, in other words, to contribute to the (re)development of dense secondary centres that redistribute to public transport hubs the functions normally found in the inner city (Rogers and Gumuchdjian 1998). In view of all this, brownfields represent particularly strategic opportunities

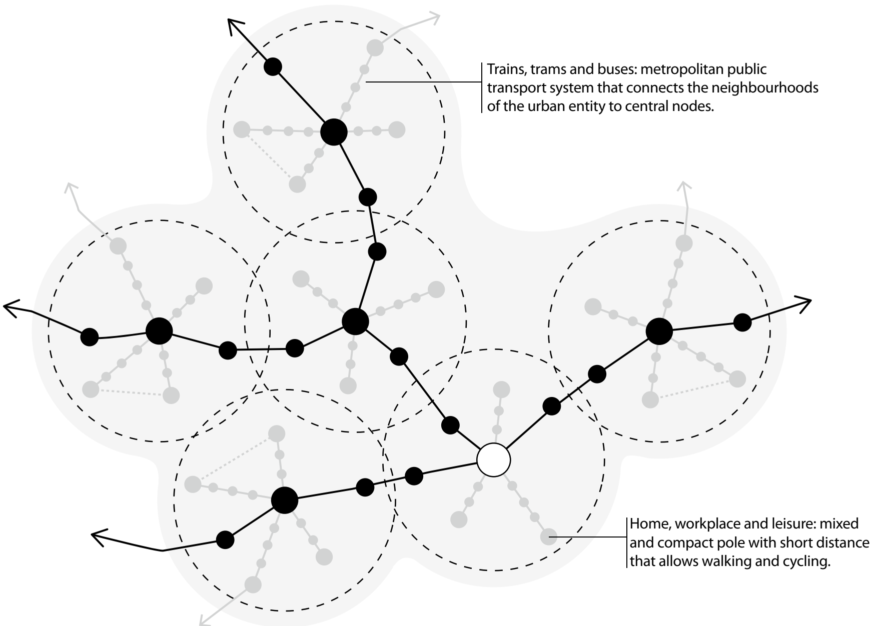

Fig. 3.1 Schematic representation illustrating the compact and polycentric city model adapted to the metropolitan area. From the metropolization phenomenon emerges a hierarchy within the city and its transport network. The neighbourhoods are mixed and compact poles, which allow a certain reduction in the need for individual motorized journeys by the creation of dense and multifunctional secondary centres

for the sustainable transition of metropolitan territories considered as a whole (Rey and Lufkin 2015; Rey et al. 2015).

In that sense, it is also worth strengthening those secondary centres' accessibility and multifunctionality (Lufkin 2010). Let us first remind the reader how important the proximity of modal transport nodes is for that model and, by extension, for urban brownfields. By definition, the densification of those sites will always offer more opportunities in terms of connection to public transport networks and soft mobility than the development of peri-urban or rural sites. Therefore, their densification makes sense only if coordinated with a reflection on mobility (Williams et al. 2000).

Ultimately, we also note that because of their very size (at least a half hectare), urban brownfields truly represent a piece of the city. In other words, they clearly relate to neighbourhood-scale issues. Their redevelopment thus provides an opportunity to create a mixed-use built environment that combines housing, shops, offices, services or craft workshops, as well as quality public spaces and infrastructure. This diversity aims at avoiding monofunctional spaces, such as bedroom communities or business districts, which empty out completely at certain hours of the day (Merlin and Choay 2010). Moreover, merging density and functional mix reduces the geographical gap between activities and supports the creation of a short-distance territory (Hauri 2011).

3.2.2 Opportunities for the Environment, Society and Economy

As previously explained, in accordance with the compact and polycentric city model adapted to the metropolitan area, the regeneration of urban brownfields is a relevant strategy for containing urban sprawl (Schulze Bäing and Wong 2012) and thus for minimizing its numerous negative impacts (European Commission 2013). We highlight here how the regeneration of urban brownfields embodies significant potential to improve the built environment, with positive repercussions on environmental, sociocultural, and economic levels.

We can start by considering projects located on brownfields with contaminated soil. Their remediation represents a real improvement for a wide range of ecosystems (small wildlife, groundwater, soil quality, etc.) (Martin et al. 2005; ADEME 2014). From this perspective, we can cite the "greening" and "soft re-use" approaches, both fast-growing fields of research (Doick et al. 2009; Pediaditi et al. 2010; De Sousa 2014; Bardos et al. 2016). Furthermore, brownfield decontamination provides the advantage of reducing health hazards, and even premature deaths (Rowan and Fridgen 2003; Gilderbloom et al. 2014).

Studies have established a link between abandoned sites and low property value of adjacent plots, as well as an increased number of foreclosures associated with residents' precarity and low quality of life (Gilderbloom et al. 2014). Although decontamination costs can be extremely high, a strategic redevelopment project can create a win–win scenario for the local economy, the environment, and the community

(Thornton et al. 2007; Kotval-K 2016). Indeed, works have highlighted the capacity of regeneration projects to positively influence the economy (Sousa 2002; Lange and McNeil 2004), generate local tax income (Kotval-K 2016), increase employment levels (Sousa 2008), as well as revitalize communities and property values (Dennis and Norman 2006; Schulze Bäing and Wong 2012). Furthermore, some rehabilitation projects count among the strategies developed to tackle the phenomenon of urban shrinkage, which mainly affects Eastern Europe (Rall and Haase 2011). Even though brownfields are an unfortunate (but natural) consequence of a maturing metropolitan economy, their regeneration can become a significant—even vital—contribution to the local economy, notably as an opportunity for diversification.

In parallel, it is essential to understand that regeneration projects enable a restructuring of the metropolitan area, reflected in the emergence of a new urbanity serving the community (Dumesnil and Ouellet 2002). This urban remodelling can occur either by erasing the history of the brownfield, when negatively perceived, or by enhancing the site through an emblematic architectural project (ADI 2015). From the sociocultural perspective, redeveloping a brownfield site can act as a powerful tool to valorise abandoned cultural heritage (Berens 2011; Mieg and Oevermann 2014), creating, once again, positive impacts on neighbouring property values (Van Duijn et al. 2014) (see also Chap. 5 for more detail on preservation of architectural heritage). In addition, the valorization of this heritage contributes to improving the public's perception of the abandoned site, all while reviving a site's specific history (CABERNET 2004). The previously cited example in Germany of Emscher Valley (see Chap. 2) is particularly emblematic of those dynamics.

Regenerated sites, which are very often transformed into cultural spaces, must continue to offer creative and fertile spaces, avoiding the pitfalls of "museumification" (Mieg and Oevermann 2014; Matthews et al. 2014). Indeed, regardless of the building quality, brownfields often temporarily host artist groups and associations with social added value, who take advantage of low-cost premises offering high flexibility of use. The redevelopment of these sites provides an occasion to include a cultural component embedded in local economic and social life, improve user services, regularize situations, and secure the spaces (Barthel 2009; OFEV 2010a; Lusso 2013). The previously mentioned Belle de Mai brownfield in Marseille provides a successful illustration of these processes (see Chap. 2). However, if culture and "patrimonialization" can provide lever effects, their broader definition encourages the diversification of objectives in terms of social, functional, or even economic mix (Mckenzie and Hutton 2014). Figures 3.2, 3.3 and 3.4 show two successful brownfield regeneration projects in France that illustrate this point.

Our multiple converging findings clearly underline the richness of urban brownfields' qualitative potential. Politics aiming at controlling urban sprawl and strategic brownfield regeneration offer the advantage of improving the built environment for the simultaneous benefit of projects' initiators, future users, and the metropolitan territory as a whole. Therefore, in many European countries, that kind of argument has slowly contributed to shifting the perception of urban brownfields from burden to opportunity (Adams et al. 2010).

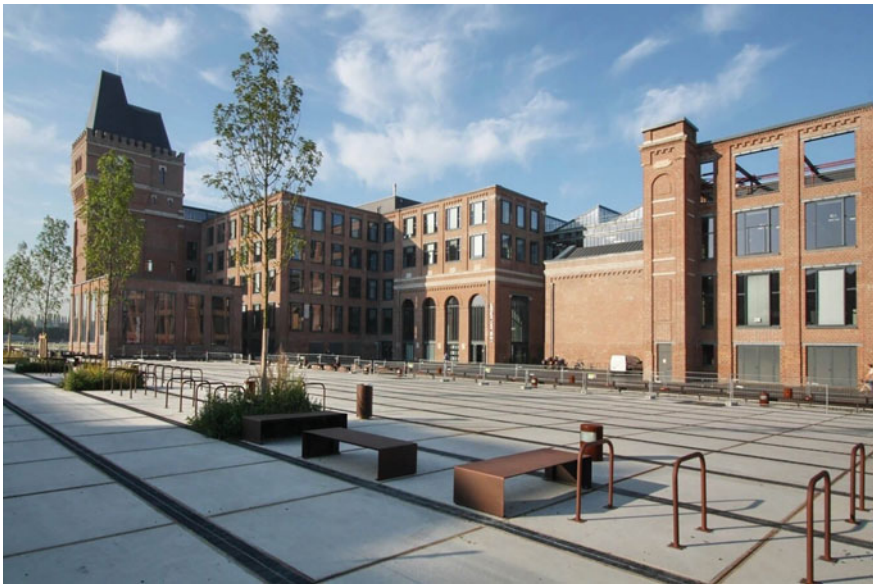

Fig. 3.2 EuraTechnologies Campus, Lille (FR). Transformation of a former spinning mill into a start-up incubator and accelerator. B + A Architectes, 2009 (photo: Stefan83~fwiki, 2018)

Fig. 3.3 La Cité du Cinéma, Paris (FR). Conversion of a former power station into a film studio complex supported by director and producer Luc Besson. Reichen et Robert & Associés Architectes Urbanistes, 2012 (photo: © Reichen et Robert – Architectes Urbanistes © Laurent Desmoulins, photographer, 2016)

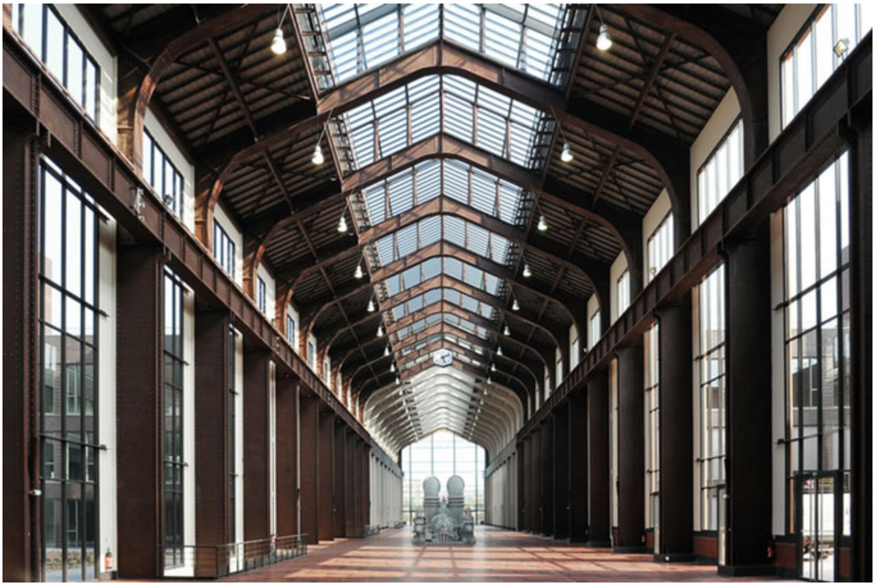

Fig. 3.4 La Cité du Cinéma, Paris (FR). Conversion of a former power station into a film studio complex. View of the central nave. Reichen et Robert & Associés Architectes Urbanistes, 2012 (photo: © Reichen et Robert – Architectes Urbanistes © Laurent Desmoulins, photographer, 2016)

3.3 The Quantitative Potential of Urban Brownfields

After this qualitative perspective, we now propose to evaluate the quantitative potential of urban brownfields, that is, the magnitude of the available European brownfield stock. Indeed, while brownfield regeneration appears to be a relevant densification strategy, it nevertheless implies that a sufficient reserve of land is available in order to engage policymakers. Therefore, inventories are key. Beyond static inventories, the main objective is to enable a community to observe its territory in order to anticipate and detect transformations, and to proactively address the spaces about to become available. An inventory is not only the basis for promoting dialogue between private and public partners (Williams and Dair 2007), but it also contributes to reducing the transitory period during which a site remains abandoned. Ultimately, inventories are powerful tools to help brownfields serve the urban development objectives that the community has set for itself (ACUF 2010).

To proceed with an efficient and reliable census approach, a robust shared definition of a brownfield is required (Oliver et al. 2005). However, as mentioned in Chap. 2, since the EU does not yet have a general brownfield policy (Vanheusden 2009), there is no such thing as a common definition at the European level; nor is there an inventory. Overall, when it comes to collecting data on brownfields, technical issues—in particular contamination—are the main concern. Our understanding of brownfields must therefore evolve beyond simple contamination risks and extend towards a more integrated reflection in terms of sustainable urban development. This naturally requires a broader definition, allowing public institutions to realize the full potential of brownfield regeneration strategies (Oliver et al. 2005).

Due to the lack of definition at the European level, a very few, yet valuable works have taken up the challenge of outlining a European brownfield inventory based on the available data. As far as we are aware, two studies are worth mentioning. The first one was realized in 2002 by the "Brownfield Redevelopment" working group of CLARINET (Ferber and Grimski 2002). Although by then, most European countries were already aware of brownfield issues, the report stated that only a few countries have started collecting data. It estimated or identified approximately 128,000 ha of brownfield land in Germany, 39,600 ha in the United Kingdom, 20,000 ha in France, between 9,000 and 11,000 ha in the Netherlands, and some 14,500 ha in Belgium (Fig. 3.5).

The second study, carried out by the CABERNET network in 2005 (Oliver et al. 2005), is the most recent and comprehensive European brownfield inventory work as of today. Since the report by CLARINET, the 2004 expansion of the European Union from 15 to 25 member states significantly increased the brownfield stock by adding a large number of former industrial, mining, railway, and military sites (Franz et al. 2006), making the task of collecting data even more complex. The study first identifies a list of countries that present no data at all, or very limited data: Bulgaria, Greece, Hungary, Slovak Republic, Denmark, Finland, Ireland, Sweden, Italy, Portugal, and Spain. The surfaces for nations with some form of national dataset available are consistent with the previously cited CLARINET study, in particular Germany, France, and the Netherlands.

The cases of Poland and Romania, respectively, 800,000 and 900,000 ha, reveal the methodological issues with recording brownfield land statistics without a generic

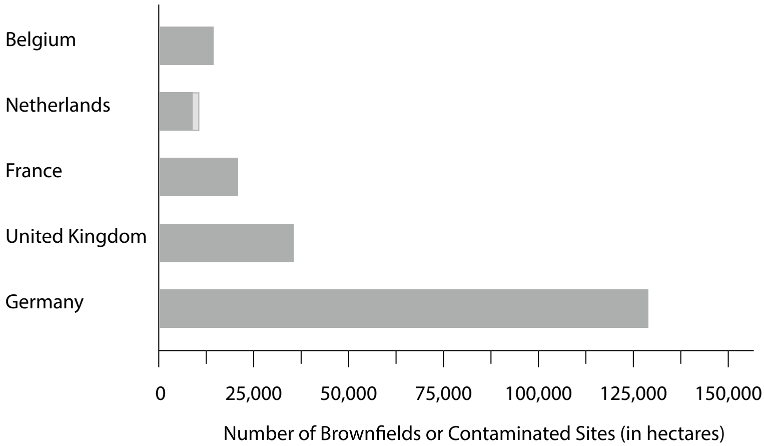

Fig. 3.5 Estimation of the area of urban brownfields in European regions and countries. Data according to Ferber and Grimski (2002)

definition. Indeed, the authors of the study suggest that the magnitude of brownfields in these two latter countries could be explained by how brownfields are defined and information is collected. Since Polish and Romanian brownfield lands are defined by the presence of contamination, large sections of contaminated coalfields that remain in operation have been inventoried as brownfields—which would not be the case in Western Europe. This illustrates the considerable impact of methodology and criteria when collecting data for inventorying purposes.

In order to illustrate the diversity of approaches, we briefly discuss the strategies developed by three countries: the United Kingdom, Switzerland, and France. We analyse the different existing brownfield inventories for each of these nations, which allows an understanding of the urban development potential offered by these specific territories. The data will subsequently serve as a basis to calculate the theoretical construction potential of brownfield sites for the three nations.

3.3.1 Situation in the United Kingdom

Of all the European countries, the United Kingdom is a role model when it comes to brownfield inventory. The fact that the UK was the birthplace of the industrial revolution—after centuries of intense industrial activities generating large numbers of brownfield—certainly helps explain this situation. After publishing the revised version of its development strategy in 2005, which aims at achieving sustainability with the planning system (DEFRA—Department for Environment, Food and Rural Affairs 2005), the UK government has made brownfield regeneration one of its top priorities. It has provided incentives for remediation and redevelopment with recent legislation and made available monitoring tools and triggering networks (Williams and Dair 2007; Uklanddirectory 2014).

In terms of brownfield inventory, England is clearly a few steps ahead of the other countries in the UK (Scotland, Wales, and Northern Ireland). In 2019, the Campaign to Protect Rural England (CPRE) affirmed in its annual State of Brownfield report that "each local planning authority now has a brownfield register recording brownfield land considered to be suitable for housing led development" (CPRE—Campaign to Protect Rural England 2019). These brownfield registers reported over 18,000 sites, covering over 26,000 ha, which could accommodate more than 1 million homes, according to CPRE calculations. Interestingly enough, these estimates differ substantially from the numbers published by the CABERNET study, which calculated 65,760 ha for England (and 10,847 ha for Scotland) based on data from 2003–2004 (Oliver et al. 2005).

Aiming at extending the English approach nationwide, the UK Government communicated the launch of a national brownfield sites map in its 2020 policy document "Planning for the Future" (Ministry of Housing, Communities and Local Government 2020). At the time of writing, the announced document—geared at complementing the existing interactive English brownfield land map (National Housing Federation 2019)—was not yet published.

3.3.2 Situation in Switzerland

Switzerland, due to its small territory and limited urbanization possibilities, is another interesting example. Although the country does not have official, exhaustive statistics on urban brownfields, several surveys on industrial and artisanal brownfields have demonstrated the scale of the phenomenon. In 2003, a study estimated approximately 1,700 ha of Swiss industrial brownfield land, which may seem of lesser significance given the previously mentioned surfaces across European countries. It nevertheless corresponds approximately to the area of the city of Geneva (Valda and Westermann 2004). In 2008, a report including military, railway, and infrastructural brownfields estimated the total surface at 1,820 ha (ARE 2008), mainly located within urban areas (Rey and Froidevaux 2009).

In 2014, the new legislation on territorial planning (Loi sur l'aménagement du territoire, or LAT), aiming at stabilizing urbanized land, in particular by exploiting existing under-utilized reserves more rationally (DETEC 2014), resulted in prioritizing the redevelopment of urban brownfields (CH 2013). In this context, a private company created a database called "Development Atlas", a nationwide database of Swiss sites with a densification potential that are at least 10,000 m^2 (Wüest & Partner AG 2014). The inventory identifies 704 sites, for a total surface of 5,626 ha. Among those sites, 381 items (or 1,922 ha) are clearly industrial, railway, or military brownfields. The remaining 323 sites, which include neighbourhood developments, existing buildings with transformation potential, and vacant building plots, are not considered as brownfields based on the previously proposed definition (see Chap. 2).

However, since the Development Atlas only reports sites measuring 1 ha and more, the Swiss quantitative potential could be more important if we consider brownfield sites from 0.5 ha, as specified in the definition section of this book (see Chap. 2). Completing this dataset, the Federal Office for the Environment (FOEN) launched a web platform designed as a continuously updated observation and information tool on industrial brownfields. Aiming at bridging the gap between private and institutional landowners, site developers, temporary users, investors and public authorities, the platform also presents useful information on legal procedures (in particular, sourcing financial aid) and best practice projects of redeveloped sites (OFEV 2010b).

Based on these multiple sources, a more recent study calculates the total surface of Swiss brownfield land at between 2,500 and 3,500 ha (Rey and Lufkin 2015). While this number remains an indicative range, it nonetheless provides a realistic order of magnitude and serves as a benchmark on the subject.

3.3.3 Situation in France

Although France is also a country with a rich industrial past and, therefore, great diversity and abundance of brownfields, until recently it had neither an official territorial planning definition for the term "urban brownfield", nor did it have a planning or monitoring tool likely to enable the realization of a consistent nationwide inventory. However, as we will see at the end of this section, things are rapidly progressing, thanks to many actors insisting on the necessity of agreeing on a common, integrative definition established at the national level (ACUF 2010), capable of extending the brownfields phenomenon beyond the notion of potentially contaminated former industrial sites (ADEME, Agence de l'Environnement et de la Maîtrise de l'Energie 2014).

Previously, scarce information could be obtained, and only for the most affected regions. In the 1990s, for instance, it was established that the Nord-Pas-de-Calais region held the sad record of 10,000 ha of industrial brownfields, which represented 50% of the total surface of brownfields in France (Pacaux and Decocp 2010). In 2010, after the redevelopment of approximately 5,000 ha of brownfields, a total of 20,000 ha could be estimated for the country, located mainly in urban areas (Merlin and Choay 2010).

The Delegation for Local Development and Regional Action (DATAR) also carried out a national census, which estimated the same total surface of 20,000 ha of industrial brownfields (Rey 2012). This slightly dated estimate, however, is only a very rough calculation. Moreover, it does not include other types of brownfield—such as military, waterfront, infrastructural, commercial—and reports sites located outside metropolitan or urban regions. Therefore, based on a combination of sources, experts estimated the total surface of urban brownfields of all types between 30,000 and 35,000 ha (Rey 2012). This clearly exceeds the calculations by (Oliver et al. 2005), which approximated the figure of 20,000 ha. Furthermore, the Agency for the Environment and Energy Control (ADEME), which promotes brownfield regeneration (among other things, by financially supporting soil remediation to initiate redevelopment projects) estimated a surface of tens of thousands of hectares of urban brownfields (ADEME 2010).

Very recently, the growing interest for redeveloping brownfields—in particular contaminated ones (ADEME 2020a)—and for land and real estate monitoring tools (ACUF 2010) reflects the emergence of territorial knowledge as a new challenge. In this favourable context, initiatives and activities by various actors, such as the Laboratoire d'initiatives foncières et territoriales innovantes (LIFTI), are about to lead to the creation of a national brownfield inventory. Indeed, such an inventory was recently identified by a working group launched by the Ministry of Ecological Transition as a powerful tool to stop the urbanization of new land and reach the target of net zero artificialization (Laperche 2020). As a result of these joint efforts to support the national brownfield inventory, a test version of an online application called "Cartofriches", developed by the Cerema, was launched in July 2020 (Cerema 2020).

The realization of this online portal, which should soon provide researchers and practitioners with updated, reliable, and precise quantitative data on the brownfield situation in France, was made possible by the creation in 2020 of a 300 million € government fund aiming at supporting the regeneration of urban brownfields. The main objective of this special "brownfield recycling fund", open to public authorities and private companies, is to unblock situations which fail to progress without public support, in particular due to soil contamination (ADEME 2020b; Ministère de la Transition écologique 2020).

However, for the time being, since certain urban communities still lack precise statistics on the scale and nature of brownfields located on their territory, we have to make do with the above-mentioned order of magnitude of 20,000 ha, which, again, reflects the methodological complexities of making an efficient and meaningful inventory.

3.3.4 Construction Potential: Urban Brownfields' Contribution to Containing Urban Sprawl

The previous section demonstrated that the scale of urban brownfields in each of the selected countries—except England—remains a more or less approximate estimate. As illustrated, the numbers from one nation to another are difficult to compare because each inventory is based on a different definition. Despite this, the above-mentioned estimates can allow us to calculate the theoretical construction potential offered by urban brownfields. Based on three densification scenarios: "S1-Low density", with a floor area ratio (FAR) of 0.5; "S2-Medium density", with a FAR of 1; and "S3-High density", with a FAR of 2 (Table 3.1), we now present these densification perspectives (Table 3.2).

Based on our calculations and with a medium-density assumption (S2), the current urban brownfield stock could host a population increase between 7% (Switzerland and France) and 11% (England). At first glance, these estimates of the potential number of housings and inhabitants could seem ambitious. But one must take into account that the density of this type of metropolitan site is often higher than the average urbanized land. We would also like to underline the fact that new brownfield

Table 3.1 Densification scenarios

Scenario assumptions	S1 low density	S2 medium density	S3 high density
Densification potential	FAR = 0.5	FAR = 1	FAR = 2
Housing potential	96 m^2 GFA[a]		
Inhabitants potential	2.3/housing[b]		

[a]European average. Average size of dwelling by household type and degree of urbanization, eurostat, 2012. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_hcmh02&lang=en
[b]European average. Taille moyenne des ménages - enquête EU-SILC, eurostat, 2018
FAR = Floor area ratio
GFA = Gross floor area

Table 3.2 Theoretical construction potential offered by urban brownfields in England, Switzerland, and France

	Reference	UK (England)	Switzerland	France
Estimated surface (ha)	Census (official/partial)	26,000 ha	1,922 ha	20,000 ha
	Rey (2012)	–	2,500–3,500 ha	30,000–35,000 ha
	Oliver et al. (2005)	65,760 ha	–	20,000 ha
	Adopted estimate[a]	26,000 ha	2,500 ha	20,000 ha
S1 low density	Densification potential	130 M m^2	12.5 M m^2	100 M m^2
	Housing potential	1,354,167	130,208	1,041,667
	Total inhabitants	3,114,583	299,479	2,395,833
S2 medium density	Densification potential	260 M m^2	25 M m^2	200 M m^2
	Housing potential	2,708,333	260,417	2,083,333
	Total inhabitants	6,229,167	598,958	4,791,667
S3 high density	Densification potential	520 M m^2	50 M m^2	400 M m^2
	Housing potential	5,416,667	520,833	4,166,667
	Total inhabitants	12,458,333	1,197,917	9,583,333
Percentage of the population	Total population	56,286,961[b]	8,606,000[c]	67,098,824[d]
	Percentage of the population (S1)	5.5%	3.5%	3.6%
	Percentage of the population (S2)	11.1%	7.0%	7.1%
	Percentage of the population (S3)	22.1%	13.9%	14.3%

[a]For Switzerland, due to approximative and/or incomplete data, we adopted an average value. For France and England, we used the more recent, reliable source
[b]Office for National Statistics, National Records of Scotland, Northern Ireland Statistics and Research Agency – Population, 2019 Estimates. https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2019estimates#population-growth-in-england-wales-scotland-and-northern-ireland
[c]Office fédéral de la statistique, 2020
[d]Population au 1er janvier, eurostat, 2020

inhabitants are hosted without using additional land. In that sense, the higher the hosting capacity, the lower the pressure on developing other, not yet urbanized sites. Therefore, regardless of incomplete or imprecise inventories, we can affirm that urban brownfields offer a very real, far from negligible construction potential. From that perspective, their regeneration is a relevant strategy to limit urban sprawl.

To wrap up this reflection on brownfields' quantitative potential, allow us to digress on the idea that, as certain opponents claim, urban brownfield stock is about to disappear. On the contrary, as authors L. Andres and B. Bochet remind us, "[brownfields] are a punctual, yet perennial phenomenon in urban history. They reflect economic, political, democratic, ideological and social upheavals in urbanized societies" (Andres and Bochet 2010). They are certainly not perennial on the long-term, but rather are an integral part of a constantly evolving territory. Brownfields can thus be considered as a "perpetually regenerating resource, with the potential to provide a steady pipeline of development opportunities" (CPRE—Campaign to Protect Rural England 2019). Evidence of these processes includes recent events, such as the 2008 economic crisis, which has proven to turn the system into a true "brownfield maker" (Lafeuille and Steichen 2015).

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Chapter 4
Urban Brownfield Regeneration Projects: Complexities and Issues

Abstract Because of urban brownfields' inherent complexity related to their very nature, as well as their intermediate scale—the neighbourhood—regeneration projects are not a spontaneous process. Indeed, an urban brownfield regeneration project may encounter several issues, which can be obstacles, barriers, or resistance, that we classify in four types: sociocultural barriers, governance involved by the multiplication of actors, legal and regulatory constraints, and deterrent costs. While these issues contribute in turn to complexify brownfield regeneration projects, they are not insurmountable. Finally, to overcome urban brownfield regeneration projects' complexities and issues, we argue that there is a need to implement real project dynamics. To this end, we provide four potential approaches to foster the creative development of tailored solutions.

Keywords Urban brownfield regeneration project · Sociocultural barriers · Stakeholders · Governance · Legal and regulatory constraints · Costs · Soil contamination · Project dynamics

4.1 Regenerating Urban Brownfields

While urban brownfields' potential for the sustainable transition of metropolitan areas has been demonstrated in the previous chapters, notably as a densification strategy, it should be noted that their redevelopment is far from a spontaneous process. In the real world, brownfield regeneration projects encounter a series of issues—not to say obstacles, barriers, or resistance—related in particular to the complexity of such operations. Indeed, brownfield regeneration projects are far more complex than the construction of an isolated building or the development of a new neighbourhood on a vacant plot. Related to the very nature of urban brownfield sites covering an intermediate scale—the neighbourhood—with a building legacy of variable quality, often disconnected from their context, sometimes contaminated, and suffering from a poor image, we identify regeneration project issues according to four distinct types: sociocultural barriers, governance involved by the multiplication of actors, legal and regulatory constraints, and deterrent costs. In turn, these issues contribute to complexify brownfield regeneration projects. The proposed classification of issues

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needs to be balanced by a certain degree of flexibility in terms of permeability between the different types of issues, since the legal, economic, or social dimensions are sometimes combined within a single resistance factor. Ultimately, we argue that the emergence of a real project dynamic in an urban brownfield regeneration, which extends far beyond the initial stages of the process, can contribute to revealing the site's potential and establishing a guiding vision. This approach is essential to allow for efficient management of these complex operations.

4.2 Sociocultural Barriers

4.2.1 Negative Perceptions

The implantation of certain programmes—in particular, housing—on brownfield sites may, a priori, appear counter-intuitive. By definition, urban brownfields are partially or totally abandoned sectors, which tends to give them a sense of decline. For a long time assimilated to inhospitable territories, these abandoned sites tend to become a privileged place for the expression of urban counter-cultures and marginalities of all sorts, sometimes resulting in a nefarious reputation (Menerault and Barré 2001). This negative image can discourage many potential investors.

Uncertainties related to soil contamination (more on this below) also contribute to reinforcing the negative perception of these sites. In addition, the inhospitable aspect or the resulting negative connotations do not support the triggering of investments nor the identification of target users. Hence, a veritable vicious circle can set in: unattractive sites do not encourage investment, and this lack of investment makes them even less desirable.

Despite this climate of negative perceptions, there is a true renewal of interest in city life. The desire for fresh air and open nature, which motivated many city dwellers to seek single-family houses in rural areas, is now clearly counterbalanced by the idea that urban life has become "chic" (Federal Environmental Agency 2005). In many European cities, populations are on the rise again. Among other aspects, city residents are typically attracted by such urban attributes as old building atmosphere, historical character, proximity to workplaces or educational facilities, infrastructures, cafés, restaurants, etc. The "back to the city" trend certainly gives new chances to urban brownfields and positively influences their overall perception.

4.2.2 Railway Related Nuisances

Railway brownfields and industrial brownfields located in proximity to railroads are particularly affected by this phenomenon. Indeed, often too close to heavy mobility infrastructure, with an environment characterized by air pollution and electromagnetic fields, railway stations were systematically located away from urban centres. Today, advances in technology make it possible to overcome a large part of the nuisances traditionally associated with railway, in particular noise pollution, both in terms of emissions (modern disc brakes, composite brake blocks) and immissions (localization of living areas, noise barrier walls, soundproofing double glazing, etc.). Regarding non-ionizing radiation, railway electric transport lines have been shown to generate a relatively low level compared to other sources. Furthermore, additional shielding measures can be implemented within buildings.

European metropolitan regions host several successful examples of residential buildings located close to railways. One of the really noteworthy realizations is probably the Röntgenareal in Zurich, Switzerland, in particular because three inhabitant surveys have been carried out on this ensemble of nine housing units built along the railways (Gloor and Meier 2010). Results demonstrate users' feeling of improved quality of life and railway-related nuisances are seldom mentioned. Hence, the study speaks to the general satisfaction of the "railway residents", which is certainly the result of intelligent, carefully planned architectural measures.

4.2.3 Opposition Risks

Diverse types of opposition related to the presence of former users of the site also represent a significant sociocultural resistance factor. Stemming from individual actors or interest groups who fear the loss of character of the site or reject the new proposed programme, these oppositions may lead to the temporary blockage or definitive end of the regeneration project's process. Typically, they appear when the project is submitted for public approval, during the phase of changing land-use regulations to obtain building rights.

Two main categories of actor can be identified in terms of action potential: the beneficial owners (owners of the land concerned by the redevelopment project, direct neighbours, and some associations), who can be, according to national regulations, directly subject to the right of opposition; and the other citizens, i.e., any inhabitant enjoying civil and political rights, who might have the possibility of participating in referendum-type processes against decisions made by a public authority. Here again, the latter's scope for action greatly depends on national political systems: direct democracies, such as Switzerland and Luxembourg, are clearly more concerned by this potentially critical situation for a brownfield regeneration project.

Aiming at reducing the risk of opposition, participatory approaches allow planners to understand the concerned users' expectations and desires before reaching this critical stage. Very often, in practice, the result of a public inquiry or a referendum appears to depend both on the intrinsic qualities of the project and the communication strategies deployed by the project leaders (Lufkin 2010). The section of this book dedicated to the project's process (see Chap. 6) will provide the opportunity to return to and go further into that topic.

4.3 The Multiplication of Actors in the Project's Process

4.3.1 Five Categories of Stakeholders

Considering their size (according to our adopted definition, their surface is superior to a half hectare) and their strategic importance for the development of the entire metropolitan region, brownfield regeneration projects are typically characterized by the involvement of a multiplicity of stakeholders, which undeniably tends to complexify the process. Presenting a large diversity of interests and degrees of influence, these stakeholders can be structured according to five main categories:

1. **Public authorities and services** are involved through their role of guardian of the general interest and their direct or indirect support for the project process.
2. **Landowners** play an active role at the beginning of the project, in particular for the sake of valorising their property. Subsequently, their involvement can either continue if they decide to invest themselves or diminish if they decide to sell their property.
3. **Clients** (or principals) include the different private or public investors participating in the project's funding.
4. **Planners** (or agents) include the different professionals involved in the project design and realization: urban planners, architects, engineers, specialists, and construction companies.
5. **Users** are represented either directly in the client's structures, in the case of an investment of their own, or in a more limited way if they are only tenants. Besides, temporary uses may mean that the clients need to manage relations with users not directly related to the project.

The first two categories of stakeholders (i.e., public authorities and services and landowners), which play strategic roles at the beginning of the project, may potentially generate greater complications in the redevelopment project process, as we will see in the next section. For municipal authorities, an urban brownfield regeneration represents an opportunity to support a project in line with the strategic objectives of sustainable urban development, which notably aim at encouraging the densification of already built-up metropolitan areas (more on sustainability issues in Chap. 5). Furthermore, a regeneration project may be an opportunity to meet the need for specific infrastructure (cultural activities, sports facilities, etc.), foster the creation of new housing or diversify the range of commercial premises. Established within a global approach of improving the metropolitan region's image, it offers the possibility of reintroducing urban continuities while simultaneously creating new public spaces. For landowners, the primary purpose is to add value to their property, either by selling it to a third-party investor or by an investment of their own, which should allow them to generate new rental incomes.

4.3.2 The Importance of Governance

The multiplicity of stakeholders involved in the process, and therefore of interests and deployed strategies, represents an additional challenge in starting up and realising a regeneration project. Therefore, governance becomes key. It can be defined as the ability to produce an informed decision based on a plurality of stakeholders. The organization of discussions between the latter is indeed the subject of many tensions and requires some expertise on the part of the decision-making actors.

The first difficulties to overcome are related to the possible necessity of redefining the land register (sometimes called parcel framework) and to the determination of the land price (agreement to be reached between the different landowners). This coordination between several owners' actions in order to establish a common vision sometimes faces differences of intention or blockages by certain key stakeholders.

On another level, institutional coordination also represents a major issue in the project process. Indeed, brownfield sites are often located on different municipalities within a metropolitan area and are often governed by regional policies. This may lead to conflicts related to inter-communality and coordination between the different political and administrative levels. Intersectoral coordination is also of paramount importance in the interplay of governance. Municipal or regional public authorities may experience internal communication difficulties, which can result in different services expressing contradictory views. The complex coordination between transport and urban planning policies can be cited as an example. Many reasons can explain this complexity, including the projects' temporality (transport project typically last 1 to 5 years, while urban planning projects last between 10 and 15 years), the continuity of public action, the involved stakeholders' professional cultures, and the potential power struggles between administrative services (Ollivier-Trigalo and Piechaczyk 2001).

4.4 Legal and Regulatory Constraints

One of the primary objectives of the legal framework is to ensure citizens' security and safety. However, some adverse effects may result directly from overly rigid architectural or urban planning norms, which can potentially act as additional constraints. Therefore, the challenge is to find a balance between pragmatism and standardization, through creative, specific solutions and incentive public policies.

Until recently, in most European countries, planning tools were relatively inappropriate to brownfield regeneration strategies. Most regional masterplans projected significant construction potential in suburban and peri-urban municipalities, which made it difficult to channel urbanization within already built-up areas. In Chap. 3, we briefly illustrated the trend of territorial politics in the UK, Switzerland, and France. This evolution can also be observed in most European nations, where consensus is growing that brownfield regeneration can play an important role in revitalizing metropolitan areas (Vanheusden 2009). It aims at rectifying a situation inherited from the "glorious thirty" (the years of reconstruction following the Second World War) by integrating densification strategies in proximity to city centres.

However, despite this favourable context, legal and regulatory frameworks are often cited as important barriers on the European level (European Commission 2019). The fact that the European Union does not yet have a general brownfield policy (Vanheusden 2007) probably contributes to complexifying the situation. Among the various obstacles, we can cite unclear or complex (transfer of) liability, inadequate, conflicting or changing legal frameworks, compliance with the polluter pays principle (e.g., orphan sites), or the unnecessary conservatism and precaution of some regulations.

Among the different situations where legal standards may have a constraining impact on brownfield regeneration, we find the specific example of former railway sites. The case of Switzerland, here again, is relatively eloquent. The Swiss Ordinance on Protection against Major Accidents applies to all developments next to infrastructures with frequent transportation of hazardous materials. A development threshold (in terms of buildings' human density) is set for such areas considered at risk, according to the probability of a major accident and the severity of the potential consequences (Lufkin 2010). This can result in the implantation of low-density professional activities, at the expense of residential programmes, commercial premises or public institutions with heavy attendance—which, of course, is intrinsically contradictory to strategies of qualitative densification.

However, since debate on softening territorial or urban planning standards is not on the agenda of the majority of European states, the most realistic strategy is certainly to consider regulatory constraints, and standards in particular, as incentive obstacles to be overcome with increased inventiveness and creativity in architectural design. In parallel, the development of a common, long-term, and integrated vision, among other solutions, may constitute an efficient approach to deal with the complexities of the legal and regulatory frameworks (European Commission 2019). We will pursue these reflections on using the project as a basis for urban and architectural coherence in Chap. 6.

4.5 Deterrent Costs for Potential Investors

Financial resistance can also constitute a particularly problematic parameter in brownfield regeneration projects (European Commission 2019). Abandoned sites, as their name evokes, are generally characterized by relatively low demand and therefore low land values. In most cases, this general lack of interest can be explained by the additional investments generated by longer planning or construction periods for brownfield regeneration projects with respect to new developments on a vacant piece of land.

4.5.1 Soil Contamination

A whole range of parameters tends to increase the uncertainty level in a brownfield regeneration project, starting with soil contamination, cited earlier. The high costs of soil investigation and remediation, determined by the level and type of pollution, represent a significant risk factor. Furthermore, in addition to generating potential obstacles to brownfield regeneration, the issue of soil, as a non-renewable resource, has been identified by many European public entities as a major challenge. Soil quality, especially in terms of soil functions and associated services to humans, is of paramount importance, and probably even more so in increasingly urbanized metropolitan contexts (Monfort et al. 2020).

