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,

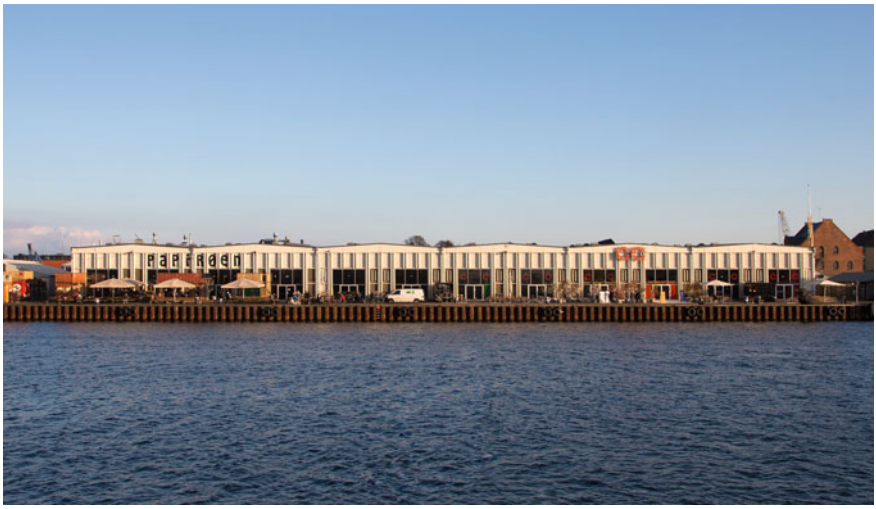

Fig. 2.10 Paper Island, Copenhagen (DK). Rehabilitation of former maritime paper storage facilities into a new district with street food halls, art exhibitions, fashion shows, concerts, and flea markets. Cobe architects, ongoing project (photo: News Øresund – Jenny Andersson, 2016)

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.

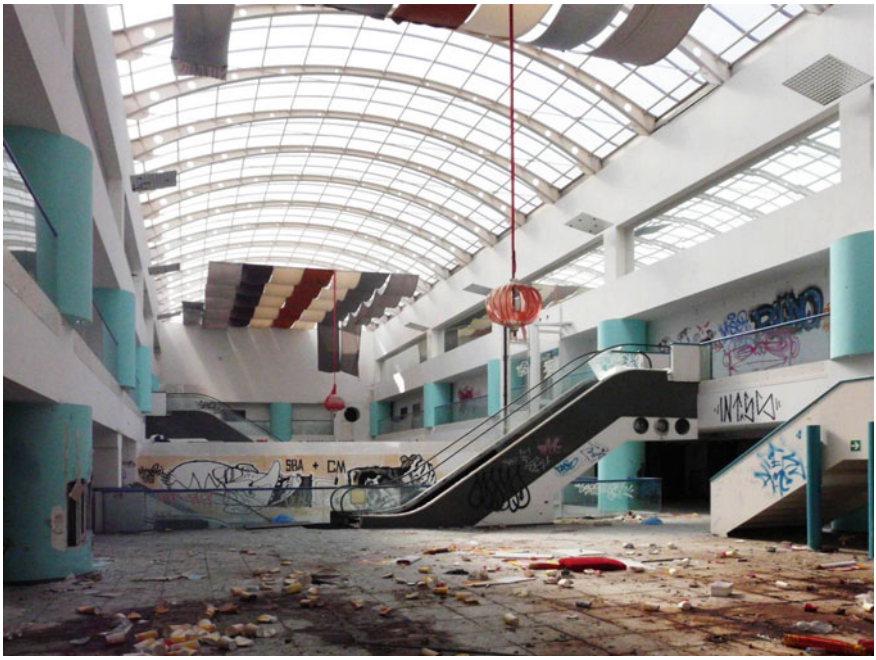

Fig. 2.14 Magic Movie Park, Muggiò (IT). 21,000 square metres multiplex and commercial centre in the outskirt of Milan, abandoned since 2006 (photo: Roberto Barbone, 2016)

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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