Chapter 11
Industrial Transformation and Sustainable Urban Planning in the Pearl River Delta: A Landscape-based Approach

Daniele Cannatella

Abstract Industrialization in the PRD has brought about great economic growth and contributed to the rise and consolidation of this deltaic region as a key global player. However, it also generated severe environmental imbalances and pollution of vital and non-renewable resources, such as soil, water and air. Nowadays, the increasing shift towards service-oriented and innovation-driven sectors makes abandoned and decommissioned industrial areas available for transformation. However, to make the most of the potential of these areas to achieve sustainable urban development, novel approaches in planning and design practise are needed to tackle the complexity arising from the challenges posed by climate change and urbanization. This contribution provides a landscape-based approach to adaptive industrial transformation that looks at the spatio-temporal dimension, leveraging the intrinsic and relational qualities of these sites. The approach is tested through two applications in the Chancheng district (Foshan) and Haizhou (Guangzhou).

Keywords Industrial transformation · Landscape-based approach · Adaptive urban transformation · Sustainable urban design

11.1 Introduction

With around 60 million people living in the region, projected to be more than 120 million by the 2050s (Chan and Yao 2008; Zhu et al. 2002), the Pearl River Delta (PRD) is the fastest urbanizing delta in the world. Since the implementation of the economic reforms that marked the transition from a rural economy to an industrial one in the late 1970s, the PRD has been undergoing a series of sudden structural transformations that have not only affected the regional economy but also its spatial configuration and its relationship with the environment. Industrialization brought

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about greater wealth and the recognition of the PRD as the ‘world’s factory’. The downside of this astonishing growth as a national and global key economic player is revealed in the environmental imbalance and the growing loss of social and ecological resilience due to the joint pressure exerted by urbanization and climate change, which threaten the long-term development of the region.

Today, the PRD is facing the same challenges as other urbanized deltas around the world, where industrialization and other anthropic activities alter water and sedimentary dynamics of the landscape (Tessler et al. 2015). Urbanization jeopardises the natural capacity of the floodplain to absorb and retain water, increasing both vulnerability and exposure of people and assets to flood events. Climate change impacts exacerbate such conditions, due to the uncertainty arising from the alteration of precipitation patterns caused by the shifting climate regime. In the PRD, the combination of these two factors result in increasing flood risks due to urbanization in flood-prone areas (Chan et al. 2021), air and water pollution due to industrial activities (Chan and Yao 2008; Zhu et al. 2002), the disappearance of mangrove forests (Zacharias and Tang 2010), ecological fragmentation and agricultural land loss (Yeh and Li 1999), water shortage (Yan et al. 2018), and the erosion of social and cultural values (Xiong 2016) amongst others.

To face these challenges and ensure a more sustainable future for the PRD, new approaches and strategies are needed to enhance its resilience to water-related risks, while simultaneously enhancing ecological conditions and the quality of life, leveraging the potential that those portions of territory left abandoned or underused by the transformative economic dynamics offer in rethinking the spatial development of the whole region.

In this regard, industrial transformation in the PRD serves as the ideal ground for investigating and proposing integrated approaches that go beyond the urgency of adapting to climate change, charting new trajectories that explore the potential of spatial solutions to offer a novel and more balanced relationship between human beings and the natural environment. As the manufacturing sector in the PRD is undergoing a fast restructuring, vast amounts of land are increasingly becoming available in urban, peri-urban and rural areas, presenting the opportunity for water and land restoration, water safety enhancement and socio-economic upgrading in urban areas. This multi-faceted palimpsest of vacant land acquires a territorial and landscape dimension that solicits multi-scalar and systemic approaches—ranging from the single fragment to the urban scale up to the large-scale systems that shape the region—to make the most out of their redevelopment. In this light, a landscape-oriented approach to industrial transformation provides methods and solutions to develop spatial strategies aiming at fostering ecological regeneration while contributing to more adaptive water management and a better quality of life.

This contribution presents an integrated landscape-based approach to industrial transformation for sustainable urban development in the PRD, exploring its potential on two urbanized areas in the delta: the Changchen historic district, in Foshan, and the Haizhu district, in Guangzhou. The paper is structured as follows: the following section provides an overview of the industrial transformation dynamics in the PRD over the past forty years, tracing the spatial outcomes of this process, as well as the main social and ecological challenges that the delta is facing; section three elaborates on the opportunities and challenges in industrial regeneration, highlighting the increasing importance of the role of landscape in promoting sustainable adaptive strategies linked to industrial redevelopment; subsequently, a landscape-based adaptive industrial transformation approach is proposed and tested through the application on two case studies in the PRD. Finally, in the discussion and conclusions sections, the paper argues that industrial transformation can be a valuable tool to stimulate adaptation practises at the local scale and contribute to bridging the gap between adaptation and spatial planning.

11.2 Industrial Transformation in the PRD

The PRD is home to nine major cities on the mainland—namely, Guangzhou, Guangdong Province's capital, Shenzhen, Foshan, Dongguan, Jiangmen, Zhongshan, Zhuhai, Zhaoqing and Huizhou—and the two Special Administrative Regions (SARs) of Hong Kong and Macao (Fig. 11.1). The region is nowadays one of the most economically vibrant and innovative mega clusters in China and in the world. With over 60 million permanent inhabitants, it is also the most populated and the largest urbanized deltaic region worldwide (Yeung 2010).

Since the implementation of the *open-door* policy in 1979, the PRD has experienced an unprecedented development led by industrialization that has dramatically changed its spatial and economic structure in just over forty years. This set of reforms aimed at transforming the regional economy, previously based on agriculture, into a manufacturing-based one, taking advantage of its proximity to two outposts of the Western world, Hong Kong and Macao. The establishment of the two Special Economic Zones (SEZs) of Shenzhen and Zhuhai in 1980, intended to attract foreign investment, turned out to be an extremely fortunate choice. In the first two decades

Fig. 11.1 The Pearl River Delta. *Map* Daniele Cannatella

after the reforms, the PRD accounted for almost 70% of Guangdong's total GDP, and 91% of the province's export values (Shen et al. 2000). The regional economic growth is still reverberating in more recent times. In 2018, the PRD's GDP grew by an average 6.9%, accounting for 80.2% of the total GDP and the 95.1% of exports of Guangdong.[1]

However, this incredible economic development coincided with a progressive deterioration of environmental resources caused by uncontrolled industrial production. Intensive land use and manufacturing still affect both water quantity and quality. In 2015, the industrial sector in the PRD accounted for 37% of water use (1.4 times more than in the Guangdong Province and 1.6 times more than the national average) and was amongst the major contributors to wastewater discharge, resulting in 39% of water bodies to be classified as 'unfit for human touch'.[2]

To date, the ambition of the PRD is to position itself as a world-leading service-oriented and innovation-driven economy, as revealed in the Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area (2019).