In quantitative terms, the European Environmental Agency (EEA) estimates a total of 250,000 contaminated sites across Europe, and approximately 3 million potentially contaminated sites (i.e., where an investigation is necessary to establish whether remediation is required) (European Environmental Agency (EEA) 2007). However, this impressive figure must be put into perspective. In addition to sites contaminated by industrial and military use, it includes sites polluted due to waste landfills and agricultural activities. Contamination caused by industrial and military use represents around 70% of all cases (European Court of Auditors 2012). Thus, the number of sites potentially contaminated by such activities can be estimated at 2.1 million. Considering the industrial past of most EU countries, a relatively large proportion of the latter could be considered as brownfields (Vanheusden 2009). Therefore, despite the roughness of the calculations, potentially contaminated brownfield sites represent a consequent figure.

Many European countries such as the Netherlands, Germany, Belgium, or the United Kingdom have established finely tuned legal instruments to manage soil contamination issues (Ferguson et al. 2005). In Switzerland, all cantons are required to make a land register of polluted sites. The inventory, which is mainly based on a historical investigation on the type of activity and operational life of the site, determines the risk of soil pollution for each plot in the territory (Rey and Lufkin 2015). In France, similar mechanisms have been implemented by the ALUR law (2014), which aims at overcoming barriers to contaminated brownfield regeneration, in particular by clarifying responsibilities and introducing information on soil pollution in the Plan Local d'Urbanisme (Local Urbanism Plan) (Lafeuille and Steichen 2015).

At the European level, although community legislation specifically focused on soil protection does not exist so far, there are several relevant legal documents which address brownfield remediation (Vanheusden 2009). Recent actions have been taken by the European Commission and new official directives have been approved by the European Parliament. The latter can contribute to improving the situation with respect to liability and traceability of environmental contamination, in particular by identifying the company responsible for the contamination—which, according to the Environmental Crime Directive (Official Journal of the European Union 2008), may now be seen as a criminal offence.

In the real world, however, things are not so simple. On the one hand, access to information is not always guaranteed. On the other hand, the speculative nature of this type of investigation should not be minimized. Indeed, without an in-depth study of the soil, the determination of the precise level of contamination will always remain approximative. Therefore, investigations are not totally reliable instruments, and the fact that a site is not reported in an inventory does not necessarily mean that it is clean (Indaco and Chappuis 2008). Furthermore, each contaminated site has unique characteristics and features, which will determine the specific methods to be applied for its remediation (in situ, on-site or off-site), as well as the resulting costs. Off-site treatments are clearly the most expensive ones because they combine excavation, transport, and elimination. The elimination costs alone may vary a lot, depending on the adopted approach. On an indicative basis, experts calculate a factor 50 between the simple discharging of inert materials and their high-temperature incineration in a specialised centre (Indaco and Chappuis 2008).

In most European countries, the necessary measures (investigation, monitoring, sanitation, or reporting) are theoretically covered by the holder of the contaminated land (owner or tenant). Depending on the circumstances and national regulations, the polluter pays principle may sometimes be applied in order to privilege equal treatment.

Of course, this is not always possible, for instance in case of orphan sites with no traceability (impossible to find out who is responsible), or if the polluter is found to be insolvent. In those situations, a public authority may assume part of the remediation costs. However, despite the variance in legal provisions from country to country, the idea that the site owner is required to bear the remediation costs remains widespread. Therefore, since the financial risk associated with potential costs is proportional to the level of uncertainty, unknown information about the nature and scale of contamination tends to discourage some investors.

4.5.2 Relocation of Activities

Besides soil contamination, the relocation of activities also occupies a considerable place in the list of financial resistance factors. Some transitory uses (residual rentals, temporarily authorized occupations) may put up resistance to the regeneration project because it implies their end. They may therefore stay on the site longer than initially expected. In addition, many abandoned sites depend on the relocation of part of persisting activities, whether industrial, artisanal, harbour, or other. The relocation of these activities may present challenges: the relocation costs can not only be high, but their temporalities can also be shifted from a site's development requirements. Therefore, the phasing of the project in conjunction with existing uses can sometimes be delicate. It may even lead more extended planning to deadlock.

Beyond financial aspects, the relocation of activities deserves to be viewed with a critical and global eye because it transcends conflicts of interest internal to the brownfield. Indeed, from a sustainable territorial development perspective, the strategy to relocate industrial and artisanal activities or freight transport towards the outskirts of metropolitan regions is questionable. A mix of functions and the preservation of production activities within cities are necessary conditions to create sustainable neighbourhoods which are dynamic on the economic and sociocultural levels (see Chap. 5).

The example of railway brownfields, for instance, provides a clear illustration of the complexity of relocation issues. In terms of logistics, the relocation of sorting centres towards peripheral areas contributes to increasing the distance with the end consumer, thus generating important truck traffic within the metropolis. Relocating also tends to reproduce dynamics of territorial fragmentation similar to those of zoning practices. Indeed, the removal of cargo activities from urban centres increases the development of production sectors in peri-urban districts. And since public transport networks perform less well there than in denser areas, the rise in commuter flows results in massive use of individual cars.

Similar arguments can be developed with regard to regeneration projects of harbour brownfields. Arbitrage between the creation of new residential neighbourhoods and the preservation of port activities is a delicate issue, which needs to be considered from a global and systemic perspective—and certainly not a sectorial viewpoint. The systematic removal of freight transport activities (and artisanally or industrially related functions) for the benefit of exclusively residential or tertiary programmes does not provide a satisfactory answer to the challenges faced by metropolitan areas in transition.

Ultimately, the coexistence of activities of various scopes and natures requires an arbitrage that needs to be operated upstream, including all concerned stakeholders in order to avoid major blockages or large-scale functional deficits.

4.6 The Need for Project Dynamics to Overcome Obstacles

While all the above-mentioned issues contribute to complexify brownfield regeneration projects, they are not, however, insurmountable obstacles. To better understand these mechanisms and identify the leverage likely to encourage these sites' redevelopment, a survey was carried out on Swiss industrial brownfield landowners (Valda and Westermann 2004). The results analysis shows that the most acutely perceived barriers are mainly related to unfavourable conditions (lack of users or land-use plan building constraints) and to the difficulty of triggering the necessary investments to launch a project (lack of initial funding and absence of financial help).

Given these results, it appears essential to note that the importance generally assigned to brownfield remediation costs should not be overemphasized (see Fig. 4.1). No brownfield landowner has cited the latter in the list of obstacles to brownfield redevelopment. To explain this outcome, the survey's authors mention several assumptions:

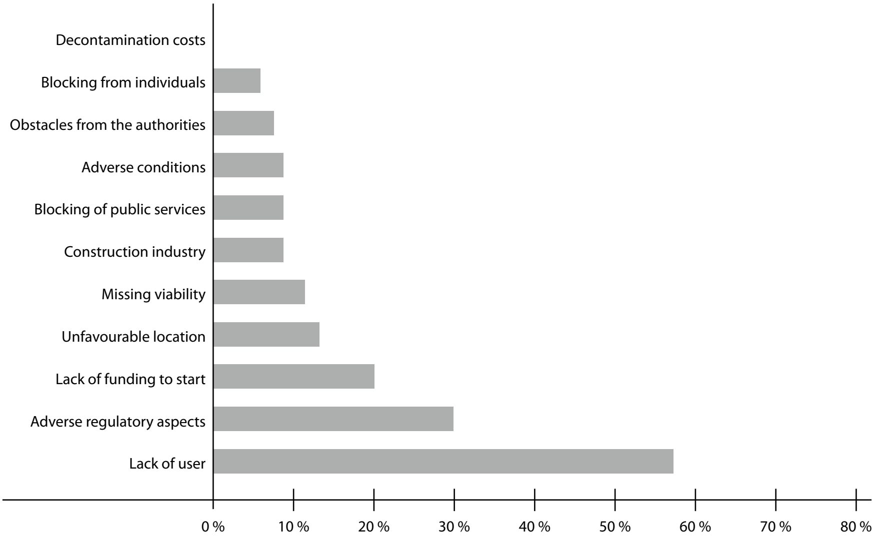

Fig. 4.1 The relative importance of the various obstacles to the regeneration of brownfields. Data according to Valda and Westermann (2004)

- Remediation costs may have been assessed through an evaluation of the site's contamination; therefore, it was possible to integrate them into the project's financial plan;
- Contamination is not perceived as an issue for owners, but rather for investors;
- The contamination obstacle may sometimes be classified in the "lack of users" category;
- Contaminated sites may be perceived less as a financial obstacle than as a slowdown factor at the beginning of the project;
- Owners who consider remediation costs as a major obstacle did not participate in the survey.

However, it remains true that the emergence of real project dynamics is often confronted with the difficulty of overcoming the above-identified issues. The observation of multiple projects of this type also allowed us to highlight that their realization is often marked by the commitment of a main stakeholder who leads the project and plays a driving role. The latter may come from any number of professional horizons, but in the case of urban brownfield regeneration projects, architects or urban planners often assume this function, whether through their specific position within a public structure or a public or private mandate. Sometimes, following an action triggered by a stakeholder's initiative, he or she may be recognized as project lead and therefore acquire a specific position within the involved stakeholders' group (Wyss et al. 2011).

Having a political representative lead the project can also become a key element for the smooth rollout of the regeneration process. These dynamics, however, are often complex and generally unpredictable. Indeed, the time span of an urban project considerably exceeds that of an elected person's office, which tends to generate conflicts of interest or interruptions in decision-making processes.

The presence of a driver at the operational level also appears as an essential element not only to motivate investors' interest in the regeneration project, but also to organize negotiations, implement adequate regulations, and, more generally, to overcome blocking points throughout the operation. More specifically, this can be translated into the creative development of tailored solutions, which can be structured according to four axes (Von Fischer and Bulliard 2002):

- *Consultation processes.* The project dynamics enables to stimulate converging interests and arbitrate between the potentially divergent interests of some stakeholders (networking and mediation);
- *Organization and cooperation models.* The project dynamics supports the emergence of innovative partnership models, which aim at pragmatically conciliating public interest (in particular in terms of sustainable development) and private sector logics;
- *Funding Mechanisms.* The project dynamics encourages the implementation of financial synergies between private investors and public authorities, which are responsible for stimulating the dynamism of the urban territory they are in charge of;
- *Tools for controlling urban development*. The project dynamics facilitates the development of innovative processes, which allow the achievements of a concrete strategy for the site's management.

Ultimately, the need for implementing a project dynamic in an urban brownfield regeneration extends far beyond the initial stages of the process, which relate to revealing the site's potential and establishing a guiding vision. Until the project's completion, this approach is essential to allow efficient management of such a complex operation. The Chap. 6 dedicated to the "Key steps of a regeneration process" will provide us with an opportunity to analyse the different stages of a brownfield regeneration project and study operational project strategies likely to facilitate the operation's success.

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Chapter 5
Sustainability Issues at the Neighbourhood Scale

Abstract We previously identified that urban brownfield regeneration projects are relevant strategies to limit urban sprawl while revitalizing portions of cities, namely mixed-use neighbourhoods. Moreover, these neighbourhoods in transition are opportunities to foster the implementation of sustainability objectives within European metropolitan areas. This chapter explore this subject by deepening the sustainability issues at the neighbourhood scale. To provide the basis for discussion, we first attempt to frame the urban sustainability concept and to explain how the neighbourhood scale is a means of action for cities. Then, we analyse the different sustainability issues according to a wide variety of parameters that must especially be taken into account during sustainable neighbourhood projects, and more precisely urban brownfield regeneration projects. These parameters cover the four pillars of sustainability—the environment, society, economy, and governance—and the polycentric reorganization of European metropolitan areas.

Keywords Urban sustainability · Neighbourhood scale · Sustainable neighbourhoods · Transition dynamics · Environmental balance · Sociocultural quality · Economic efficiency · Governance

5.1 Sustainability and Europe's Changing Urban Territories

The sustainable city has now for decades been the dominant paradigm of urban development (Whitehead 2003). According to ideologies and discourses, sustainable urban planning as a holistic approach is a unique opportunity to create dynamic cities that respect both the population and the environment (Rogers and Gumuchdjian 1998) as well as mitigate climate change (IPCC et al. 2018). But in practice, striving concretely towards the sustainable city is a subject in perpetual construction (UN 2015; iiSBE 2020), which requires concerted efforts with research. According to K. Williams, we can identify two challenges for the sustainable city: the first challenge is that of a vision (do we know what the sustainable city is?) and the second challenge is that of change (do we know how to make and support the sustainable city?) (Williams 2010). Following these considerations, we concentrate in this chapter on the vision

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challenge by focusing on the changing urban territories of European metropolitan areas, marked by the post-industrial era.

In fact, the European population being highly urbanized, mainly in small to medium-sized cities of less than 250,000 inhabitants, these territories do face the challenges of sustainability (Carter 2016). In general, their more-or-less organized growth model is responsible for irrational soil consumption: urban sprawl, sector-by-sector urban approach, deindustrialization, increased urbanization, etc. This model's many negative repercussions on the environment (pollution linked to transport, degradation of ecosystems, etc.), the economy (infrastructure costs, increased energy costs, etc.), and society (social segregation, inadequate services and equipment, etc.) have been well proven (Newman and Kenworthy 1999; EEA and OFEV 2016). Consequently, a critical reading of the urban evolution of these territories allows us to frame the concept of urban sustainability. This understanding of the concept is confronted with the neighbourhood scale as a means of action. This focus will allow the identification of specific sustainability issues later on, notably for urban brownfield regeneration projects.

5.2 Framing the Concept of Urban Sustainability

The concept of sustainable development has its origins in the determination provided by the Brundtland report in 1987 (BRUNTLAND 1987).[1] In 1992, at the Earth Summit in Rio de Janeiro, the concept evolved towards a search for balance between preserving the environment, social justice, and economic progress: namely the three pillars of sustainability (UNCED 1992). These three dimensions now have consensus support and sustainable development has acquired legal and political legitimacy. Reinforced through the 2030 Agenda's 17 Sustainable Development Goals (SDGs), it remains, however, a concept with no real modus operandi, notably when juxtaposed with the built environment such as in Goal 11, "Sustainable cities and communities" (SDSN and IEEP 2019).

Since the milestones laid down by the Aalborg Charter in 1994, updated by the New Urban Agenda in 2016, cities have emerged as key players in sustainable urban development. Within these cities, the concept of urban sustainability is mentioned in many political objectives but remains complex and hardly tangible. The adoption of a unique definition of urban sustainability is rare and often disputed. This is mostly explained by the great number of actors—from practitioners to urban thinkers—involved in the making of the city. Each field (engineering, social sciences, urban planning, architecture, etc.) prefers an adaptation of the concept representing the most essential elements, a kind of ideal from their own perspective of what the sustainable city could be (Bithas and Christofakis 2006; Tanguay et al. 2010). In the words of S. Guy and S. Marvin, "none of these definitions represents a global

[1] "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

portrait—although some claim it—since each is only part of a complex whole which is the city". Far from being a problem, it is important to continue to develop this multitude of definitions, which opens the dialogue on the kind of future that we can create. This role can be assumed, inter alia, by research (Guy and Marvin 1999).

In accordance with the latter, the definition advanced here of urban sustainability is adjusted to the context and challenges of the changing territories of European metropolitan areas, marked by post-industrialisation. In that sense, it does not pretend to be universal. In order to keep a certain consistency with major discourses, our definition is first anchored on the consensus around the three pillars of sustainability and enriched by a fourth pillar, that relates together to transition dynamics. Secondly, by linking sustainability to the built environment, it relates to the polycentric restructuration of built territories, which introduces the neighbourhood scale.

5.2.1 Sustainability as Transition Dynamics: The Four Pillars

To contribute to the discourse on the sustainable city, we rely first on the commonly accepted concept that is the search for balance between the three pillars of sustainable development (Elkington 1997), also known as the "triple bottom line" (People, Planet and Profit/Prosperity) (UN 2002). Figure 5.1 below shows objectives linked to this search for balance in the context of urban projects, which notably underlies the ecological management of resources, decarbonation of urban systems, and proactive anticipation of societal changes.

Even though the conceptual approach to sustainable development makes it possible to formulate clear objectives, from an operational point of view, it seems impossible to reach only "win–win–win" solutions that are systematically the most ecological, the most interesting at the sociocultural level, and the most economically advantageous (Rey 2006; Voituriez 2013).[2] More likely, the definition of sustainability for European urban territories is made up of trade-offs between the three dimensions. Nevertheless, these trade-offs must maintain and strengthen natural and human capital, an idea underpinned by strong sustainability (Allen 1980), as well as consider temporal and territorial scales (Andres 2013; Mallet and Zanetti 2015).

Making these trade-offs can be a complex task for the stakeholders involved in the future of a sustainable city. In response to this, the three-pillar concept is, nowadays, enriched by adding a fourth pillar, governance, which provides, in a way, the means to realize these trade-offs (Yigitcanlar and Kamruzzaman 2015). This transversal pillar refers to all means deployed to identify and integrate sustainability objectives in a project process to increase their success by aiming to improve overall quality (Tanguy et al. 2020). Governance considerations serve as a link between short and

[2] The theory refers to this complex challenge as "wicked problems", which are confronted by interdependencies, uncertainties, circularities, and conflicting effort to find a solution (Rittel and Webber 1973; Rowe 1987; Lazarus 2009).

long-term preoccupations as well as between local and global scales (Sharifi and Murayama 2013). This supports the idea that the concept of urban sustainability is not an end in itself, but a means embodied in transition dynamics.

In that respect, it is also interesting to mention the 4P approach, which strongly focuses on practice and reflects on what the fourth pillar of sustainability may entail (Van Dorst and Duijvestein 2004). First, the approach is linked to the 3P of the concept of the triple bottom line (People, Planet, and Profit/Prosperity). To these is added a fourth P, which refers to Project and Process. The P-Project represents the spatial qualities, which are the result of the integration of sustainability aspects in relation to the specific features of a site. The P-Process refers to the interactions between the different actors and institutions to carry out the project. Here too, the 4P approach emphasizes the transition dynamics towards holistic sustainable development: not only must the 3P be taken into consideration, but also the context and the particularities of each project in a given territory as well as the decision-making process related to environmental, economic, and social aspects (who is in charge?

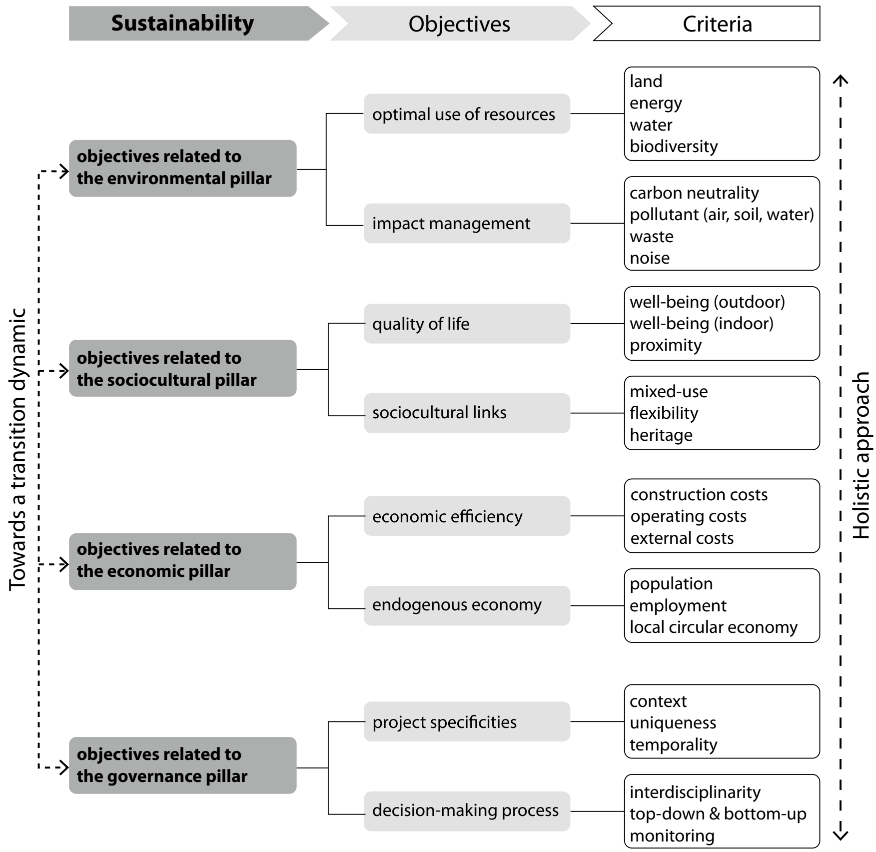

Fig. 5.1 The four pillars of sustainability in relation to the urban project

how? and when?) (Norrman et al. 2015). Essentially, it stresses the importance of governance as the fourth pillar of sustainability. On the basis of the above, we refer again to Fig. 5.1 showing governance objectives and criteria in the context of urban projects.

5.2.2 *The Polycentric Restructuration of Built Territories*

In his book “Cities for a Small Planet”, R. Rogers argues that the sustainable city is a compact and polycentric city that protects the countryside, targets and integrates communities within the neighbourhoods (poles), and maximizes proximity (Rogers and Gumuchdjian 1998). Already introduced in Chap. 3, the compact and polycentric city model adapted to the metropolitan area represents a relevant strategy to address the shortcomings of land-use planning for European metropolises.

This model comes from the compact city densification model, which supports the idea of inward urbanization or, in other words, building the city within the city. Yet, densification must be understood as a “necessary but not sufficient condition” to approach sustainable urban development (Jenks 1998; Burton 2000). Hence, going from a unipolar point of view to a more nuanced one, the compact and polycentric city model reinforces density, diversity and mobility at several focal points of an urban territory, while limiting the risks that an excessive concentration of activities in the city centre could generate (Dupont and Pumain 2000). The compact and polycentric city model is, therefore, appropriate for European post-industrial urban territories, which often have an urban structure with multiple centres (metropolitan areas for example) accompanied by a public transport network with varying degrees of efficiency.

The advantage of this model lies in the coordination between urbanization and mobility while increasing quality of life (satisfaction of sociocultural aspirations, diversity, optimal densification) and maintaining economic attractiveness (strengthening the economic fabric in urban areas) (Rey 2012). In other words, the polycentric restructuration of built territories can be seen as a form of optimisation of existing metropolitan areas based on their potential at the various interconnection points of their territory—namely, the neighbourhoods—to reinforce their inherent characteristics (density, diversity, mobility).

5.2.3 *Neighbourhoods in Transition*

Our framing of the concept of urban sustainability provides a vision for the evolution of European metropolitan areas and is the result of a convergence between two inputs. First, it is reflected in a transition dynamic, which concerns the connection of environment, society, economy to the governance of urban transformations. Second, it relies on the polycentric restructuring of built territories, including the management of ecological resources, urban system decarbonation, and proactive anticipation of societal changes. In this regard, developments at the neighbourhood scale can be determinant tools to help build and support the transition towards urban sustainability. Urban brownfield regeneration projects perfectly embody these neighbourhoods in transition. In other words, a regeneration project is a neighbourhood in transition that turns urban brownfield potentials (Chap. 3) into strengths for sustainability.

5.3 The Neighbourhood Scale as a Means of Action for Cities

Between city and building, the neighbourhood scale offers a sample of the urban reality that is sufficiently broad to address sustainability criteria (see Fig. 5.2). It goes beyond the single building by including open spaces and urban networks, but is also targeted enough to consider concrete interventions within a reasonable timeframe (Rey 2011; Sharifi 2015; Hajer et al. 2020). In addition, the neighbourhood scale turns out to be the minimum operational level to consider the social dimension of urban sustainability (Berardi 2011). As a portion of a city, there is no official definition for the neighbourhood. We can consider it as a spatial unit that people can relate to, that is a coherent living environment where we work, live, and have shops and services (Talen 2019). The physical limit is not precisely defined because it will depend on the type of neighbourhood (density of housing, public spaces, diversity of building functions, identity) and any future interventions (Choguill 2008; Riera Pérez et al. 2018).

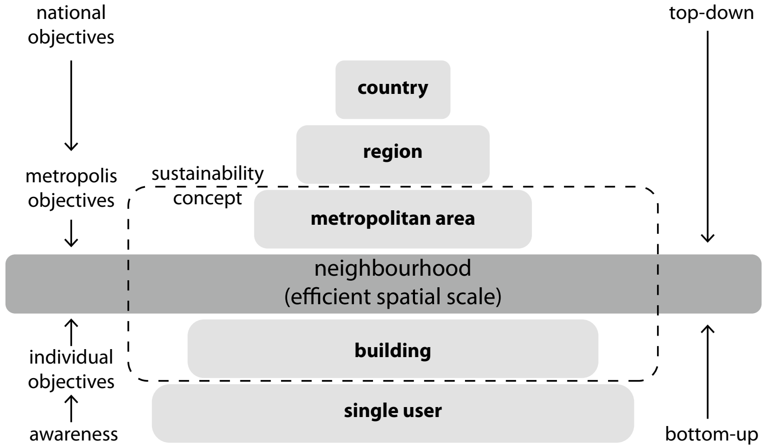

Fig. 5.2 The neighbourhood as an efficient spatial scale for the implementation of transition dynamics towards sustainability

From the urban densification perspective, the neighbourhood must embody an urban way of life, with dense, good quality and sustainable housing, in order to offer a credible alternative to the peri-urban single-family home. In this sense, the "sustainable neighbourhood" now appears to be the emblematic figure of the sustainable city in the making, as can be seen from the abundance of initiatives promoting this type of project (Machline et al. 2020; Hajer et al. 2020).[3]

Still, a sustainable neighbourhood is not a panacea, and faces multiple and complex challenges (see Chap. 8). In many cases, sustainable neighbourhoods are, within social, economic, and urban issues, used as an opportunity to work on the local image and identity of a city. Hence, through its—often mostly environmental (Tanguy et al. 2020)—performance, the sustainable neighbourhood contributes to extracting the site, and more generally the city, from a negative image towards an attractive, dynamic, and innovative one. This is particularly true for the sustainable neighbourhoods developed as a response to the presence of urban brownfields.

According to the definition elaborated in Chap. 2, urban brownfield regeneration projects concern areas of at least 5,000 m^2. Therefore, they are not limited to the construction or transformation of a single building, but most often correspond to the creation of a real neighbourhood. Hence, the thought processes that govern their development are situated on an intermediate scale between urban strategies and the architectural creation of buildings. They are part of the interlocking logic of planning activities that today covers the notion of "urban project".

A meticulous regeneration of an urban brownfield is able to respond to the compact and polycentric city model while incorporating a transition dynamic towards sustainability. As such, the urban brownfield regeneration project embodies the neighbourhood in transition. Hence, urban brownfield regeneration projects are subject to issues similar to those that govern sustainable neighbourhood projects. If they are sometimes perceived as additional constraints, these issues can also turn into resources for the project (Rey 2014). They then become potential sources of creativity and inspiration for the architects or urban planners in charge.

No unilateral formula can be applied to the sustainable neighbourhood. Nevertheless, the next sections of this chapter will provide a detailed overview of the concept of sustainable neighbourhood by drawing up a non-exhaustive inventory of the main sustainability issues at the neighbourhood scale. It is indeed a question of reconciling a wide variety of parameters.

[3] Highly publicized, the first eco-neighbourhoods such as the Vauban neighbourhood in Freiburg im Breisgau (DE), Bo01 in Malmö (SE), Hammarby Sjöstad in Stockholm (SE), BedZED in Beddington (UK), Eva-Lanxmeer in Culemborg (NL) or Ecoparc in Neuchâtel (CH) have often been considered from a technical-environmental perspective. These have inspired many other initiatives, but with generally more modest requirements.

5.4 Built Density, Functional Mix, and Sustainable Mobility

The creation of a sustainable neighbourhood falls within the coordination between urbanization and mobility, by structuring the transformation of the built environment with the development of public transport (encouraging "soft" or sustainable mobility) (Zhu and Leibowicz 2020) and by simultaneously breaking with the principle of dissociation of activities (encouraging a diversity of functions). Studies have shown that an attractive public transport offer requires a good perceived availability comparable to that of the private car as well as a perception of safety, highlighting information and comfort as main drivers (Steg 2003; Friman et al. 2020). According to expert opinions, the area served by public transport must meet a minimum built density corresponding to a floor area ratio (FAR) between 0.3 and 0.6 to be environmentally and economically sound (Gasser 2003). In urban areas, recent examples show that quality regeneration projects can be carried out with a clearly higher floor area ratio of the order of 1–2 (Lauring et al. 2010; Kurvinen and Saari 2020).

The compact and polycentric city model can be a relevant strategy to promote joint control of urbanization and mobility. Indeed, as previously described, this model is part of an evolution and optimisation logic based on the current situation of European urban territories. It follows the idea of an urban structure with multiple centres whose implementation appears both flexible and adapted to metropolitan areas. This urban development approach allows greater compactness within metropolises while limiting problems such as road congestion and air or noise pollution in the city centre caused by an excessive concentration of activities. It leads to the creation of "mixed and compact poles", namely the strengthening and development of dense and multifunctional secondary sectors, which distribute the functions of the metropolis at public transport interconnection points.

At these strategic poles, the objective is therefore to create dense and mixed-use neighbourhoods with proximity to public transport stops to promote sustainable mobility. As detailed in Chap. 3, this objective coincides with the regeneration opportunity of urban brownfields, contributing concurrently to densify and revitalize existing built fabrics. The provision within the same neighbourhood of spaces devoted to housing, activities, and local services avoids creating monofunctional sectors, like bedroom communities or business districts, which are deserted at certain hours of the day or night (Merlin and Choay 2010). To link these different functions, special care must be taken to provide sustainable mobility networks throughout the neighbourhood (walking and cycling routes) and its connections with surrounding areas. Moreover, giving pedestrians more space increases the safety of all users (Wang and Yang 2019).

5.5 High Environmental Quality of Buildings and Developments

Among the various issues raised by the creation of a sustainable neighbourhood, environmental considerations—especially energy consumption—have been integrated primarily into the thought processes. This echoes the gradual emergence of collective ecological awareness since the 1970s. Within the context of climate change mitigation (UN and UNFCCC 2015), environmental considerations still play a central role in the architectural and urban concerns related to sustainable development. This is largely explained by the fact that building construction and exploitation remains a particularly energy-intensive sector. Even if there are large disparities in building performance across countries, buildings account for 41% of final energy consumption and 60% of electricity consumption in the EU-28. The average annual consumption for all types of buildings reaches around ~200 kWh/m^2. Two-thirds of this consumption is from residential buildings (Rousselot and Pollier 2018). Moreover, the construction sector accounts today for 36% of the European Union's GHG emissions (EU 2017).

In the face of such a challenge, a sustainable neighbourhood should be designed to reduce not only its energy consumption, but also that of all non-renewable resources (soil, water, biodiversity), as well as minimize its ecological footprint. A sustainable approach results in the adoption of bioclimatic architectural strategies and high-performance technological devices. The latter aim is, in particular, to reduce heating requirements (high thermal quality of the envelope, controlled air renewal in winter, promotion of passive solar gains and internal gains), reduce demand for electricity (natural light, solar protection, passive cooling, high-efficiency devices), and develop renewable energies (active solar, wood, geothermal, biomass) to cover the remaining needs. The use of environmentally friendly materials is another relevant strategy, by integrating ecological analysis (grey energy and pollutant emissions) into the early architectural design process of the buildings (Jusselme 2020). The aim is to limit the generation of waste during construction and to ecologically manage those that are unavoidable (sorting at source). Promoting circularity in building practices through the re-use of onsite materials is also an opportunity to be seized during brownfield regeneration projects (Fivet and Brütting 2020). Ultimately, both on the neighbourhood and building scale, the optimal management of water aims to reduce water consumption and maintain the natural regime of rainwater (recovery, infiltration, retention).

Life Cycle Analyses (LCA) of buildings, labelling processes, performance monitoring after commissioning and raising users' awareness of environmental considerations are also effective levers for action and an integral part of the sustainable neighbourhood process. We will address these topics in detail in Chap. 8.

5.6 Urban Contextualization and Preservation of Architectural Heritage

As previously mentioned, the creation of a sustainable neighbourhood is often taken as an opportunity to restructure a city and work, at the same time, on local image and identity. Unlike new neighbourhoods built in the outskirts on greenfields, neighbourhoods as brownfield regeneration projects confront an urban situation that is already strongly constructed. In order to promote the integration of the future neighbourhood into the existing surroundings, the project should consider the notions of built heritage and cultural identity from the outset.

Indeed, many urban brownfields, whether industrial, infrastructural, military, or other types, are home to buildings of significant historical interest (see Chaps. 2 and 3). Initially, their transformation involved the demolition of the existing infrastructure because the brownfield site was considered too negative, not to say too complex (see Chap. 4) (Lusso 2013). But an urban brownfield "also bears the interests, hopes, fears, and memories of the different actors related to each vacant site" (Trigo 2020). More often today, under the impetus emanating notably from civil society, brownfield regeneration into a sustainable neighbourhood implies enhancing the site via an emblematic architectural project (Berens 2011; ADI 2015).

Thus, strategies for recycling existing infrastructures are often prioritized (Berens 2011; Mieg and Oevermann 2014), while producing positive effects on surrounding property values (Van Duijn et al. 2014).[4] This heritage dynamics, by which the society recognizes a site as worthy of conservation, contributes to improving the perception and image of the brownfield while reviving a specific history of the place (CABERNET 2004). Entering into interaction with existing structures, the regeneration project implies by definition taking a stand for that which deserves to be preserved, transformed, or replaced. Thus, in a prospective and dynamic vision, it is a question of considering the historical and morphological substance of the buildings and adapting them to contemporary needs. The example of the Emscher Valley in Germany described in Chap. 2 is particularly representative of that matter.

Often converted into spaces with a cultural vocation, culture becomes a tool for improving the conditions in given areas of cities and handling their new urban trajectories (Mecca and Lami 2020). These new places must continue to offer creative and fertile spaces while avoiding the pitfalls of "museumization" (Mieg and Oevermann 2014; Mecca and Lami 2020). Indeed, urban brownfields offer the possibility of new third places,[5] particularly in neighbourhoods where culture, in its traditional form, is absent (Bertrand 2018). Whatever the quality of the buildings, urban brownfields are often temporary hosts of artists and associations with added social value who take advantage of inexpensive spaces offering flexible use. As discussed in Chap. 3, the regeneration of these places is, therefore, an opportunity to include a cultural component, which can be an integral part of the local economy and social life of

[4] The counterpart may be new-built gentrification. See Sect. 5.9.

[5] A third place is the social surroundings separate from the two usual social environments of home (first place) and the workplace (second place) (Oldenburg 1999).

sustainable neighbourhoods. The regeneration of the Belle de Mai brownfield in Marseille, France, is a particularly good example of this approach (see Chap. 2).

However, if culture and heritage can be levers for the transformation of a brownfield into a sustainable neighbourhood, a broader definition of these aspects invites a diversification of objectives in terms of social and programmatic mix and economic activities (Mckenzie and Hutton 2014). Our search for the optimal degree of intervention, depending on the specific project dynamics, involves a certain number of diagnoses, which are an integral part of the project evaluation. This will be dealt with in the second part of this book, entitled Project Dynamics and Support Tools.

5.7 Well-being and Conviviality Within the Neighbourhood

An argument often opposed to urban densification strategies is that they do not correspond to inhabitants' aspirations, whose ideal would be to live in a detached house in the countryside and move freely by car. If these aspirations symbolize a certain number of wishes and needs (privacy, property, proximity to natural spaces), some studies today put their scope into perspective. Residential preferences, which result from psychological, sociological, and financial considerations, are not limited to the peri-urban countryside. The suburban model—and resulting dependence on the automobile—are, therefore, not the result of a general aspiration (Vos et al. 2016; Jansen 2020). Whether urban or suburban, neighbourhood satisfaction can be defined as the extent to which the residential neighbourhood's needs are met (Lovejoy et al. 2010).

Earlier, we described the sustainable neighbourhood as the development of a dense and multifunctional secondary sector in coordination with public transport services. As this strategy increases the density of the already-built fabric, like with urban brownfield regeneration, it consequently implies improving the image of housing in urban areas. This densification with high added value—both for the inhabitants of the neighbourhood and for those of the whole metropolis—is taking even more importance in peri-urban territories, because it allows an alternative to the single-family home (Vos et al. 2016). Questions of quality of life and user comfort, therefore, occupy a central place in the process of designing built and non-built spaces.

Among the many qualitative parameters that can contribute to a neighbourhood's attractiveness and conviviality, the development of green spaces and quality public places is particularly important (Shaftoe 2012). The spaces allow the generation of a specific identity for each neighbourhood and promote exchanges and meetings amongst inhabitants. They accompany the integration of a diversified offer of local services (institutional spaces, cultural places, cafe-restaurants, small shops, game and leisure spaces), adapted in particular to the needs of families and older people (Reiter 2007; Gehl 2010). Being part of sustainable neighbourhood design processes, diverse degrees of participation and bottom-up planning approaches can help define the future-users' needs and promote their acceptance of the project. We will further develop this topic in Chap. 6.

5.8 Intergenerational and Social Diversity

The planning of framework conditions that favour intergenerational and social diversity is also, to a certain extent, part of a search for wellbeing and conviviality in the broad sense of the term. A rich and balanced neighbourhood life contributes to quality exchanges between inhabitants.

To encourage this diversity, a particular emphasis should be placed on mechanisms likely to promote intergenerational cohabitation as well as a social and cultural mix. We can cite, for example, the establishment of childcare facilities (crèches, after-school drop-in, extracurricular programmes), spaces specifically adapted for exchanges between users (community centres, cafes, meeting spaces, libraries, fab labs, repair cafés) or opportunities for leisure activities (cultural spaces, entertainment and creative workshops, community gardens, sports facilities).

The creation of a variety of types of housing, in terms of dimension, standards, and spatial typologies, also allows one to respond to a wider audience (students, single people, families, early retirees, elderly people, people with reduced mobility). Moreover, this varied offer opens up possibilities to explore different avenues of intermediate or semi-individual housing; the resulting density enables the reconciliation of a satisfactory appropriation of the neighbourhood and an attractive public transport offering.

Once the neighbourhood is completed, the existence of organizations allowing residents to get involved in neighbourhood life also tends to favour the identification of residents with their living environment and the harmonious coexistence between all neighbourhood users. Ultimately, the use-value will be a good indicator to judge, a posteriori, the success of the transition from urban brownfield to a sustainable neighbourhood. If the neighbourhood is lively throughout the day, the feeling of urbanity intensifies, offering a multitude of possible appropriations according to individual lifestyles.

5.9 Control of Global Costs

As urban areas account for the vast majority of the population and jobs, they are legitimately considered the main drivers of economic activity in most European countries (EU 2019). Hence, strategies to limit urban sprawl and develop sustainable mobility should be done while simultaneously aiming to strengthen the economic attractiveness of specific urban areas (Glaeser 2011). This urban densification—as an alternative to new constructions on the outskirts—can offer a favourable framework for diversification of economic activities in metropolises, which helps to maintain and create jobs in urban areas. In that sense, brownfield regeneration contributes to an image of economic dynamism, favourable to the strengthening and development of urban areas.

At this stage, it is important to remember that, on the whole, urban brownfields are characterised by good accessibility and a high centrality. Inventories carried out in several European countries show that most of the identified brownfields are located within metropolitan territories (see Chap. 3). In fact, at the time of their construction, industrial facilities were installed on the outskirts of cities to avoid any nuisance. Still, the choice of their location was carefully studied, i.e., close to traffic routes, particularly railways, to facilitate access to goods and users. Following the extension of urbanization, these sectors gradually found themselves integrated into the metropolitan area. In most cases, they have been able to preserve—or even reinforce—their advantageous accessibility conditions.

From the end of the 1990s, the literature wondered about the existence of certain behaviours, which tend to demonstrate that physical accessibility remains a real asset for places of life and work, despite the emergence of a society increasingly oriented towards information and communication technologies (Ascher 1995). "It is clear today that what is not communicable, digitizable, takes more and more value in economic life as in social life. Yet, never before the value of office real estate has depended that much on the quality of its location, its physical accessibility, and its economic and urban environment (Ascher 2001)".

