Chapter 5
A Landscape-Based Regional Design Approach for Sustainable Urban Development in the Pearl River Delta, China

Steffen Nijhuis, Yimin Sun, Daniele Cannatella, and Guangyuan Xie

Abstract Adaptive urban transformations employ landscape-based regional design as an integrative and multiscale design and planning approach for sustainable urban development. In this approach, natural and urban dynamics as derived from systems analysis set the pace and nature of adaptation. This chapter presents an initial strategy for adaptive urban transformation in the Pearl River Delta to illustrate the potential of landscape-based regional design as form of territorial governance that takes the natural and urban landscape as the basis to steer urban–rural transformative processes through a combination of sector activities towards more coordinated sustainable outcomes. The strategic spatial plan and subsequent implementation by means of pilot projects will focus on the potential of interlinked economic and ecological development at multiple scales. Together with the assessment of urban landscape growth over time and the evaluation of current spatial development projects in the region, several significant factors of future development have been identified, leading to an initial strategic vision and transformation perspectives for the PRD. This vision is based on the idea that the PRD will develop into China's Silicon Valley, with strongly developed and well-connected urban qualities, robust green–blue frameworks, cultural-historical assets connected to the region and water-sensitive socio-ecological inclusive urbanism.

Keywords Adaptive urban transformation · Landscape-based regional design · Vision Pearl River Delta · Transformation perspectives · Adaptive design principles

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Fig. 5.1 In some parts of the PRD, there is barely any room left for the water. *Photo* Guangyuan Xie

5.1 Introduction

Adaptive urban transformation requires planning and design strategies and principles that take the (natural) landscape as the basis for working with natural processes for the benefit of socially and ecologically inclusive and thriving urban landscapes. Such an approach takes the landscape first and considers the biosphere the context for social and economic development (Nijhuis 2022). The assumption is that through a design-oriented multiscale and transdisciplinary approach resiliency and adaptive capacity can be built up in terms of the development of spatial structures, but also in terms of people, business, knowledge and governance. Landscape-based regional design is considered an essential strategy for developing resiliency and adaptive capacity by providing ways to deal with uncertainty, finding ways to safeguard resources and cope with vulnerabilities (Nijhuis 2022).

This chapter presents an initial strategy for adaptive urban transformation in the Pearl River Delta (PRD) to illustrate the potential of landscape-based regional design as form of territorial governance that takes the natural and urban landscape as the basis to steer urban–rural transformative processes through a combination of sector activities towards more coordinated sustainable outcomes (Fig. 5.1).[1] The strategic spatial plan and subsequent implementation by means of pilot projects will focus on the potential of interlinked economic and ecological development at multiple scales. But first, we will elaborate the concept of landscape-based regional design, as well as the four key phases of the process it constitutes.

[1] Parts of this chapter have been published in adapted form in Nijhuis (2022) and Nijhuis et al. (2019, Chinese, 2020, English).

5.2 Landscape-Based Regional Design

Landscape-based regional design is a form of design and planning that applies principles from landscape architecture, urban design and planning, landscape ecology and geography to spatially oriented research, design and planning (Nijhuis 2022). It also utilises knowledge from systems thinking and complexity theory to promote a more comprehensive regional planning and design form that addresses the complex web of relationships making up the urban landscape (Nijhuis and Jauslin 2015). In landscape-based regional design, the physical landscape structure and associated natural processes are taken as a foundation to generate favourable conditions for future development and to guide and shape spatial transformations. Therefore, this approach offers a model for urban development and transformation, the preservation of biodiversity, water resource management, improved leisure facilities, community building, stronger cultural identity and economic development (cf. Neuman 2000) while taking the landscape as the basis.

Landscape-based regional design identifies and guides urban development towards the most advantageous places, functions, scales and inter-relationships through the development of robust landscape structures. These resilient and adaptive spatial frameworks ensure the coherent development of the region (long-term strategy) and, at the same time, create conditions and flexibility for local projects (short-term intervention). Research through design is an essential means to explore the possibilities of and contextualise adaptive design principles, such as nature-based solutions, water-sensitive design, social-ecological inclusive design or design with heritage (Figs. 5.2, 5.3 and 5.4). This implies landscape-based regional design operates at different scales, from regional to local, and accommodating both general and more specific measures. In this process, the utilisation of knowledge of physical, biological and cultural aspects of the landscape is inevitable. Enabling digital technologies, such as Geographic Information Systems (GISs), is a powerful tool in landscape-based urbanism for pre-processing, modelling, analysing and representing data to gain new insights and augment the design process with tremendous calculating and visualisation capacities (Nijhuis 2015).

Balancing the relationship between experts, citizens and authorities is also necessary to make landscape-based regional design work. This calls for a process that is not limited to the domain of landscape and urban planners and designers but that also actively involves other knowledge domains, such as data scientists, environmental technology and urban studies. It also affects people who live in the area, the business community, administrators and other stakeholders. The idea is that through meaningful participation of all stakeholders in envisioning, design and policy decisions, the resilience and adaptive capacity of urban landscapes will be increased, not only in physical terms but certainly also in socio-economic terms (Ahern 2011). This implies a shared understanding and also indicates a future-oriented, proactive approach in which the interaction between citizens, businesses, experts and the government is central.