This raises a question as to what opportunities abandoned or decommissioned industrial land offers to jointly address socio-economic and ecological challenges to ensure sustainable urban development for the PRD and to adapt to changing climate regimes. To answer this question, it is necessary to understand what the transformative dynamics that have characterized the industrial development of the PRD over time are, and what the spatial and environmental implications at the different scales are.

11.2.1 The Three Phases of Industrial Transformation in the PRD

Before the reform era, the PRD was a grain-producing region, in which farming and aquaculture played a leading role in shaping basic land use patterns (Sepúlveda Carmona et al. 2014). The peculiar morphology of the delta, formed by sediments carried by the Xi, Bei and Dong rivers, and the massive presence of water represented the ideal conditions for waterway transportation, farm production and trade (Lin 1997). The almost total absence of rural–urban migration, along with the lack of investment in manufacturing and infrastructure, enormously hindered urban development. Major urban areas were mainly located in the central and western part of the delta. This was due to the resource scarcity of the eastern side, characterized by land of relatively recent river formation and high salt content, which made it unsuitable for intensive cultivation. The implementation of the open-door policy initiated a process that completely changed the face of the PRD, not only from a purely economic point of view, but also spatially.

[1] Guangdong Statistical Yearbook, 2019.

[2] See https://www.chinawaterrisk.org/resources/analysis-reviews/pearl-river-delta-5-water-must-knows/.

In the PRD, urbanization and industrialization are closely connected. During the first two decades after the implementation of the reforms, the consequent economic and spatial restructuring that occurred in the region was led by the rapid surge of rural industry. The deregulation of rural–urban migration and the inflow of foreign investment gave birth to rapid industrialization that took place mainly in the countryside. This process, known as rural industrialization, was characterized by mostly small-scale, labour-intensive and market-oriented industries based in rural villages and small towns. For this reason, during this phase, economic development did not correspond to actual urban growth. Rather, small towns played a dominant role in urbanization and land transformation process through the reclamation of nearby agricultural land. Between 1980 and 1990, more than 132,000 hectares of countryside were transformed into non-agricultural land, of which industrial expansion accounted for about one third (Lin 1997). The spatial outcome of this process was a peculiar landscape in which industrial, urban and agricultural land uses alternated, leading to a progressive blurring of the rural–urban borders. Most of the factories were small-sized and located at the entrance of towns and villages, along the main transportation axes or in the middle of rice fields. Rural industrialization and transport development were the main factors that promoted urban sprawl and land fragmentation. In addition, rural industry, as spontaneous and unregulated process, created serious environmental consequences. Many of these industries did not have the technology for proper treatment of industrial waste, and often wastewater was released directly into streams and rivers, leading to serious contamination of farmland, crops and fishponds (Lin 1997).

At the dawn of the new millennium, changing social conditions and the rising concern on environmental issues started a new regional restructuring process that saw the progressive abandonment of manufactories in the central delta. The increasing lack of low-cost labour, alongside the rise of minimum wage, forced industries to move towards more inland areas in the Guangdong Province, economically more convenient. During this phase, industrial parks specifically designated to host the relocated manufactories popped up throughout the province. Simultaneously, this process inaugurated the first wave of transformation of industrial areas, in particular those close and within the main cities. However, early industrial parks were characterized by a condition of separation between production and the city (Chao 2018).

The last phase is connoted by a shift of focus from urban development towards innovation-driven redevelopment of existing construction land. With the increasing control of land use and a change of course towards more sustainable development models, manufacturing sites located in inner areas began to be relocated to the urban fringe, and the redevelopment of idle industrial sites took hold, mainly through the regeneration of 'old towns, old factories and old villages' programme, initiated in 2009. The 'Three Olds' policy aimed at adjusting, transforming and upgrading industrial land located within towns, streets, villages and industrial parks to improve urban functions and the quality of life in cities and countryside. These comprehensive urban upgrading measures involved a total of 126 km^2 of industrial land in Shenzhen alone, and 171.66 km^2 in Guangzhou (Schoon 2014), and saw the emergence of

Fig. 11.2 OCT loft area. *Photo* Daniele Cannatella

creative parks, recreational facilities, new industries and an overall increase in public green space within the two cities. One example is the OCT loft (Fig. 11.2), an old factory located in the western industrial zone of Shenzhen that was redeveloped in a creative industry district with exhibition space, artists' studios, restaurants and bars.

Meanwhile, the recent construction of the Hong Kong-Zhuhai-Macao bridge and the development of the Shenzhen-Zhongshan bridge, aiming at connecting the two sides of the estuary, raises the question of what will be the future of cities such as Zhongshan and Jiangmen, on the western side of the delta, where farmland is still characterized by relatively high integrity and spatial continuity (Cannatella 2019).

11.2.2 Industrial Typologies in the PRD

In the PRD, the industrial landscape is a ubiquitous, multi-faceted spatial phenomenon which acquires many forms and creates an infinite number of relationships with the natural and cultural systems that form the delta. Manufacturing spaces are found in the interstices of urban centres, in urban villages surrounded by the dense city, compressed between the city and streams, or in the open countryside, connected by major transportation axes. Their pervasiveness represents in fact a spatial framework articulating the physical continuity of open space that connects along the main transport corridors, grafts along the edges of the cities and provides potential space for adaptation in urban areas.