Years later, a central location still offers significant advantages in terms of access to job markets, various urban facilities, and services. It is increasingly sought after by companies, whose location strategies are based on trade-offs between proximity to transport hubs, land prices, and taxation (Pritchard and Frøyen 2019).[6] For households, residential location refers to the same types of criteria, even if these choices are more complex. As we have seen before, trade-offs are of course made in terms of accessibility and price, but also according to possibilities or constraints and aspirations to certain residential models (single-family homes, townhouses, etc.).

As a result, due to their central and accessible location, new sustainable neighbourhoods on regenerated urban brownfields find themselves at the heart of a series of tensions. At the same time, places of concentration of flows and public spaces, these sectors can quickly become a city showcase, supposing a strong architectural, symbolic, and land valuation. However, the opportunity to revitalize a declining sector, both economically and socially, is also criticized for the phenomenon of "new-built gentrification" that it generates (Rérat et al. 2010), and gentrification in the neighbouring sectors (Schulze Bäing and Wong 2012). As previously discussed, without consideration for social diversity, these projects are often for the sole benefit of the upper social classes (Squires and Hutchison 2021). Because social problems are less apparent in brownfield regenerations than in the case of the urban renewal of degraded districts, their regeneration focuses more intensively on the dense and dynamic city (Andres and Bochet 2010).

Despite the obvious advantages linked to location attractiveness, the economic feasibility of a brownfield's regeneration into a sustainable neighbourhood is risky due to the complexity of this type of operation (see Chap. 4). It involves controlling

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[6] However, the impact of the recent democratization of teleworking due to the COVID-19 pandemic on business property and the demand for office space is difficult to assess (CreditSuisse 2020).

overall costs over the long term, either by considering the construction or the operating phase. Poorly controlled costs tend to penalize the balance of the operation due to inefficiency, or even to unfortunately defer certain charges to the finances of public authorities.

The next chapter, which addresses the key steps of an urban brownfield regeneration process, will discuss questions of land management and the distribution of costs between owners. It will be an opportunity to elaborate on the participation of civil society not only in economic and social aspects, but also in environmental design considerations. Participation is an integral part of the governance of a neighbourhood in transition.

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Part II
Project Dynamics and Support Tools

Chapter 6
Key Steps of a Regeneration Process

Abstract Because of their inherent complexity, urban brownfield regeneration projects are long-term operations. The study of the evolution from urban brownfield site to a new—and ideally sustainable—neighbourhood through a regeneration process has led to the identification of five key steps: *Backgrounds*, *Initiators*, *Guidelines*, *Legal Basis*, and *Realization*. This chapter highlights the specific issues encountered during these different steps. Thus, our early reflections on the future of an urban brownfield at the regional and metropolitan levels concern the *Background* and *Initiator* steps. The formulation of a coherent project to overcome negative perception and foster a shared vision relates to the *Guidelines* steps. The transition from the urban to the architectural project is dealt with during the *Legal Basis* and *Realization* steps. Finally, issues concerning the multiple forms of participatory processes and the evaluation of sustainability objectives must be taken into consideration throughout the regeneration process. These reflections provide a foundation for developing a series of measures and more concrete lines of action.

Keywords Regeneration process · Key steps · Urban project · Architectural project · Project dynamics · Participatory processes · Civil society · Sustainability evaluation

6.1 Identification of Five Key Steps

A study of urban brownfields at various stages, from early phases of revealing the site potential to completed construction, including first steps of the building site and planning process under development, has led to the identification of five key steps within a regeneration project: *Backgrounds*, *Initiators*, *Guidelines*, *Legal Basis*, and *Realization* (Jaccaud et al. 2009; Lufkin 2010). Each step results in the elaboration of a planning document, which allows the team to validate a segment of the process and proceed to the next step.

The present chapter aims to highlight the specific issues encountered during each of these steps. These reflections will provide a foundation for developing a series of measures and more concrete lines of action, which will be presented in Chap. 7.

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6.2 Early Reflections at Regional or Metropolitan Level

The *Backgrounds* step is, not strictly speaking, a phase of the project. Instead, it constitutes a sort of position zero in the regeneration process. It refers to events that are external to the project and have indirectly contributed to its elaboration. In many case studies, the antecedents may be other projects developed on the brownfield's perimeter that, due to various circumstances, have experienced blocking situations and therefore were not taken to their completion.

Thanks to those more or less unfruitful experiences, and provided that they stay involved in the new project, stakeholders acquire an expertise in the local context. This allows them to understand what factors led to the total or partial failure of the previous projects and to identify the positive aspects worth keeping.

As a second step, the phase involving the *Initiators* includes all the events that contribute to triggering the project's development. In most cases, these catalysing events belong to a relatively large planning scale. They define development objectives for the urban or metropolitan area, without necessarily mentioning a specific action for the urban brownfield's perimeter.

In some cases, the reflection focuses exclusively on the concerned urban region, which tends to facilitate the process. The question then becomes to identify the most strategic sectors for intervention, while leaving enough place for the uncertainty associated with the economy and the market. In that configuration, the early discussions often take place within non-institutional or informal frameworks. The meeting between an informed personality (from the political or business world) and a committed architect or urban planner often initiates the launch of the process.

During this step, time constraints can also play a triggering role, especially when linked to funding possibilities. For instance, in the framework of government support, which may be conditional on strict realization deadlines, time constraints can become a strong incentive.

Questions raised during the *Initiators* step are not related to architectural or urban design. The focus is instead on the specifications of the future regeneration project. Although they stay relatively vague in terms of concrete actions to be undertaken, the decisions made at that moment set the rules on cooperation between the main stakeholders. In other words, they give precise indications on "how to do" rather than defining "what to do". Ideally, the selection of processes and regulation modes between stakeholders takes place during that step (more or less cooperative procedure, more or less close cooperation, etc.).

Official documents resulting at the end of this step (regional masterplan or road map, synthetic reports, etc.) are of paramount importance for the next steps of the process. These documents validate the selected options and constitute a long-term reference basis for future developments. Therefore, a statement of intentions helps to launch the formulation of objectives, especially when there is a large number of stakeholders and the decision-making power is diffuse among them.

6.3 The Project as a Basis for Reflection on Urban and Architectural Coherence

Once the site has been identified as a strategic intervention sector at a regional or metropolitan level, the brownfield's evolution potential must be demonstrated by a convincing urban project. This next step aims at defining the regeneration project's main *Guidelines*. This neighbourhood-scale vision will not only help overcome the various previously analysed obstacles (see Chap. 4), it will also reveal the site's potential and act as a detonator.

6.3.1 Overcoming Negative Perceptions

Overcoming negative perceptions associated with the brownfield site is one of the major obstacles when defining the regeneration project's main guidelines. First, the appropriation of abandoned territories by pioneer populations is likely to positively impact the site's image, notably through temporary uses. Thanks to the development of public activities, in particular cultural activities, these once impenetrable territories gradually become accessible to the population. Furthermore, these mechanisms contribute to rebuilding links between the brownfield and its surrounding context. On the topic of temporary cultural uses, it is interesting to mention the TransEurope-Halles network, a European platform for the exchange of information, support, and expertise between cultural sites established on urban brownfields (Bertrand 2018) or the Yes We Camp initiative for the inventive use of available space (Yes We Camp 2020). Other examples are the Saint-Sauveur and Fives-Cail industrial brownfields in Lille (FR) that builds on the co-creation of viable third places on these sites. The latter approach is both the expression of transitory actors participating in the symbolic revaluation of brownfields and those same actors claiming a full role in the making of the urban project (Liefooghe 2020).

The notion of regeneration is understood by analogy with living tissue. It is a modification process that consists of a coordinated and progressive renewal of the brownfield site, aiming at recovering certain lost features. While the impulse given by the project can be triggered by different channels, direct or indirect involvement by public authorities is frequent. Indeed, as highlighted when analysing *Initiators* step-related issues, this type of project contributes to the urban and economic development of the entire urban or metropolitan region. Besides, partnerships with the private sector are not rare, as part of the land is often owned by private landlords.

6.3.2 Fostering the Emergence of a Shared Vision

The vision emerges during the definition phase of the guidelines. It allows decision-makers to formulate what is desirable—and feasible—on the site awaiting redevelopment. The site's image plays an essential role, in the sense that it helps to convey quantitative and qualitative information, which can also influence emotions and atmospheres. The project dynamics, which we already addressed in Chap. 4, are typically implemented during this step of the regeneration process.

The triggering action can occur with the realization of a first sketch, either spontaneously initiated by an urban planning office or in the framework of a study mandated by the private or public sector. Whenever possible, the vision's fabrication process should be participatory, that is, open to all concerned stakeholders. Its definition is of great importance for the next steps of the process. According to the local context and urban planning specificities, many different types of possible procedures exist: urban planning, architecture competition, and mandate for parallel studies or test-study, to name a few.

Multiple recent brownfield regeneration processes across Europe selected the test-study procedure. Essentially, a test-study brings together several teams of urban planners and architects (in general 3 or 4, according to the project), to work on the same site. To foster synergies without the competitive mind that sometimes characterizes architecture competitions, all offices are paid equally for their outputs, regardless of their experience or reputation. Projects are, therefore, developed in a participatory way. The proposals are discussed and evaluated during workshops involving different members: a strategic committee, an operational committee, the clients (or their representative), and the experts. Besides which, representatives from civil society may punctually be invited to share their opinion. At the end of each workshop, guidelines are given to each team so they can orient their work in the direction that seems desirable for the site's future development. Ultimately, the main objective is to elaborate a first analysis that must generate a certain consensus among the involved entities. That consensus becomes the basis for the emergence of a first vision of the site's desired future (plans, models, 3D renderings, etc.).

Beyond this revealing role, the brownfield regeneration project also has the vocation to initiate an evolution of the concerned sector. Symbolized by a global concept for the site, this dynamic gives the project a guiding thread for the different buildings to be renovated or constructed. It also serves as a common basis for all stakeholders during the multiple development phases of the project. Provided it is consensually elaborated, this shared vision contributes to defining various orientations for the site and serves to gather and mobilize the stakeholders towards a common goal.

Indeed, in an urban context marked by the rapid evolution of needs, this notion of dynamics is of particular importance. Considering that urban regeneration projects are in most cases achieved in stages, they must generate, from the first design phases, guidelines that are strong enough to maintain the urban and architectural coherence of the project and flexible enough to absorb the eventual evolutions of needs and circumstances.

Advancing based on a global concept is deeply linked to the project's outcome. This logic is radically different from approaches based on the simple addition of expert reports or the coordination of punctual solutions to juxtaposed problems. The strength of project-based strategies is to enable designers to deal with the uncertainty that is inevitable during the early stages of a regeneration process. Indeed, the study of successful brownfield regeneration projects stresses the catalyst role of such approaches. Projects allow a focus on spatial coherence at an early stage. They have the advantage of acting both as a tool for anticipation (vision embodied in a still approximate pattern) and as a tool for integration for sectorial approaches, necessarily varying according to the stakeholders under consideration.

Taking part in the broader evolution of classical urban planning, project-based approaches enable planners to imagine guidelines for the site that go beyond abstract programmatic data. Even during the earlier stages, they address the notion of space in a comprehensive, concrete, and evolutive sense (Devillers 1994).

In terms of concrete results, the main objective of the *Guidelines* step is the validation of the regeneration project, which will allow to endorse the selected options for the sector's development. The goal is therefore to set guidelines for the elaboration of the legal bases, without freezing the programming. The more complex the situation, the greater the extent of that step.

6.3.3 Identifying Sectors and Phasing Operations

The *Guidelines* phase also aims at defining the perimeter of intervention. This approach involves establishing a finer differentiation inside the sector—often a neighbourhood—and identifying areas with a specific vocation. This sectorization must be done considering the project's temporality. Indeed, the scale and complexity of urban brownfield regeneration projects generally generate an important time gap between the identification of the site's potential (competition, feasibility study, etc.) and the moment when the last built or transformed buildings are put into service. This process will usually take more than ten years. Such a lengthy duration requires a staged process, associating successive stakeholders in an evolutive context. Financial risk for investors can be kept to a minimum by staggering the operation.

The phasing of operations implies that decision-makers and planners must deal with fixed elements, which guarantee the coherence of the initial concept, and with fluctuating elements, which make it possible to absorb contextual changes. Evolution can be linked either to the surrounding context (economic situation, needs, framework conditions, etc.) or directly to the project (entry or departure of a stakeholder, modification of the decision-making structures, details linked to the project's progress, etc.).

When defining the phasing, as reflections become more and more concrete, it is essential not to lose sight of the big picture. The rushed realization of partial projects can give the illusion a faster progress. However, when the *Guideline*s step of the vision's formulation and validation is neglected, it becomes difficult to generate or maintain interest around the project as a whole.

6.4 The Transition from Urban to Architectural Project

Subsequently, the step establishing *Legal Basis* consists of translating the guidelines into a special masterplan. According to the local context, a great variety of expressions can be used: Neighbourhood Plan, Detailed Development Plan, Partial Land-Use Plan, etc. The main objective is to obtain approval from the public authorities. Indeed, the masterplan represents an official document, recognized by all stakeholders, and is binding in nature for municipalities and landowners. Failure can come in the form of refusal by the municipal council or by oppositions from civil society.

Provided that the project has been conducted in a spirit of cooperation between the partners (public authorities, owners, civil society, etc.), the likelihood of having communal approval denied is rather low. Some parameters nevertheless tend to complexify the situation, especially when a project involves inter-municipal nature, which multiplies potential risks. In parallel, in order to avoid the hurdle of public oppositions, communication and participatory approaches are central elements of the project's steering activities (more on this topic in Sect. 6.5). Overall, the implementation of a specific structure to deal with these issues, in the form of an interdisciplinary urban planning platform, has increasingly proven to be a factor for success.

Once the masterplan is approved (*Legal Basis* step), the project can finally evolve towards the *Realization* step. This step of the development process follows a more classical pattern, which leaves room for architects and investors to maneuvre. However, certain considerations must be taken into account. In order to optimize time management, it is possible—and even desirable—to overlap the *Legal Basis* and *Realization* steps. In other words, it may not be necessary to wait for the final recourses to be dismissed before launching projects or architecture competitions. Reducing realization time increases the project's economic attractiveness by decreasing the financial risk for investors.

The *Realization* step ensures the communication between urban and architectural scales. Thus, it should guarantee the quality, coherence, and continuity of the entire project over the long term. An architectural competition can provide an adequate means to manage the transition between the two scales. The selection of jury members is of utmost importance. It guarantees the competition's outreach and, in a sense, the propositions' architectural quality. The organization of competitions in multiple stages allows for framed interactions between the jury and the participants, which tends to guarantee coherence at the various scales of the project. Besides, the involvement of actors from the process's previous steps is a crucial element to ensure the continuity of the project's development.

6.5 Multiple Forms of Participatory Processes

Depending on the local urban planning context, participation can take various forms. Its definition can vary considerably from country to country, ranging from information to coproduction (co-decision), including consultation and concertation (Da Cunha 2006). Participatory processes are an essential component to creating a form of social pact, or, in other words, support of the project by all stakeholders. The social pact contributes to implementing a virtuous cycle dynamic and reduces risk at each step of the project.

Therefore, optimizing the participatory process is of high importance. The aim should be a transversal and concerted participation, conducted throughout the project, ideally already at the early stages. In order to specify the various issues raised by participatory processes, it is essential to distinguish two types of approaches: the first one, conducted with landowners directly concerned by the regeneration project, and the second one, aiming at establishing a link with civil society.

6.5.1 Participation of Landowners and Land Management

This first approach to participatory processes focuses primarily on the landowners who are directly concerned. It aims at implementing appropriate platforms to ensure their support and involvement in the regeneration project. Often neglected in urban planning, the land management issue is key. Indeed, a total or partial lack of land management can generate obstacles and is high on the list of resistance factors to brownfield regeneration. Hence, it is worth examining this crucial question.

Two notions can help us clarify the land management issue: on the one hand, land-use regulations, and on the other hand, their utilization. Land-use regulations are governed by public law and deal with public interest objectives and measures defined in the framework of territorial planning. They can only be observed through a representation of reality (land-use plans, etc.). The notion of utilization is governed by private law. Directly observable, it reflects the reality of land appropriation by landowners. Therefore, it relates to landowners' level of support and room for manoeuvre, since European legal provisions can make it very difficult to use expropriation for planning purposes.

Urban brownfields are, by definition, emblematic examples of a discrepancy between land-use regulations and land utilization (Rey 2012). Implementing better coordination between territorial planning and land management—in other words, a greater convergence between public and private interests—appears to be the best strategy to overcome this obstacle. Indeed, it is important to keep in mind that a brownfield regeneration project generates financial advantages for landowners. The added value created by the acquisition of building rights, notably land-use change—for instance from industrial to mixed zone—justifies their contribution to planning and equipment costs. It is essential early on in the project to negotiate the allocation method of these costs and the added value to avoid any blockage or opposition risk in the project's later steps.

While each brownfield has its own land tenure issues, it is nevertheless possible to define two basic patterns: shared and single ownership. Because their scale relates to that of a neighbourhood, the large majority of urban brownfields belongs to the first category, which presents an increased degree of complexity. The multiplication of landowners raises a certain number of challenges when it comes to re-drawing plot boundaries and cost allocation. There is no such thing as an ideal procedure; there exist as many urban planning tools as specific contexts. Overall, the main issue is to define fair distribution rules among the different owners, who do not necessarily have liquid assets that are available over the short term. This is what the project developed during the *Guidelines* phase is all about. It will allow the landowners to unite around a shared vision to overcome land-related obstacles. The involvement of public authorities plays an essential role in dealing with situations of shared land ownership.

As mentioned above, a large array of instruments exists to deal with such issues, but not all are adapted to the specificities of urban brownfields, where the number of landowners can sometimes be considerable. Among the approaches likely to solve particularly complex situations, we can cite, for instance, bilateral contractual agreements between the municipality and each owner. This allows for the resolution of issues related to public equipment financing—for instance, according to proximity to the concerned equipment.

The second category of brownfield includes abandoned sites where a single actor owns virtually all the land, such as military or railway brownfields (see Chap. 2). In this situation, it may be possible to engage in a joint reflection between the concerned public authority and the entity in charge of the site, more specifically, its real estate division. The latter may take the initiative in the planning procedures, and discussions around public equipment financing may be conducted directly with representatives from the municipality. This can potentially make the process significantly easier, but here again, it is important to bear in mind that solutions must be pragmatic and tailor-made in order to be successful.

6.5.2 Integration of Civil Society to Foster Stakeholder Support

The second approach to participatory processes seeks to integrate civil society. First, thanks to their lived field experience, civil society may contribute to better identifying brownfield-related issues that are not easily identified by technical experts. Therefore, the integration of civil society mobilizes local stakeholders and takes into consideration their diverse and specific interests. Here, the main challenge is finding an optimal adaptation of the participatory process according to the type of actor. This requires an integration of their expertise into the regeneration project without overly slowing down the decision-making process. Moreover, the project's acceptance, as well as its connection to the surrounding city and metropolitan area, can be greatly facilitated by the implementation of participatory processes that enable better integration of future users' needs.

Once again, several forms of participatory structures are possible depending on the specificities of the local context and the stage of the project. We can cite, among other examples, coffee get-togethers with stakeholders from the economic, academic, and administrative worlds, sounding boards gathering interest groups, information sessions or open house events for the population, site visits, discovery trails, etc. Although these approaches constitute a sort of urban planning toolbox for participatory processes, they are not the main focus of this book. Therefore, we will not enter into details but refer the interested reader to the abundant existing literature on the topic.

The nature of communication supports during participatory processes is of high importance because the large majority of them implies a bilateral exchange of expertise between civil society and technical experts in the fields of urban planning. Representation tools which help transfer information to civil society (plans, models, 3D visualizations) aim at presenting the vision developed for the site and the future actions that will be undertaken. To avoid misunderstandings when using these communication supports, it is essential to develop adapted tools, that is, tools that are both understandable for laypersons and updatable according to progress. This subject will be further developed in the following chapters, notably within Chap. 9, which introduce an operational monitoring tool designed to support urban brownfield regeneration projects.

In that sense, despite their reduced accessibility for certain parts of the population (elderly people, disadvantaged socio-professional groups, etc.), websites offer an interesting platform to support participatory approaches, which consistently complement in situ experiences.

Ultimately, these reflections illustrate the complexity of driving forces behind communication strategies in a brownfield regeneration project, but also their essential role in the project's process. Several experts claim that the success of a redevelopment operation is linked to the project's intrinsic qualities as much as to the communication skills of its leaders (Rey and Lufkin 2015). Overall, it appears that successful regeneration projects are characterized by personalities or steering groups that have demonstrated innovation and creativity to experiment with tailor-made forms of participatory approaches. Original initiatives have proven to be efficient and have significantly contributed to the success of the concerned projects.

6.6 Evaluation of Sustainability Objectives

While urban brownfield regeneration theoretically fights against urban sprawl, these projects often integrate sustainability issues only partially or superficially. Moreover, environmental aspects are almost systematically privileged, particularly at the expense of sociocultural considerations (Laprise et al. 2014). Indeed, to ensure a regeneration project's global quality, an important number of parameters must be integrated into the decision-making process leading to its realization. In order to be efficient, this simultaneous consideration of environmental, economic, sociocultural and governance aspects, which involves a vast array of actors, cannot be conducted superficially nor only on occasion. It must be part of an in-depth evaluative approach, allowing for continuous, iterative monitoring of the project, starting from the *Initiators* steps, and integrated in the *Guidelines*, *Legal Basis* and *Realization* steps.

Furthermore, it is important to stress that brownfield regeneration projects require a specifically adapted evaluation. The latter should take into consideration the particular features of that kind of project, which have been carefully analysed in the previous chapters of this publication. Indeed, urban brownfields are not sites like any other, in the sense that they occupy large areas—often disconnected from their direct environment—involve strategies to transform already built-up areas, and often have a relatively strong identity, which can sometimes be negative (contamination, insecurity, etc.). Regeneration projects are also distinguished by their complex processes: their duration tends to be longer than that of a traditional construction project, framework conditions may vary, and stakeholders may multiply throughout the process. Therefore, a tailored evaluation is required to ensure the rigour and reliability of the results.

6.6.1 The Various Roles of Operational Evaluation

If it is based on a methodology adapted to the issues, the evaluation may play diverse, complementary roles at the service of the project's dynamics. First, operational evaluation provides increased knowledge of the project concerning multiple dimensions of sustainability. The goal is not so much to offer turnkey solutions to decision-makers, but rather to allow them to make a more informed choice. Indeed, it is essential to have precise and structured information on how the project meets the objectives and expectations that have been set. By providing practitioners and decision-makers with indications on the project's performance, the evaluation is not disconnected from the latter, but rather participates in its definition. Evaluation can thus become a precious tool for critical analysis, verification, and decision support, which allows the establishment of a balance between complexity of information and transparency of the results (Schädler et al. 2011).

In parallel, the evaluation also plays the role of support tool, thanks to the information it provides. It enables stakeholders to assess the project's evolution and compare, if necessary, different options to feed into a structured problem-solving and optimization process.

Unlike label or certification approaches, the implementation of evaluation at each step of the project's process can also provide the main stakeholders with efficient communication support. The dynamics of sustainable neighbourhoods are indeed

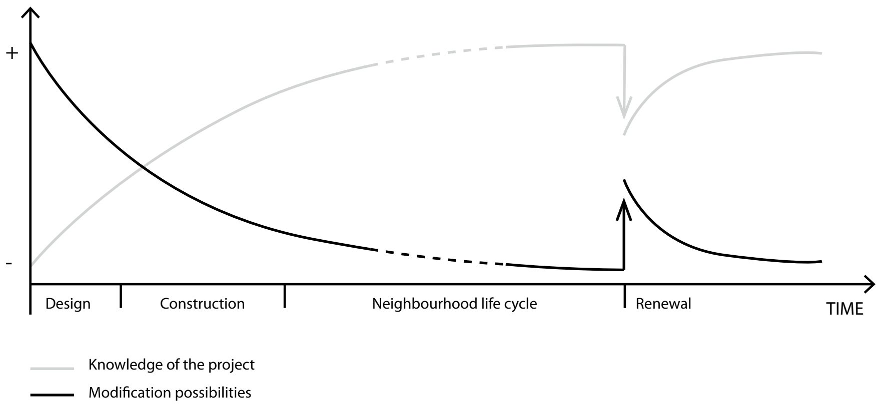

Fig. 6.1 Modification possibilities compared to the level of information according to the project progress

based on the organization of increased communication between multiple stakeholders. In this perspective, an operational evaluation may offer an efficient way to structure and manage exchange between the partners involved in the project. Its results may also feed into some participatory processes.

6.6.2 Operational Evaluation Integrated in Project Dynamics

The operational evaluation should ideally be integrated as early as possible in the regeneration project's dynamics. Indeed, the most crucial decisions are often made in the initial phases. These early stages, which are characterized by considerable freedom to optimize the project, correspond, however, to a moment when knowledge of the project parameters is often very weak (Fig. 6.1).

Gradually, as the design and realization stages progress, knowledge on the project tends to increase, but decisions made in the early stages generate fixed points and can decrease room for manoeuvring to influence the project and reduce the planners' reaction possibilities. In order for the best decisions to be made at the critical moment, that is, when they have great weight in the project's formulation, it is essential to have the maximum amount of information at the earliest stage possible.

Subsequently, it is necessary to continue evaluation beyond the design process to achieve sustainability objectives. Many decisions made during the project's design phase should be specifically followed up on during the next stages, mainly because their materialization depends on decisions taken during the realization phase and concerning later use of built and unbuilt spaces. Considering their rather long duration, this need for follow-up or monitoring is particularly significant in the case of urban brownfield regeneration into sustainable neighbourhoods.

Evaluation should therefore cover several distinct phases:

- Prospective evaluation: At the project's early stages, evaluation consists in an estimate of the expected performances. It is obtained with estimation and simulation methods which allow a comparison of the project's estimated performances with the aims set.
- Supporting evaluation: During the phases leading to the project's realization, evaluation consists in a regular verification of the project's performances, as well as an optimization of the latter through successive adjustments (decision-making and problem-solving support).
- Synthetic evaluation: At the end of the operation, evaluation offers a synthesis of the project's features and highlights singular aspects of its process. In the event of discrepancies between set objectives, expected performances, and achieved results, the evaluation can foster the emergence of new knowledge, particularly valuable for the future stages of the project and, more broadly, for other similar brownfield regeneration operations.

A large array of methods is available to evaluate the sustainability of metropolitan areas today in Europe. Very few, however, meet the above-mentioned conditions (tailored to brownfields' specificities, integrated throughout the project's dynamic, and with a search for overall quality in all dimensions of sustainability). Chapter 8, "Sustainability Monitoring: Principles, Challenges and Approaches", will be the occasion to come back to and further develop this crucial aspect of brownfield regeneration projects.

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Chapter 7
Specific Skills and Adapted Support

Abstract Although urban brownfields hold significant inherent potential, especially in limiting urban sprawl, a large number of sites are still awaiting a regeneration project. Moreover, many of these projects only partially or superficially address sustainability principles. Hence, concrete courses of action are required to support the evolution of current practices towards increased sustainability. These courses of action, which rely on specific skills and adapted supports, require a complementary approach. In other words, strategies should be conducted consistently at the territorial, metropolitan, and project levels. In this regard, the present chapter provides a series of courses of action to be implemented at these levels. Our aim here is to foster the sustainable transition of metropolitan areas, and more precisely brownfield sites, into lively neighbourhoods.

Keywords Urban brownfield regeneration · Sustainable transition of European metropolitan areas · Evolution of current practices · Increased sustainability · Territorial strategies · Metropolitan strategies · Project strategies

7.1 Courses of Action to Support the Evolution of Current Practices

When observing brownfields in European metropolitan areas, we must stress that the majority of them are not in the process of regenerating. Moreover, many redevelopment operations only partially or superficially address sustainability principles. Due to their adverse impacts on environmental, sociocultural, and economic levels, the issue of brownfields is not only well understood at the European level but also ranked high on the agenda of European Union regional development, environmental protection, and urban initiatives (Franz et al. 2006).

In this context, the different concerned stakeholders must converge to a series of measures and more concrete courses of action to support the evolution of current practices towards increased sustainability. In a complementary approach, these actions should be conducted consistently not only at the territorial levels of the metropolitan area, urban region, and municipality but also at the urban and architectural levels, embodied in the neighbourhood scale of the regeneration project itself. In this regard,

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the present chapter provides strategies at different levels to develop courses of action involving specific skills and adapted support.

7.2 Strategies at the Territorial Level

First, three main courses of action can be identified at the level of public authorities in charge of territorial development at the national or regional scales. It should be specified that some of these strategies already (partially) exist in certain European countries.

7.2.1 Awareness of Urban Brownfield Potential

The first course of action focuses on raising awareness of urban brownfields' potential (see Chap. 3). The main objective is to modify the general perception of brownfields and to make stakeholders more aware of their potential to increase the sustainability of European metropolitan areas. Several professional urban planning networks have been developed in the past, such as CABERNET or RESCUE, but it is essential that exchanges of that type also be created or reinforced with non-specialists.

Just like with other challenges related to the densification of built fabric, urban brownfields' potential is not automatically perceived by all political and economic decision-makers. Among the various possible measures to improve this situation, we can cite:

- developing communication campaigns (publications, public conferences, dissemination in the media, etc.);
- valorizing exemplary projects in terms of sustainability integration, stressing, in particular, their compatibility with economic success (pilot projects, awards, etc.);
- organizing meetings between brownfield landowners and potential investors;
- raising awareness of sustainable development issues within structures in charge of the real estate management of large urban brownfield landowners, in particular armies and railway companies.

In parallel, it is highly important that quantitative monitoring of an urban brownfield be generalized in European countries, with a detailed and regularly updated inventory. As explained earlier, the lack of data about brownfields tends to prevent an objective picture of the phenomenon or even to minimize its importance (Rey and Lufkin 2015).

7.2.2 Evolution of the Legal Framework

The second course of action aims at creating a legal framework that supports the launching of brownfield regeneration operations. Keeping in mind that obstacles to redeveloping abandoned sites concern primarily the initial, start-up phase of the project, improving the framework in the early stages helps mitigate blockages and fosters the emergence of project dynamics. Diverse forms of impulse may exist:

- integrating one or more specific articles focusing on urban brownfield regeneration in territorial planning regulations (in particular to enable procedures facilitating land-use change and the project's start-up);
- explicitly mentioning urban brownfield regeneration as a strategic objective of territorial development policies;
- promoting a general territorial organization of dense, mixed-use polarities, coordinated at the national or regional scales, which will help actors anticipate the evolution of urban brownfields' regulatory status and react more rapidly to the evolution of needs (exogenous economic promotion, housing stock to anticipate the risk of shortages, etc.).

In order to overcome obstacles related to remediation costs, it also seems appropriate to implement financial support for the investigation and remediation of contaminated sites. A possible measure is the creation of specific funds managed at the national level, made up of part of the increased value of land generated by brownfield regeneration. This mechanism offers landowners the advantage of removing uncertainty regarding their site's contamination, focus initial investments on the project itself and refund certain expenses once the redevelopment is guaranteed (risk reduction).

7.2.3 Development of Financial Levers

The third course of action, probably one of the most efficient, focuses on the development of financial levers, which support—directly or indirectly—urban brownfield regeneration and, more broadly, the densification of built fabrics. Today, it is not necessarily more interesting for a real estate stakeholder to invest in an urban site than a peripheral one. Tax mechanisms, which tend to be impacted by strong competition between municipalities, do not really reflect costs generated by peri-urban development and may not adequately reflect the potential brownfield regeneration has for contributing to the general interest. In Great Britain, the president of the Royal Town Planning Institute summarized this situation by declaring that urban planners were asked to fight the battle of sustainable development without any weapon (cited in Fouchier 1997).

The better orientation of certain fiscal or regulatory modalities for sites redeveloped in a sustainability perspective may also help accelerate the regeneration of urban brownfields. As examples, we can cite improving financial equalization between municipalities of an urban or metropolitan area, adapting certain taxes for urban brownfields or implementing premia for higher densities, which may allow for a better valorization of the land.

Support for exemplary projects in terms of sustainability, as well as targeting certain subsidies specially attributed to this kind of project, may also help consolidate the most interesting approaches. Considering their strategic importance, some urban brownfield regeneration operations could benefit from specific financial supports. As an example, we can cite the case of the German North Rhine-Westphalia, who, since 1997, only subsidizes housing located near train stations or efficient public transport—including housing created on regenerated urban brownfield sites. Besides density and sustainable mobility, the next step would be to consider additional criteria related to environmental, sociocultural, and economic sustainability in the calculation of the financial supports to be attributed.

7.3 Strategies at the Metropolitan Level

To amplify their impact, the three above-described territorial courses of action should be relayed at the metropolitan and city levels, which requires active participation by public entities and, especially, increased inter-municipal collaboration. Indeed, the development of urbanization and the complexity of post-industrial European cities tend to explode the traditional limits of municipal management. Moreover, it appears that collaboration is necessary at an inter-municipal level. It implies the emergence of novel types of governance, which are capable of managing metropolitan or conurbation projects and pooling converging visions of territorial development.

7.3.1 Integration of Urban Brownfield Regeneration Projects Within Urban Planning Tools

The first course of action at the metropolitan level focuses on increased integration of urban brownfield regeneration projects within urban planning tools, in particular metropolitan or conurbation projects, which help overcome inter-municipality-related obstacles. This type of approach seems likely to strongly impact the localization of urban activities, limit peripheral constructions based on public transport systems, support the densification of already built-up areas, and efficiently meet the various sociocultural needs of metropolitan areas.

Considering its potential contribution to the built environment's sustainability, urban brownfield regeneration—in particular, that of large sites—should be included in the issues to be examined within metropolitan or conurbation projects. This embedding will help multiply their chance of redevelopment. By integrating urban brownfields into a vision that goes beyond the limits of their perimeter, it is indeed possible to increase opportunities for convergence between needs—considered at metropolitan scale—and land available for new (re)development.

7.3.2 Identification of Strategic Sectors for Urban Development

In parallel, the embedding of urban brownfields within metropolitan or conurbation projects should lead to a finer census of the latter, integrating specific information such as the degree of proximity to public transport systems, effective densification possibilities, possible land-use changes, and funding possibilities for a regeneration project. As illustrated in Chap. 3, this type of analytical inventory is far from systematic among European countries, which sometimes makes it difficult to identify the most strategic sectors to be redeveloped.

However, the identification of an abandoned site as a pole of strategic development is not sufficient to guarantee the spontaneous start of its regeneration process. In some cases, the site has real estate potential, but may eventually redevelop without integrating broader issues related to needs at the metropolitan level or sustainability aspects. In other cases, the site is strategic for the sustainable transition of the metropolitan area but struggles to find investors.

Therefore, it is fundamental that the dialogue between partners from the public and private sectors be intensified, and all the more so when land is privately owned. Collaboration in the early stages of the regeneration process helps to target the most important aspects, concretely discuss framework conditions, and potentially accelerate the procedure by anticipating any risk of blockage. According to the site's features and the circumstances surrounding the project launch, the objective will be to find a tailored strategy to best accommodate the general interest and financial constraints.

This proactive involvement of public authorities becomes even more essential because their means are often limited to buying land or investing directly in regeneration projects. Even if the public authority does not own the land, it can, by collaborating with private stakeholders, take advantage of certain dynamics all while materializing sustainability-related objectives such as densification, functional mix and social diversity, sustainable mobility, or the emergence of an urbanity fostering a high quality of life.

By benefitting from room to manoeuvre (such as density bonuses or adaptations of some equipment taxes), public authorities and concerned services may even obtain the guarantee of a stricter follow-up of all sustainability dimensions of the project, for instance by requiring more explicitly the use of a monitoring methodology (more on monitoring in Chap. 8).

7.4 Strategies at the Project Level

Finally, specific measures taken at the project level are necessary not only to make the start-up of a sustainable regeneration project possible but also to ensure that the future neighbourhood contributes to the sustainability transition of the city and metropolitan area. In that regard, we identify four main courses of action.

7.4.1 Initiation and Governance of Regeneration Project

In order to make the start-up of a sustainable regeneration project possible, the initiation of the operation and the emergence of the project dynamic are crucial measures. The initiation of the operation is based on a process likely to play a triggering role. It mainly results from two types of approaches, according to the site's characteristics and involved stakeholders:

- the organization of urban planning or architecture competition by the landowner (generally in collaboration with the concerned public authority);
- the realization of a test study or a project, either mandated by the landowner or a potentially interested investor, or on the spontaneous initiative of an urban planning or architecture office.

The different triggering possibilities demonstrate that the process is generally based on shared responsibility between different stakeholders (landowners, public authorities, project designers, investors, etc.). The initiation of the process depends on the efficiency of their collaboration. The landlord has the possibility to block the process, and therefore certainly plays a crucial role in this initial phase.

Subsequently, the emergence of the project dynamic corresponds to the consolidation of this first stage. In other words, the objective is to effectively integrate all involved partners within the approach to a project—rather than within the vision for an abandoned site. Our analysis of several large-scale regeneration projects across European metropolitan areas stresses that the creation of a project dynamic is most commonly related to the emergence of the main stakeholder, who plays the driving role for the project.

The main stakeholder may come from diverse professional backgrounds, considering the multiple possibilities a project represents. Our study of different operations highlights that architects and urban planners have a certain propensity to play that driving role, as long as they have the capacity to perceive a site's potential, motivate other actors to support the project, and coordinate complex processes or even conduct mediation when interests diverge or the risk of blockage appears. This observation results in the need to raise awareness of the importance of this skill set, not only among architecture and urban planning students but also among the concerned professional associations.

7.4.2 *Integration of Sustainability Objectives*

Moreover, the recognition and integration of sustainability objectives in the project dynamics are essential conditions for their materialization. To be effective, this integration should be translated into the implementation of a holistic, inter-disciplinary, and evaluative approach, under the auspices of the main stakeholder playing the driving role. Indeed, the success of an operational evaluation depends, first and foremost, on the effective motivation of the involved actors—in particular the decision-makers (public and/or private clients)—to apply sustainability principles. Based on a selection of relevant indicators, the operational evaluation helps to structure the project's objectives and implement a consistent monitoring methodology.

The project's transition towards increased sustainability involves implementing participative and inter-disciplinary collaborations, which should be consistently integrated within the project. For the project leader, this requires, by definition, a great capacity to integrate data from heterogeneous sectors, coordinate actors with diverse references and knowledge, and identify future necessary competencies. For all important stakeholders involved in the project, this entails increased competencies in the field of sustainable development, allowing them to establish links between the variety of dimensions at stake.

7.4.3 *Follow-Up of Sustainability Objectives*

According to the project's characteristics, two main scenarios are possible for identifying the person responsible for the evaluation, the major condition is that the entity in charge of the project supports the selected process.

- In the first scenario, the project's driver (for instance, the public authority's urban planning department) directly steers the evaluation, motivated by integrating sustainability within the project. This option tends to facilitate the process and allows for continuous optimization. The risk of subjective evaluation can be limited by constituting a follow-up group including different interests (representatives of the authorities, the client, etc.).
- The second scenario consists of selecting an external expert to steer the evaluation. This situation may ensure greater independence in the evaluation process. However, it poses the risk of creating a gap between the evaluation results and the project development. This may be avoided by implementing a tight collaboration between the external expert and the project's driver, which may generate a more unwieldy and costly process. This type of approach may be recommended, in particular, when the project's driver lacks competences or motivation—or both—with regard to sustainability.

In both scenarios, a follow-up group must be created to regularly accompany the project's evolution and its operational evaluation during specific meetings (as a rule, every 3–6 months). The project's usual coordination meetings then help address the concrete integration of the measures adopted. In that sense, creating a specific framework for discussion relating to sustainability seems to encourage the emergence of an adhesion and ripple effect among the different involved stakeholders.

The implementation of a sustainability follow-up—or more precisely monitoring (see Chap. 8)—necessarily generates additional costs compared to current planning expenditures. The latter should, however, be weighed against the operation's global cost, especially since this approach results in most cases in buildings of superior overall quality. The long-term benefits induced by the increases in the properties' real estate value often outweigh the additional costs incurred (Chegut et al. 2019). Based on our analysis of brownfield regeneration projects into sustainable neighbourhoods, the specific cost of sustainability monitoring and data synthesis is estimated at approximately 0.5% of the operation's global cost (Rey 2012).