These qualities constitute an enormous potential for the exploration of multi- and cross-scale strategies to intercept and enhance the performance of large-scale structuring systems (such as the water system, mobility, ecological areas and corridors) that go beyond the administrative boundaries. Although it is difficult to trace an exhaustive map of industrial areas in the PRD, due to the lack of accessibility to official information and the extent of the region, looking at their spatial qualities it

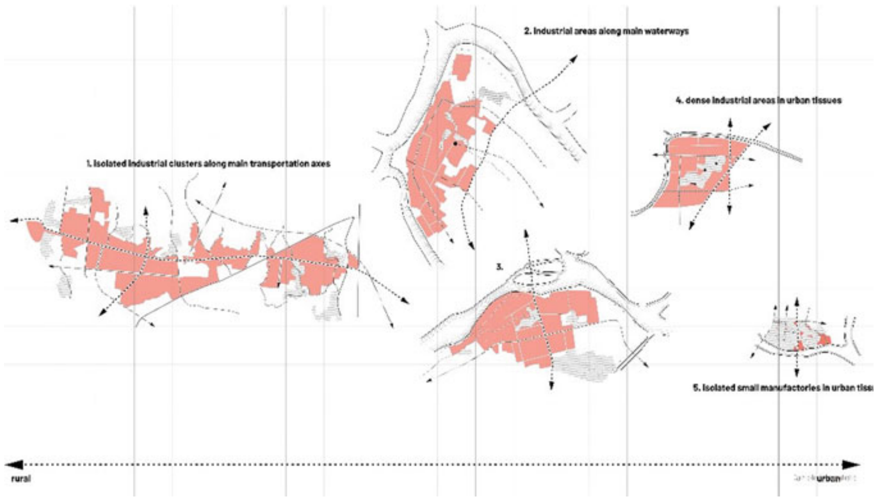

Fig. 11.3 Four main industrial typologies in the PRD. *Image* Daniele Cannatella

is possible to distinguish at least four main types of industries, located in different contexts (Fig. 11.3):

- Industrial areas along main waterways: these areas are located in the proximity of main rivers and/or streams. Often, they constitute a buffer between urban settlements and riverways, with main transportation axes that guarantee high accessibility while physically separating them from other areas with different land uses; furthermore, most of the time they are equipped with piers and docks for water transportation;
- Isolated industrial clusters along main transportation axes: located in rural or peri-urban areas, these industrial parks and manufactories are marked by high accessibility due to the presence of high-speed motorways. Although the presence of waterways is not a main feature, they encroach agricultural land and dyke-ponds, resulting in the fragmentation of the natural landscape;
- Dense industrial areas within urban tissues: these areas find themselves in the urban fringes, or around historical settlements; here, waterways are often buried as a consequence of urban development;
- Isolated small manufactories in urban tissues: the last typology is common especially in urban areas, and characterized by the presence of urban villages, fragments of agricultural land and remnants of wider dyke-pond systems. Since their development was more spontaneous and less regulated, it is easy to find them along canals that still mark the spatial structure of urban villages.

11.3 Industrial Transformation: From Industry to the Production of Multiple Values

Although fundamental for economic development, industrial production is characterized by an exquisitely linear, input–output relationship between mankind and nature in which man takes the necessary resources from the environment and discharges waste and scraps into the biosphere. This attitude has proved to be not only economically unsustainable in the long run, but also harmful for people's health and the ecosystem. Starting in the last decades of the past century, with the crisis of the Fordist model, the discourse on abandoned industrial sites begun to emerge overbearingly (Waldheim 2016), with the landscape called upon to play a fundamental role in redeeming such places and reintegrating them into active and healthy urban dynamics, for its ability to stimulate multi-scale and adaptive strategies towards long-term resilience and socio-ecological sustainability (Gasparrini 2016).

However, despite the efforts in redevelopment practises, the pervasiveness of abandoned and polluted areas has reached a global extent. In Europe, there are almost 350,000 identified contaminated sites (Pérez et al. 2017); similar figures are present in the US as well, where between 500,000 and 1,000,000 brownfields have been estimated (Thornton et al. 2007). The plight is no different in emerging global economies. In China, polluted sites that need interventions are in the order of tens of millions of hectares (Li et al. 2017), with more than 100,000 factories closed in the last twenty years and over two million hectares of contaminated land left abandoned and untreated only in the main cities (Han et al. 2018). This has led idle industrial areas to emerge as an actual category of landscape, characterized by great diversity of size and former functions, sharing a common condition of contamination and vacancy (Oliver et al. 2005). This state of vacuity reverberates in both space and time and makes them spaces of transition from one use to another, physically and mentally detached from any urban function or process.

However, the benefits of reintegrating such lands in the urban landscape are manifold. Their redevelopment offers the opportunity to steer regional development towards a more sustainable future, enabling the possibility to intervene and redirect those natural, social and economic flows that shape cities, creating the ideal conditions for such flows to materialise (Bélanger 2009), adjusting the existing spatial forms and functions that require adaptation (Kempenaar and Brink 2018) and laying the foundations for more efficient and sustainable land development.

11.3.1 Opportunities and Challenges in Industrial Transformation

Linking sustainable urban development to adaptation strategies implies redesigning abandoned and underused areas, to remediate pollution when necessary, and improve local social, economic and ecological conditions while lowering the vulnerability of urban and natural systems.

Turning the gaze on industrial transformation helps preserving those untouched open spaces and *greenfields* that are at the urban edges, avoiding further land consumption (Ashley et al. 2011). At the same time, these sites are more accessible than suburban greenfields, because of their proximity to dense urban areas and the presence of already existing infrastructure (Hollander et al. 2010). These conditions make industrial redevelopment more desirable, as the possibility of reusing features such as roads and sewer lines can counterbalance the high costs needed for clean-up. Furthermore, their reuse often implies recycling and remediating land, to protect and restore soil, groundwater and surface water qualities, thus enhancing public health and safety (De Sousa 2001) and providing additional ecological value within the urban landscape.

The benefits of remediation and redevelopment go beyond the physical boundaries of industrial sites. The conversion of brownfields to green infrastructure is closely connected with biodiversity restoration and the provision of multiple ecosystem services (Atkinson et al. 2014; Bardos et al. 2016), such as protection and water management at different spatial scales (De Graaf 2012), heat island effect mitigation in the surrounding urban areas (De Valck et al. 2019), and local air quality improvement. Furthermore, brownfield redevelopment can generate positive impacts on both society and economy, triggering urban cores renewal processes, thus improving the overall quality and liveability in urban areas and providing additional public green space where it is lacking (Mathey et al. 2015), revitalising surrounding communities by reducing their shrinking property values (De Sousa 2001). Industrial transformation can support attracting both domestic and foreign investment and stimulate local economies and green jobs. Investments on novel functions and programmes (e.g. housing, retail, green industry and service sector), attract both investors and new residents, thus contributing to social and economic diversification and increasing the level of safety of residents (Karwalska and Mazur-Belzyt 2020). Lastly, it can support the preservation of historical, cultural and aesthetic values inherited in these sites, as the vestiges of past forms of industrial development are intertwined to the identity of a place and materialized in such spaces.

Despite the multiple benefits associated with industrial transformation, many aspects, mainly related to site remediation practises, are in fact challenges that represent an obstacle to its more systematic and consistent application.

Idle industrial areas have often been left abandoned by potentially pollution-intensive production activities. Therefore, fundamental resources such as soil, groundwater and surface water might contain high levels of contaminants, posing a threat for human beings and other living organisms. Traditional redevelopment practises can involve high clean-up costs for remediation, which can make investments unprofitable and generate waste that has to be treated. Remediation practises depend on several factors linked to the type of contamination, its location and magnitude. This implies that there is no single way or technique to tackle pollution; rather, remedial actions can vary a lot, ranging from the removal of a modest amount of soil to large-scale and complex engineering works entailing building demolition and soil and water body remediation (Hollander et al. 2010). In recent times, nature-based solutions such as phytotechnologies have proved to be a valid alternative to traditional remediation practises. Phytotechnology entails the use of vegetation to remediate and contain contaminants in soil, sediments and groundwater (Kennen and Kirkwood 2015). Plant-based clean-up methods can reduce remediation costs by more than 90% compared to traditional techniques (Glass 1999), are passive, solar energy-driven and can improve soil quality However, their effectiveness depends on the typology of contaminants and their location and requires a long-term approach that may preclude other short-term programmes on the site. This might result in conflicts between short- and long-term redevelopment goals, therefore requiring flexible and open-ended strategies, where nature-based remediation techniques and processes can ideally dictate redevelopment stages and steer future urbanization. The advantage of using this type of nature-based solutions in industrial transformation practises is that they can be integrated into different design strategies, from small-scale landscape interventions on vegetation and landform to urban redevelopment and adaptation plans, up to regional design, thus supporting sustainable urban development.

11.4 An Integrated Landscape-based Approach to Industrial Transformation for Sustainable Urban Development

Sustainable urban development in urbanizing deltas implies guaranteeing a long-term, dynamic equilibrium amongst three distinct dimensions: water safety, ecological values, economic growth and quality of the living environment (Meyer and Marchand 2015). When translated into industrial redevelopment, this calls for novel approaches in planning and design practises, to systemically tackle the complexity arising from different challenges and coordinate the different remediation objectives that have different temporal horizons (Fig. 11.4).

To fully exploit the potential of industrial transformation in achieving the aforementioned objectives in the PRD, a landscape-based industrial transformation approach that is systemic, opportunistic and integrated is advocated.

It must operate on different systems, connecting site redevelopment to both natural and urban elements and processes, via multi- and cross-scalar strategies ranging from the local to the regional scale. This requires looking for spatial solutions to improve existing ecological structures and urban functions (e.g. the establishment of green corridors along riverways or the implementation of creative districts). It is opportunistic, in that it addresses the different stages of the site's lifecycle while taking advantage of both social and ecological 'pioneering' processes that already exist in the area, as well as the existing architectural and natural assets, to develop flexible and shared strategies to be implemented through a phased, incremental approach. Lastly, it requires the integration of different knowledge, actors and professionals to deliver multiple values, be ecologically active, socially inclusive and economically.

Fig. 11.4 Industrial transformation and sustainable urban development. *Image* Daniele Cannatella

11.4.1 Key Phases of the Approach

The proposed landscape-based approach to industrial transformation is developed on the basis of the work of Nijhuis et al. (2019) and consists of four different iterative steps: collecting information, gaining understanding, strategy development and action perspective (Fig. 11.5). These steps are introduced below.

11.4.1.1 Collecting Information and Gaining Understanding

Before starting the design, it is necessary to determine what the objectives and the priorities of the site redevelopment strategy are. This has to be based on an effective and comprehensive knowledge of the site and the development trajectories desired by the stakeholders involved to have an overview of the opportunities that the site offers and challenges that must be faced. Challenges comprise the limitations imposed by the site conditions (e.g. the type and quantity of pollutants) that can slow down or prevent certain long-term programmes (housing, public schools, etc.) and/or hinge the use of nature-based solutions for remediation.

This phase entails the systematic collection and creation of data and information to perform critical analysis and evaluation of the site. This concerns two main aspects: the intrinsic characteristic of the site and its extrinsic properties that reveal its relational potentials. The latter concerns its geographical position, the adjacent land use (e.g. urban, peri-urban and rural context), and the spatial relationships that it establishes–or can potentially establish–at different scales with both landscape

Fig. 11.5 Key phases of the landscape-based industrial transformation approach (Adapted from Nijhuis et al. 2019)

and urban features. Furthermore, this phase includes the identification of actors–existing or potential–who may have an interest in the site redevelopment or can play a relevant role in the redevelopment process. The questions to start from regard both the intrinsic and relational aspects. These include, amongst others: (1) What is the state and intensity of the pollution of natural resources (e.g. soil, surface water and groundwater, air)? That is, what are the pollutants that persist on the site, and where they are located. (2) What are the natural (e.g. spontaneous vegetation, water bodies, canals and ditches, open green areas) and anthropogenic (e.g. buildings, infrastructures, paved areas, piers and docks) elements in the area, and what is their state of decay? (3) What are the existing formal and informal uses and practises on the site? (4) What are the existing and/or latent spatial relationships that the site intertwines with the surrounding urban and natural landscape?

Addressing these questions means starting a process of description, selection and evaluation of the elements and limits imposed by the site, to build a preliminary knowledge base for the subsequent development phase of the project.

In addition, this knowledge serves to define the main challenges to be faced, and the opportunities that the site presents in relation to the territory, for example, in consolidating or building green–blue infrastructures or restoring ecological connections at larger territorial scales; or establish new urban centralities, public spaces and services that the surrounding neighbourhoods can benefit from; or define the potential of the site to mitigate water-related risks; or the level of accessibility it offers in relation to its geographical position and the degree of mobility infrastructure it presents. Lastly, understanding what actors, uses and hidden uses exist, as well as identifying stakeholders and experts to involve in the redevelopment process can help to gain acceptance and avoid potential conflicts for future programmes.