Several measures can be envisaged to decrease the additional financial load of sustainability monitoring. Without going into too much operational detail, we can cite the following measures: using part of the increase in the land value generated by the regeneration operation, receiving financial contributions from programmes supporting exemplary projects, and collecting a specific percentage of the total construction costs.

7.4.4 User Awareness

The commissioning of an urban brownfield regeneration project is usually conducted on a step-by-step basis. It generally implies an information process for the neighbourhood's users, who will live or work for several years within a changing urban environment. Communications made in this context may also provide an opportunity to raise user awareness of specific aspects of sustainability, especially those significantly conditioned by user behaviour (such as the consumption of heat, electricity, or drinking water). This approach targeting user awareness helps to inform users of the intentions of the project's designers, as well as facilitate their appropriation thereof.

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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,
https://doi.org/10.1007/978-3-030-82208-8_8

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:

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[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).

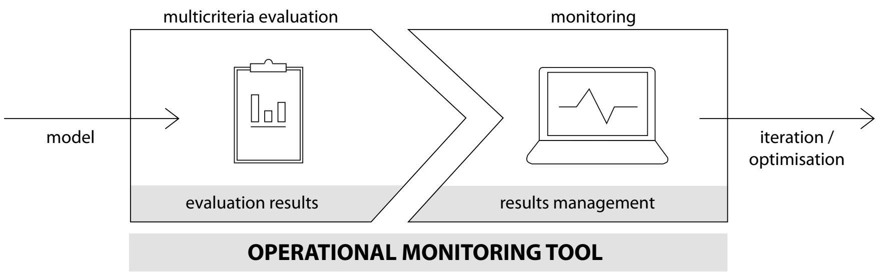

Fig. 8.1 Schematic representation of the constituent elements of an operational monitoring tool

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.

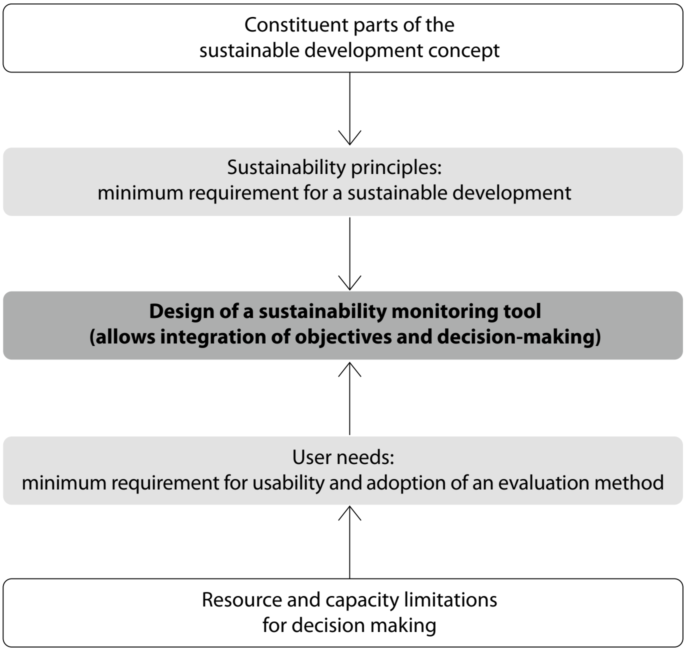

Fig. 8.2 Balance between normative principles of sustainability evaluation and practical user requirements for the design of an operational monitoring tool (Laprise 2017)

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.

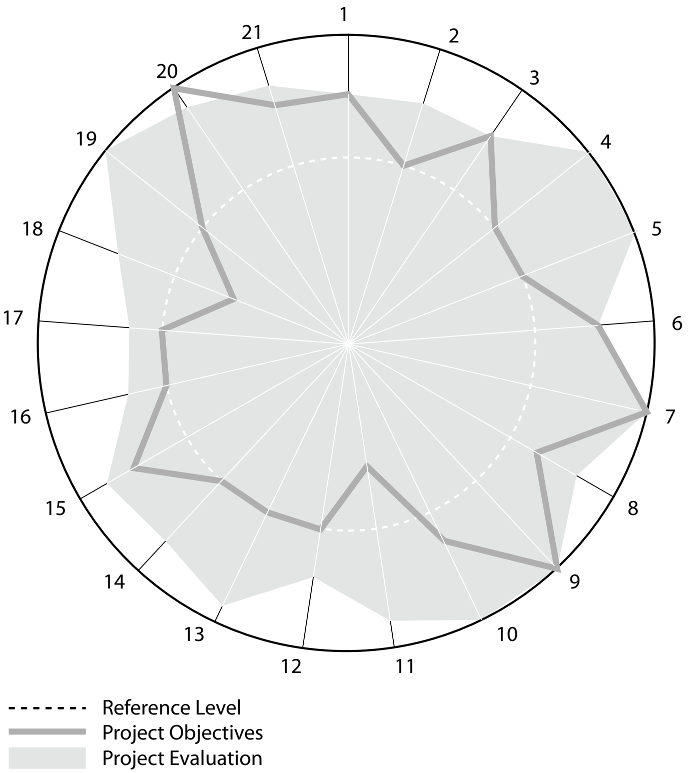

Fig. 8.3 Example of radar chart showing multi-criteria evaluation results and objectives simultaneously

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

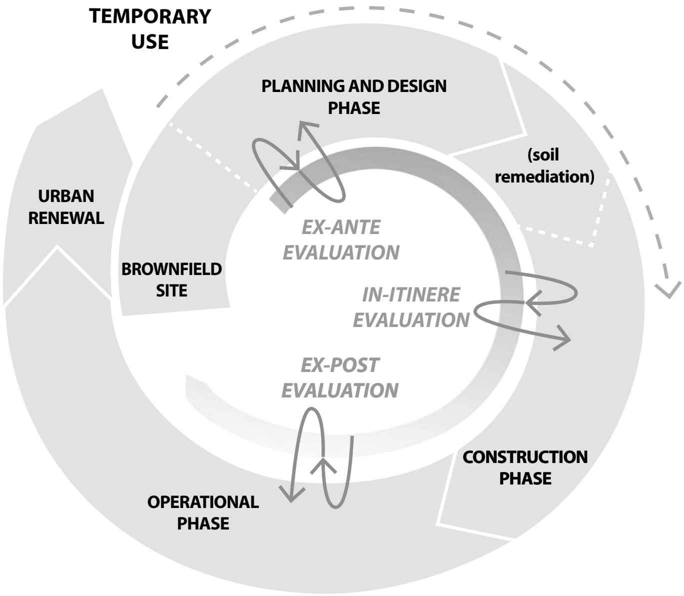

Fig. 8.4 Sustainability monitoring throughout an urban brownfield regeneration project's lifecycle

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

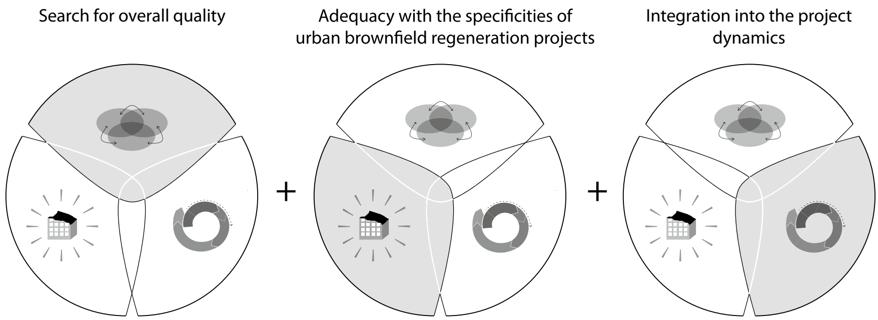

Fig. 8.5 Schematic representation of the three general requirements for a tailor-made operational monitoring tool

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.

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Chapter 9
An Operational Monitoring Tool

Abstract The transition from an urban brownfield to a sustainable neighbourhood is a complex operation. To help decision-makers reach sustainability objectives through measurement, follow-up, and communication about performance indicators, we introduce in this chapter a tailor-made operational monitoring tool. Such a tool should satisfy three general requirements: a search for overall quality, adequacy with the specificities of urban brownfield regeneration projects, and integration into the project dynamics. Accordingly, the multi-criteria evaluation system SIPRIUS and the quality management monitoring software OKpilot are hybridized to create SIPRIUS+. In the first section, we explain the functioning of the two existing methodologies and the adaptions we made to help meet the general requirements and to create the hybrid tool. Then, we present the resulting monitoring tool, SIPRIUS+, and its functionalities.

Keywords Operational monitoring tool · Hybridization · Sustainability indicators · Multi-criteria evaluation · Quality management · Monitoring software · SIPRIUS+

9.1 The Hybridization of Methodologies

Urban brownfield regeneration projects are opportunities to create new sustainable neighbourhoods within metropolitan areas. Because of the overall complexity of these neighbourhoods in transition, we previously argued that a tailor-made operational monitoring tool was required to integrate sustainability objectives, ensure their implementation, measure their performance, and communicate about their results. The tool should satisfy three general requirements: first, a search for overall quality (the tool must equally assess the economic, environmental, social, and institutional/governance dimensions of sustainability); second, adequacy with the specificities of urban brownfield regeneration projects (the tool must be specific to urban brownfield issues as well as the regeneration project process, in particular, its multidisciplinary aspect); and third, an integration into the project dynamics (the tool must include ex-ante, in itinere, and ex-post evaluation as well as promote continuous follow-up and improvement of the project).

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Chapter 8 reported some evaluation methods adapted to brownfield regeneration projects, which meet the general requirements to some extent. However, the critical analysis revealed that these methods are dissociated from the overall project dynamics. In other words, they are not operational and fail at monitoring sustainability objectives.

In response to this common major failure, a research project, conducted at Ecole polytechnique fédérale de Lausanne (EPFL),[1] allowed the development of a new operational monitoring tool tailored to issues raised by urban brownfield regeneration projects. Called SIPRIUS+, the tool is based on a hybridization strategy relying on the potential of existing knowledge and expertise. Hybridization offers the possibility of combining different techniques to compensate for the complexity of decision-making in a world where information is varied and sometimes contradictory (Zavadskas et al. 2016). It puts elements of different origin in synergy and collaboration in order to obtain a combined function that is more efficient and user-friendly. Hybridization requires adapting the two parts sufficiently to make them compatible with each other while remaining identifiable separately (Battilana et al. 2012). Creating new hybrid tools is part of transdisciplinary research (td-net and Swiss Academies of Arts and Sciences 2017). Close to our concerns, Glaeser paraphrases Janes Jacob's motto, "New ideas need old buildings", and transforms it into "New ideas are formed by combining old ideas" (Jacobs 1961; Glaeser 2011).

Thus, SIPRIUS+ originates from the hybridization of existing methodologies from different fields: the built environment and quality management. While sustainability considerations and associated indicators may differ, the methods used to monitor objectives in business or project development are considerably similar. An extensive analysis led us to the complementary selection of SIPRIUS, a multi-criteria evaluation system specifically designed to integrate sustainability into the dynamics of urban brownfield regeneration projects (see Chap. 8), and OKpilot, a web-based quality management monitoring software for public and private organizations (Laprise et al. 2018). Based on their inherent assets, the initial hypothesis was that, put together, they could fulfil the previously described requirements (Fig. 9.1).

This chapter describes the two methodologies and presents the adaptations that were required before performing the hybridization. Then, it describes the main functionalities of SIPRIUS+.

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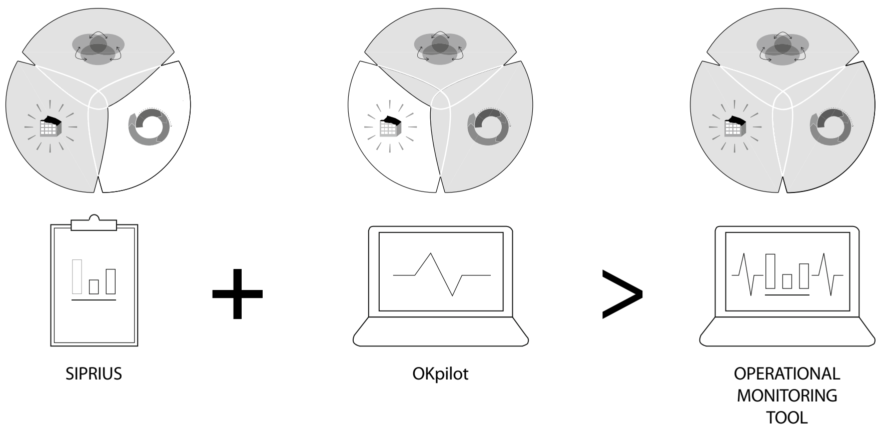

Fig. 9.1 Hybridization of the multicriteria evaluation system SIPRIUS and the quality management monitoring software OKpilot to create SIPRIUS+

9.2 The Multi-Criteria Evaluation System

9.2.1 Description

SIPRIUS is a multi-criteria evaluation system adapted to urban brownfield regeneration projects reflecting the Swiss context (Rey 2012). It develops criteria and indicators according to a holistic approach, based on a definition of the fundamental objectives of sustainable development (Rey 2006). It also includes methodological considerations for assessment and measurement (Pintér et al. 2012), seeking exhaustiveness but non-redundancy.

The criteria—and the associated indicators—cover environmental, sociocultural, and economic aspects and are grouped into two categories: context and project. Context criteria concern aspects that are clearly beyond the physical boundaries of the site. Either the project has a larger impact than that defined by the brownfield site, or external factors interact with the project. Project criteria concern aspects whose issues lie within the boundaries of the site. These criteria relate to both built and unbuilt areas of the site.

For each criterion, a set of quantitative and qualitative indicators measure a dimension of sustainability. To do so, SIPRIUS attributes four reference values. Limit value (V_L)—minimum value required for any project (or veto value); average value (V_A)—value corresponding to the usual practice, no performance in particular; target value (V_T)—value to target in order to achieve a greater performance; and best practice value (V_B)—value corresponding to particularly high performances. Each indicator has its own datasheet containing all the relevant information to perform the evaluation: description, evaluation method, measurement unit, reference values, and references.

The representation of the results in a histogram allows comparing and following the evolution of the performances according to an urban brownfield regeneration project's progress. For indicators relating to context criteria, the evaluation results show, simultaneously, the current situation (upon evaluation), the initial situation (before the regeneration process), and the expected final situation (predictable value at the end of the project, based on all the elements known at the time of the evaluation). For indicators relating to project criteria, the evaluation reflects the long duration and the realization in many stages characterizing urban brownfield regeneration projects. Indeed, one part of a regeneration project is often already completed while another is at the design phase. In this sense, the evaluation results show the different evolutionary phases of the project: the initial objective, the final expected situation, as well as the current situation (the design, construction, and operating phases). Figure 9.2 shows the histograms for the context and project criteria. In addition to the levels corresponding to the reference values (right axis), the histogram also indicates the conventional regular graduated scale (left axis).

SIPRIUS has proven to be a relevant method to evaluate the sustainability of urban brownfield regeneration projects. Indeed, a successful test application to a case study

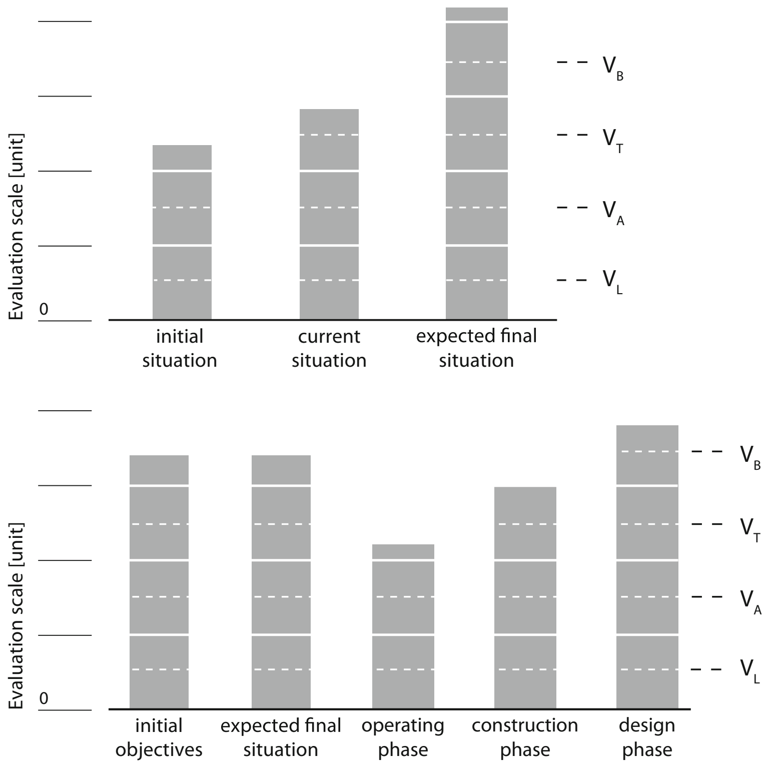

Fig. 9.2 Graphical representation of context (above) and project (below) indicators

was performed (Rey 2012): the Ecoparc Neighbourhood in Neuchâtel, Switzerland, introduced in Chap. 2. However, this earlier version of SIPRIUS is not operational; because it is not integrated into a digital tool, its use on a regular basis depends too much on stakeholders' motivation. Moreover, the indicator system does not address governance aspects. Developed in 2006, SIPRIUS needs adaptations if it is to comply with current practice.

9.2.2 Adaptations

To help meet our three general requirements, the following adaptations of the multi-criteria evaluation system SIPRIUS were necessary: first, the update of the existing indicators and reference values, second, the inclusion of missing criteria and indicators, and third, the creation of a list of governance criteria and indicators.

Our update concerned seven indicators to reflect current concerns and evolving practices, norms, and standards. In these cases, the reference values (V_L, V_A, V_T, and V_B) are more restrictive today than the ones suggested by the original version of SIPRIUS. For example, indicators regarding global warming potential (GWP) and non-renewable primary energy for construction, renovation, and demolition of buildings had no reference values in the first version of SIPRIUS because, at the time, no comparative calculations or targets were available. Since then, the Swiss recommendation SIA 2040 has been released, which encloses objectives for both indicators (SIA 2017).

We added four new indicators after comparing SIPRIUS with other indicator systems specifically developed for brownfield regeneration projects and sustainability certifications at the neighbourhood scale (see Chap. 8). For example, mobility plans for companies and the prevention of light emissions are considerations that we integrated as new indicators.

To meet the fourth pillar of sustainability, governance, we created a new list by analysing the literature as well as other indicator and certification systems. The list contains 11 indicators, which use a determined reference value to evaluate the management and the process of the project. The indicators linked to the management of the project have a concrete dimension such as remediation, temporary use, construction site, and commissioning. They are limited in time to a specific project phase. This does not exclude a regular evaluation, starting from the beginning of the project, in order to set objectives. The indicators linked to the process evaluate the smooth execution of the regeneration project and the proper implementation of the sustainability objectives. Participation, collaboration, information access, and the evaluation process are integrated. As was done with the context and project indicators, the evaluation results for each indicator are presented in a histogram. Figure 9.3 shows the performance for the objective, the current situation, and the expected final situation.

After completing these adaptations, the multi-criteria evaluation system offers 57 indicators. Tables 9.1, 9.2, and 9.3, respectively, list the context, project, and

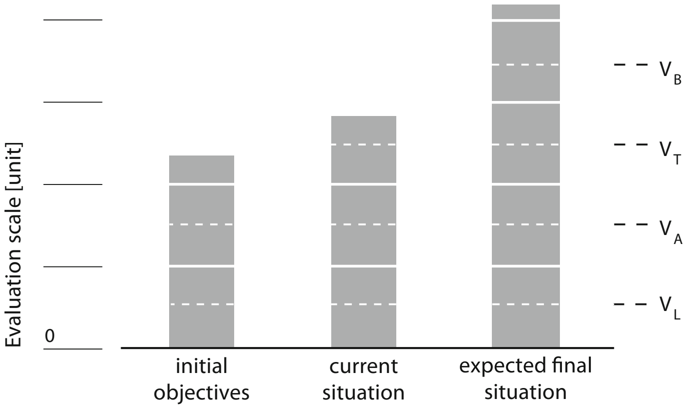

Fig. 9.3 Graphical representation of governance indicators

governance criteria and indicators. Within each list, we identify indicators that have been updated and ones that have been added from the original version of SIPRIUS. The full catalogue of indicators is available in datasheet form in the appendix.

The resulting multi-criteria evaluation system was then adjusted to other national contexts. The challenge was to reflect current and innovative practices from different countries and regions while keeping a certain homogeneity of the indicator system. So far, adjustments have been made to comply with the French and Belgian national contexts. The changes concerned mostly quantitative indicators, and more precisely their reference values. The qualitative indicators remain mostly unchanged, as long as this does not conflict with specific national practices (also available in the appendix).

9.3 The Quality Management Monitoring Software

9.3.1 Description

OKpilot is a web-based collaborative monitoring tool developed as a software-as-a-service (SaaS) based on cloud computing, which ensures the user's smooth implementation, simple maintenance, and lower operating costs. It is accessible online simultaneously via different individual logins (usernames and passwords). It is designed to help private and public organizations comply with different standards (sustainability, quality, social responsibility, health and safety, etc.) using checklists of indicators and increase their performance (GLOBALITE Management 2014). In service to those users, the tool emphasizes clear, simple, and transparent communication of results. The operational monitoring software has features that allow setting, managing, and reaching objectives for optimal control of projects and activities. OKpilot is actually composed of four main inter-related modules: evaluation (based

Table 9.1 Context criteria and indicators. Indicators marked by an asterisk (*) have been updated from the original version. Criteria and indicators marked by a plus sign (+) have been added to the list

Context criteria and indicators			
Environmental impact			
C1	Mobility	C1.1	Quality of service in public transport
		C1.2	Number of parking spaces
		* C1.3	Tying status with "soft" mobility networks
		+ C1.4	Company mobility plan
C2	Air pollution	* C2.1	Average annual emissions of NO2
		* C2.2	Global warming potential (GWP)
		C2.3	Acidification potential (AP)
C3	Noise pollution	C3.1	Average emissions of noise—day
		C3.2	Average emissions of noise—night
+ C4	Light pollution	+ C4.1	Degree of prevention of light emissions
Sociocultural impact			
C5	Proximity of school facilities	C5.1	Average distance to a nursery
		C5.2	Average distance to a kindergarten
		C5.3	Average distance to an elementary school
		C5.4	Average distance to a junior high/middle school
		C5.5	Average distance to a high school
C6	Proximity of commercial facilities	C6.1	Average distance to a commercial zone
C7	Proximity of recreational facilities	C7.1	Average distance to a public park
		C7.2	Average distance to a recreational green/natural area
		C7.3	Average distance to a cultural centre

(continued)

Table 9.1 (continued)

Context criteria and indicators			
		C7.4	Average distance to a sport centre
Economic impact			
C8	Population	C8.1	Net population density
C9	Employment	C9.1	Net employment density
C10	Local economy	C10.1	Proportion of work carried out by local companies

on a checklist of indicators evaluated at different states); outcomes (with diverse possibilities of visualization modes, benchmarking, and reporting exports); management (including management solutions such as the setting of objectives and responsibility assignment, risk alerts, internal messaging, user configuration, etc.); and information database (gathering documents and other evidence on the evaluated object as well as documentation supports for the evaluation like norm or standards).

Although OKpilot is business-oriented—and consequently not used to monitor sustainability in the built environment—its versatility and high level of flexibility are major assets. Thanks to a clear dissociation between its monitoring functionalities and the evaluation database, OKpilot has the potential—with some adaptations—to answer the need for an operational monitoring tool tailored to urban brownfield regeneration projects.

9.3.2 Adaptations

In collaboration with the software's computer service, we made a series of adaptations of OKpilot to make it compatible with the revised version of SIPRIUS. More precisely, we adapted some features of OKpilot to evaluate and display sustainability indicators according to the logic of SIPRIUS. Consequently, our adaptations concerned the evaluation and outcome modules; the management and information database modules were highly functional and already compatible with SIPRIUS.

Most of the adaptations required only minor programming adjustments. For example, this was the case for the harmonization of technical terms used by OKpilot and SIPRIUS, the addition of an extra level of evaluation to make a distinction in the results between sustainability dimensions, or the possibility to unselect irrelevant indicators according to projects (heritage or remediation for instance). Nevertheless, two adaptations required more extensive programming.

The first one asked for a change in the way indicators are measured and had a direct impact on the evaluation module (see Fig. 9.4). OKpilot originally worked with relative values, expressed as a percentage. We made an adaptation allowing the measurement with absolute values, corresponding to SIPRIUS' reference values

Table 9.2 Project criteria and indicators. Indicators marked by an asterisk (*) have been updated from the original version. Criteria and indicators marked by a plus sign (+) have been added to the list

Project criteria and indicators			
Environmental balance			
P1	Land	P1.1	Floor area ratio
P2	Energy	* P2.1	Non-renewable primary energy for construction, renovation, and demolition of buildings
		* P2.2	Non-renewable energy for buildings in operation
P3	Water	P3.1	Infiltration surface and stormwater use
P4	Biodiversity	P4.1	Green surfaces
		+ P4.2	Degree of ecosystem considerations
Sociocultural quality			
P5	Well-being	* P5.1	Annual hours of overheating
		P5.2	Interior noise level
		* P5.3	Spatial daylight autonomy (sDA)
		P5.4	Degree of electrosmog
		P5.5	Degree of individualization of housing
		P5.6	Quality of outdoor spaces
P6	Security	P6.1	Degree of security
P7	Heritage	P7.1	Degree of enhancement of existing heritage
P8	Diversity	P8.1	Degree of functional mix
		P8.2	Potential of social diversity
		P8.3	Degree of universal access
Economic efficiency			
P9	Direct costs	P9.1	Investment costs
		P9.2	Gross rental yield
P10	Indirect costs	P10.1	Annual operating costs
		+ P10.2	Level of occupancy
P11	External costs	P11.1	External costs
P12	Flexibility	P12.1	Degree of building flexibility

Table 9.3 Governance criteria and indicators. Criteria and indicators marked by a plus sign (+) have been added to the list

Governance criteria and indicators			
Management			
+ G1	Remediation	+ G1.1	Logic of project footprint
		+ G1.2	Degree of site remediation
		+ G1.3	Degree of residual contamination
+ G2	Temporary use	+ G2.1	Transitional occupation initiatives
+ G3	Construction site	+ G3.1	Management of construction waste
		+ G3.2	Management of construction disturbances
+ G4	Commissioning	+ G4.1	Commissioning plan for buildings
Process			
+ G5	Participation	+ G5.1	Degree of participation of population
+ G6	Collaboration	+ G6.1	Degree of collaboration of professionals
+ G7	Information access	+ G7.1	Degree of access to information
+ G8	Evaluation	+ G8.1	Degree of integration of an evaluation process

(V_L, V_A, V_T, and V_B). Accordingly, we developed a new slider in the evaluation module, which allows assigning a value to each indicator. A standard colour code was associated with each reference value: orange corresponds to V_L, yellow to V_A, light green to V_T, and dark green to V_B. As for red, it corresponds to an indicator whose performance does not reach the limit value (V_L). Finally, the module improvement also includes all relevant information and references to assist the evaluation for each indicator, thanks to a digital transposition of the datasheet presented in the appendix.

This adaptation required coding work that had repercussions on the presentation of the results in the outcomes module. Thus, we did this work concurrently with the second major adaptation: enhancement of the graphical displays. The "Chart" display, which gives an overview of the results at a given moment, showed in the previous version only aggregated results under each criterion. It has thus evolved to show every indicator simultaneously. Furthermore, we developed options allowing for customized visualization according to a selection of indicators, a sustainability dimension, or a value obtained (Fig. 9.5). The resulting graphical display called "Evolution" is a completely new monitoring feature of OKpilot. It shows the evolution of a given indicator from the objective or initial situation to the expected final situation, including the various situations (Fig. 9.6). It has the same options as the "Chart"

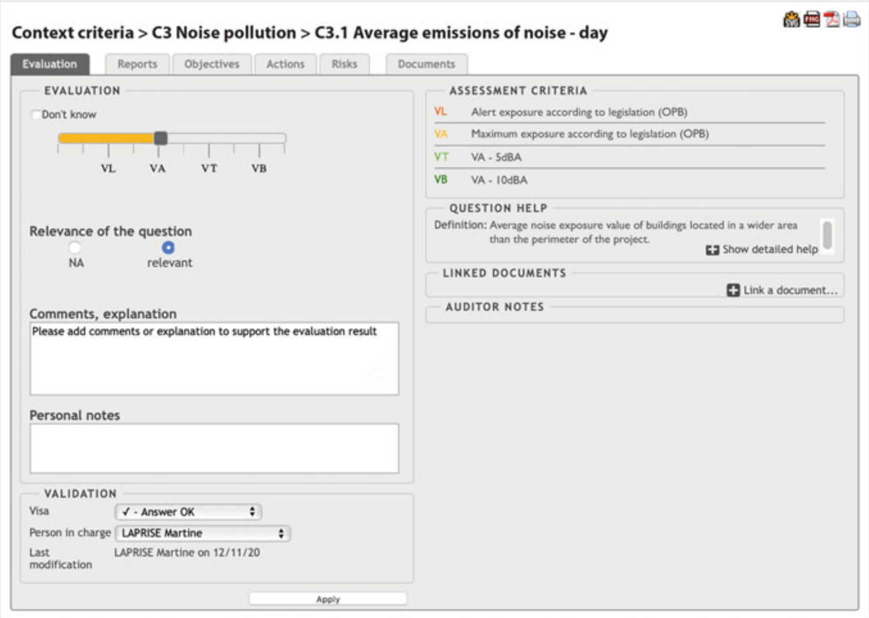

Fig. 9.4 Evaluation module for a given indicator

display, plus the option to show a summary of the repartition of several indicators (context, project, or governance), according to their performance (Fig. 9.7).

9.4 An Operational Monitoring Tool to Support Neighbourhood in Transitions

Following these adaptations, we consolidated the hybridization between the indicator system SIPRIUS and the monitoring software OKpilot, allowing the creation of the operational monitoring tool SIPRIUS+. Figure 9.8 is a schematic representation of the tool's structure. More precisely, SIPRIUS provides the content of SIPRIUS+, while OKpilot supports it and makes it operational. It means that the three summary lists of criteria and indicators (context, project, and governance and the attached datasheet) were coded and imported into OKpilot. From there, they became checklists used to monitor, in this case, urban brownfield regeneration projects located in Switzerland. The operation was then repeated for the French and Belgian lists. In total, nine checklists are available within SIPRIUS+.

Figure 9.9 introduces the homepage of SIPRIUS+, which welcomes users with a simplified menu designed to make the tool more user-friendly. It can be customized to the project that is monitored. To start using the tool, users must create a "site", that is to say, an urban brownfield regeneration project in a specific country. Then, they

Fig. 9.5 Chart display showing the expected final situation of context indicators

must select a checklist (context, project, or governance) and a state (initial situation or objective, current situation, and expected final situation). Users can always access these selection buttons in the top toolbar. After these preliminary steps, they can start monitoring their neighbourhood in transition.

Essentially, the result of this hybridization process is a tailor-made operational monitoring tool that specifically supports the regeneration of urban brownfields into sustainable neighbourhoods. In that sense, it is designed to meet the three general requirements set at the beginning: a search for overall quality, adequacy with the specificities of urban brownfield regeneration projects, and integration into the project dynamics.

In order to validate this result, SIPRIUS+ went through a complementary two-step verification process (Laprise et al. 2018). The first step consisted in the test application on three case studies: Val Benoit neighbourhood in Liège (Belgium), Gare-Lac neighbourhood in Yverdon-les-Bains (Switzerland), and Pôle Viotte neighbourhood Besançon (France). The aim was to validate the functioning and robustness of the monitoring tool. The second step consisted of interactions with the stakeholders involved in each case study. The aim was to challenge the tool and gather points

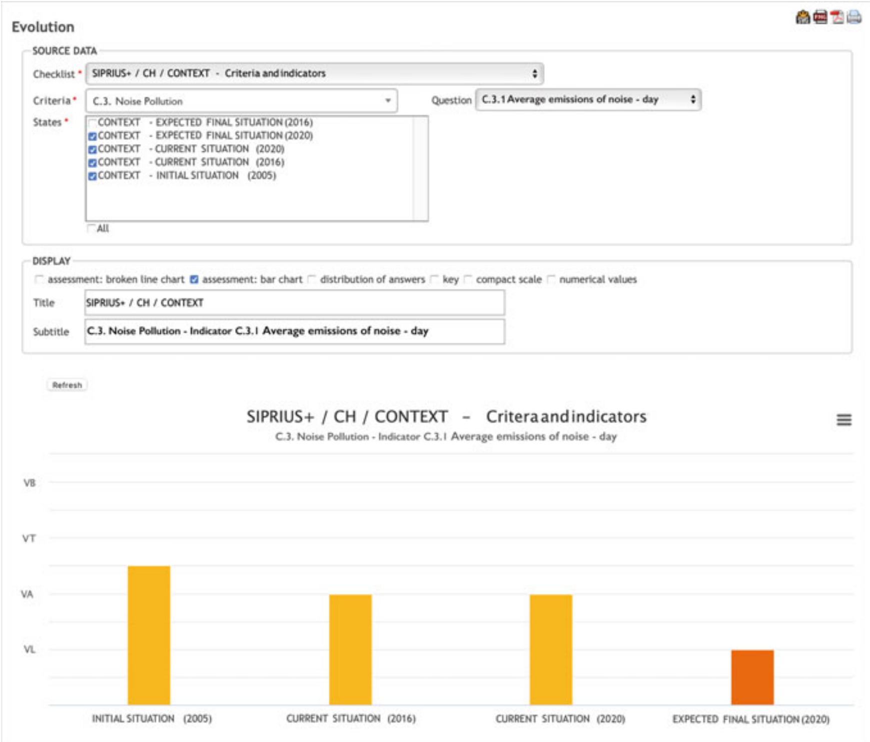

Fig. 9.6 Evolution display showing the performance of given indicators

of view of future end-users on the reality of the practice. The process has shown that the inclusion of a monitoring practice is not only feasible but also realistic and desired. It revealed that SIPRIUS+ has the potential, not only to facilitate a structured and regular follow-up of sustainability objectives integrated into project dynamics but also to provide outputs easy to interpret by different professionals involved in the project and simple to communicate to a wider audience. Hence, SIPRIUS+ is expected to contribute to decision-making in a multi-disciplinary manner, without giving ready-made solutions, but allowing iterative project settings. Concretization of the sustainability vision and maintaining the objectives will always depend on the motivation and involvement of the stakeholders (Laprise and Rey 2019). The next chapter illustrates a real-world application on an ongoing urban brownfield regeneration project.

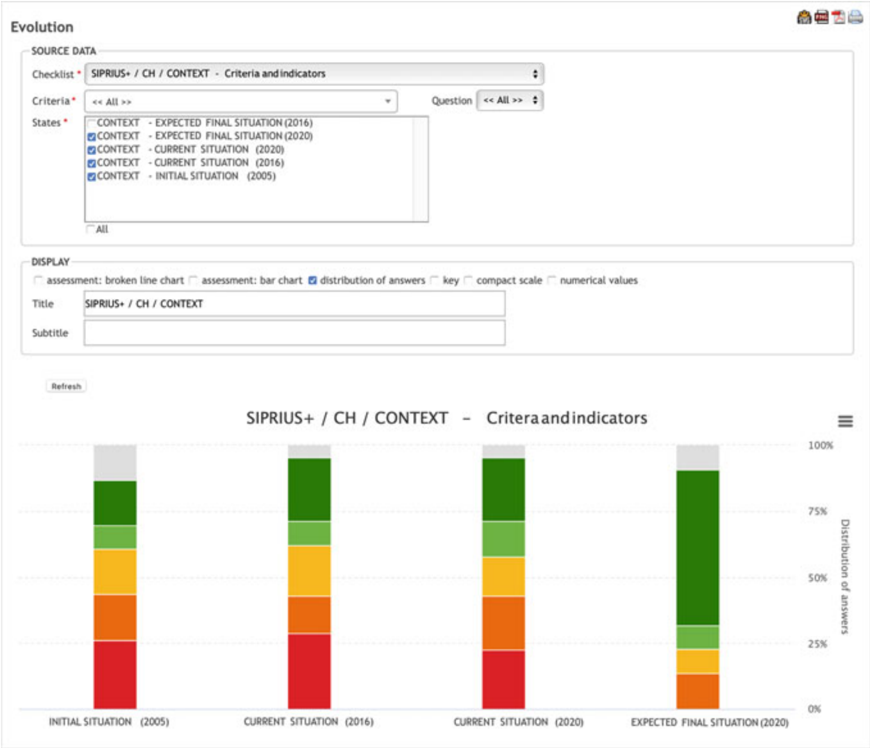

Fig. 9.7 Evolution display showing all indicators' performances

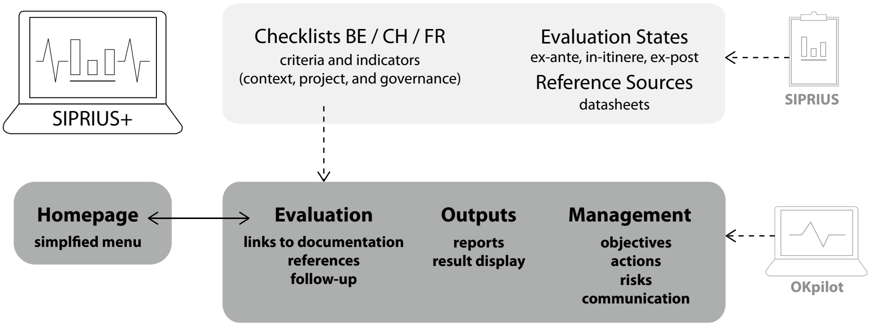

Fig. 9.8 Schematic representation of the structure of SIPRIUS+ hybridizing an indicator system (SIPRIUS) and a monitoring software (OKpilot)

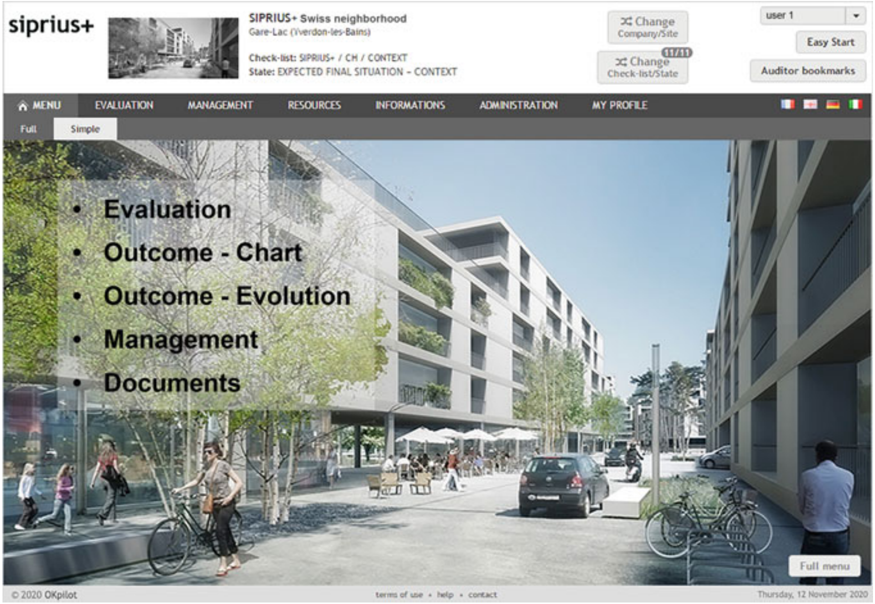

Fig. 9.9 SIPRIUS+ Homepage

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Chapter 10
Application to a Case Study

Abstract We present an application of the operational monitoring tool SIPRIUS+ to an ongoing case study representative of urban brownfield regeneration projects: the Pôle Viotte neighbourhood, located in Besançon (France). We start with a description of the brownfield site, followed by the regeneration project. Then, we evaluate 52 indicators linked to the context, project, and governance. Each monitoring result is illustrated by a graph showing the evolution of the performances. Then, we analyse the overall results, which allows us to assess the sustainability strategy of the regeneration project. Through this analysis, we identify four actions to improve sustainability objectives. Finally, we conclude that SIPRIUS+ has the potential to contribute to the integration of sustainability issues into the dynamics of neighbourhoods in transition. The operational monitoring tool is expected to contribute to decision-making in a multi-disciplinary manner, without giving ready-made solutions. Interactions with project stakeholders reveal that, while the use of such a tool would require a change in project management, the evolutions to adopt to include this practice appear not only feasible but realistic and desired.