11.4.1.2 Strategy Development and Action Perspective

After the analysis and synthesis phases, with the definition of the main challenges and opportunities, the next step is the development and testing of integral and multiscale design strategies. The questions to be addressed at this stage are: (1) What are the techniques and processes that can be implemented for remediating the site? (2) How to preserve or reinforce the formal, ecological and socio-cultural values of the site? (3) What is the temporal horizon of remediation processes, and what are the temporary or final uses and programs that can be implemented accordingly? (4) How is it possible to make the most of the site's potential by means of multi- and cross-scale projects to ensure that the intended uses, vegetation, water and existing infrastructures can facilitate the provision of ecosystem services and socio-economic development? (5) Who are the important actors that need to be involved, and how to actively involve them in the process to ensure social acceptance, economic feasibility and optimal ecological performance? (6) How to synchronize long-term objectives and processes with short-term design intervention, to avoid possible conflicts and pursue an incremental and flexible development strategy?

To answer these questions, a survey of previous studies and best practises is useful to discern what principles and strategies can find an effective application on the site. Research through design and design thinking are a useful way to investigate the possible spatial configurations of the application and evaluate the impacts of the latter. In particular, visual exploration is also important for communicating project choices and co-assessing the effectiveness and feasibility of project alternatives with stakeholders, experts and local communities.

At this stage, it is also important to define a reasonable time plan that can support a robust and flexible strategy, where technical and ecological remediation and socio-cultural processes can go hand in hand throughout the whole process. The time plan must be able to provide a roadmap in which the actions necessary for redevelopment are identified and evaluated, to grasp what the possible synergies that can accelerate the process of re-appropriation of abandoned spaces are, and which ones are a priority to unlock the subsequent phases.

Such an approach necessarily looks at the temporal dimension to better capitalize the redevelopment of industrial sites through an incremental process that does not start from a *tabula rasa*, but rather builds on the existing elements and values. In this regard, it can be understood as a social and ecological recolonization process. Moreover, it can be applied to sites having different spatial and formal conditions–both on small sites and larger clusters–and in different geographical contexts–in urban, peri-urban or rural areas.

Even when the redevelopment objectives are driven by economic or social goals, such as the creation of new housing, commercial areas or new forms of industrial production, it is important not to underestimate or neglect the potential of the site in improving socio-ecological conditions at different scales. Lastly, such an approach finds its application as a stand-alone strategy, and it can be integrated into broader urban redevelopment strategies.

11.5 Two Applications in the PRD

The approach presented in the previous section was applied on two case studies in the PRD (Fig. 11.6). The applications are graduation projects developed within the Adaptive Urban Landscape lab, part of the Flowscape graduation lab (TU Delft Landscape Architecture track).

The two design explorations share a common approach to industrial transformation, although with different perspectives. The first makes use of the historic district of Chancheng, in Foshan, to explore spatial strategies based on the systemic reuse of abandoned and decommissioned manufacturing sites addressing environmental and water-related issues. In Chancheng, industrialization has resulted in heavy soil

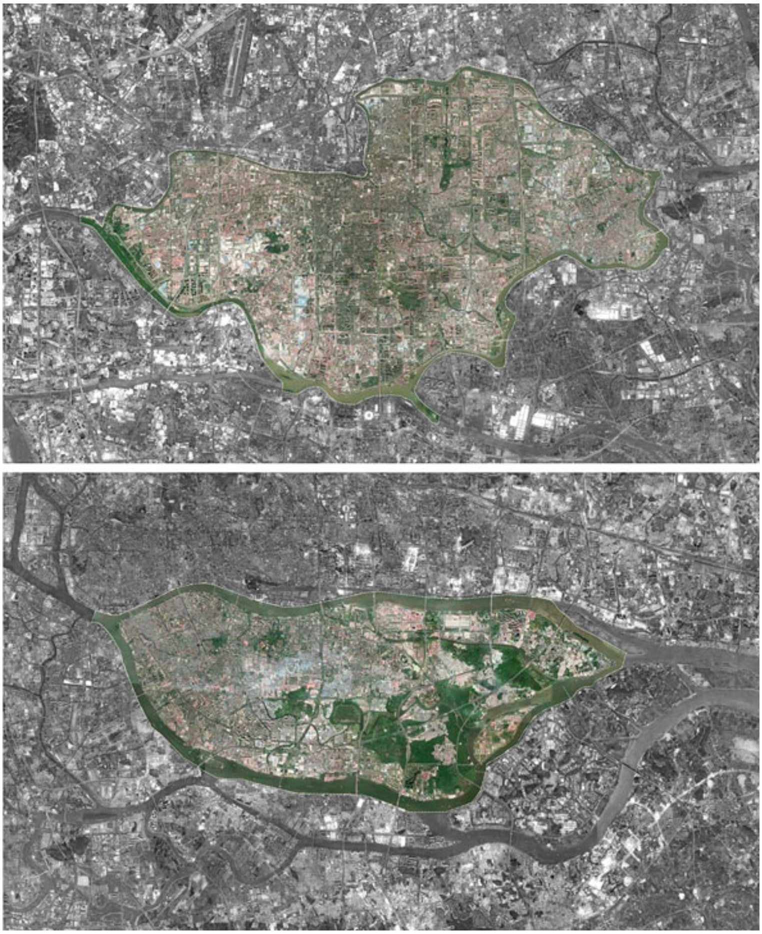

Fig. 11.6 Two study areas of Chancheng, Foshan (above), and Huizhou, in Guangzhou (below) (Google Earth images, adapted by the author)

and water pollution. At the same time, urban development has led to the progressive disappearance of natural water courses, increasing urban flooding in urban areas, and the weakening of the relationship between inhabitant and water. Landscape-based solutions and principles are proposed to explore the potential of green–blue networks to clean the polluted water and mitigate urban flood risk, while at the same time offering a diversified set of programmes and open spaces reconnecting people with water.

The second exploration integrates landscape-based industrial transformation principles in a broader urban regeneration strategy for the Haizhu district. Located in the centre of Guangzhou, Haizhu is nowadays facing social segregation and ecological fragmentation problems due to its rapid and uncontrolled urbanization. Here, a socio-ecological network is proposed, starting from the reinterpretation of physical barriers in the dense urban tissue (e.g. roads, canals) into corridors connecting existing ecological hot spots and newly created functional nodes, leveraging on the reuse and demolition of the fine grain of manufactories within the urban settlements.

11.6 Results

The application in Chancheng started from the research question: 'What is the spatial potential of post-industrial transformation of areas along waterways to mitigate the impacts of urban flooding and water pollution, while redefining the relationship of the nearby inhabitants?'.

To answer this question, the first step consisted in mapping and defining industrial typologies in the district based on their spatial qualities, building materials, and location. This resulted in the classification of the manufactory types that served as a basis for the design phase. In Chancheng, four main types of factories have been identified, namely: metal structured factories, reinforced concrete and steel factories, brick factories and small-scale factories (Fig. 11.7). The analysis has been further integrated with information on the location of polluting industries in relation to waterways and the urban flooding spots at the district scale. Results show that pollution sources are located mainly on the central and western areas of the district and mainly along the Fenjiang River. In this area, due to urban expansion and industrialization, waterways have been gradually buried underneath factories and roads. Urban flooding is concentrated in the old city core, due to the high rate of soil sealing and the disappearance of the original water system (Fig. 11.8).

To tackle water pollution and urban flooding, a toolbox of landscape-based principles is applied around a robust, multi-scale green–blue network. The strategy is structured around the resurfacing of buried waterways and their reconnection to the existing surface water system to create a blue spatial framework serving as a backbone for greater ecological connectivity (Fig. 11.9) and new productive functions. By redesigning industrial sites along the major waterways, green buffer areas are established. The demolition of buildings provides space for shallow areas allowing for sedimentation and phytoremediation, while waterways depth and width are modified

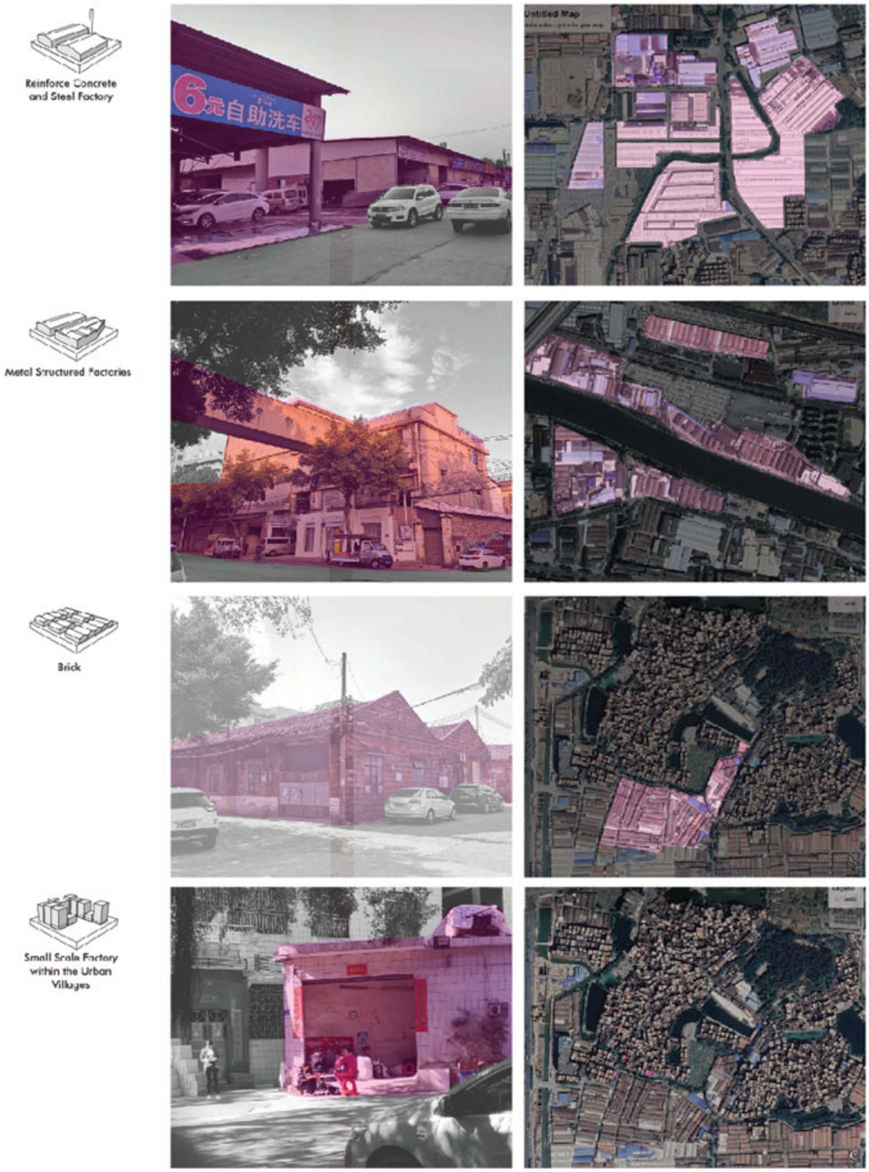

Fig. 11.7 Industrial typologies in the Chancheng district. *Image* Marina Mohamed Rani, TU Delft

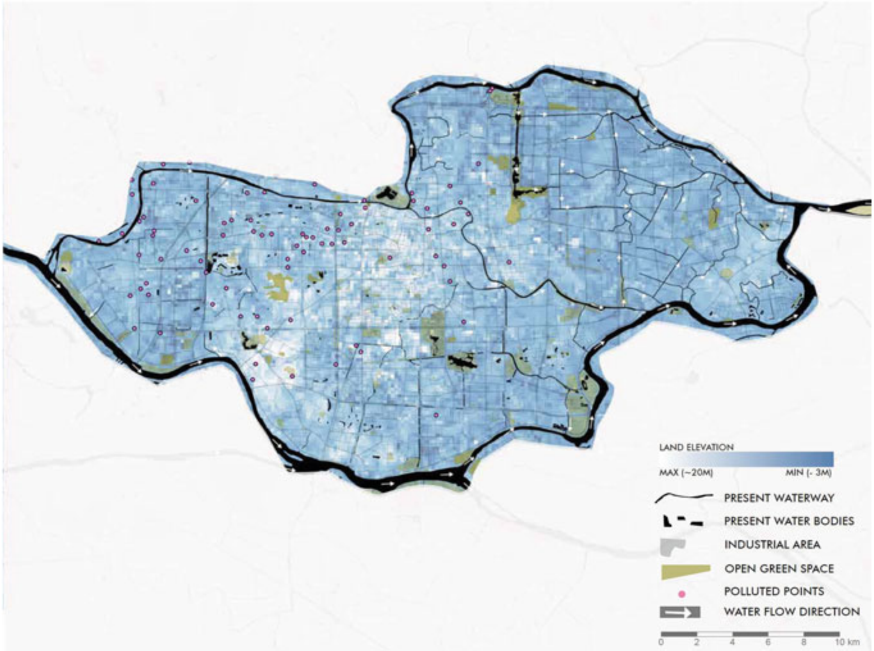

Fig. 11.8 Urban flooding due to the high rate of soil sealing and the disappearance of the original water system. *Image* Marina Mohamed Rani, TU Delft

to ensure a more efficient circulation, thus avoiding water stagnating. Wetlands, bio retention swales and permeable surfaces are introduced for increased permeability and water retention, alleviating the occurrence of waterlogging in urban areas.