Keywords Urban brownfield regeneration project · Operational monitoring tool · SIPRIUS+ · Case study · Pôle Viotte neighbourhood · Sustainable neighbourhood · Results reporting · Decision-making support

10.1 Monitoring the Pôle Viotte Neighbourhood in Besançon, France

Chapter 9 explained briefly the functioning of the operational monitoring tool SIPRIUS+. The objective of this chapter is to demonstrate the benefits and limitations of SIPRIUS+, thanks to its application to an ongoing case study representative of urban brownfield regeneration projects: the Pôle Viotte neighbourhood, located in Besançon (France). The monitoring is carried out in a neutral way; as a rule, performance is not compared with other projects and no specific recommendations are made. The first application of the monitoring tool took place during fall 2016, performed by the research team (LAST—EPFL) with the support of the case study's project manager (Direction Urbanisme Projets et Planification, Grand

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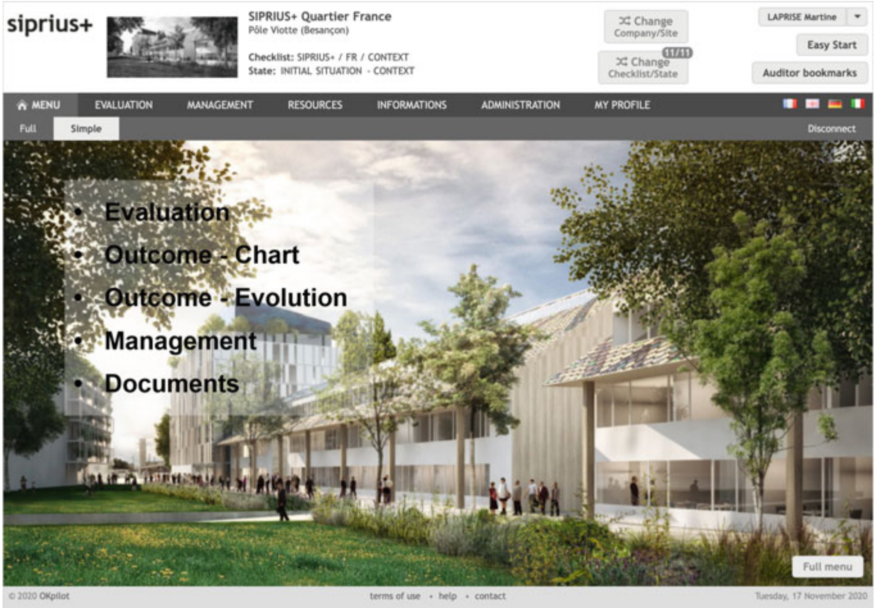

Fig. 10.1 SIPRIUS+ Homepage customized for the Pôle Viotte monitoring

Besançon Metropole) (Laprise 2017). We present here the latest monitoring results. They were obtained with an application of the monitoring tool during fall 2020 and performed by the same team configuration (see Fig. 10.1).

We start with a description of the urban brownfield site, followed by the regeneration project. Then, we present the detailed monitoring results of the context, project, and governance indicators illustrated by the evolution displays of SIPRIUS+. Finally, we show the overall monitoring results using the graph display of SIPRIUS+ as well as an analysis of the monitoring tool's potential to facilitate the integration of sustainability issues into the project dynamics of a neighbourhood in transition.

10.1.1 Description of the Urban Brownfield Site

Railway activities characterize the Viotte site. The railway station was built in 1885 and then rebuilt in 1962 to make room for underground circulation systems, which later became difficult to access and illegible for users. It added to the decline in rail operations throughout the site. More specifically, the closure of the old Sernam Hall (Fig. 10.3) in 2001 caused the loss of several jobs. At the beginning of the twenty-first century, the Viotte site embodied a typical urban brownfield, breaking with its context. The steep drop in level between the northern sector and the southern sector, as well as the lack of vitality of in situ activities, accentuated the barrier created

Fig. 10.2 Aerial view of the brownfield site surrounding Viotte train station (photo: Ville de Besançon, 2007)

by the railways. Only a few jobs linked to the SNCF (the French National Railway Company) remained on site.

The brownfield site has a global hold of 11 hectares in the city, including the surface occupied by railways and various neglected spaces. It is located at the intersection of the Charpais and Saint-Claude neighbourhoods, near the Battant neighbourhood and the *glacis* (paved wall) of Vauban ramparts, which was transformed into a public park in 2013. The Parc des Glacis, listed as a UNESCO World Heritage site, forms a green corridor towards the city centre. The urban brownfield is accessed mainly by Avenue de la Paix to the south and Rue Nicolas Bruand to the north. It benefits from a location that is both privileged—its proximity to the historical city centre—and strategic, due to the expanded transport offer of the Besaçon-Viotte railway station (TGV, regional train, tram, bus, etc.), which can help promote economic development. Figure 10.2 is an aerial view of the brownfield site before the start of the regeneration project. Figures 10.3, 10.4, 10.5, and 10.6 give an overview of the initial situation of the brownfield site. Figure 10.7 locates the brownfield within the city of Besançon.

10.1.2 Description of the Urban Brownfield Regeneration Project

Since 2008, the city of Besançon has been supporting a global project to reclaim the urban brownfield site surrounding the Viotte railway. The Pôle Viotte neighbourhood is designed as a new dense and mixed vibrant sustainable neighbourhood where it will be possible to work, live, do daily shopping, move around, or travel. The trigger

Fig. 10.3 The old Sernam Hall south sector of the brownfield was an emblematic building of railway sites (photo: Martine Laprise, 2016)

Fig. 10.4 View on the brownfield site from Rue Jeanneney showing the steep drop and an SNCF building, 2016 (photo: Martine Laprise, 2016)

Fig. 10.5 The military platform in the northern sector of the brownfield site, 2016 (photo: Martine Laprise, 2016)

Fig. 10.6 A parking in the northern sector of the site next to public access to the multi-modal hub, which was completed during the first phase of development (photo: Martine Laprise, 2016)

Fig. 10.7 Location map of the Viotte brownfield site, Besançon, France

for the regeneration project was the Viotte station's transformation into a 2-ha multi-modal hub. This first phase of development addressed a global mobility issue for the City area, which opened the station to the north and made it accessible to all travel modes. A preliminary consultation file was made public in 2009, following a series of studies carried out by the firm Arep, architects-urban planners, representing a multi-disciplinary group. Work on this first phase—the multi-modal hub—began in November 2012 and ended in October 2014.

The multi-modal hub created in phase 1 serves as an anchor and support for the second phase of development, another urban and metropolitan issue: developing a multi-functional neighbourhood of 3.1 ha to the north and south of the tracks as part of a comprehensive sustainable development approach. As previously described, the sector is a brownfield mainly occupied to the south by the old Sernam Hall and to the north by various abandoned areas impervious to rainwater. At a global cost of 58 M € (excluding tax), 46,535 m^2 of the surface will emerge from the ground creating almost 1,000 jobs and more than 225 housing units. The driving force behind this new neighbourhood is Sernam Hall's replacement by a new tertiary centre (approx. 27,000 m^2, buildings A and B). It will bring together several hundred agents from the state and regional services, currently spread over the territory of Besançon. The project was subject to an architectural competition won in July 2016 by Métra + Associés architects. The tertiary centre project is under the stewardship of SEDIA, a local semi-public company. The developer of the urban brownfield regeneration project is Territoire 25, a local public development and construction's company.

Figure 10.8 shows the masterplan of the Pôle Viotte neighbourhood. The delivery of the first neighbourhood buildings A and B is scheduled for 2021 (see Fig. 10.9). Final delivery of all buildings, landscaping, and exterior facilities is scheduled for 2025.

10.2 Detailed Monitoring Results

From a monitoring point of view, it is especially interesting to focus on the detailed results. Doing so makes it possible to see the effects that some sustainability objectives set by the regeneration project may have on the site's improvement, including the risks, challenges, and opportunities. We present here the detailed monitoring results updated during fall 2020. To do so, we start with the complete checklist of context indicators, followed by the project indicators and the governance indicators. We can retrieve from the datasheet in the appendix the definition of each indicator, the evaluation method, the measurement unit, and the level assigned to the reference values (V_L—limit value, V_A—average value, V_T—target value, and V_B—"best practice" value).

The monitoring focuses mainly on the second phase of development of the project but also takes into account planned improvements of the recent multi-modal hub (phase 1). The documents used for the evaluation are mainly the masterplan, the application file for the EcoQuartier Label—phase 2 (Ville de Besançon 2018), and diverse communications on the project produced by the City and the Arep representatives (Ville de Besançon 2015; Arep ville et al. 2015, 2016). The Grand Besançon website was also regularly consulted. As a complement, we performed site visits, interviews, and working sessions with the city of Besançon projects and planning department to acquire the necessary knowledge and data for the project evaluation.

10.2.1 Checklist—Context Indicators

For these indicators, we evaluate the initial, current, and expected final situations (see Figs. 10.10, 10.11, and 10.12). The initial situation corresponds to that of 2007, before the start of the project. The current situation corresponds to the one closest to the evaluation period (fall 2020) for which the data was available. Since construction work on the southern sector of the site—started in 2018—is still in progress, we note that it is sometimes not relevant to measure the current situation. In these cases, evaluation of the current situation will evolve with the project. Such is the case for the indicators under the sociocultural impact (C5.1 to C7.4). We evaluate these indicators by the various services supplied for the neighbourhood inhabitants within a given radius from their residence place (entrance of the building). For the moment, no existing or new apartment building allows measuring these indicators for the initial and current situation. Only the expected final situation gives an overview of what

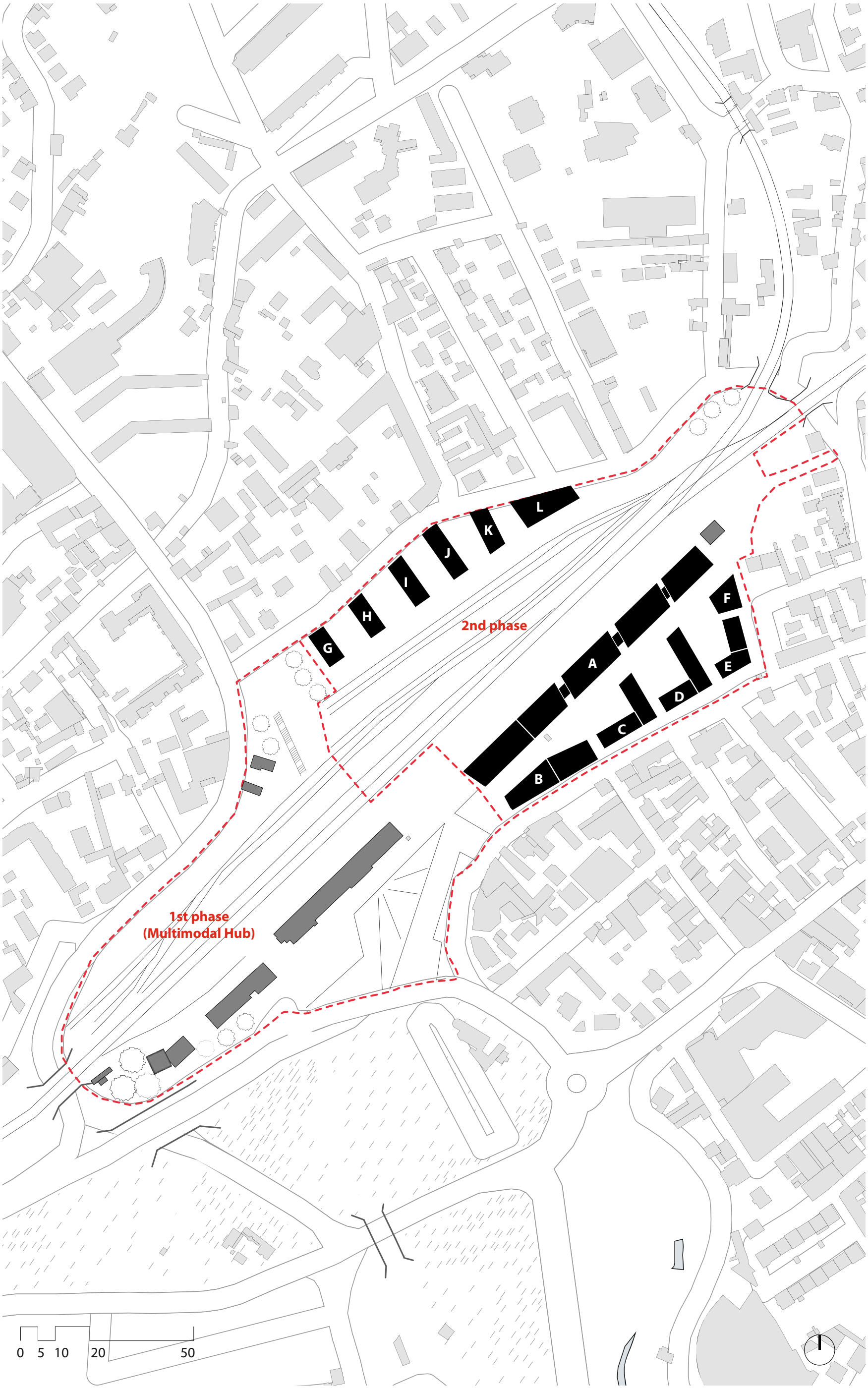

Fig. 10.8 Masterplan of the Pôle Viotte neighbourhood

Fig. 10.9 New tertiary centre under construction (photo: Ville de Besançon, 2021)

can be anticipated; the evaluation of the current situation will be specified as the project progresses. To date, the expected final situation corresponds to the objectives described in the project guidelines used for the assessment.

Moreover, we cannot evaluate indicators *C2. Air pollution—C2.2. Global warming potential (GWP)* and *C2.3. Acidification potential (AP)*—because there are not enough comparable calculations on full lifecycle analysis of buildings to establish reliable reference values.

10.2.1.1 Environmental Impact

C1. Mobility—C1.1. Average distance to a public transport stop

The future neighbourhood will benefit from a real quality of service in public transport, thanks to the multi-modal hub's existence within the Viotte site perimeter. Indeed, the offer includes, for the railway station, the TGV and the main and regional lines, and, for the public transport of greater Besançon, the tramway, the urban and suburban bus network GINKO, and the regional and departmental inter-urban bus network. For the expected final situation, we calculate a weighted average distance of 192 m to the closest public transport stop, which leads to the best practice value (V_B). For the initial situation calculation, the public transport offer was not as complete

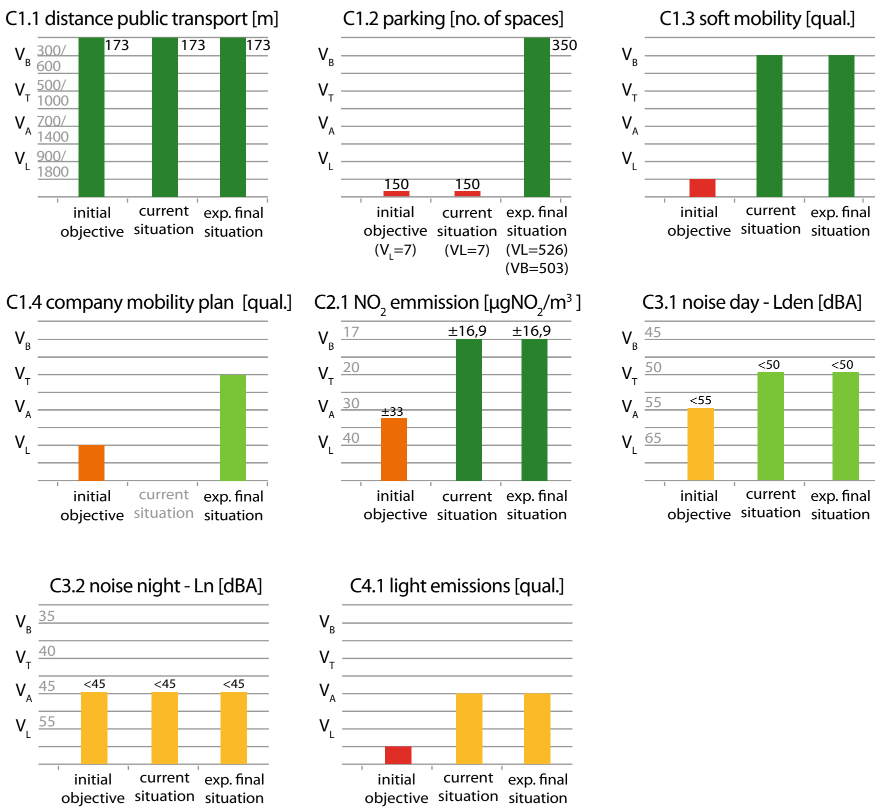

Fig. 10.10 Evolution displays for the context indicators—environmental impact

as it is now: the TGV Rhin Rhône came at the end of 2011, the tramway in 2014. At the same time, very few users worked on the site. However, jobs in the sector were already close to the train station (173 m). Due to this advantageous position, the calculation corresponds to the best practice value (V_B). The evaluation for the current situation is similar to the initial situation (173 m) and gets also the best practice value (V_B).

C1. Mobility—C1.2. Number of parking spaces

Since the new neighbourhood provides numerous jobs – notably within the tertiary sector – and several new inhabitants, parking is an important issue. For this indicator, we limit the calculation to the second phase of development. The parking issue related to the multi-modal hub contains specific and complex requirements that go beyond this indicator.

The initial situation is hard to calculate because the SNCF did not wish to communicate the number of jobs on-site nor its needs for station employees. However, we estimate that some parking lots, spread on the site, offer around 150 spaces used by

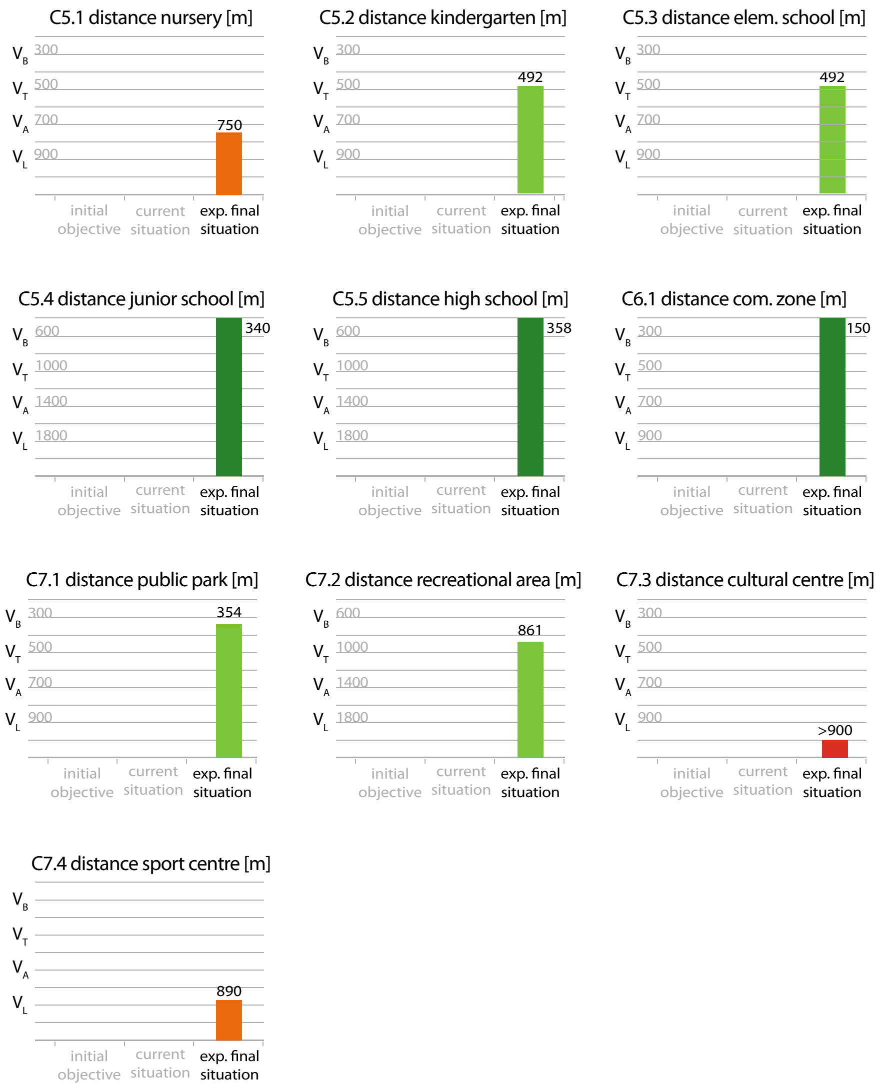

Fig. 10.11 Evolution displays for the context indicators—sociocultural impact

SNCF employees. If we strictly consider the second-phase sector, we calculate the limit value (V_L) at 75 parking spaces. So, we evaluate the initial situation under the limit value (V_L). The evaluation of the current situation is not relevant because there is no activity at the moment in the northern sector, and the southern sector of the site is under construction.

Based on the urban planning code requirements, the future inhabitants' and workers' needs will be 526 spaces for the limit value (V_L) and 503 spaces for

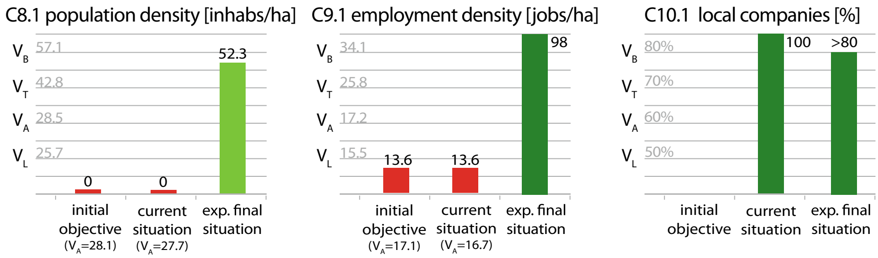

Fig. 10.12 Evolution displays for the context indicators—economic impact

the best practice value (V_B). The new neighbourhood project intends to provide an optimal number of parking spaces. First, we know that no parking spaces will be offered to employees of state services. In the southern sector, the project includes a semi-underground car park with 300 spaces. A shared car park with 150 spaces will probably equip the northern part. Of these spaces, 100 are not taken into account, as they are intended for SNCF agents. With its estimated total of 350 parking spaces, we assign the best (V_B) practice value to the expected final situation.

C1. Mobility—C1.3. Tying status with "soft" mobility networks

For the initial situation, we notice that the Viotte sector made little room for pedestrians and bicycles, particularly because of the rupture between the northern and southern sectors of the site caused by the railways. This observation is one of the triggers that led to the new multi-modal hub's conception. Indeed, one of the objectives was to "get across the station" as well as to create "clear, legible, and secure pedestrian links from the city centre" and "continuity of paths". Another achieved objective was "the accessibility and the provision of bicycle parking". Given the development work completed in 2014, the current situation corresponds to the best practice value (V_B). We evaluate the initial situation as below the limit value (V_L).

Finally, the guidelines for the Pôle Viotte neighbourhood also show strong consideration of soft and sustainable mobility. Indeed, in the neighbourhood's southern sector, a landscaped lane will be accessible only to pedestrians and bicycles. Throughout the site, the project plans a fine-meshed pedestrian and bike network, accompanied by the strong presence of greenery. It will improve the neighbourhood's connectivity to the rest of the city, both in its northern and southern sectors. For these reasons, we assign the best practice value (V_B) to the expected final situation.

C1. Mobility—C1.4. Company mobility plan

A company mobility plan between the tertiary centre's different agencies to promote non-motorized commuting is currently under development. For example, state employees could be offered a 50% reduction in public transport subscriptions. Due to the tertiary centre's strategic localization close to the multi-modal hub and the city centre, we can also expect that a significant proportion of employees will use public transport or other sustainable mobility modes (cycling, walking, etc.). As mentioned for indicator *C1.2 Number of parking spaces*, no parking space for state employees is granted, representing the vast majority of future jobs in the sector. Besides, the Pôle Viotte neighbourhood will offer an optimal supply of parking spaces, based, among other things, on a pooling strategy. According to this information, the expected final situation is likely to reach the target value (V_T).

Evaluating the initial situation required an examination of the measures formerly in place for SNCF employees. The latter had free use of SNCF transport services. On the other hand, we also know that all employees had a free parking space available, which was used systematically. Faced with this ambiguity and the simplitic offer as an alternative to motorized private transport, we evaluate the initial situation at the limit value (V_L). Evaluating the current situation is not relevant because there is no activity at the moment in the northern sector, and the southern sector is under construction.

C2. Air pollution—C2.1. Average annual emission of NO_2

For the current performance in air pollution, we take into account the measurements of the European Prévoyance station (urban type), located about 500 m from the Pôle Viotte neighbourhood. An average annual emission of 16.9 $\mu gNO_2/m^3$ was measured for the year 2019 (13.2 $\mu gNO_2/m^3$ is currently foreseeable for the year 2020) (ATMO BFC 2020). This measurement corresponds to the best practice value (V_B).

For the initial situation, we must refer to the Mégevand station (traffic type) located in downtown Besançon at a distance of about 1.5 km and an altitude of +246 m. Indeed, the Prévoyance station (+281 m) is only been effective since 2013. The average annual emission for 2007 was 43 $\mu gNO_2/m^3$, which is below the limit value (V_L). However, we note significant differences between the two stations' measurements of the order of 10 $\mu gNO_2/m^3$ from 2013 to 2016. For this reason, we judge the initial situation to be more or less 33 $\mu gNO_2/m^3$, that is to say, the limit value (V_L).

As for the expected final situation, trends observed since 2013 show general improvement, which, however, does not allow us to affirm continuity or stabilization of emissions level. We know from the outset that an increase in site occupancy, including new buildings and increased traffic, will have an impact on the level of NO_2 emissions. That said, the project plans energy-efficient buildings (RT2012 −20%) based on renewable energies, such as geothermal energy. Besides, constant technical development in the automobile and a change in mentality about public transport use can help improve air quality. For these reasons, we give the best practice value (V_B) to the expected final situation, in continuity with the current situation.

C3. Noise pollution—C3.1. Average emissions of noise—day (Lden)

For the initial situation, we consider the cartographic data of rail and road noise from 2012 (Grand Besançon 2016). The current and expected final situations use Type A maps with isophone curves starting at 55 dBA, updated in 2019 (Ministère de la Transition Ecologique et Solidaire and Ministère de la Cohésion des Territoires 2019). For this indicator, we evaluate only the second phase of the development of the project. Indeed, the multi-modal hub (first phase) has specific requirements, less impacted by noise pollution.

Regarding noise caused by road traffic, 13% of the site is in a 55–60 dBA zone and 9% in a 60–65 dBA zone. These areas are scattered around the site. For railway noise, 12% of the site is in a 55–60 dBA zone, 36% in a 60–65 dBA zone (in the northern part), and 6% of the site reaches levels between 65 and 70 dBA (in the south-eastern part, near Rue du Chasnot, where the free spaces are). The Sernam Hall makes a significant contribution to noise reduction in the south. For the initial situation, there is no building to the north. We estimate through the analysis of these data that most of the occupied site is below 55 dBA, which corresponds to the average value (V_A) for the initial situation.

For the current and the expected final situation, the new measurements show that almost all the buildings will be located outside the noise pollution zones greater than 55 dBA (railways and roads combined). Only the west tip of the tertiary centre (building A) meets a zone of 60 dBA. The noise is mainly around the station, Rue de Vesoul, and Avenue de la Paix. At this stage of the project, there is no indication of specific construction measures to counter noise. Like the Sernam Hall, we expect that the tertiary centre will have a deflecting effect in the southern sector. Based on these data, and for lack of more precise measurement, we evaluate the two situations for the moment at the target value (V_T).

C3. Noise pollution—C3.2. Average emissions of noise—night (Ln)

The evaluation conditions for Ln are similar to the previous indicator Lden. For the initial situation, we consider the cartographic data of rail and road noise from 2012 (Grand Besançon 2016). The current and expected final situations consider Type A maps with isophone curves starting at 50 dBA, updated in 2019 (Ministère de la Transition Ecologique et Solidaire and Ministère de la Cohésion des Territoires 2019).

For the initial situation, concerning road traffic noise, 10% of the site area is in a 50–55 dBA zone. These areas are located around the site. For rail traffic noise, 16% of the site is in a 50–55 dBA zone, 30% in a 55–60 dBA zone (i.e., almost all of the northern portion), and 4% in a 60–65 dBA zone to the north along the Sernam Hall. For the initial situation, there is no building to the north. We estimate through the analysis of these data that most of the occupied site is below 45 dBA, which gives the average value (V_A) for the initial situation.

For the current and expected final situations, the new measurements show that all the buildings will be located outside noise pollution zones greater than 50 dBA (railways and roads combined). The noise is concentrated around the main roads of Rue de Vesoul, Avenue de la Paix, and near the station. The deflecting effect of the tertiary centre has less impact on this indicator since almost no train travels overnight. Based on these data, and for lack of more precise measurement, we evaluate the two situations for the moment at the average value (V_A).

C4. Light pollution—C4.1. Degree of prevention of light emissions

For the initial situation, there is no measure to prevent light emissions. The evaluation is below the limit value (V_L). For the expected final situation, public lighting will be installed according to the city of Besançon's recommendation. Indeed, the city has paid particular attention since 2010 to the right level of public lighting and the energy savings that can be achieved (standby-mode from 10 p.m. to 6 a.m., remote management, low-consumption devices, etc.) (Ville de Besançon 2010). However, the project has not yet developed a more precise lighting plan, which would go beyond these initiatives to the neighbourhood scale. Thus, we assign the average value (V_A) for the expected final situation. Similarly, the current situation (the multi-modal hub) follows the city of Besançon's recommendation, which corresponds to the average value (V_A).

10.2.1.2 Sociocultural Impact

C5. Proximity of school facilities—C5.1. Average distance to a nursery

At the beginning of the project, building F included a nursery to meet the needs of employees and inhabitants with families. Given the limited car access to the building, the programme has evolved into another function, that of urban greenhouse. The closest public nursery stands to the west of the site (Avenue du Commandant Marceau), the weighted average distance to which is 750 m. The expected final situation corresponds to the limit value (V_L). Note that the indicator does not take into account the reception capacity of the nursery.

C5. Proximity of school facilities—C5.2. Average distance to a kindergarten

C5. Proximity of school facilities—C5.3. Average distance to an elementary school

We evaluate these two indicators simultaneously because they involve research concerning buildings accommodating the two functions. For the average distance to a kindergarten and elementary school, the closest school facilities to consider are the Viotte kindergarten and the Viotte elementary school, located about 10 m apart, north of the tracks on the Chemin Français. The weighted average distance is 492 m, which is equivalent to the target value (V_T) for both indicators.

C5. Proximity of school facilities—C5.4. Average distance to a junior high/middle school

For this indicator, the closest establishments are the Collège Stendhal (Avenue du Commandant Marceau) for the northern sector of the site, and the vocational school École des Métiers Artistiques (Rue du Balcon) for the southern sector. Due to the latter's proximity, the weighted average distance is 358 m, which is equivalent to the best practice value (V_B) for the expected final situation.

C5. Proximity of school facilities—C5.5. Average distance to a high school

For this indicator, we take into account the Regional Directorate of Youth and Sports and Social Cohesion (Direction Régionale de la Jeunesse et des Sports et de la Cohésion Sociale—DRJSCS). Located on Rue Nicolas Bruand, this establishment offers various higher education courses. The weighted average distance for the expected final situation is 340 m, which gives the best practice value (V_B) for this indicator.

C6. Proximity of commercial facilities—C6.1. Average distance to a commercial zone

The project guidelines allocate shops on the ground floors along the tertiary centre, notably local services and a brewery in building B. Small convenience stores are also present at the station. In general, for the expected final situation, we can assume that the weighted average distance to a commercial zone will be approximately 150 m, equivalent to the best practice value (V_B.) We note that the neighbourhood benefits from proximity to the Battant district with a varied commercial offer (about 300 m from the station). Also, the city centre is about 900 m from the station.

C7. Proximity of recreational facilities—C7.1. Average distance to a public park

The site of the future Pôle Viotte neighbourhood benefits from proximity to the Parc des Glacis. Finished in 2013, the Parc des Glacis is a public park located within a Vauban fortification. In a wooded environment, equipped with various facilities for users of all ages, and offering a belvedere position over the Doubs valley and the old town, the Parc des Glacis is at a weighted average distance of 354 m, which may correspond to the target value (V_T).

C7. Proximity of recreational facilities—C7.2. Average distance to a recreational green/natural area

It is possible to reach the landscaped banks of the Doubs river relatively quickly from the Pôle Viotte neighbourhood site. The weighted average distance to reach the natural area of the river is 861 m, which is equivalent to the target value (V_T). We note that the evaluation does not take into account the distance from the Doubs banks of an urban walking area.

C7. Proximity of recreational facilities—C7.3. Average distance to a cultural centre

Most cultural facilities such as theatres, movie theatres, museums and exhibition spaces, libraries, or other equivalents in Besançon are in the city centre. The project guidelines do not specifically mention the integration of a cultural programme. In all cases, the weighted average distance is more than 900 m, which is below the limit value for the expected final situation.

C7. Proximity of recreational facilities—C7.4. Average distance to a sport centre

For this indicator, we note that outdoor play areas for children do not specifically fall into this category, nor for small private sports facilities (training rooms, studios, fitness clubs, etc.). Likewise, the swimming pool in building D (retirement home), which will be open to the public at certain times, is not taken into account either. For the expected final situation, we consider the Denfert-Rochereau gymnasium, which is the closest sports centre to the site. We measure the weighted average distance at 890 m, which places the indicator just above the limit value (V_L).

10.2.1.3 Economic Impact

C8. Population—C8.1. Net population density

The city of Besançon has a territory of 6,505 ha, of which 2,324 ha are green spaces (forests, parks, and natural areas). For this indicator, we estimate the entire city's net population density at 28.1 inhabitants per hectare (inhabs/ha) for the initial situation and 27.7 inhabs/ha for the current situation (Insee 2020a). For the expected final situation, an annual average population increase of 0.32% is forecast until 2025. This makes it possible to estimate the entire city's net population density at 28.5 inhabs/ha.

Following the indicator's logic, the brownfield's entire area is considered for the density calculation for the initial, current, and expected final situations. As already mentioned, the site was uninhabited during the initial and current situations, which in these two cases corresponds to an assessment below the limit value (V_L).

The Pôle Viotte project development principles are to make continuity with the city by creating a new lively, calm, and peaceful neighbourhood estimated at 268 housing units, which can eventually accommodate 575 inhabitants. This is made possible by creating favourable conditions, such as a strong presence of nature. It allows a greater density than that corresponding to the city average in the metropolis centre. Thus, for the expected final situation, the population density is estimated at 52.3 inhabs/ha. This result is above the target value (V_T), set at 42.8 inhabs/ha, which is one-and-a-half times the metropolitan area's net population density.

C9. Employment—C9.1. Net employment density

The calculation for this indicator is similar to that for C8.1 Net population density. For this indicator, we estimate the employment density of the entire city at 17.1 jobs per hectare (jobs/ha) for the initial situation (2007 statistics) and 16.7 jobs/ha currently (Insee 2020a). Regarding the evolution of employment, it is hard to make predictions. The statistics institute expects an average annual population increase of 0.32% until 2025. We use the same rate to estimate the employment density for the expected final situation, which gives 17.2 jobs/ha. It is a balance between the expectations of a late retirement of the older working group and a lower entry of young working people into the job market.

Following the indicator's logic, the brownfield's entire area is considered for the initial, current, and expected final situations. Thus, for the initial and current situation, the net employment density mainly takes into account the SNCF station, which provides several jobs.[1] For the initial situation, few activities on the site provide employment related to the company. We assume for the current situation that these jobs are relocated to the operating portion of the site (multimodal hub). Despite a generally degraded condition, the site currently provides 13.6 jobs/ha, which remains below the limit value (V_L).

Initiated as a veritable dynamic centre to bring together various government departments under one roof, the tertiary centre plans to accommodate nearly 1,000 agents (state and regional services). If we estimate 1 job/50 m^2 for the rest of the spaces provided for local services and shops, we already know that the Pôle Viotte neighbourhood will reach around 1,075 jobs. This corresponds to an employment density of 98 jobs/ha, which is above the best practice value (V_B) for the expected final situation.

C10. Local economy—C10.1. Proportion of work carried out by local companies

We should first note for this indicator the systematic absence of a value for the initial situation. In fact, the said work begins in principle with the realization of the project.

The current situation first takes into account the work for the multi-modal hub, completed in 2014. For this first phase of development, the project management was provided by the SNCF, which concluded work contracts according to its procedures. All of the companies selected were local. For buildings A and B—as a reminder under the contracting authority of the local semi-public company SEDIA—the law on public contracts does not allow the setting of objectives as to the proportion of the work to be carried out by a local company. Nevertheless, this proportion also amounts to the whole. The current situation is, therefore, evaluated at the best practice value (V_B). The same evaluation goes for the expected final situation, although the proportion may be less because the other buildings will be under the contracting authority of private developers.

10.2.2 Checklist—Project Indicators

For these indicators, we evaluate the objective and the expected final situation, together with the current situation, namely the design, construction, and operating phases. This allows us to monitor the regeneration project in detail (see Figs. 10.13, 10.14, and 10.15).

The evaluation of the initial objective takes its data from the document provided by the city of Besançon's projects and planning department (project guidelines, masterplan, etc.) (Ville de Besançon 2018).

When it is relevant, the operating phase evaluation relates mainly to the multi-modal hub sector (first phase of development). The construction phase evaluation

[1] The SNCF does not wish to disclose the number of jobs on-site. Thus, we hypothesize this number by extrapolating from current parking needs (150 spaces).

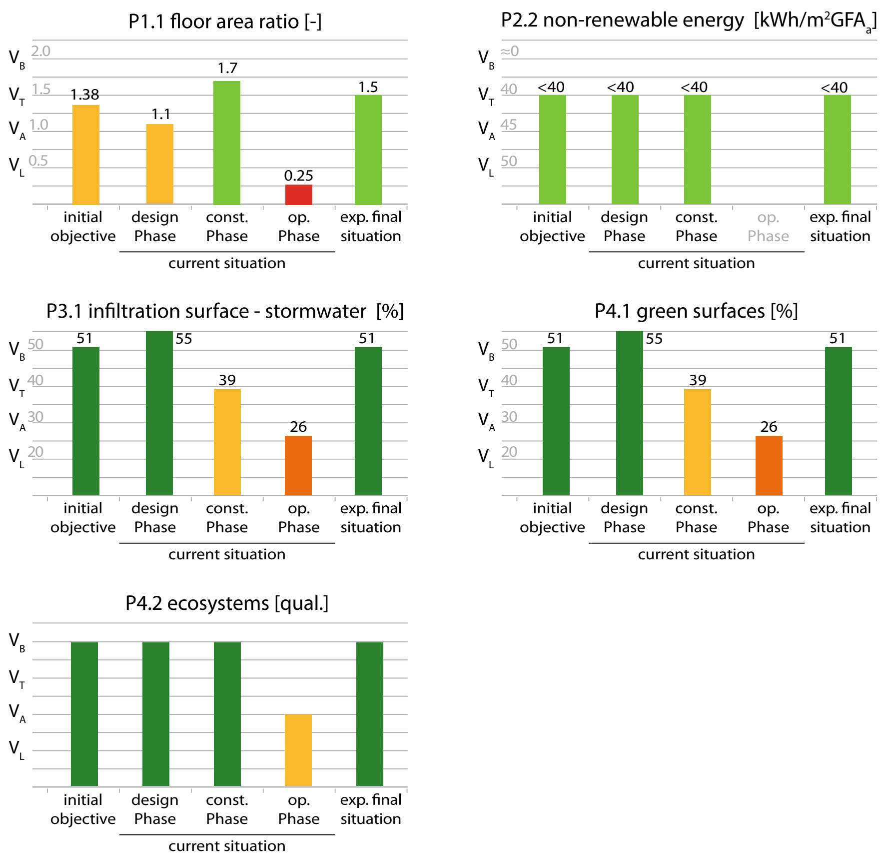

Fig. 10.13 Evolution displays for the project indicator—environmental balance

corresponds to the tertiary centre (buildings A, B, and the underground parking—southern sector). The elements evaluated for the design phase correspond to all the other buildings and planned arrangements described in the project guidelines, mainly the northern sector.

The expected final situation is, at this stage, extrapolated from the objective and the construction phase.

Even if the proximity of SNCF railway lines immediately raises the question of exposure to non-ionizing radiation, the indicator *P5.4 Degree of electrosmog* is considered irrelevant for the Viotte neighbourhood, since the responsibility rests solely with the SNCF. An ANSES report mentions that the SNCF has, for 15 years, carried out various series of measurements on station platforms and in the perimeter

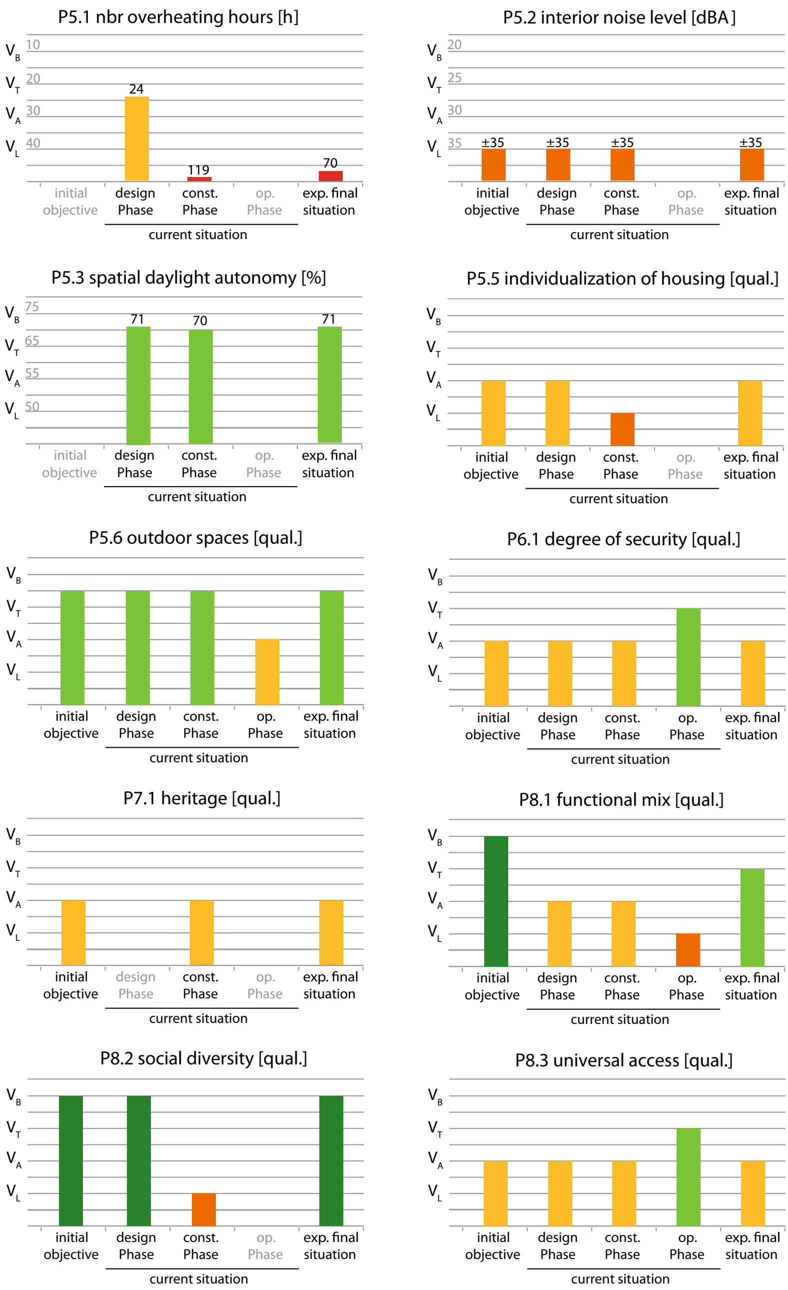

Fig. 10.14 Evolution displays for the project indicator—sociocultural quality

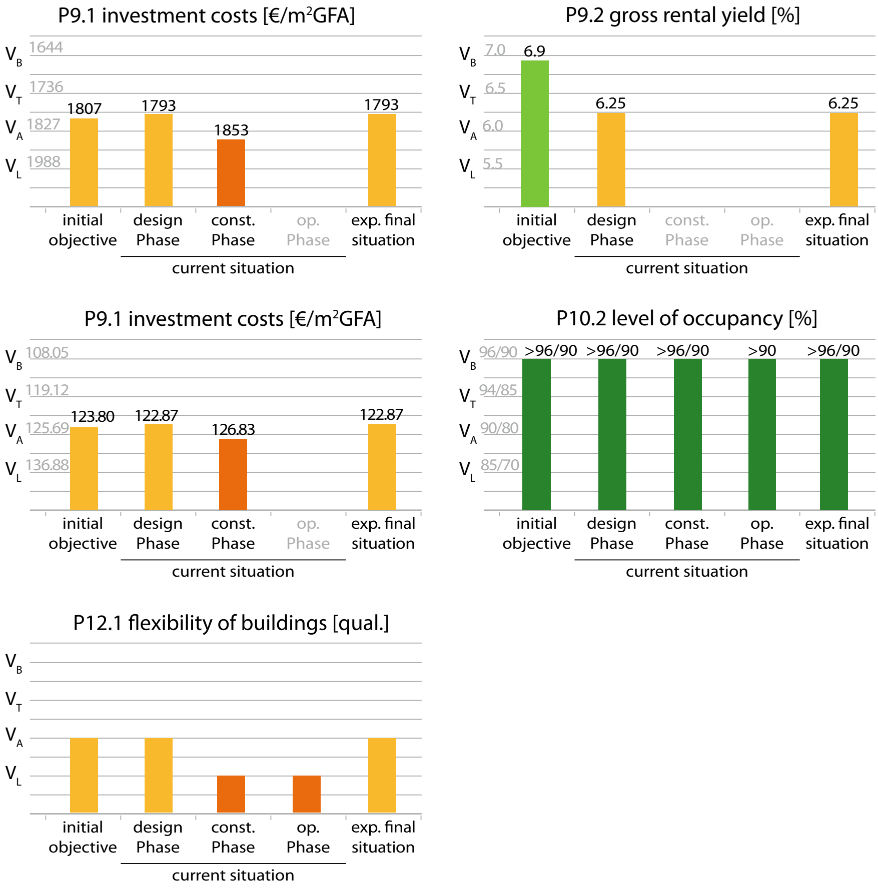

Fig. 10.15 Evolution displays for the project indicator—economic efficiency

of passenger buildings (afsset 2010). The measurement results are below the limit values.[2] That said, the report recommends organizing specific monitoring measures.

Furthermore, the SIPRIUS+ evaluation framework cannot currently provide sufficiently robust reference values for two project indicators: *P2.1. Non-renewable primary energy for construction, renovation, and demolition of buildings* and *P11.1 External costs.*

[2] The exposure limit value recommended by WHO, and adopted by France, is 100 µT. It is a recommended protective value for the public, not the level at which exposure is dangerous.

10.2.2.1 Environmental Balance

P1. Land—P1.1. Floor area ratio

Like most urban brownfield regeneration projects, the new Viotte neighbourhood project allows the densification of a city sector with loose built fabric. For the floor area ratio (FAR) indicator calculation, the portion of the brownfield site taken into consideration corresponds to the perimeter of the second phase of development, i.e., 3.1 ha.

For the initial objective, we consider a programme of 42,712 m^2 of floor area planned for the northern and southern sectors. The FAR is 1.38, which is equivalent to the average value (V_A). It is interesting to mention that the FAR is around 0.25 for this portion of the site in its brownfield state. For the expected final situation, we consider an increase in the planned square meters to 46,535 m^2. The FAR is therefore 1.50, which is equivalent to the target value (V_T).

For the current situation, taking the same data, the design phase (northern sector) plans 10,530 m^2 of floor area, whereas the construction phase (southern sector) provides for 36,005 m^2 of floor area. Reported to their respective sectors, this suggests that the average value (V_A) and the target value (V_T) are 1.1 and 1.7 FAR, respectively. The multi-modal hub centre's operating phase has a 0.25 FAR, below the limit value (V_L). This is explained by the large logistical clearances specific to transportation management.

P2. Energy—P2.2. Non-renewable energy for buildings in operation

The project guidelines state that the buildings will have to reach the RT2012 norm minus 20%, corresponding to the Effinergie + label. The project also commits to a minimum of 40% renewable energy in the energy mix used to heat each building (biomass, solar, geothermal, etc.). Among the possibilities offered to achieve this goal, the developer proposes creating geothermal batteries in the underground level, allowing the immediate development of a naturally renewable potential present on the site.

Our evaluation is equivalent to the target value (V_T) for the initial objective and the expected final situation. We give the same target value (V_T) for the design and construction phases of the current situation. Regarding the operating phase, the SNCF does not wish to communicate information on the energy performance level of their buildings.

P3. Water—P3.1. Infiltration surface and stormwater use

The project plans to discharge only wastewater from the neighbourhood into the network of the city of Besançon. While the site's karstic terrain is conducive to rainwater infiltration, the project will also encourage on-site water reuse (interior—sanitary/exterior—irrigation). Each plot will store its own rainwater, closest to buildings. The creation of green open conduits will make it possible to channel rainwater from public spaces to two retention and infiltration basins in green areas to the neighbourhood's northern and southern sectors. The project will also seek to control the runoff of surface water by limiting impermeable surfaces through careful management of topography and slopes in the design of public spaces.

For the initial objective and the expected final situation, we estimate about 51% of the surface to be suitable for stormwater infiltration, without counting the green roofs mentioned in the guidelines as a possibility. Some preliminary renderings and the tertiary centre do, however, feature pitched roofs. We give the best practice value (V_B) to these two situations.

For the current situation, taking the same data, the design phase (northern sector) offers about 55% of infiltration surfaces, whereas the construction phase (southern sector) provides 39% of infiltration surfaces, which correspond to the best practice value (V_B) and the average value (V_A), respectively. Finally, for the operating phase (multi-modal hub sector), we estimate that about 26% of the area is suitable for rainwater infiltration. The means used for the harvesting of rainwater and wastewater are not known. We thus grant the limit value (V_L).

P4. Biodiversity—P4.1. Green surfaces

The project guidelines describe the future Pôle Viotte as a natural neighbourhood where vegetation is predominant. The intention is to create generous, open green areas and to favour green roofs. The project also plans to install an urban greenhouse (building F). At this stage of the project, the green areas taken into account are the same as the infiltration areas calculated for the previous indicator.

For the initial objective and the expected final situation, the project plans about 51% of the area as green surfaces, which corresponds to the best practice value (V_B) for both situations.

For the current situation, taking the same data, the design phase (northern sector) offers about 55% of green surfaces, whereas the construction phase (southern sector) provides 39% of green areas, which correspond to the best practice value (V_B) and the average value (V_A), respectively. Finally, for the operating phase (multi-modal hub sector), we calculate about 26% developed as green surfaces, which correspond to the limit value (V_L).

P4. Biodiversity—P4.2. Degree of ecosystem considerations

Reclaiming abandoned landscaped areas is one of the strong intentions of the Pôle Viotte neighbourhood. Hence, the project proposes a development principle emphasizing the natural potential of the site, notably biodiversity. It includes continuous landscaped public spaces to form a green network that fits with the city's great green belt logic (Parc des Glacis among others). In this sense, the project plans for significant embankments around the site to promote biodiversity development at the interface of the surrounding neighbourhoods. Besides, the project provides for the construction of an urban greenhouse allowing social exchanges within the district and other ecological measures such as ponds or nest boxes. Note that the city of Besançon is very attached to the ecological management of green spaces, particularly via the Ecojardin label.

These intentions allow for now to evaluate the initial objective and the expected final situation at the best practice value (V_B). Likewise, the best practice value (V_B)

applies to the design and construction phases of the current situation. Regarding the operating situation, the interventions in the northern part (the belvedere) receive the average value (V_A).

10.2.2.2 Sociocultural Quality

P5. Well-being—P5.1. Annual hours of overheating

The initial project guidelines make no mention of measures taken to ensure summer comfort. The initial objective is, therefore, not evaluated for this indicator. To evaluate the expected final situation and the current situation, we performed a numerical simulation, allowing us to estimate the annual number of overheating hours or hours during which the interior temperature of the buildings is above 28 °C. To do this, we produced a 3D model representing the volumes of the Pôle Viotte neighbourhood's buildings, excluding the urban greenhouse, building F.[3] We obtained in this way the number of overheating hours for each building. It was then extrapolated in proportion to the gross floor area of the entire neighbourhood.

On this basis, we estimated the annual number of hours exceeding 28 °C at 70 for the entire neighbourhood, which is below the limit value (V_L) for the expected final situation. For the construction phase, we estimated the annual number of hours exceeding 28 °C at 119 h for buildings A and B, which is also below the limit value (V_L). We noted that the south orientation, the windows of the two buildings, and mainly the internal gains of buildings dedicated to activities influenced overheating. Evaluating this indicator using digital simulations helps identify a risk to be verified once the buildings are operational. For the design phase (buildings C to L), we estimate that annually 24 h will be exceeding 28 °C, which corresponds to the average value (V_A). We explain this difference in the results mostly by the building type, i.e., housing. It appears that climatic changes, the continental climate condition in the Franche-Comté region, associated with the increasing thermal performances of new buildings, can create overheating pathologies within the new neighbourhood. The guidelines mention thus that the question of thermal comfort should be treated with care when designing new housing buildings.

Finally, the operating phase evaluation is not relevant: no requirement regarding overheating hours applies for the station.

P5. Well-being—P5.2. Interior noise level

In the southern sector, the tertiary centre along the railway tracks is designed to generate a deflecting effect. The intention is to reduce the negative impacts of noise pollution on residential buildings. In the northern sector, the residential buildings will be set back from the railway tracks to minimize noise pollution.

[3] The simulation was performed with Design Builder v5.0. (EnergyPlus). For the working assumptions used to perform the simulation (U values of materials, proportion of glazed surfaces, sun protection, etc.), see Laprise (2017).

Since the buildings are not built yet, we obviously could not give a precise evaluation for the moment. Considering the quite simple measures described above and the relatively high level of railway noise, the initial objective is estimated at the limit value (V_L). For the moment, we gave the same value to the design and construction phases and the expected final situation. The evaluation will evolve following the project's progress. Regarding the operating phase, it would be erroneous to evaluate it because of its eminently noisy function, especially since there is no housing and only a few offices.

P5. Well-being—P5.3. Spatial daylight autonomy (sDA)

The spatial daylight autonomy (sDA) metric is the surface percentage of a given area that reaches a minimum of 300 lx during a given number of hours per year (50% of hours between 8 a.m. and 6 p.m.).

Since the project guidelines made no mention of the amount of natural light desired in the buildings, we did not evaluate the initial objective. We performed a numerical simulation to estimate the sDA of the expected final situation and the current situation. To do this, we produced a 3D model representing the volumes of the buildings of the Pôle Viotte neighbourhood—except the urban greenhouse, building F—assuming that the central spaces of the floors would be occupied by functions that do not need natural light (circulation, technical rooms, etc.).[4] We obtained in this way a specific percentage for each building. It was then reported in proportion to the gross floor area of the entire neighbourhood.

Our simulations revealed that the autonomy in natural light for the entire site would reach 71% of the areas assigned to offices or housing. This estimation gave the target value (V_T) for the expected final situation. It generates similar results to the design phase of the current situation. We can add that buildings A and B of the tertiary centre obtain 74% and 56%, respectively. Extrapolated to their gross floor area yields an sDA of 70%, which corresponds to the target value (V_T) for the construction phase of the current situation. However, this good performance will probably be affected by the use of blinds. An evaluation of the operating phase is not relevant at the moment in the case of this indicator.

P5. Well-being—P5.5. Degree of individualization of housing

At this stage of the project, the guidelines provide little information on the degree of housing individualization. Within the diversity of housing expected, modularity is desired and encouraged to adapt to inhabitants' different life stages. Otherwise, we note that the buildings' shape will follow the natural slope of the terrain. It will provide distant views of the historic centre while minimizing views on the railway tracks. Treatment of the boundaries between public and private spaces will be subject to architectural prescriptions.

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[4] We performed the simulation with Diva for Rhino v4.0. For consistency, the fenestration is the same as for P5.1 annual hours of overheating. For the other working assumptions made at this stage of the project, see Laprise (2017).

Thanks to this information, we evaluated the initial objective and the expected final situation at an average value (V_A). For the current situation, the design phase received the same average value (V_A). Buildings A and B provide 14 luxury apartments with a slight degree of individualization. Hence, the construction phase gets the limit value (V_L). As regards the operating phase, here evaluation does not apply because the buildings do not contain accommodation.

P5. Well-being—P5.6. Quality of outdoor spaces

The guidelines include the intention to pay particular attention to the design of the public spaces, which will be mainly free from cars. The project foresees a network of landscaped pedestrian and cyclist paths. The latter will settle around central green alleys in the northern as well as the southern sectors. The treatment of public spaces will follow a logic of sobriety and optimization. A public urban greenhouse managed by the neighbourhood's users will contribute to making the public spaces lively.

Based on these descriptions, we set the initial objective at the target value (V_T). For now, we attributed the same value to the expected final situation and the design and construction phases of the current situation. Regarding the operating phase, the belvedere in the northern sector and the landscaping in the southern sector improved the initial situation to a level that corresponds to the average value (V_A).

P6. Security—P6.1. Degree of security

The guidelines recommend the implementation of passive measures to ensure general safety within the neighbourhood. More specifically, the project plans to secure public outdoor spaces through several means. It will promote pedestrian and cyclist paths and mutualized parking to avoid cars on the neighbourhood's roads and on-street parking. Also, the mix of functions (offices, housing, and shops) combined with the quality of outdoor spaces will generate a neighbourhood that is "lively, calm, and peaceful" for several hours of the day throughout the week.

These few elements allowed us to assign the average value (V_A) to the initial objective, to the expected final situation, and to the design phase of the current situation. For the construction phase, security measures congruent with the requirements of the state and regional services are put in place (e.g., video surveillance). Hence, the average value (V_A) is also assigned.

The station and its surroundings are secured by standard measures for this type of building (security agents, adequate public lighting, surveillance cameras, etc.). The multi-modal hub's facilities also contribute to clarifying motorized and non-motorized traffic on-site. We evaluated the operating phase at the target value (V_T).

P7. Heritage—P7.1. Degree of enhancement of existing heritage

None of the brownfield buildings is officially listed as historic monuments. However, some of them attest to the old railway activity of the site, which has marked the Besançon urban space since the mid-nineteenth century (military platform to the north, Sernam Hall to the south). The Pôle Viotte neighbourhood project does not preserve any specific buildings. However, the tertiary centre's principal building (building A) will faithfully evoke Sernam Hall's morphology through its location along the railway tracks and its size. Moreover, the construction principle will evoke the original wooden frame of the Sernam Hall. The tinted tiles of the pitched roof are a reinterpretation of the “Blue City”, which highlights the stone of Chailluz, typical of Besançon.

Based on these considerations, we give an average value (V_A) to the initial objective, the expected final situation, and the construction phase of the current situation. The design and operating phases are not affected by heritage considerations. We note the presence of a significant Gallo-Roman archaeological heritage site, mainly in the northern sector, that will be investigated before construction begins. But these aspects are not taken into account by this indicator.

P8. Diversity—P8.1. Degree of functional mix

By developing a mixed-use district near the station, the Pôle Viotte neighbourhood project, with the various urban functions offered, strengthens the role of the extended urban city centre. In other words, functional diversity is at the centre of project planning. By bringing together several complementary functions, it transforms the monofunctional past of the site dedicated to rail activities.

From the initial objective comprising a 54% ratio activities/housing—best practice value (V_B)—the project evolved to a 66% ratio activities/housing for the expected final situation—target value (V_T). For the construction phase of the current situation (southern sector), we estimated the ratio of activities/housing at 77%, which corresponds to the average value (V_A). On the contrary, for the design phase of the current situation (northern sector), the ratio of housing/activities was estimated at 70%, which also corresponds to the average value (V_A). The operating phase, mainly occupied by the multi-modal hub activities, corresponds for its part to the limit value (V_L).

P8. Diversity—P8.2. Potential of social diversity

The Pôle Viotte neighbourhood aims at a strong integration of social diversity. Indeed, among the 230 housing units planned, 20% will be public housing (including 10% social housing) and 15% low-cost housing, reserved for first-time buyers. Additionally, the guidelines recommend an extended typology of housing. That means spacious apartments intended for families and others adapted to inter-generational needs. Building D will accommodate a retirement home. Some self-promotion opportunities will also be possible.

This information is sufficient to assign the best practice value (V_B) to the initial objective, the expected final situation, and the design phase of the current situation. As for the construction phase, buildings A and B are making way for 14 luxury apartments, which limits the potential for social diversity. Hence, we temporarily evaluate this phase at the limit value (V_L). Evaluation of the operating phase is not relevant for the moment.

P8. Diversity—P8.3. Degree of universal access

Because of the steep slope of the site (more than 17 m difference between the north and south sectors), it is relevant to consider accessibility for users with impaired mobility throughout the various exterior developments. Therefore, gently sloping facilities and lifts are planned where necessary to allow universal access to the whole site. However, the guidelines do not mention particular measures regarding the design of the different buildings.

The average value (V_A) is given to the initial objective, the expected final situation, as well as to the construction and design phases of the current situation. For the operating phase, all the multi-modal hub's facilities are accessible to users with reduced mobility, including the underpass, which constitutes a clear improvement in terms of freedom of movement for these users. Here, the target value (V_T) is assigned.

10.2.2.3 Economic Efficiency

P9. Direct costs—P9.1. Investment costs

To evaluate this indicator, we need to know the average construction cost of buildings in the Besançon area. However, the most reliable data available is from the construction cost index for residential buildings calculated by the INSEE. The latter is estimated at 1,765 €/m^2 for the third semester of 2020 (Insee 2020b). We also needed to know the average constructible land price within a radius of 5 km from Besançon city centre, which is 93 €/m^2 (Terrain-construction.com 2016, 2020). With an average floor area ratio of 1.5, we obtained for this indicator an investment cost of 1,827 €/m^2, which was the reference for the average value.

At this stage of the project, when work with the various public and private developers is not yet underway, it is hard to precisely evaluate this indicator for the entire neighbourhood. Besides, the guidelines do not set any formal objective in this area. The gross amount communicated on land acquisitions (1.3 M €, excl. tax) tells us, at least, about land price, which is equivalent to 42 €/m^2. Hence, for the initial objective, we estimated the investment cost at 1,807 €/m^2, i.e., the addition of the average construction cost and the actual cost of the land (floor area ratio of 1.38), which corresponds to the average value (V_A).

For the construction phase of the current situation (the tertiary centre, buildings A and B), it is estimated that the construction costs will be around 50 M € (private investment). With a floor area of 27,458 m^2, this equates to a cost of 1,828 €/m^2. When we add the actual cost of the land (floor area ratio of 1.7), we obtain an investment cost of 1,853 €/m^2, which corresponds to the limit value (V_L). However, this is only a partial view of the entire Pôle Viotte neighbourhood project; the tertiary centre (two office buildings with 14 luxury apartments) is designed as signature buildings.

Because the other constructions will be more standard ones, the costs will likely be lower. For the moment, therefore, we situate the design phase of the current situation as well as the expected final situation at around 1,793 €/m^2, i.e., the addition of the average construction cost and the cost of the land (floor area ratio of 1.5). It corresponds to the average value (V_A).

Regarding the operating phase of the current situation, we know that the multi-modal hub represented an investment of 15.3 M € excl. tax. However, because we cannot rely on robust comparable costs to establish the reference values, the evaluation of this phase is currently irrelevant.

P9. Direct costs—P9.2. Gross rental yield

For this indicator, we did not consider data concerning offices and commercial premises. Hence, at this stage of the project, we made a theoretical calculation of this indicator based on the spaces allocated to housing, which corresponds to a gross floor area of 15,399 m^2. As a reminder, we previously estimated the construction cost at 1,827 €/m^2. A minimum income of around 28 M € is thus required. In Besançon, around the Pôle Viotte neighbourhood, the average monthly rent fluctuates between 12.30 €/m^2 (Battant district), 11.80 €/m^2 (St-Claude district), and 11.50 €/m^2 (Charpais district) (SeLoger.com 2020). We considered an average monthly rent of 11.90 €/m^2. Besançon has rental profitability that oscillates between 4.07 and 7.97% (OuInvestir 2019). Thus, we considered an average gross rental yield at 6.02% for the reference value.

According to the preliminary calculation of the initial objective, the gross rental yield was set at 6.9%, i.e., the target value (V_T). The construction phase of the current situation is not relevant to this indicator. 14 luxury apartments (15% above the price market) are offered for sale. The design phase of the current situation and the expected final situation follows the same calculation. We estimated the net living area at 12,319 m^2 or 20% less than the gross floor area. Thus, we estimated a gross rental yield at 6.25%, which corresponds to the average value (V_A).

Concerning the operating phase, the evaluation is not relevant because the multimodal hub does not include housing.

P10. Indirect costs—P10.1. Annual operating costs

We estimated the heat and energy consumption costs according to the results obtained for indicator P2.2 and the investments and maintenance costs of buildings according to the results obtained for indicator P9.1. Together, these results determine an indication of the annual operating costs.[5] For the investment costs, we assumed an interest rate on the capital of 2.0% amortized over 25 years, i.e., a coefficient of 0.051 for the calculation of annuities. For maintenance costs, we used an average rate of 1.5% (the annuity by the amortization period) (SIA 2004). For heat costs, the assumption used to establish the average reference cost was heat production running 100% on natural gas, costing 8.43 cents/kWh (Le médiateur national de l'énergie 2020). The price change takes into account an average increase of 5% over the next 25 years, i.e., a coefficient of 1.78 (Müller and Walter 1994). Finally, the average reference cost for electricity in Besançon is 14.25 cents/kWh (Le médiateur national de l'énergie 2020). The price change takes into account an average increase of 3% over the next 25 years, i.e., a coefficient of 1.39 (Müller and Walter 1994).

For the initial objective, the expected final situation as well as the design phase of the current situation, the same assumptions applied for the costs of investment,

[5] We based the calculation on the 2016 reference values, the launch year of the second phase of the project following the architecture competition.

maintenance, heating, and electricity, even if other sources of energy supply are considered (such as geothermal). We know that the investment costs are equivalent to 1,807 €/m^2, 1,793 €/m^2, and 1,793 €/m^2, respectively. For the buildings' operation primary energy, we estimated performance to be equivalent to RT2012 −20%. The sum of the various operating costs amounts to 123.80, 122.87, and 122.87 €/m^2 GFA annually, which is below the average value (V_A).

For the construction phase of the current situation (the tertiary centre, buildings A and B), we have estimated an investment cost of 1,827 €/m^2. Similarly, we expect an RT2012 −20% energy performance. The calculation for operating costs turns out to be 126.83 €/m^2 GFA annually, which corresponds to the limit value (V_L).

The evaluation of the operating phase is not relevant because of the complexity and specificity of the multi-modal hub's installations.

P10. Indirect costs—P10.2. Level of occupancy

As with the previous economic indicators, we based the evaluation of this indicator on estimations. Indeed, the project sets no official objective for this indicator. That said, interviews with the project team revealed that strong demand for office rental exists, which would already exceed the current supply planned by the project. Furthermore, we know that the project carried out conclusive pre-marketing tests based on urban planning studies and the real estate market reality (unfortunately not disclosed). Finally, built to accommodate the state and regional agents of Besançon, the tertiary centre will be fully occupied.

Based on this information, we gave the initial objective and the expected final situation the best practice value (V_B). We assigned the same value for the moment to the construction and design phases of the current situation. For the operating phase, we know that the multi-modal hub rental spaces are all occupied and that the occupation intensity of the SNCF offices increased due to the restructuring on-site. The best practice value (V_B) was therefore also attributed.

P12. Flexibility—P12.1. Degree of building flexibility

At this stage of the project, it is hard to judge the concrete means implemented to promote flexibility. Only the intention to "encourage modular housing to cope with the different life stages of the inhabitants" is mentioned in the project guidelines.

Given this meagre information, we considered the degree of building flexibility for the initial objective equivalent to the average value (V_A). By extrapolation, we assigned the same value to the expected final situation and the design phase of the current situation. It is interesting to note that the car park is designed with reversibility measures to eventually minimize its capacity and respond to new uses for this sector ideally served by public transport. However, the tertiary centre (buildings A and B) contains no specific flexibility measures. Thus, we evaluated the construction phase of the current situation at the limit value (V_L). For the operating phase, which mainly concerns the station, the evaluation is also at the limit value (V_L), because the building typology with construction features specific to its function leaves little room for flexibility.

10.2.3 Checklist—Governance Indicators

For these indicators, we evaluate three situations: the initial objective, the current situation, and the expected final situation (see Figs. 10.16 and 10.17). Although the project guidelines set no clear objective for some indicators, observation of the project progress makes an evaluation possible. It incidentally reveals the risks or opportunities associated with a given indicator. As a reminder, we divide governance indicators into two dimensions: management and process. While the indicators under the process dimension may extend to the entire regeneration project, indicators under the management dimension often refer to a specific project phase and may be limited in timespan.

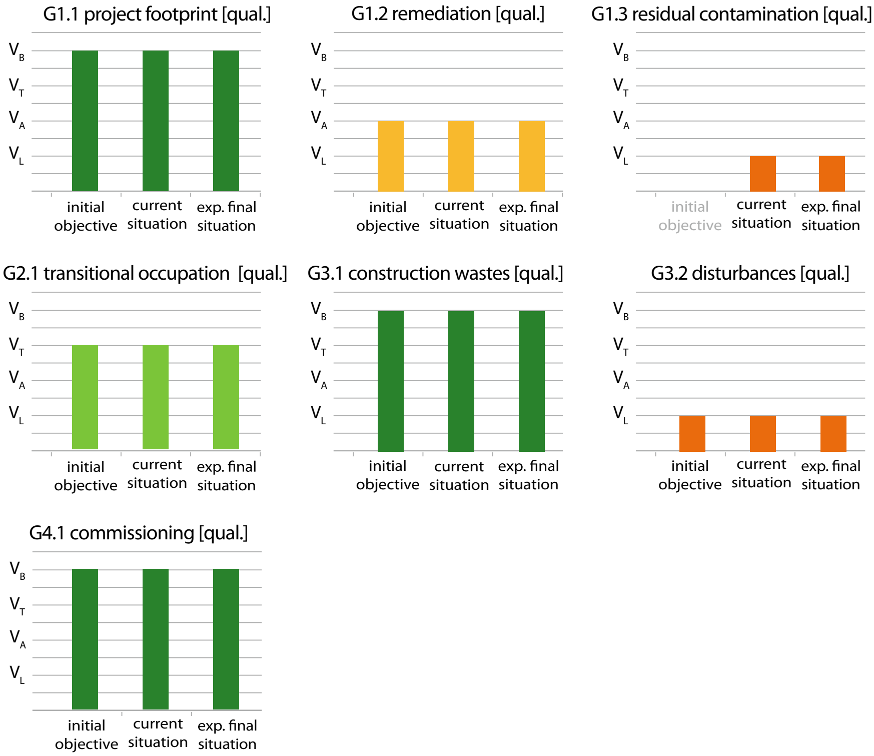

Fig. 10.16 Evolution displays for the governance indicators—management

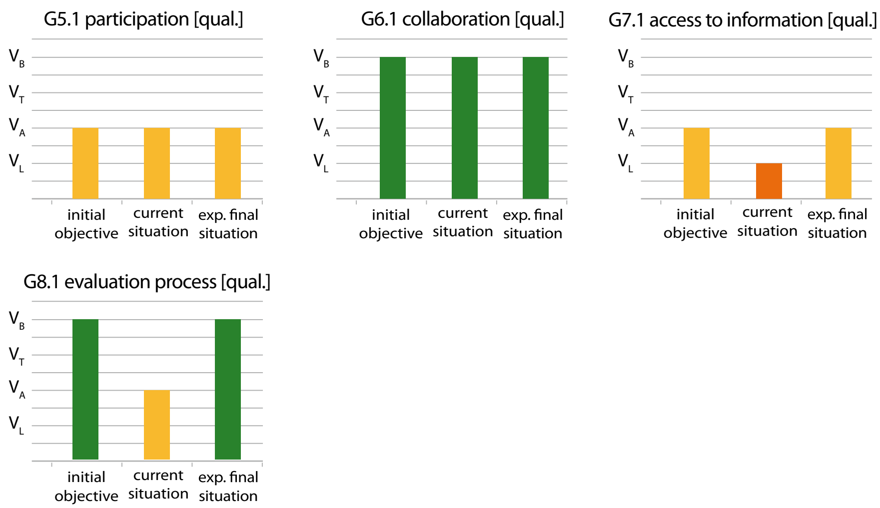

Fig. 10.17 Evolution displays for the governance indicators—process

10.2.3.1 Management

G1. Remediation—G1.1. Logic of project footprint

The environmental impact assessment, which includes an investigation of health risk, revealed some soil pollution traces. For the southern sector, moderate pollution gradients were measured (3,200 m^3), mainly coming from old landfills linked to the nineteenth-century railway activities and located on the first layers of soil near the Sernam Hall. The organization of the public spaces and the programming of urban functions—notably the parking and building A location—deal with this pollution presence, which is compatible with the project. Thus, the project provides for an optimized and economic management plan for contaminated soil (excavation and backfill) to limit the risks. For the northern part, the investigation reveals a small amount of contaminated soil (80 m^3) that will be evacuated to a treatment centre. In any case, the masterplan is flexible enough to evolve based on the unlikely discovery of soil pollution. Based on this information, we evaluate the initial objective, the current situation, and the expected final situation at the best practice value (V_B).

G1. Remediation—G1.2. Degree of site remediation

As mentioned in the evaluation of the indicator G1.1, the brownfield site has 80 m^3 of contaminated soil in the northern sector, which will be evacuated to a treatment centre, and 3,200 m^3 of contaminated soil in the southern sector. The treatment of this latter pollution is to correlate with the use of the site. A pedestrian ramp to the east of the site will use around 1,200 m^3 of contaminated soil to consolidate the foundations. The ramps will serve to connect the new neighbourhood with its surrounding. The remaining contaminated soil (2,000 m^3) will be confined inside a geotextile membrane under the self-ventilated car park, which is used as a buffer. These ongoing remediation measures make it possible to evaluate the initial objective, the current situation, and the expected final situation at the average value (V_A).

G1. Remediation—G1.3. Degree of residual contamination

For now, management of the residual contamination is limited to the obligation of a mention in the deeds of sale to keep records. We give thus the limit value (V_L) to the current situation and expected final situation. No initial objective was set for this indicator.

G2. Temporary use—G2.1. Transitional occupation initiatives

There were initially some activities related to SNCF jobs in the southern sector of the site, such as a canteen for employees' children, an activity room, and a small library. The new neighbourhood project planned to combine these services within new programmes (e.g., a company restaurant could serve the canteen meals), or to relocate them within the surroundings of the site. We evaluated the initial objective at the target value (V_T). The project evolved slightly differently along with the initial objective. Only the SNCF library is reconstituted in building A. The previous canteen users have contracted with nearby company restaurants, although an inter-agency restaurant is also available in building A. We evaluate the current situation and the expected final situation at the target value (V_T).

G3. Construction site—G3.1. Management of construction waste

The guidelines mention the implementation of a "Green Charter" for the construction site annexed to the works contract. It aims at limiting the carbon footprint of the works. It includes, notably, recommendations on waste sorting, a limitation on outsourced backfill, and on-site reuse of material from excavation and demolition. The "Green Charter" also requires a certain percentage of waste recovery (sorting, recycling, reuse, and reduction). Moreover, a "Green Charter" manager is appointed before the construction works begin to ensure its application by all companies and workers on the site. Currently, no detailed data as to the share of waste reused are available yet. We know that various public landscaping and installations include a certain percentage of recovered waste. Since buildings are being demolished, the products resulting from the demolition work are reused in road fill. Besides the on-site remediation measures (see indicator G1.2), the making of public spaces will reuse 8,000 m^3 of clean soil from the 17,000 m^3 excavation material.

Based upon this information, we give the initial objective, the current situation, and the expected final situation the best practice value (V_B).

G3. Construction site—G3.2. Management of construction disturbances

The neighbourhood site is surrounded to the north, south, and east by residential areas. However, the steep slope between the site and the south area creates a buffer. In the west, the multi-modal hub is quite crowded in the daytime. This observation highlights the importance of taking into account disturbances during the construction phase. However, no specific mention is made to this effect in the guidelines, nor during the tertiary centre construction.

Given this lack of measures, we give the limit value (V_L) to the initial objective and the current situation. By extrapolation, the expected final situation obtains the same evaluation.

G4. Commissioning—G4.1. Commissioning plan for buildings

The new neighbourhood project provides for the establishment of workshops called "Ateliers Viotte". The workshops aim to transmit and share the project's spirit with the different building developers, including, notably, energy issues. The guidelines also specify that the "Ateliers Viotte" must integrate future building managers. Additionally, a prescription book for each building will make users aware of the issues linked to climate change, mainly summer overheating management, as soon as they arrive in the neighbourhood. Finally, monitoring by an environmental expert and ex-post evaluation questionnaires will be put in place to take advantage of any performance gaps between the design and the construction of buildings and improving the project along the way.

These various measures allow us to evaluate the initial objective, the current situation, and the expected final situation at the best practice value (V_B).

10.2.3.2 Process

G5. Participation—G5.1. Degree of participation of population

Since 2008, the city of Besançon has initiated consultation for the entire regeneration of the brownfield.[6] The public consultation closed at the end of the neighbourhood pre-operational studies, i.e., at the end of 2015. A series of more specific public meetings with various associations (surrounding neighbourhood, transport users, cyclists, etc.) are closely associated with the project throughout the different stages. The city of Besançon projects and planning department is available at any time to collect requests for information and suggestions. Finally, the "Ateliers Viotte" provides the opportunity to exchange views with all stakeholders, including future site managers, and to take into account the practices of future end-users.

These elements lead our evaluation of the initial objective at the average value (V_A). The current situation and the expected final situation follow this evaluation.

G6. Collaboration—G6.1. Degree of collaboration of professionals

Our evaluation of this indicator is also based on the workshop principle, the "Ateliers Viotte". In addition to the city of Besançon and future users, as described above, the "Ateliers Viotte" involves the developer and the project team (urban project management) from the pre-operational studies phase. During the design phase, it is expected that the building projects proposed by the different developers will be optimized and

[6] Complies with provisions L 300-2 of the Urban Planning Code (Code de l'urbanisme).

finalized within the framework of these workshops with the support of the consultant architect of the urban project management. The same will apply to the supervision of construction work. These interactive workshops allow co-construction, that is to say, a project that is negotiated and shared between all professionals while opening a permanent and effective dialogue between urban and built spaces. The "Ateliers Viotte" also aims to convey and share the project's spirit with the different operators, as recently experienced for the choice of buildings C, D, and E's architects and developers.

We set the initial objective at the best practice value (V_B). The current situation and the expected final situation obtain the same evaluation.

G7. Information access—G7.1. Degree of access to information

According to the project guidelines, a dedicated website for the Pôle Viotte neighbourhood will be online with the first arrivals. A testimonial book retracing the entire development is being produced. The website will include an exchange platform between users, which will facilitate, among other things, the organization of client groups or local economy initiatives. However, the degree of access to information is currently limited to the few downloadable presentation documents on the city of Besançon website.

In light of this information, we evaluate the initial objective and the expected final situation at the average value (V_A) and the current situation at the limit value (V_L).

G8. Evaluation—G8.1. Degree of integration of an evaluation process

The Pôle Viotte neighbourhood has initiated a certification process since 2014: the EcoQuartier Label. Currently, the project has the label for step 2 (four steps: design, construction, delivery, and post-occupation). The project guidelines mention that all the commitments related to the EcoQuartier Label process are integrated into a spreadsheet. The aim is to facilitate their monitoring, like a sustainable development dashboard. Annually, a global update on this dashboard is produced and available to the various stakeholders upon request. Moreover, the guidelines prescribe post-occupancy performance monitoring of all buildings, performed through an online questionnaire available on the neighbourhood's website. With the intent of providing feedback and continuous improvement opportunities, private developers will be required to communicate the results.