The spatial outcome is a new topography and vegetation system allowing water to slow down and be purified by plants, which in turn are harvested and processed into biomass. Factories along the waterways are reintegrated with new and cleaner forms of production, taking advantage of their characteristics: reinforced concrete and steel factories, with high ceilings, host spaces for plants processing and cleaner production activities, while the metal structures of buildings are reused for new public space, leisure activities, and offices. Industrial buildings within the urban village are demolished, to make room for new community space or public open green space (Fig. 11.10).

In Haizhu, a composite spatial strategy based on the introduction of public facilities, integrated mobility system and ecological space is proposed to overcome spatial segregation and environmental fragmentation.

As for the Chancheng district, the project started from the understanding of the bio-physical and socio-economic dynamics throughout different spatial scales, adopting the layer approach and mapping as methods of investigation to gain knowledge of the context and the spatial forms of urban settlements, transport network and landscape features. Haizhu district contains the presence of a great variety of settlements: within

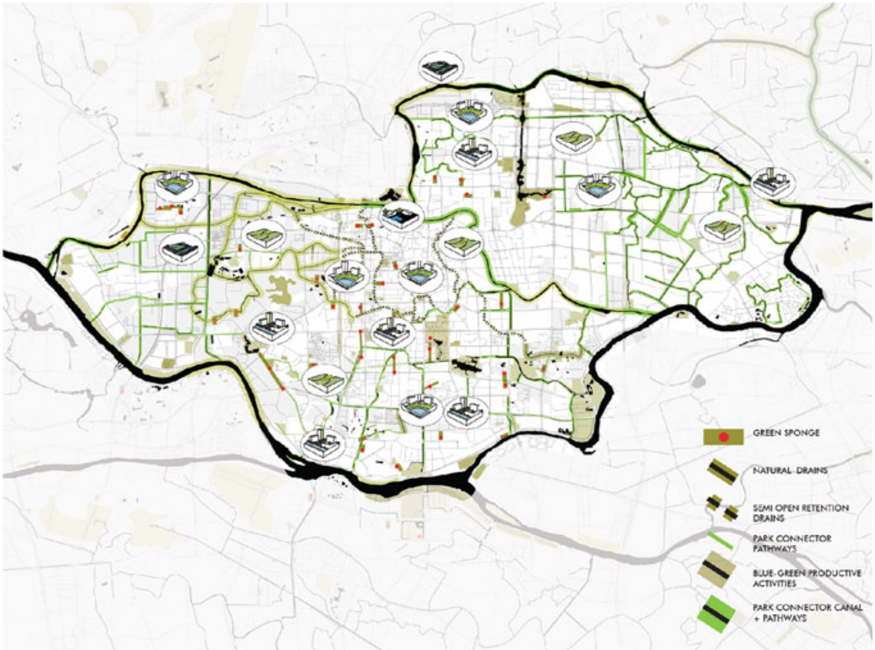

Fig. 11.9 Proposed green–blue network for the Chancheng district. *Image* Marina Mohamed Rani, TU Delft

the thick urban tissue of the area, historical villages, traditional communities, urban villages and modern communities can be found, each characterized by different living conditions, open spaces and relationships with water (Fig. 11.11). However, the district presents an uneven distribution of public and commercial spaces, as well as lack of connection between ecological spaces and the built-up areas.

To overcome these issues, design principles and a toolbox are developed to foster great accessibility and interconnection to social and ecological spaces, provide diverse and integrated public spaces for more social inclusion and multifunctional ecological areas and services (Fig. 11.12).

These principles are applied at three different scales: regional (the whole Haizhu district), urban and local scale. At the local scale, different routes are designed, each of which having characteristics based on the peculiarities of the existing elements in the site. For the active route, vacant lots, abandoned factories and other underused spaces are transformed into recreational and ecological spaces, and the existing structures of the buildings are regenerated into new functions, such as urban farming and cafés. The freed space is redesigned to increase water storage and retention through the introduction of water squares, retention basins and soft edges along the waterways. The textile cluster that currently creates a barrier between neighbourhoods is reconverted into a more inclusive and creative space, with sport facilities, pocket parks and community parks. This new set of public facilities provides open, resilient

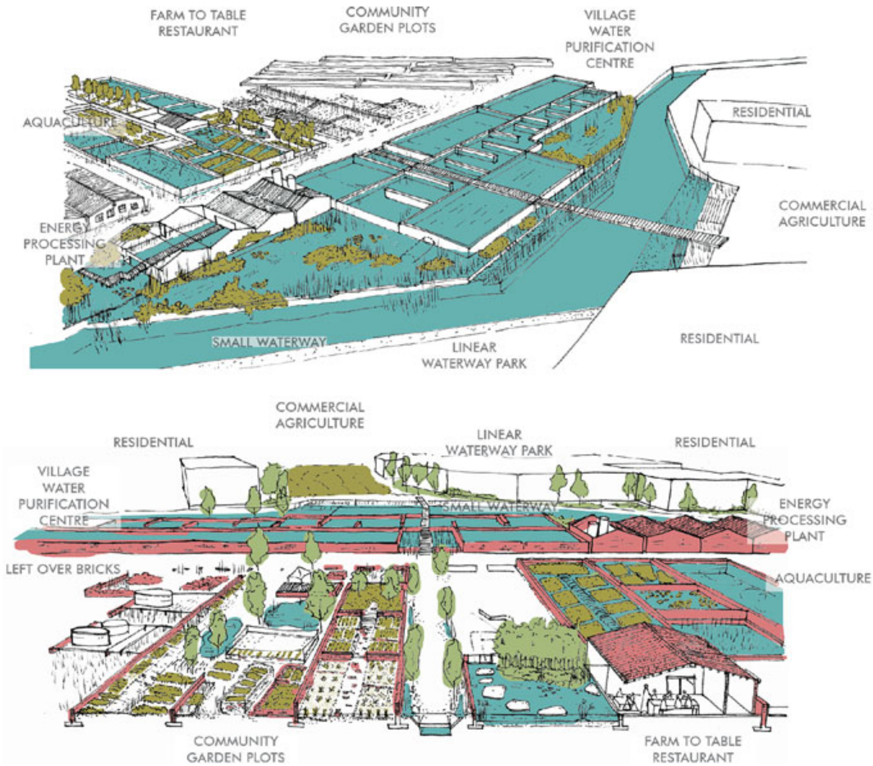

Fig. 11.10 Bird's-eye view of transformation interventions on two industrial sites in Chancheng district. *Image* Marina Mohamed Rani, TU Delft

space for new functions and events, such as a new informal market, an open theatre and sport areas for local communities (Fig. 11.13).

11.7 Discussion and Conclusions

This paper introduced a landscape-based approach to industrial transformation in the PRD and two applications in two different areas in the region.

Despite focusing on two different design objectives, the two applications share some similarities in looking at the transformative potential of industrial sites in the PRD in providing safer, healthier and more liveable urban landscapes while setting the base for greater sustainable urban development for the region.

To achieve these goals, such an approach must have different characteristics.

One of the key characteristics is the multi-scale and systemic approach.

As shown above, the green–blue infrastructure proposed for the Chancheng district is structured around the relationship between industries and water. In Foshan, the

Fig. 11.11 Settlement typologies and their relation with built environment, road system, water and open space. *Image* Xinyan Zhao, TU Delft

burial and channelling of waterways had an impact on the natural drainage. Their resurfacing creates the conditions for a more composite and resilient water system, where all the elements play a role in flood defence, but also in remediating polluted sites. Here, large industrial sites are reinterpreted as green buffer zones protecting urban areas from flooding, ensuring ecological connectivity and greater biodiversity.

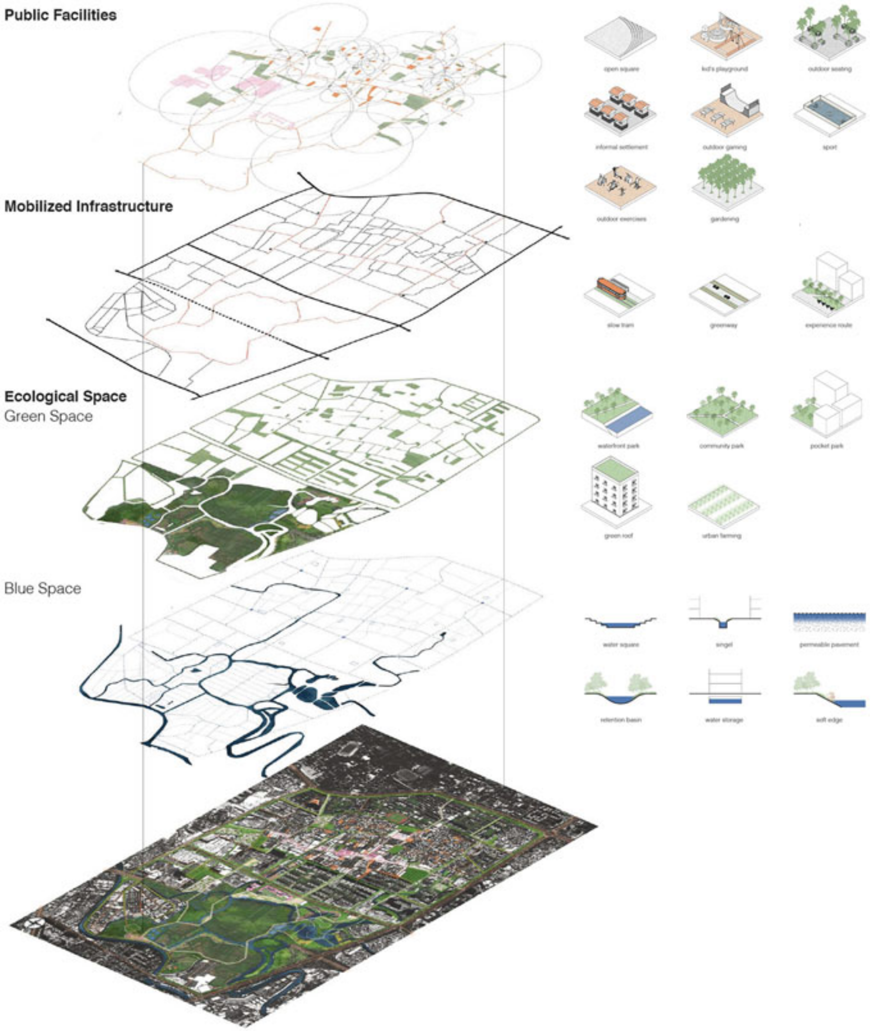

Fig. 11.12 Design toolbox. *Image* Xinyan Zhao, TU Delft

In a similar fashion, the punctual demolition of small industrial plots and single buildings proposed for Haizhu provides a new system of public spaces and centralities that become the new socio-ecological network of the district, reconnecting ecological hotspots at the district scale with the fragmented green areas in and around its neighbourhoods and acting as water management devices that are grafted onto the existing system.

Another important feature of the proposed approach is related to the temporal dimension. In Chancheng, a temporal strategy is developed through different phases, to explore programmes and functions accommodating remediation processes. Such

Fig. 11.13 The industrial area transformed into an inclusive, creative space. *Image* Xinyan Zhao, TU Delft

an incremental approach sets the hierarchy of interventions, identifying what the priority actions to be pursued are to create the condition for further development in each phase, while leaving room for adjustments and synchronization. This implies understanding the landscape and ecological processes. Water and vegetation play a role in both risk mitigation and pollution reduction, but they have their own dynamics of development and follow their own processes and cycles. Redesigning industrial areas as green spaces for remediation can be a valuable strategy to accommodate rainwater and provide room for the rivers while making areas available again for new urban programmes. However, these programmes should strive to balance social, economic and ecological goals.

This approach strongly relies on nature-based solutions to provide both greater ecological and social resilience in urban areas, working with natural processes to remediate soil and water, while creating the conditions for new, greener economies. However, these need to be integrated into broader planning strategies involving residents and local communities.

Lastly, the two applications show how the proposed landscape-based industrial transformation approach can be applied both as a guiding strategy, starting from the systemic redevelopment of idle or decommissioned industries, or as integrated programme into broader urban redevelopment processes. In this regard, industrial transformation can be a valuable tool to stimulate adaptation practises at the local scale and offers the chance to bridge the gap between adaptation and spatial planning.

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