For these reasons, we evaluate the initial objective and the expected final situation at the best practice value (V_B). Because all these measures are not yet in place, we evaluate the current situation at the average value (V_A).

10.3 Overall Monitoring Results

We have just carried out the one-by-one monitoring of the indicators related to the context, the project, and the governance of the Pôle Viotte neighbourhood project using the SIPRIUS+ monitoring tool, which represents a total of 52 out of 57 indicators. One indicator was deemed irrelevant (*P5.4 Degree of electrosmog)* and four indicators were not evaluated due to the current lack of robust reference values *(C2.2. Global warming potential (GWP), C2.3. Acidification potential (AP), P2.1. Non-renewable primary energy for construction, renovation and demolition of buildings,* and *P11.1 External costs*).

We argue that, from the perspective of integrating sustainability issues into the dynamics of the urban brownfield regeneration project, communicating the overall results of the monitoring is just as important as the monitoring itself. The latter is the source of iterations aimed at continuous improvement of the project. In that regard, SIPRIUS+ allows the different actors involved in the project to visualize the overall results in several forms. As a rule, the tool is not designed to compare projects in different locations, nor to rate projects, as some labels do. Nevertheless, as can be seen in Figs. 10.18, 10.19, and 10.20, the Chart displays make visible and comparable the overall monitoring results for specific stages of the project. Figure 10.21 provides a synoptic view of all the indicators for the expected final situation according to the performance achieved at the moment of the evaluation.

These visualizations of the results allow the actor who consults them to make some general observations. First, for the context indicators, the expected final situation is generally better than the initial and current situations. The comparison between these different situations allows assessing the efforts undertaken by the brownfield regeneration project in terms of sustainability issues improvement. For project indicators, the initial objective and the expected final situation are very similar. Only two indicators get different results (*P1.1 Floor area ratio* and *P8.1 Degree of functional mix*). This fact can be explained by the progress level of the project; the expected final situation is still a transposition of the initial objective. However, variations appear in the evaluation of the current situation (especially the construction phase). It can be an opportunity to pay attention to certain aspects that could potentially affect project performances. For governance indicators, the initial objective and the expected final situation are also similar. However, the current situation indicates possible trends that the project may take. Finally, through the Evolution display (Fig. 10.21), we note in general that the evaluation results of the expected final situation are quite favourable, with more than half being above the target value (V_T). However, it is interesting to underline that the environmental dimension is more efficient than, in particular, the social dimension. As mentioned in Chap. 5, this is typical of new sustainable neighbourhood projects, where a focus is often on energy or ecological aspects.

By looking more closely, the three Chart display comparison makes it possible to identify four critical aspects of the project that deserve special attention from the project stakeholders. This is where SIPRIUS+ can best play its decision-support role.

- The first is to identify the indicators that are not taken into account by the brownfield regeneration project and, ideally, integrate them into new objectives. In the case of the Pôle Viotte neighbourhood, little consideration is given to *P5. Well-being—P5.1. Annual hours of overheating* and *P5.3. Spatial daylight autonomy (sDA).*

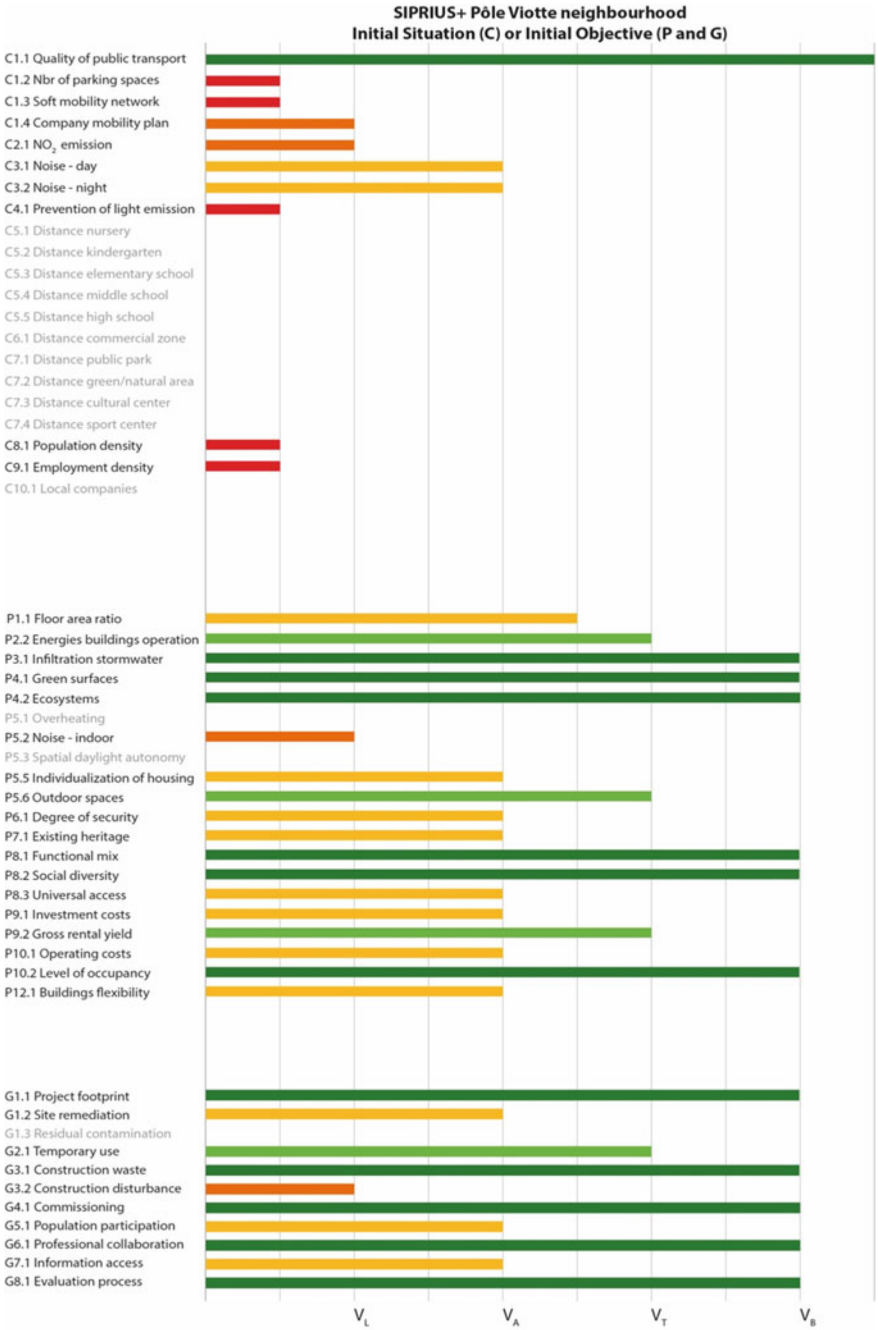

Fig. 10.18 Overall results of the initial situation (context indicators) and the initial objective (project indicators and governance indicators)

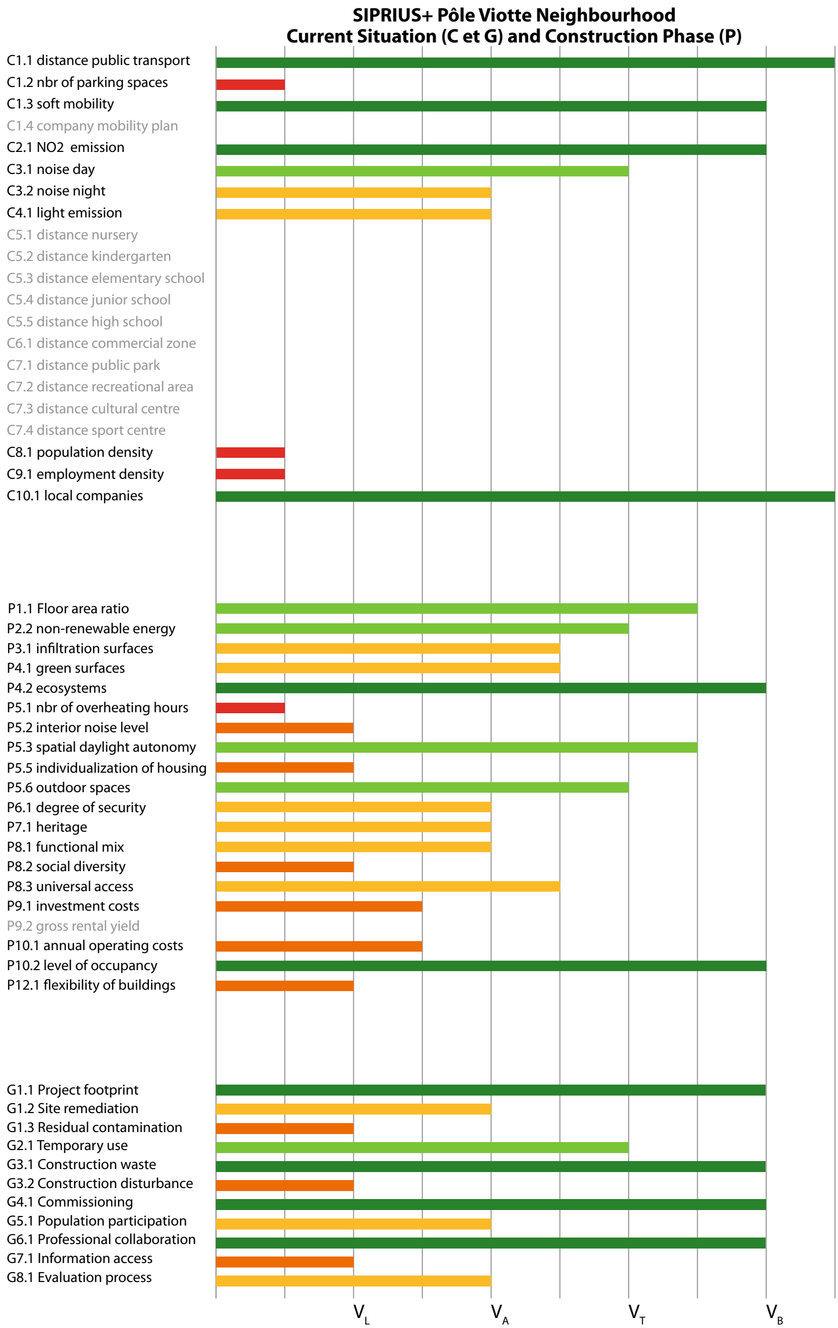

Fig. 10.19 Overall results of the current situation (context and governance indicators) and the construction phase of the current situation (project indicators)

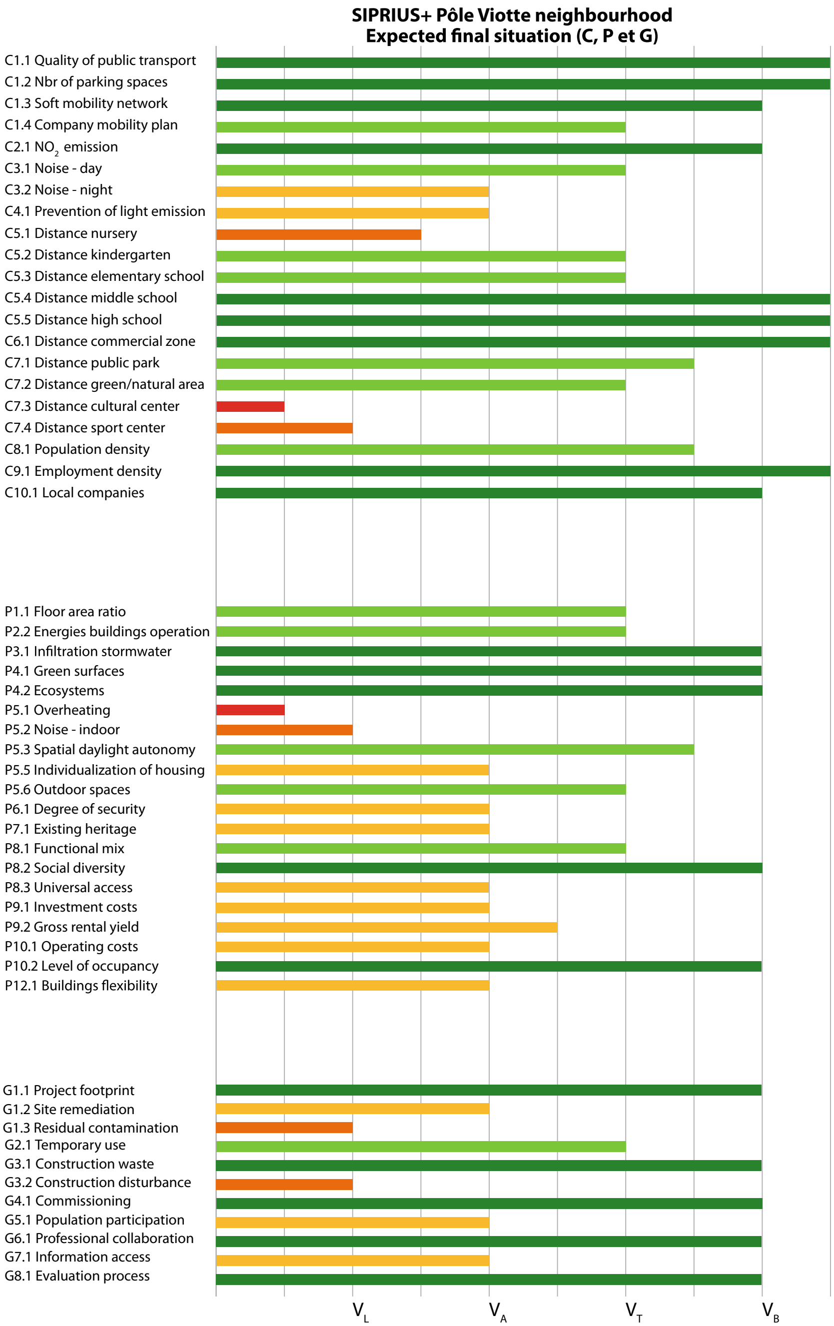

Fig. 10.20 Overall results of the expected final situation (context, project, and governance indicators)

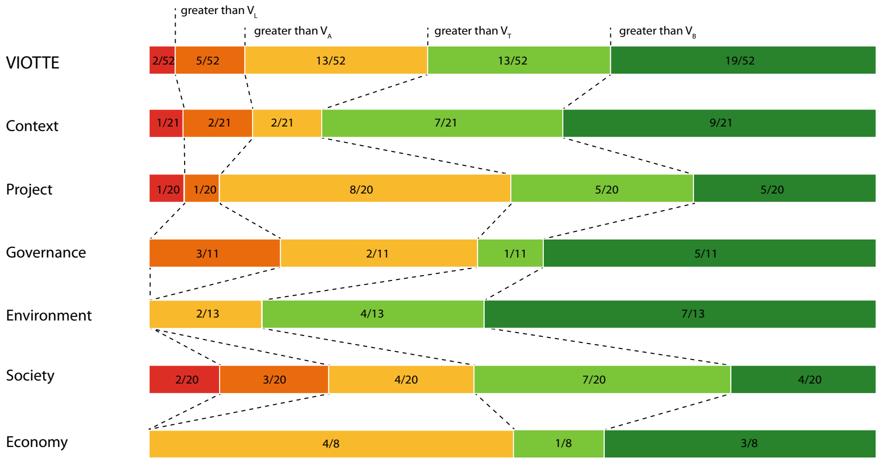

Fig. 10.21 Evolution display showing the distribution of all indicators' performances based on the values obtained for the expected final situation. The figure also shows the breakdown by sustainability dimension: environmental, sociocultural, and economic impact

- The second is to focus on the expected final situation results that would be below the limit value (V_L), or in other words, a veto value. Indeed, two indicators of the Pôle Viotte neighbourhood project deserve to be improved: *C7.3. Average distance to a cultural centre* and *P5.1. Annual hours of overheating*.
- The third is to pay particular attention to the indicators whose expected final situation result is lower than the initial situation or the initial objective. For the Pôle Viotte neighbourhood project, this is the case for indicator *P8.1 Degree of functional mix*.
- Finally, stakeholders involved in the project can look for indicators whose performance could be improved, such as those evaluated at the limit value (V_L). As an example, indicator *G3. Construction site—G3.2. Management of construction* disturbances could be better considered during the next upcoming work.

Essentially, taken together, the indicators embody different urban strategies used by the brownfield regeneration project to promote the transition towards more sustainable cities. The monitoring of sustainability—using evaluation of indicators and management functionalities—makes it possible to transcribe these various urban strategies and to visualize their performance through time. With the monitoring results and following the above considerations, SIPRIUS+ can support, in their decision-making, the stakeholders who are concerned about greater integration of sustainability into their regeneration project.

10.4 Towards Integration of Sustainability Issues into the Project Dynamics of a Neighbourhood in Transition

These monitoring results using SIPRIUS+ are, by definition, the portrait of a situation at a given moment. Hence, they are subject to change according to the evolution of the projects. In other words, the monitoring makes visible urban changes within the neighbourhood in transition. It provides useful information to integrate and pursue sustainability objectives throughout the regeneration process, thanks to global and detailed results. It can be used to iteratively compare different options, especially during the preliminary phases when the project is the most flexible and offers room for the integration of high-sustainability targets.

It is interesting to mention that the Pôle Viotte neighbourhood project is currently subject to considerable change that, unfortunately, could not be included in the present monitoring. Indeed, the development of the northern sector is on hold in the aftermath of the municipal team change after the election of 2019. Because the neighbourhood project is an important method of exploration to implement sustainable urbanistic and architectural solutions, the new political team wants to improve its sustainability objectives (reduce built density to increase green spaces, make a car- and parking-free area, etc.). In this case, the monitoring update promises to be interesting.

As a reminder, this monitoring was performed by the research team (LAST—EPFL) with the support of the case study's project manager (Direction Urbanisme Projets et Planification, Grand Besançon Metropole). To verify the potential of SIPRIUS+ as a support for the practical integration of sustainability in the Pôle Viotte neighbourhood project, we presented and discussed the previous monitoring results with different stakeholders of the development team (Laprise et al. 2018). The stakeholders agreed that SIPRIUS+ could contribute to maintaining sustainability objectives over the long term, much like a dashboard. They also agreed that SIPRIUS+ could be a relevant tool to build a shared vision on sustainability for the neighbourhood. In that sense, it could facilitate multi-disciplinary communication about this vision within the internal and external teams of the project. It could also facilitate communication with a broader audience, such as the population. However, divergences appeared among stakeholders about the level of information to communicate to the public. In the end, the stakeholders agreed that the monitoring provided by SIPRIUS+ could stimulate a willingness to improve and optimize the sustainability parameters of their project.

Ultimately, what emerges from these interactions is that, whereas the use of such a tool would imply a change in the management of the projects, the evolutions to adopt to include this practice appear not only feasible but realistic and desired. In this sense, the operational monitoring tool is expected to contribute to decision-making by facilitating unavoidable trade-offs in a multi-disciplinary manner, without giving ready-made solutions. However, at present, the monitoring tool is still not used regularly. It could be consulted on a yearly basis, for example, coinciding with the annual reviews. In any case, concretizing a sustainability vision and maintaining the objectives will always depend on the stakeholders' motivation and genuine involvement.

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Chapter 11
Conclusion

Abstract The inventory of urban brownfields in post-industrial European metropolitan areas and the study of regeneration projects highlight the absolute necessity of these resources for the sustainability transitions of urban territories and the undeniable complexity of this type of process. Given the complexity of the variables involved, there is no simple and unambiguous recipe to make urban territories evolve towards more sustainability. In a synthetic way, we recall how this book examines the strategies and methods of regenerating urban brownfields through the lens of sustainability at the neighbourhood scale. Then, we question how the urban brownfield phenomenon will evolve in the decades to come. Finally, we argue that it is through inter-disciplinarity of approaches that neighbourhoods in transition can contribute, on their scale, to the mutation and adaptability of urban territories.

Keywords Post-industrial European metropolitan areas · Sustainability transitions · Urban brownfield regeneration project · Neighbourhood scale · Future urban brownfields · Resilience · Inter-disciplinary approaches · Integrated design

The inventory of urban brownfields in post-industrial European metropolitan areas and the study of regeneration projects, of which many are in the course of being developed, highlight the absolute necessity of these resources for the sustainability transitions of urban territories and the undeniable complexity of this type of process. Identifying obstacles to development (negative public image, risk of opposition, multiplication of players, regulatory constraints, and dissuasive costs) largely justifies the panoply of development strategies that are deployed at different levels of territorial intervention to increase the chances of success of such operations (Rey 2014).

Given the complexity of the variables involved, there is no simple and unambiguous recipe to make urban territories evolve towards more sustainability. At the moment when a consensus appears in the face of the need for a response to the ecological and climate crises, this evolution will rather emerge from the realization of tailor-made solutions, developed in a manner that is iterative and adapted in terms of project and process to the specificities of each metropolitan area, municipality, and site. Faced with this simultaneous demand for precision, innovation and flexibility, an approach to sustainability issues in urban brownfield regeneration projects constitutes a set of particular interesting experiences. Due to its inherently intense operational

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complexity, this type of operation developed at the neighbourhood scale represents a suitable place for invention and experimentation and encourages the emergence of solutions that are both creative and unifying, leading to the engagement of an increasing number of actors.

Beyond the characteristics specific to each particular situation, the realization of the first experiences of transforming urban brownfields into sustainable neighbourhoods has made it possible to generate new operational approaches, explore new working methods, and test the integration of evaluation processes into the project approach. These first projects clearly demonstrate the need for a structured means of evaluation, in particular at the neighbourhood scale. These turn out to be all the more essential, as the complexity induced by the multiplicity of parameters to be considered on this scale exceeds the limits of intuition alone. From a sustainability perspective, this evaluative approach is part of a holistic process that translates into a global, optimized, and integrated look at the issues to be addressed (Rey and Lufkin 2016). It implies a simultaneous and optimal consideration of environmental, sociocultural, and economic parameters, a visualization of architectural projects not only as isolated objects but also as participating elements of a broader whole, and an optimization between the different constituent elements of the sustainable neighbourhood project.

These first experiments were often seen as "laboratories", paving the way for an evolution of common practices towards better consideration of the complexity inherent in sustainability. However, they cannot be considered as recipes to be used as-is for other projects. Strategies for sustainable development of the built environment cannot be seen as the search and application of an ideal and fixed model. Rather, they result from a logic of evolution from the current situation of various European metropolitan areas that need to be recognized, rethought, and redesigned, based simultaneously on existing characteristics and new perspectives.

The complex encounter between parameters linked to sustainability transitions and fixed points stemming from pre-existing situations makes the work of urban planners and architects who can, in partnership with other actors in urban areas, integrate multiple distinct aspects within a coherent spatial synthesis. The neighbourhood scale, which is an integral part of the regeneration of urban brownfields, constitutes, in this context, a basis for particularly interesting work. Situated on the scale between city and building, the neighbourhood appears well-suited to experimenting with specific practices aimed at increasing the sustainability of the urban environment. This makes it possible to make tangible and understand urban issues that clearly go beyond the scale of a single building. The necessity of a coordinated mastery of urbanization and mobility, the creation of dense mixed clusters, and the search for an increased quality of life in urban areas can thus be approached and trialled through concrete solutions. Thus, the regeneration of urban territories clearly takes place at a crossroads with large-scale considerations such as territorial development and more circumscribed definitions of buildings and public spaces in search of new configurations (Rey and Lufkin 2015).

This book examines the methods of regenerating urban brownfields through the lens of sustainability. It testifies to the pivotal period currently experienced by urban territories after the calling into question of continued urban sprawl and increased attention being paid to reserves remaining within the built environment. Following this effort towards synthesis is the question of how this phenomenon will evolve in the decades to come. Indeed, the metropolitan areas currently undergoing renovation projects address sectors that became urbanized during the nineteenth and twentieth centuries, afterwards becoming obsolete. Given the importance accorded nowadays to urban densification projects, the regeneration of urban brownfields is truly underway, and could thus indicate a gradual disappearance of the phenomenon.

It must, however, be noted that the multitude of sites still awaiting revitalization implies that urban brownfields will, in fact, be visible for a long time to come in the heart of European metropolitan areas and, probably, in other continents facing spatio-functional changes of the same order. Given the accelerated development of economic activities and their constantly changing needs, it is likely that some imbalances will continue to appear between the built environment and the functions it is supposed to fulfil. New types of brownfield not yet imagined in this book are likely to emerge in the coming decades, even if low population growth of European countries and increased interest in densification potential should, in principle, reduce the intensity of the phenomenon.

Faced with the profound functional changes observed today within European post-industrial metropolitan areas, it is also legitimate—beyond the extension of current urban brownfields and possible new spaces facing the risk of abandonment—to question the potentially cyclical nature of this type of phenomenon. In other words, will the neighbourhoods resulting from the regeneration of urban brownfields themselves become brownfields in a more distant future? It would be reckless, to say the least, to attempt to respond to this question in a definitive and peremptory manner, which would be tantamount to predicting the future of metropolitan territories quite precisely and over a very long term. The multiple interactions facing the urban environment in the twenty-first century will be as strongly marked by the globalized framework of socioeconomic exchanges as by changing geopolitical situations, locally diverse sociodemographic evolutions, and tensions related to limited access to resources.

In this context, oscillating between the hope of transition and apocalyptic announcements of collapse, it is not easy to predict the nature of the trade-offs that will be established in the face of these variables. Nevertheless, the issues discussed in this book underline the need for multi-dimensional approaches to transforming underused metropolitan sites. The integration of a functional and sociocultural mix in operations, as well as taking into account certain flexibility at the scale of the neighbourhoods considered, suggests a potentially greater adaptability than in previous occupations and, in principle, a lower risk of the sudden reappearance of obsolescence or abandonment.

If specific attention is paid to these conditions, brownfields can realize their intrinsic evolutive potential, allowing them to resist future contextual changes and influence their use. One can thus avoid a vacancy phase specific to urban brownfields in favour of a more continuous and fluid logic of renovation, transformation, and urban renewal, going beyond the classic vision of the urban brownfield's lifecycle (Laprise 2017).

On their level, sustainable neighbourhoods built on urban brownfields are thus likely to join and integrate certain dimensions inherent in the concept of resilience. Applied to the city, this can be defined as "the capacity of an urban system to absorb a disturbance and to regain its functions following this disturbance" (Toubin et al. 2012). As future developments always remain surrounded by uncertainty, it seems opportune to question the ability of urban territories to resist changes they have undergone and to withstand sudden impacts. As Thomas Sieverts points out, the objectives of resilience are mainly the conservation of resources through careful maintenance, tolerance for errors, and an ability to remedy them, reconciling the longevity of urban structures with scalable uses and the achievement of resource-saving through the versatility of use (Sieverts 2013). That which we build or rehabilitate today must, therefore, be able to serve future needs by integrating several possibilities of resetting its use.

The vast field of investigation opened by this challenge implies integrating an increased number of skills in the development of regeneration projects, which translates into the need to develop intelligent inter-disciplinary cooperations. It is through this inter-disciplinarity of approaches—firmly coupled with a process of conceptual, spatial, and expressive integration of distinct contributions to coherent design—that neighbourhoods in transition can contribute, on their scale, to the mutation and adaptability of urban territories.

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Appendix

Context indicators

Environmental impact

Indicator	C1.1 Quality of service in public transport	BE
Definition	The level of service offered by public transport, defined by the type of transport, the rate of service, and the distance to the nearest stop	
Evaluation method	Analysis of the frequency of public transport (bus, tram, subway, train) and measurement of the average distance to the stop under consideration	
Measurement unit	[–]	
V_L (limit value)	At least 1 mode of public transport reaches a low level of service	
V_A (average value)	At least 1 mode of public transport reaches an average level of service	
V_T (target value)	At least 1 mode of public transport reaches a good level of service	
V_B (best practice value)	At least 1 mode of public transport reaches a high level of service	
Data sources	Information from public transport companies, schedule analysis, measures on city plans	
References	SPW (2011, 2015)	

E. Rey et al., *Neighbourhoods in Transition*, The Urban Book Series,
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Indicator	C1.1 Quality of service in public transport	CH
Definition	The level of service offered by public transport, defined by the type of transport, the rate of service, and the distance to the nearest stop	
Evaluation method	Analysis of the frequency of public transport (bus, tram, subway, train) and measurement of the average distance to the stop under consideration	
Measurement unit	Class A, B, C, D	
V_L (limit value)	Class D	
V_A (average value)	Class C	
V_T (target value)	Class B	
V_B (best practice value)	Class A	
Data sources	Information from public transport companies, schedule analysis, measures on city plans	
References	VSS (1993), Bridel (1996), Bonanomi (2000)	

Indicator	C1.1 Average distance to a public transport stop		FR
Definition	The average distance to walk from the front door of the apartment and office buildings to the closest public transit stop under consideration, weighted by the respective gross floor area of the different buildings		
Evaluation method	Measurement of the distance to the public transport stop (bus, tram, subway, train)		
Measurement unit	[m]		
	Bus/subway/tram	Train station	
V_L (limit value)	900 (about 15 min walk)	1800 (about 30 min walk)	
V_A (average value)	700 (about 12 min walk)	1400 (about 25 min walk)	
V_T (target value)	500 (about 8 min walk)	1000 (about 15 min walk)	
V_B (best practice value)	300 (about 5 min walk)	600 (about 10 min walk)	
Data sources	Information from public transport companies, measures on city plans		
References	Tarzia (2003), Charlot-Valdieu and Outrequin (2012), Cerema (2015)		

Indicator	C1.2 Number of parking spaces	BE
Definition	The number of parking spaces planned to meet the needs of inhabitants, workers, and visitors	
Evaluation method	Calculation of the number of parking spaces in relation to the quality of public transport services	

(continued)

(continued)

Indicator	C1.2 Number of parking spaces	BE
Measurement unit	Number of parking spaces	
V_L (limit value)	≤maximum theoretical need	
V_A (average value)	≤the value between V_L and V_T	
V_T (target value)	≤maximum optimized need	
V_B (best practice value)	≤minimum optimized need	
Data sources	Plan and table of parking spaces, report of the impact study, calculations of reduced needs according to SPW (2015)	
References	SPW (2011, 2015)	

Indicator	C1.2 Number of parking spaces	CH
Definition	The number of parking spaces planned to meet the needs of inhabitants, workers, and visitors	
Evaluation method	Calculation of the number of parking spaces	
Measurement unit	Number of parking spaces	
V_L (limit value)	Value corresponding to the maximum reduced need according to VSS (1993)	
V_A (average value)	Mean value between V_L and V_B	
V_T (target value)	Mean value between V_M and V_B	
V_B (best practice value)	Value corresponding to the minimum reduced need according to VSS (1993)	
Data sources	Plan and table of parking spaces, report of the impact study, calculations of reduced needs according to VSS (1993)	
References	VSS (1993), Bridel (1996)	

Indicator	C1.2 Number of parking spaces	FR
Definition	The number of parking spaces planned to meet the needs of inhabitants, workers, and visitors	
Evaluation method	Calculation of the number of parking spaces	
Measurement unit	Number of parking spaces	
V_L (limit value)	≤the requirements of "Code de l'Urbanisme" (or PLU/PDU if more restrictive)	
V_A (average value)	≤the mean value between V_L and V_B	
V_T (target value)	≤ the mean value between V_A and V_B	
V_B (best practice value)	≤optimized theoretical need	
Data sources	Plan and table of parking spaces, report of the impact study, and calculations of the optimized theoretical need	

(continued)

(continued)

Indicator	C1.2 Number of parking spaces	FR
References	Charlot-Valdieu and Outrequin (2012), Meunier-Chabert (2012), Legifrance (2016)	

Indicator	C1.3 Tying status with “soft” mobility networks	BE/CH/FR
Definition	The intensity of connection to different “soft” and sustainable mobility networks for pedestrians and bicycles	
Evaluation method	Analysis of the number and quality of the different connections	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The project is characterized by a relatively low consideration of “soft” mobility and is relatively weakly connected to surrounding areas (every 900 m)	
V_A (average value)	The project is characterized by a relatively moderate consideration of “soft” mobility and is moderately connected to surrounding areas (every 700 m)	
V_T (target value)	The project provides for a significant consideration of “soft” mobility and is significantly connected to surrounding areas (every 500 m)	
V_B (best practice value)	The project provides for systematic consideration of “soft” mobility (several specific devices) and is systematically connected to surrounding areas (every 300 m)	
Data sources	Site plan, project guidelines	
References	écoconso (2008), Meunier-Chabert (2012), OFROU and Mobilité piétonne Suisse (2014), DGO2 (2015), Ministère de l’écologie, du développement durable et de l’énergie and Ministère délégué aux transports, à la mer et à la pêche (2015)	

Indicator	C1.4 Company mobility plan (CMP)	BE/CH/FR
Definition	The measures offered by on-site companies to encourage the use of alternative transport during commuting or business trips	
Evaluation method	Qualitative analysis of the measures of the company mobility plan (CMP) and their accessibility	
Measurement unit	[Qualitative scale]	
V_L (limit value)	A small proportion of jobs have access to a CMP, limited to a single alternative measure to individual transport	
V_A (average value)	A moderate proportion of jobs have access to a CMP, supported by a great offer of alternative measures to individual transport	

(continued)

(continued)

Indicator	C1.4 Company mobility plan (CMP)	BE/CH/FR
V_T (target value)	An important proportion of jobs have access to a CMP, supported by a great offer of alternative measures to individual transport	
V_B (best practice value)	An important proportion of jobs have access to a CMP, supported by a great offer of alternative measures to individual transport and relying on a permanent communication campaign	
Data sources	Site plan, project guidelines	
References	Mobilservice and Kanton Aargau (2009), Etat de Vaud, Département des infrastructures and Etat de Genève, Département de l'intérieur, de l'agriculture et de l'environnement (2014), DGO2 (2015), ADEME (2016), mobitool (2016)	

Indicator	C2.1 Average annual emissions of NO_2	BE
Definition	The estimated average concentration of NO_2 induced by emissions of nitrogen oxides (NOx) due to road traffic and heating of buildings in a wider area compared to the project under consideration	
Evaluation method	Methodology specific to Environmental Impact Assessment (EIA)	
Measurement unit	[$\mu gNO_2/m^3$]	
V_L (limit value)	40 limit value according to WHO (2005)	
V_A (average value)	32 mean value between V_L and V_T (urban area)	
V_T (target value)	23 mean value weighted according to population (irCELine 2015)	
V_B (best practice value)	15 annual spatial value (irCELine 2015)	
Data sources	Project data, EIA report, on-site measurement	
References	WHO (2005), irCELine (2015)	

Indicator	C2.1 Average annual emissions of NO_2	CH
Definition	The estimated average concentration of NO_2 induced by emissions of nitrogen oxides (NOx) due to road traffic and heating of buildings in a wider area compared to the project under consideration	
Evaluation method	Methodology specific to Environmental Impact Assessment (EIA)	
Measurement unit	[$\mu gNO_2/m^3$]	
V_L (limit value)	30 limit value according to Opair (1985) (Conseil fédéral suisse 1985)	

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Indicator	C2.1 Average annual emissions of NO_2	CH
V_A (average value)	25 mean value between V_L and V_T	
V_T (target value)	20 low annual average value in urban site (background pollution)	
V_B (best practice value)	13 rural area (OFS 2013)	
Data sources	Project data, EIA report, on-site measurement	
References	Conseil fédéral suisse (1985), Hertig (2006), OFS (2013)	

Indicator	C2.1 Average annual emissions of NO_2	FR
Definition	The estimated average concentration of NO_2 induced by emissions of nitrogen oxides (NOx) due to road traffic and heating of buildings in a wider area compared to the project under consideration	
Evaluation method	Methodology specific to Environmental Impact Assessment (EIA)	
Measurement unit	[$\mu gNO_2/m^3$]	
V_L (limit value)	40 limit value according to WHO (2005) (WHO 2005)	
V_A (average value)	30 mean value between V_L and V_T (flora protection)	
V_T (target value)	20 annual mean value in urban site	
V_B (best practice value)	17 low annual average value in urban site (percentile 10%)	
Data sources	Project data, EIA report, on-site measurement	
References	WHO (2005), MEEM (2014), MEDDE (2014)	

Indicator	C2.2 Global warming potential (GWP)	CH
Definition	The annual equivalent quantity of kg CO_2 caused by the construction, renovation, operation, and demolition of buildings	
Evaluation method	Methodology specific to lifecycle analysis (LCA) (cf. indicator P2.1)	
Measurement unit	[$kg_{eq}CO_2/m^2{}_{CA}y$]	
V_L (limit value)	125% of V_B	
V_A (average value)	Between V_L and V_B	
V_T (target value)	Between V_A and V_B	
V_B (best practice value)	Values corresponding to the recommendations of the 2000 Watt Society/SIA 2040 (SIA 2011; Liman et al. 2014)	
Data sources	LCA realized with the project data	
References	SIA (2011), Liman et al. (2014), Swissenergy et al. (2014)	

Indicator	C2.2 Global warming potential (GWP)	BE/FR
Definition	The annual equivalent quantity of kg CO_2 caused by the construction, renovation, operation, and demolition of buildings	
Evaluation method	Methodology specific to lifecycle analysis (LCA) (cf. indicator P2.1)	
Measurement unit	[$kg_{eq}CO_2/m^2{}_{CA}y$]	
V_L (limit value)	To date, there are not enough comparable calculations on full lifecycle analysis of buildings in order to establish reference values	
V_A (average value)		
V_T (target value)		
V_B (best practice value)		
Data sources	LCA realized with the project data	
References	Agence wallonne de l'air & du climat (2014), Lebert et al. (2014), Wallonie (2014), Association HQE (2015), CSTB (2016), INIES (2016)	

Indicator	C2.3 Acidification potential (AP)	BE/CH/FR
Definition	The annual equivalent quantity of kg SO_2 caused by the construction, renovation, operation, and demolition of buildings	
Evaluation method	Methodology specific to lifecycle analysis (LCA) (cf. indicator P2.1)	
Measurement unit	[$kg_{eq}SO_2/m^2{}_{CA}y$]	
V_L (limit value)	To date, there are not enough comparable calculations on full lifecycle analysis of buildings in order to establish reference values	
V_A (average value)		
V_T (target value)		
V_B (best practice value)		
Data sources	LCA realized with the project data	
References	Brecheisen and Theis (2015), Lotteau et al. (2015)	

Indicator	C3.1 Average emissions of noise—day (Lden)	BE/FR
Definition	The average noise exposure value of buildings located in the perimeter of the project and in a wider area	
Evaluation method	Methodology specific to Environmental Impact Assessment (EIA)	
Measurement unit	[dBA]	
V_L (limit value)	65 (+10 dBA according to WHO 2009 Lnight, rule of thumb)	
V_A (average value)	55	
V_T (target value)	50 (+10 dBA according to WHO 2009 Lnight, rule of thumb)	

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Indicator	C3.1 Average emissions of noise—day (Lden)	BE/FR
V_B (best practice value)	45	
Data sources	Cadastre of road and motorway network, project data, EIA report, on-site measurement	
References	CE (2002), Gouvernement wallon (2004), RF et al. (2006), WHO (2009), EEA (2010)	

Indicator	C3.1 Average emissions of noise—day	CH
Definition	The average noise exposure value of buildings located in the perimeter of the project and in a wider area	
Evaluation method	Methodology specific to Environmental Impact Assessment (EIA)	
Measurement unit	[dBA]	
V_L (limit value)	VA = alert value according to OPB (CH 2015)	
V_A (average value)	VLI = limit value according to OPB (CH 2015)	
V_T (target value)	VLI—5 dBA	
V_B (best practice value)	VLI—10 dBA	
Data sources	Cadastre of road and motorway network, project data, EIA report, on-site measurement	
Reference	CH (2015)	

Indicator	C3.2 Average emissions of noise—night (Lnight)	BE/FR
Definition	The average noise exposure value of buildings located in the perimeter of the project and in a wider area	
Evaluation method	Methodology specific to Environmental Impact Assessment (EIA)	
Measurement unit	[dBA]	
V_L (limit value)	55—threshold according to WHO (2009)	
V_A (average value)	45	
V_T (target value)	40—threshold according to WHO (2009)	
V_B (best practice value)	35	
Data sources	Cadastre of road and motorway network, project data, EIA report, on-site measurement	
References	CE (2002), Gouvernement wallon (2004), RF et al. (2006), WHO (2009), EEA (2010)	

Indicator	C3.2 Average emissions of noise—night	BE/CH/FR
Definition	The average noise exposure value of buildings located in the perimeter of the project and in a wider area	
Evaluation method	Methodology specific to Environmental Impact Assessment (EIA)	
Measurement unit	[dBA]	
V_L (limit value)	VA = alert value according to OPB (CH 2015)	
V_A (average value)	VLI = limit value according to OPB (CH 2015)	
V_T (target value)	VLI—5 dBA	
V_B (best practice value)	VLI—10 dBA	
Data sources	Cadastre of road and motorway network, project data, EIA report, on-site measurement	
Reference	CH (2015)	

Indicator	C4.1 Degree of prevention of light emissions	BE/CH/FR
Definition	The level of measures put in place in order to prevent useless light emissions during the night, while respecting security standards	
Evaluation method	Qualitative analysis of the project's lighting plan	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The lighting of the project is limited to the minimum legal requirements in terms of prevention	
V_A (average value)	The lighting of the project is integrated into a global lighting plan, which meets the legal requirements in terms of prevention	
V_T (target value)	The lighting of the project is integrated into a global lighting plan, which meets the legal requirements in terms of prevention and imposes authorizations and schedules for public lighting	
V_B (best practice value)	The lighting of the project is integrated into a global lighting plan, which meets the legal requirements in terms of prevention and imposes authorizations and schedules for private and public lighting	
Data sources	Plans and data of the project, lighting plan description	
References	ADEME (2002), OFEFP (2005), FRAPNA (2013), SIA (2013), ASCEN (2015)	

Sociocultural impact

Indicator	C5.1 Average distance to a nursery	BE/CH/FR
Definition	The average distance to walk from the entrance of residential buildings to the nearest nursery, weighted by the respective gross floor area of the different buildings	
Evaluation method	Measurement on maps and city plans	
Measurement unit	[m]	
V_L (limit value)	900 (about 15 min walk)	
V_A (average value)	700 (about 12 min walk)	
V_T (target value)	500 (about 8 min walk)	
V_B (best practice value)	300 (about 5 min walk)	
Data sources	Municipal data on nursery, specific studies, maps and city plans	
References	Bridel (1996), OFL (2000), Teller (2009), Ministère de l'égalité des territoires et du logement (2014)	

Indicator	C5.2 Average distance to a kindergarten	BE/CH/FR
Definition	The average distance to walk from the entrance of residential buildings to the nearest school facilities, weighted by the respective gross floor area of the different buildings	
Evaluation method	Measurement on maps and city plans	
Measurement unit	[m]	
V_L (limit value)	900 (about 15 min walk)	
V_A (average value)	700 (about 12 min walk)	
V_T (target value)	500 (about 8 min walk)	
V_B (best practice value)	300 (about 5 min walk)	
Data sources	Municipal data on school facilities, specific studies, maps, and city plans	
References	Bridel (1996), OFL (2000), Teller (2009), Ministère de l'égalité des territoires et du logement (2014)	

Indicator	C5.3 Average distance to an elementary school	BE/CH/FR
Definition	The average distance to walk from the entrance of residential buildings to the nearest school facilities, weighted by the respective gross floor area of the different buildings	
Evaluation method	Measurement on maps and city plans	
Measurement unit	[m]	
V_L (limit value)	900 (about 15 min walk)	

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Indicator	C5.3 Average distance to an elementary school	BE/CH/FR
V_A (average value)	700 (about 12 min walk)	
V_T (target value)	500 (about 8 min walk)	
V_B (best practice value)	300 (about 5 min walk)	
Data sources	Municipal data on school facilities, specific studies, maps, and city plans	
References	Bridel (1996), OFL (2000), Teller (2009), Ministère de l'égalité des territoires et du logement (2014)	

Indicator	C5.4 Average distance to a junior high/middle school	BE/CH/FR
Definition	The average distance to walk from the entrance of residential buildings to the nearest school facilities, weighted by the respective gross floor area of the different buildings	
Evaluation method	Measurement on maps and city plans	
Measurement unit	[m]	
V_L (limit value)	1800 (about 30 min walk)	
V_A (average value)	1400 (about 24 min walk)	
V_T (target value)	1000 (about 16 min walk)	
V_B (best practice value)	600 (about 10 min walk)	
Data sources	Municipal data on school facilities, specific studies, maps, and city plans	
References	Bridel (1996), OFL (2000), Teller (2009), Ministère de l'égalité des territoires et du logement (2014)	

Indicator	C5.5 Average distance to a high school	BE/CH/FR
Definition	The average distance to walk from the entrance of residential buildings to the nearest school facilities, weighted by the respective gross floor area of the different buildings	
Evaluation method	Measurement on maps and city plans	
Measurement unit	[m]	
V_L (limit value)	1800 (about 30 min walk)	
V_A (average value)	1400 (about 24 min walk)	
V_T (target value)	1000 (about 16 min walk)	
V_B (best practice value)	600 (about 10 min walk)	
Data sources	Municipal data on school facilities, specific studies, maps, and city plans	
References	Bridel (1996), OFL (2000), Teller (2009), Ministère de l'égalité des territoires et du logement (2014)	

Indicator	C6.1 Average distance to a commercial zone	BE/CH/FR
Definition	The average distance to walk from the entrance of residential buildings to the nearest commercial zone, weighted by the respective gross floor area of the different buildings	
Evaluation method	Measurement on maps and city plans	
Measurement unit	[m]	
V_L (limit value)	900 (about 15 min walk)	
V_A (average value)	700 (about 12 min walk)	
V_T (target value)	500 (about 8 min walk)	
V_B (best practice value)	300 (about 5 min walk)	
Data sources	Municipal data on businesses, information from merchant associations, maps, and city plans	
References	Bridel (1996), OFL (2000), Teller (2009), Ministère de l'égalité des territoires et du logement (2014)	

Indicator	C7.1 Average distance to a public park	BE/CH/FR
Definition	The average distance to walk from the entrance of residential buildings to the nearest public park, weighted by the respective gross floor area of the different buildings	
Evaluation method	Measurement on maps and city plans	
Measurement unit	[m]	
V_L (limit value)	900 (about 15 min walk)	
V_A (average value)	700 (about 12 min walk)	
V_T (target value)	500 (about 8 min walk)	
V_B (best practice value)	300 (about 5 min walk)	
Data sources	Municipal data on public parks, information from cultural and sports associations, maps, and city plans	
References	Bridel (1996), OFL (2000), Teller (2009), Ministère de l'égalité des territoires et du logement (2014)	

Indicator	C7.2 Average distance to a recreational green/natural area	BE/CH/FR
Definition	The average distance to walk from the entrance of residential buildings to the nearest recreational green/natural area, weighted by the respective gross floor area of the different buildings	
Evaluation method	Measurement on maps and city plans	
Measurement unit	[m]	
V_L (limit value)	1800 (about 30 min walk)	

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Indicator	C7.2 Average distance to a recreational green/natural area	BE/CH/FR
V_A (average value)	1400 (about 24 min walk)	
V_T (target value)	1000 (about 16 min walk)	
V_B (best practice value)	600 (about 10 min walk)	
Data sources	Municipal data on recreational green/natural area (forest, lake or river shore, et.), maps, and city plans	
References	Bridel (1996), OFL (2000), Teller (2009), Ministère de l'égalité des territoires et du logement (2014)	

Indicator	C7.3 Average distance to a cultural centre	BE/CH/FR
Definition	The average distance to walk from the entrance of residential buildings to the nearest cultural centre, weighted by the respective gross floor area of the different buildings	
Evaluation method	Measurement on maps and city plans	
Measurement unit	[m]	
V_L (limit value)	900 (about 15 min walk)	
V_A (average value)	700 (about 12 min walk)	
V_T (target value)	500 (about 8 min walk)	
V_B (best practice value)	300 (about 5 min walk)	
Data sources	Municipal data on cultural centre, information from cultural associations, maps, and city plans	
References	Bridel (1996), OFL (2000), Teller (2009), Ministère de l'égalité des territoires et du logement (2014)	

Indicator	C7.4 Average distance to a sport centre	BE/CH/FR
Definition	The average distance to walk from the entrance of residential buildings to the nearest sport centre, weighted by the respective gross floor area of the different buildings	
Evaluation method	Measurement on maps and city plans	
Measurement unit	[m]	
V_L (limit value)	900 (about 15 min walk)	
V_A (average value)	700 (about 12 min walk)	
V_T (target value)	500 (about 8 min walk)	
V_B (best practice value)	300 (about 5 min walk)	
Data sources	Municipal data on sport centre, information from sports associations, maps, and city plans	
References	Bridel (1996), OFL (2000), Teller (2009), Ministère de l'égalité des territoires et du logement (2014)	

Economic impact

Indicator	C8.1 Net population density	BE/CH/FR
Definition	The number of inhabitants per hectare of buildable land (excluding green areas, forests, water bodies, etc.)	
Evaluation method	Estimated number of inhabitants according to the project's gross floor area and the expected occupation rate according to the statistical values, divided by the buildable land area for the site	
Measurement unit	[hab/ha]	
V_L (limit value)	90% of the net density of the centre of the city or the metropolitan area	
V_A (average value)	100% of the net density of the centre of the city or the metropolitan area	
V_T (target value)	150% of the net density of the centre of the city or the metropolitan area	
V_B (best practice value)	200% of the net density of the centre of the city or the metropolitan area	
Data sources	Data of the housing project, municipal statistics	
References	Fouchier (1997), Ruzicka-Rossier and Kotchi (2002), DREIF (2009), IWEPS (2011), Insee (2016)	

Indicator	C9.1 Net employment density	BE/CH/FR
Definition	The number of jobs per hectare of buildable land (excluding green areas, forests, water bodies, etc.)	
Evaluation method	Estimated number of jobs according to the project's gross floor area and the expected occupation rate according to the statistical values, divided by the buildable land area for the site	
Measurement unit	[job/ha]	
V_L (limit value)	90% of the net density of the centre of the city or the metropolitan area	
V_A (average value)	100% of the net density of the centre of the city or the metropolitan area	
V_T (target value)	150% of the net density of the centre of the city or the metropolitan area	
V_B (best practice value)	200% of the net density of the centre of the city or the metropolitan area	
Data sources	Communal statistical tables of employment	
References	Fouchier (1997), Ruzicka-Rossier and Kotchi (2002), DREIF (2009), IWEPS (2011), Insee (2016)	

Indicator	C10.1 Proportion of work carried out by local companies	BE/CH/FR
Definition	The percentage of the costs of the work—preparatory work, buildings, and landscaping—made by companies located in the project's urban area	
Evaluation method	Analysis of construction cost	
Measurement unit	[%]	
V_L (limit value)	50% of the total construction cost	
V_A (average value)	60% of the total construction cost	
V_T (target value)	70% of the total construction cost	
V_B (best practice value)	80% of the total construction cost	
Data sources	Final construction cost, statistics of federations of contractors	
References	CRB (2001), MEEM (2012), SPW (2014)	

Project indicators

Environmental balance

Indicator	P1.1 Floor area ratio	BE/CH/FR
Definition	The ratio between the floor area of buildings and the total area of the site	
Evaluation method	Measure of the project plans' surface area	
Measurement unit	[–]	
V_L (limit value)	0.5 (the limit for public transport according to Gasser (2003)	
V_A (average value)	1.0	
V_T (target value)	1.5	
V_B (best practice value)	2.0 (density of central urban areas)	
Data sources	Project plans, land cadastral data	
References	SIA (2004b), IAURIF (2005a, b, c), CPDT (2013)	

Indicator	P2.1 Non-renewable primary energy for construction, renovation, and demolition of buildings	BE/FR
Definition	The quantity of non-renewable primary energy needed for the construction, renovation (maintenance and replacement of elements), and demolition of buildings	
Evaluation method	Methodology specific to lifecycle analysis (LCA)	
Measurement unit	[$MJ/m^2{}_{CA}y$]	
V_L (limit value)	To date, there are not enough comparable calculations on full lifecycle analysis of buildings in order to establish reference values	
V_A (average value)		
V_T (target value)		

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Indicator	P2.1 Non-renewable primary energy for construction, renovation, and demolition of buildings	BE/FR
V_B (best practice value)		
Data sources	LCA realized with the project data	
References	UE (2010), Commission Européenne (2014)	

Indicator	P2.1 Non-renewable primary energy for construction, renovation, and demolition of buildings	CH
Definition	The quantity of non-renewable primary energy needed for the construction, renovation (maintenance and replacement of elements), and demolition of buildings	
Evaluation method	Methodology specific to lifecycle analysis (LCA)	
Measurement unit	[MJ/m^2_{CA}y]	
V_L (limit value)	125% of V_B	
V_A (average value)	Between V_L and V_B	
V_T (target value)	Between V_T and V_B	
V_B (best practice value)	Values corresponding to the recommendations of the 2000 Watt Society/SIA 2040 (SIA 2011; Liman et al. 2014)	
Data sources	LCA realized with the project data	
References	SIA (2011), Liman et al. (2014), Swissenergy et al. (2014)	

Indicator	P2.2 Non-renewable energy for buildings in operation	BE
Definition	The ratio between the primary energy required for the annual consumption for the buildings' operation (heating, hot water, and electricity) and an annual consumption of primary reference energy	
Evaluation method	Energy balance required for PEB certificate—according to Walloon calculations	
Measurement unit	[Level Ew]	
V_L (limit value)	80 (PEB Certificate)	
V_A (average value)	70 (Reference level Brussels)	
V_T (target value)	50 (Reference level Flanders)	
V_B (best practice value)	30 (UE 2021 Objective)	
Data sources	Energy balance, report on energy consumption when applying for a building permit	
References	UE (2010, p. 20), SPW et al. (2015)	

Indicator	P2.2 Non-renewable energy for buildings in operation	CH
Definition	The quantity of non-renewable primary energy needed for annual consumption for the buildings' operation (heating, hot water, and electricity)	
Evaluation method	Energy balance	
Measurement unit	[$MJ/m^2{}_{CA}y$]	
V_L (limit value)	Value determined from the limit values according to the relevant reference standard (SIA 380/et SIA 380/4)	
V_A (average value)	Value determined from the target values according to the relevant reference standard (SIA 380/et SIA 380/4)	
V_T (target value)	Value corresponding to the good performance of the practice in this area (label Minergie-P) (Minergie 2014)	
V_B (best practice value)	Value corresponding to the best performance of the practice in this area (label Minergie-A) (Minergie 2014)	
Data sources	Energy balance, report on energy consumption when applying for a building permit	
References	SIA (2009), Minergie (2014)	

Indicator	P2.2 Non-renewable energy for buildings in operation	FR
Definition	The quantity of non-renewable primary energy required for annual consumption for the buildings' operation (heating, domestic hot water, and electricity)/housing, offices and education	
Evaluation method	Energy balance	
Measurement unit	[$kWh/m^2{}_{SHON}RTa$]	
V_L (limit value)	Value corresponding to the requirements of law RT2012 (CSTB 2012)	
V_A (average value)	Mean value between V_L and V_T	
V_T (target value)	Value corresponding to the good performance of the practice in this area (RT2012-20% or label Effinergie + (effinergie 2016))	
V_B (best practice value)	Value corresponding to the best performance of the practice in this area (label BePos Effinergie (effinergie 2017))	
Data sources	Energy balance, report on energy consumption when applying for a building permit	
References	RF et al. (2010a, b), CSTB (2012), effinergie (2016, 2017)	

Indicator	P3.1 Infiltration surface and stormwater use	BE
Definition	The part of the surface area for the infiltration or recovery of stormwater relative to the total potential surface area. Note that green roofs and green areas covering the underground infrastructures are counted by only 50%	
Evaluation method	Measure of the project plans' infiltration surface area	
Measurement unit	[%]	
V_L (limit value)	30% of the total potential surface area	
V_A (average value)	40% of the total potential surface area	
V_T (target value)	45% of the total potential surface area	
V_B (best practice value)	50% of the total potential surface area	
Data sources	Plans and data of the project	
Reference	Teller et al. (2014)	

Indicator	P3.1 Infiltration surface and stormwater use	CH/FR
Definition	The part of the surface area for the infiltration or recovery of stormwater relative to the total potential surface area. Note that green roofs and green areas covering the underground infrastructures are counted by only 50%	
Evaluation method	Measure of the project plans' infiltration surface area	
Measurement unit	[%]	
V_L (limit value)	20% of the total potential surface area	
V_A (average value)	30% of the total potential surface area	
V_T (target value)	40% of the total potential surface area	
V_B (best practice value)	50% of the total potential surface area	
Data sources	Plans and data of the project	
Reference	SIA (2004c)	

Indicator	P4.1 Green surfaces	BE
Definition	The part of green surface area (grassing, natural body of water, biotope, etc.) relative to the total potential surface area. Note that green roofs and green areas covering the underground infrastructures are counted by only 50%	
Evaluation method	Measure of the project plans' green surface area	
Measurement unit	[%]	
V_L (limit value)	30% of the total potential surface area	
V_A (average value)	40% of the total potential surface area	
V_T (target value)	45% of the total potential surface area	

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Indicator	P4.1 Green surfaces	BE
V_B (best practice value)	50% of the total potential surface area	
Data sources	Plans and data of the project	
Reference	Teller et al. (2014)	

Indicator	P4.1 Green surfaces	CH/FR
Definition	The part of green surface area (grassing, natural body of water, biotope, etc.) relative to the total potential surface area. Note that green roofs and green areas covering the underground infrastructures are counted by only 50%	
Evaluation method	Measure of the project plans' green surface area	
Measurement unit	[%]	
V_L (limit value)	20% of the total potential surface area	
V_A (average value)	30% of the total potential surface area	
V_T (target value)	40% of the total potential surface area	
V_B (best practice value)	50% of the total potential surface area	
Data sources	Plans and data of the project	
Reference	SIA (2004c)	

Indicator	P4.2 Degree of ecosystem considerations	BE/CH/FR
Definition	The level of measures put in place to value existing or new ecosystems in an integrated manner in the project's logic	
Evaluation method	Qualitative analysis of the Environmental Impact Assessment (EIA) and landscape planning	
Measurement unit	[Qualitative scale]	
V_L (limit value)	2 (sur 5) A biodiversity inventory is made. The project includes the preservation of existing ecosystems of interest	
V_A (average value)	3 (sur 5) A biodiversity inventory is made. The project includes the preservation of existing ecosystems of interest and/or the creation of new ecosystems	
V_T (target value)	4 (sur 5) The project includes both internal and external connections to the site between the new and/or existing ecosystems	
V_B (best practice value)	5 (sur 5) The project includes both internal and external connections to the site between the new and/or existing ecosystems. A differentiated management plan is put in place to promote the development of ecosystems	
Data sources	EIA, biodiversity diagnostic, plans and data of the project	
Reference	ADEME (2014a)	

Sociocultural quality

Indicator	P5.1 Heat gains	BE
Definition	The number of Kelvin per hour over a year beyond 23 °C	
Evaluation method	Digital simulation, on-site measurement	
Measurement unit	[kh]	
V_L (limit value)	6500	
V_A (average value)	3750	
V_T (target value)	2375	
V_B (best practice value)	1000	
Data sources	Heat engineer report, on-site measurement	
Reference	SPW et al. (2015)	

Indicator	P5.1 Annual hours of overheating	CH
Definition	The annual number of hours when the interior temperature of a building is greater than 26.5 °C	
Evaluation method	Digital simulation, on-site measurement	
Measurement unit	[h]	
V_L (limit value)	100	
V_A (average value)	80	
V_T (target value)	60	
V_B (best practice value)	40	
Data sources	Heat engineer report, on-site measurement	
Reference	SIA (2007)	

Indicator	P5.1 Annual hours of overheating	FR
Definition	The annual number of hours when the interior temperature of a building is greater than 28 °C	
Evaluation method	Digital simulation, on-site measurement	
Measurement unit	[h]	
V_L (limit value)	40	
V_A (average value)	30	
V_T (target value)	20	
V_B (best practice value)	10	
Data sources	Heat engineer report, on-site measurement	
Reference	Sidler and MAF (2013)	

Indicator	P5.2 Interior noise level	BE/CH/FR
Definition	Interior noise level	
Evaluation method	Digital simulation, on-site measurement	
Measurement unit	[dBA]	
V_L (limit value)	35	
V_A (average value)	30	
V_T (target value)	25	
V_B (best practice value)	20	
Data sources	Acoustical engineer report, on-site measurement	
References	RF et al. (1999), CSTC (2007), Roulet (2008)	

Indicator	P5.3 Spatial daylight autonomy (sDA)	BE
Definition	The percentage of a surface of a given area that reaches a minimum of 300 lx during a given number of hours per year (50% of hours between 8 a.m. and 6 p.m.)	
Evaluation method	Digital simulation, on-site measurement	
Measurement unit	[%]	
V_L (limit value)	50% of the surface >300 lx during 50% of the time	
V_A (average value)	55% of the surface >300 lx during 50% of the time	
V_T (target value)	65% of the surface >300 lx during 50% of the time	
V_B (best practice value)	75% of the surface >300 lx during 50% of the time	
Data sources	Natural light simulation reports, on-site measurement	
Reference	IES Daylight Metrics Committee (2012)	

Indicator	P5.4 Degree of electrosmog	BE/CH/FR
Definition	The intensity of non-ionizing radiation to which project users are potentially exposed	
Evaluation method	Qualitative analysis of measures taken to limit the non-ionizing radiation and quantitative analysis of available data	
Measurement unit	[Qualitative scale]	
V_L (limit value)	Absence of specific measures to limit the electrosmog, values corresponding to the legal thresholds	
V_A (average value)	Absence of specific measures to limit electrosmog, values <70% of legal thresholds	
V_T (target value)	Specific measures to limit electrosmog, values <50% of legal thresholds	
V_B (best practice value)	Generalized measures to limit electrosmog, values <30% of legal thresholds	
Data sources	Electromagnetic simulation report, on-site measurement	
References	ICNIRP (2001), SPF and Service Politique des produits de la DG Environnement (2012), CH (2012)	

Indicator	P5.5 Degree of individualization of housing	BE/CH/FR
Definition	The level of measures offering the potential for the individualized appropriation of housing; typology fostering multiple uses, removable partitions, preservation of privacy, private, protected areas, etc.	
Evaluation method	Qualitative analysis of the project's characteristics	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The project is characterized by few measures fostering the individualized appropriation of housing	
V_A (average value)	The project is characterized by some measures fostering the individualized appropriation of housing	
V_T (target value)	The project is characterized by a large number of measures fostering the individualized appropriation of housing	
V_B (best practice value)	The project is characterized by a very large number of measures fostering individualized appropriation of housing	
Data sources	Plans and data of the project	
Reference	SIA (2004a)	

Indicator	P5.6 Quality of outdoor spaces	BE/CH/FR
Definition	The nature of the outdoor spaces and the amenities provided contributing to the well-being of users	
Evaluation method	Qualitative analysis of outdoor spaces	
Measurement unit	[Qualitative scale]	
V_L (limit value)	A small number of outdoor spaces is accessible to the public	
V_A (average value)	A large number of outdoor spaces is accessible to the public, but with few amenities for the well-being of users	
V_T (target value)	A large number of outdoor spaces is accessible to the public, with some amenities for the well-being of users	
V_B (best practice value)	A very large number of outdoor spaces is accessible to the public, with multiple amenities for the well-being of users (seating, vegetation, play area, etc.)	
Data sources	Plans and data of the project	
References	OFL (2000), Reiter (2007)	

Indicator	P6.1 Degree of security	BE/CH/FR
Definition	The level of devices contributing to the safety of the neighbourhood's users (lighting of common areas, access control, presence of technical or specialized staff, etc.)	
Evaluation method	Qualitative analysis of the security aspects of the project	

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Indicator	P6.1 Degree of security	BE/CH/FR
Measurement unit	[Qualitative scale]	
V_L (limit value)	The handling of security issues is limited to compliance with regulatory aspects	
V_A (average value)	Some simple security measures, in addition to the regulatory aspects	
V_T (target value)	Several specific security measures, in addition to the regulatory aspects	
V_B (best practice value)	Generalized security measures, in addition to the regulatory aspects	
Data sources	Plans and data of the project	
Reference	Charlot-Valdieu and Outrequin (2012)	

Indicator	P7.1 Degree of enhancement of existing heritage	BE/CH/FR
Definition	The level of appropriateness of the interventions on the existing buildings according to their heritage value	
Evaluation method	Qualitative analysis of the interventions on buildings	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The project is limited to valuing only existing buildings that are legally protected	
V_A (average value)	The project reallocates some existing buildings, in addition to those that are protected, with respect for the original substance	
V_T (target value)	The project reallocates most existing buildings, in addition to those that are protected, with high respect for the original substance	
V_B (best practice value)	The project reallocates most existing buildings, in addition to those that are protected, with particular high care for the original substance	
Data sources	Plans and data of the project	
References	CABERNET (2004), Berens (2011)	

Indicator	P8.1 Degree of functional mix	BE/CH
Definition	The level of diversity of project functions	
Evaluation method	Qualitative analysis of the distribution of different functions	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The project has essentially one function, with a small share of other secondary functions	
V_A (average value)	The project has the main function, with a significant share of other secondary functions	

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Indicator	P8.1 Degree of functional mix	BE/CH
V_T (target value)	The project has several functions that coexist randomly on the site, without being part of a specific concept	
V_B (best practice value)	The project has several complementary functions that contribute to a concept of functional diversity at the site level	
Data sources	Plans and data of the project	
References	Ruzicka-Rossier and Kotchi (2002), PUCA and Mialet (2011)	

Indicator	P8.1 Degree of functional mix	FR
Definition	The level of diversity of project functions	
Evaluation method	Qualitative analysis of the distribution of different functions and ratio between surface area allocated for light industries, offices, services, and public facilities and surface area allocated to housing	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The project has essentially one function, with a small share of other secondary functions, in a ratio <20% or >90%	
V_A (average value)	The project has one main function, with a significant share of other secondary functions, in a ratio of 20–30% or 80–90%	
V_T (target value)	The project has several functions, in a ratio of 30–40% or 60–80%, which coexist randomly on the site, without being part of a specific concept	
V_B (best practice value)	The project has several complementary functions, in a ratio of 40–60%, which are part of a concept of functional diversity at the site level	
Data sources	Plans and data of the project	
References	Ruzicka-Rossier and Kotchi (2002), PUCA and Mialet (2011)	

Indicator	P8.2 Potential of social diversity	BE/CH/FR
Definition	The potential diversity of the inhabitants, particularly at the socio-professional and generational level	
Evaluation method	Qualitative analysis of housing typologies and quantitative analysis of rent diversity and housing size	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The project has low diversity in rents and housing types	
V_A (average value)	The project has an average diversity in rents and housing types	

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Indicator	P8.2 Potential of social diversity	BE/CH/FR
V_T (target value)	The project has a high diversity in rents and housing types	
V_B (best practice value)	The project has a very high diversity in rents and housing types, with a specific search on social mix and integration of public housing	
Data sources	Plans and data of the project, tables of housing types and rents	
References	OFL (2000), Ruzicka-Rossier and Kotchi (2002), CPDT (2013), MLHD (2016)	

Indicator	P8.3 Degree of universal access	BE/CH/FR
Definition	The level of measures contributing to the integration of users with impaired mobility	
Evaluation method	Qualitative analysis of the specific devices on that matter	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The project takes into account users with impaired mobility but is limited to simple compliance with regulatory aspects	
V_A (average value)	The project takes into account a few simple measures fostering the integration of users with impaired mobility	
V_T (target value)	The project takes into account several specific measures fostering the integration of users with impaired mobility	
V_B (best practice value)	The project is characterized by a global concept that promotes broad integration of users with impaired mobility	
Data sources	Plans and data of the project	
References	CAWab (2015), CSCAH (2016), MEEM (2016)	

Economic efficiency

Indicator	P9.1 Investment costs	BE/CH/FR
Definition	The total investment, including all project costs (land purchase, construction work, secondary costs)	
Evaluation method	Calculation based on project costs and project areas	
Measurement unit	[Euro/m^2] [CHF/m^2] gross floor area	
V_L (limit value)	110% of the average cost according to the market	
V_A (average value)	100% of the average cost according to the market	
V_T (target value)	95% of the average cost according to the market	
V_B (best practice value)	90% of the average cost according to the market	

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Indicator	P9.1 Investment costs	BE/CH/FR
Data sources	Quotation, cost statements, real estate statistics	
References	SPF Economie (2014), Wüest & Partner (2015), CIFI (2016), Notaires de France (2016)	

Indicator	P9.2 Gross rental yield	BE/CH/FR
Definition	The ratio of rents to total investment costs for rental housing	
Evaluation method	Calculation based on project costs and rents	
Measurement unit	[%]	
V_L (limit value)	−0.50% of the average market yield	
V_A (average value)	Average market yield	
V_T (target value)	+0.50% of the average market yield	
V_B (best practice value)	+1.0% of the average market yield	
Data sources	Cost and rent calculations, real estate statistics	
References	SPF Economie (2014), CIFI (2016), FPI (2016), Notaires de France (2016), UPSI (2016)	

Indicator	P10.1 Annual operating costs	BE/CH/FR
Definition	The sum of annual investment, energy consumption, and maintenance costs	
Evaluation method	Calculations based on construction costs and energy consumption	
Measurement unit	[Euro/m^2] [CHF/m^2] gross floor area	
V_L (limit value)	Value deducted from the V_L for the indicators P2.2 and P9.1	
V_A (average value)	Value deducted from the V_A for the indicators P2.2 and P9.1	
V_T (target value)	Value deducted from the V_T for the indicators P2.2 and P9.1	
V_B (best practice value)	Value deducted from the V_B for the indicators P2.2 and P9.1	
Data sources	Estimates, cost and rent calculations, energy data	
References	Refer to P2.2 and P9.1	

Indicator	P10.2 Level of occupancy		BE/CH/FR
Definition	The state of occupancy (to own and to rent) after the first availability		
Evaluation method	Calculations based on the occupation data of the buildings over a year according to the function (housing or office and commercial premises)		
Measurement unit	[%]		
V_L (limit value)	Housing ≥85%	Premises ≥70%	
V_A (average value)	Housing ≥90%	Premises ≥80%	
V_T (target value)	Housing ≥94%	Premises ≥85%	
V_B (best practice value)	Housing ≥96%	Premises ≥90%	
Data sources	Rental status of the building administrator, sales statement of the building developer		
References	USECE and SVKG (2012), SNBS (2013), FPI (2016), UPSI (2016)		

Indicator	P11.1 External costs	BE/CH/FR
Definition	The external costs generated by non-renewable energy consumption for the project's buildings	
Evaluation method	Calculations from energy data and methodology specific to lifecycle analysis (LCA)	
Measurement unit	[Euro/m^2] [CHF/m^2] gross floor area	
V_L (limit value)	To date, there are not enough comparable calculations on full lifecycle analysis of buildings in order to establish reference values	
V_A (average value)		
V_T (target value)		
V_B (best practice value)		
Data sources	Energy data, LCA realized with the project data	
Reference	BBSR (2010)	

Indicator	P12.1 Degree of building flexibility	BE/CH/FR
Definition	The level of flexibility to a diversity of uses (short- and medium-term flexibility: the appropriation of the spaces) and changing needs (long-term flexibility: the adaptability of the buildings)	
Evaluation method	Qualitative analysis of typologies, measures and devices fostering flexibility	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The project's flexibility is limited to the usual constructive measures	
V_A (average value)	The project is characterized by a few simple flexibility measures fostering a diversity of appropriation of spaces	

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Indicator	P12.1 Degree of building flexibility	BE/CH/FR
V_T (target value)	The project is characterized by several flexibility measures fostering a variety of appropriation of the spaces and the adaptability of buildings	
V_B (best practice value)	The project is characterized by increased flexibility measures, which are an integral part of most buildings' concept	
Data sources	Plans and data of the project	
Reference	SIA (2004a)	

Governance indicators

Management

Indicator	G1.1 Logic of project footprint	BE/CH/FR
Definition	The level of integration and coordination between soil pollution data and the site's development plan (master plan)	
Evaluation method	Qualitative analysis of the coordination between the soil pollution diagnosis and the site's development plan (master plan)	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The masterplan is limited to ensuring that the pollution data of the site, after remediation, is compatible with the intended uses	
V_A (average value)	The masterplan takes into account the pollution data of the site in order to avoid disproportionate remediation measures	
V_T (target value)	The masterplan takes into account the pollution data of the site and provides some scenarios in order to avoid disproportionate remediation measures	
V_B (best practice value)	The masterplan's conception is an integral part of the planning and selection process of remediation measures; it is adaptable and offers different scenarios	
Data sources	Diagnosis of the site's pollution condition, remediation management plan, project masterplan	
References	Schädler et al. (2011), ADEME (2014a)	

Indicator	G1.2 Degree of site remediation	BE/CH/FR
Definition	The level of remediation achieved while offering the best compromise based on environmental, health, technical, and economic considerations	

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Indicator	G1.2 Degree of site remediation	BE/CH/FR
Evaluation method	Qualitative analysis of the remediation management plan	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The remediation is limited to complying with the legal requirements, regardless of the best compromise	
V_A (average value)	The best remediation compromise does not completely eliminate the risk of contact between pollution and people; the residual risks respect the levels in force	
V_T (target value)	The best remediation compromise leads to the long-term elimination of the possibilities of contact between pollution and people	
V_B (best practice value)	The best remediation compromise allows the complete elimination of pollution, while taking into account the global environmental and societal impact	
Data sources	Diagnosis of the state of the site, remediation management plan, pollution control plan	
References	CH (1998), ADEME (2014a), ADEME and BRGM (2015)	

Indicator	G1.3 Degree of residual contamination	BE/CH/FR
Definition	The level of implementation of residual contamination management measures (communication, traceability, monitoring, etc.)	
Evaluation method	Qualitative analysis of the residual contamination management plan	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The contamination management plan is limited to regulatory requirements for traceability and monitoring	
V_A (average value)	The contamination management plan includes some additional measures for traceability and regular monitoring (by a competent stakeholder)	
V_T (target value)	The contamination management plan includes several measures for traceability and regular monitoring; passive control devices are preferred to active ones	
V_B (best practice value)	The contamination management plan includes increased measures for traceability, regular monitoring and overall communication; passive control devices are preferred to active ones	
Data sources	Communication plan, trackability plan, guidelines	
Reference	ADEME (2014a)	

Indicator	G2.1 Transitional occupation initiatives	BE/CH/FR
Definition	The type of transitional occupation to improve and promote the brownfield and the sector's image as well as its degree of integration into the final project	
Evaluation method	Quantitative analysis of planned transitional occupation on the brownfield site	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The transitional occupation is limited to traditional activities replaced without transition by the definitive occupation	
V_A (average value)	The transitional occupation consists mainly of traditional activities gradually replaced by the definitive occupation	
V_T (target value)	The transitional occupation consists mainly of activities with sociocultural added value, some of which are retained within the definitive occupation	
V_B (best practice value)	The transitional occupation consists mainly of activities with socio-cultural added value, the majority of which will be included in the final occupation	
Data sources	Plans and data of the project	
References	OFEV (2010), ADEME (2014b)	

Indicator	G3.1 Management of construction waste	BE/CH/FR
Definition	The level of reduction, reuse, recovery, and disposal of waste and the adoption of a construction site management plan, including the preparatory work phase	
Evaluation method	Qualitative analysis of the waste management plan	
Measurement unit	[Qualitative scale]	
V_L (limit value)	Waste management is limited to the legal requirements for sorting	
V_A (average value)	A waste management plan is put in place, an effort is made to sort and recover waste off-site	
V_T (target value)	A waste management plan is put in place (sorting and recovery) and includes a systematic and regular inventory to reuse the materials on-site	
V_B (best practice value)	A comprehensive waste management plan is put in place (sorting, recovery, reuse, and reduction), adopted in advance by all stakeholders and is an integral part of the construction site's logic	
Data sources	Plans and data of the project	
References	SIA (1993), MEEM (2000), Commission Européenne (2008), Association eco-bau (2014), FFB (2014), CCW et al. (2014), Portail construction durable (2015)	

Indicator	G3.2 Management of construction disturbances	BE/CH/FR
Definition	The level of measures put in place to limit disturbance (noise, odours, air quality, cleanliness, traffic, etc.) in order to coordinate construction work and activities on the site (first occupants)	
Evaluation method	Qualitative analysis of the phasing of the project and the coordination between construction work and activities on the site	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The measures put in place only allow compliance with the legal requirements in terms of disturbance	
V_A (average value)	Some simple measures are put in place to limit disturbance in order to promote coordination between construction work and activities	
V_T (target value)	Several measures are put in place to limit disturbance in order to promote coordination between construction work and activities	
V_B (best practice value)	Increased measures integrated into the construction site's logic are put in place to limit disturbance and are fully coordinated with the site's activities and its surroundings; the measures are adjusted according to the work's progress	
Data sources	Construction site charter	
References	CCW et al. (2014), OFEV (2016)	

Indicator	G4.1 Commissioning plan for buildings	BE/CH/FR
Definition	The level of information, support, and training for users and managers provided by the commissioning plan of the various buildings	
Evaluation method	Qualitative analysis of the commissioning plan	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The commissioning plan is limited to informing and educating users and managers	
V_A (average value)	The commissioning plan includes structured support for users and managers	
V_T (target value)	The commissioning plan includes training and structured support for users and managers	
V_B (best practice value)	The commissioning plan includes training and structured support for users and managers as well as capitalization of experiences and feedbacks	
Data sources	Commissioning plan	
Reference	Ministère de l'égalité des territoires et du logement (2014)	

Process

Indicator	G5.1 Degree of participation of population	BE/CH/FR
Definition	The level of participation of population (future inhabitants and surrounding residents) in the decision-making process of the project	
Evaluation method	Qualitative analysis of the participation of population	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The level of participation is limited to sharing information	
V_A (average value)	The level of participation allows the establishment of a consultation process (interaction and dialogue)	
V_T (target value)	The level of participation provides consultation and collaboration process (to agree on a project)	
V_B (best practice value)	The level of participation allows community initiatives; future inhabitants share responsibility for their implementation (delegated management)	
Data sources	Participation charter, guidelines	
References	Arnstein (1969), ADEME (2014c)	

Indicator	G6.1 Degree of collaboration of professionals	BE/CH/FR
Definition	The level of collaboration between different professionals	
Evaluation method	Qualitative analysis of the collaboration between different professionals	
Measurement unit	[Qualitative scale]	
V_L (limit value)	The collaboration is limited to the engagement of the stakeholders within an imposed common framework of action	
V_A (average value)	Some measures promote collaboration and enable the development of a common framework of action	
V_T (target value)	Several measures promote collaboration and enable the development of a common framework of action	
V_B (best practice value)	Generalized measures promote collaboration and enable the development of a common framework of action resulting in a shared vision of the project	
Data sources	Project management plan, guidelines, organization chart	
References	Souami (2011), OpenGov (2014), ADEME (2014d)	

Indicator	G7.1 Degree of access to information	BE/CH/FR
Definition	The level of measures put in place to make information on the project accessible and exhaustive	
Evaluation method	Qualitative analysis of the accessibility to information	
Measurement unit	[Qualitative scale]	
V_L (limit value)	A limited number of measures allow access to information on the project	
V_A (average value)	Some measures allow access to information on the project	
V_T (target value)	Several measures allow access to information on the project	
V_B (best practice value)	Several measures allow access to information on the project; educational devices are put in place to inform the population	
Data sources	Website, project plans and guidelines, reports	
References	Souami (2011), OpenGov (2014)	

Indicator	G8.1 Degree of integration of an evaluation process	BE/CH/FR
Definition	The level of integration of a sustainability evaluation process into the project dynamics	
Evaluation method	Qualitative analysis of the evaluation processes put in place	
Measurement unit	[Qualitative scale]	
V_L (limit value)	An evaluation process is used as a point-in-time critical analysis of the project	
V_A (average value)	An evaluation process is used within a small team as a tool to help design and improve the project	
V_T (target value)	An evaluation process is used within the extended project team as a tool to help design, improve, and monitor the project for its entire duration	
V_B (best practice value)	An evaluation process is used within the extended project team and the general public to help design, improve, and monitor the project for its entire duration and communicate on its performance	
Data sources	Project sustainability evaluation reports	
References	Charlot-Valdieu and Outrequin (2012), Ministère de l'égalité des territoires et du logement (2014)	

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