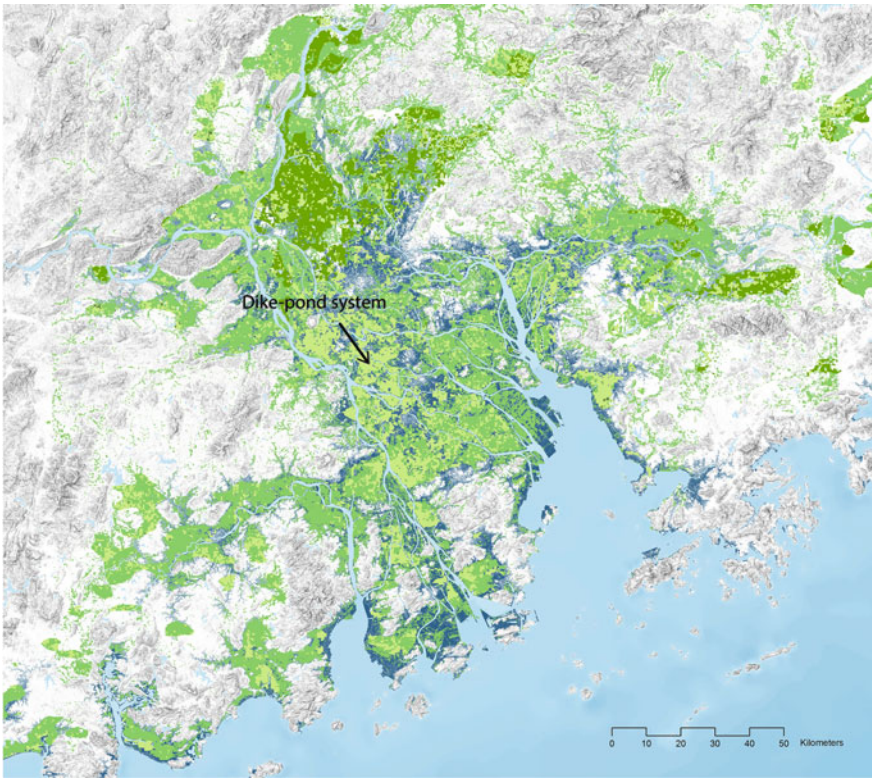

Fig. 5.2 The PRD is throughout the centuries shaped by the interaction of humans with the deltaic lowland and resulted in an intricate system of land reclamation, water management and agri-aquaculture such as the dike-pond system, here indicated in green. How can this landscape facilitate sustainable urban development? *Image* Steffen Nijhuis

Visualisation for communication of planning and design contents is key to integration of stakeholders on multiple scales in planning and design processes (Gill and Lange 2015; Lange and Hehl-Lange 2010). Recently developed innovations and state-of-the-art immersive visualisations proved to be very useful, e.g. immersive virtual reality (VR) representations using head-mounted displays for testing perceptions of different planning scenarios (Lu et al. 2021), Augmented reality (AR) interfaces for enriching GIS maps with overlays of design alternatives while running a dynamic multi-criteria analysis and mobile tablet-based AR with 3D model recognition and tracking for superimposing designs of blue and green infrastructure and virtual replacement of buildings in the physical model (Tomkins and Lange 2020; see also Chaps. 8, 9 and 10 of this volume).

In landscape-based regional design, content is thus linked to a process of promoting social-ecological inclusiveness, diversity and flexibility. Through landscape-based regional design, we can create conditions, as it were, for change,

Fig. 5.3 Adaptation of urban patterns in the agri-aquacultural landscape of the PRD. *Photo* Lixing Zhao, TU Delft

Fig. 5.4 Public space as a social infrastructure with water as a play feature and for a pleasant microclimate. *Photo* Steffen Nijhuis

and guide transformations through the development of robust landscape structures that connect spatial scales while at the same time offering space for individual interpretation at the local level (Nijhuis 2022). Spatial quality is the leading factor in finding a new balance between experience, use and future values. In addition, multi-functionality, accessibility, heritage and biodiversity are some of the ecological, economic, social and cultural interests that need to be addressed. In this way, specialised knowledge and local expertise can contribute to an integrated approach of sectoral activities and lead to coordinated, sustainable results that benefit everyone.

To summarise, landscape-based regional design (Nijhuis 2022):

- Takes the regional landscape structure and associated processes as the foundation to guide and shape spatial developments and transformation;
- Learns from landscape history and vernacular practice and makes use of the accumulation of Indigenous and local knowledge (or traditional ecological knowledge);
- Employs knowledge-based spatial design as an integrative, multiscale and transdisciplinary approach and exploits the power of enabling digital technologies;
- Develops resilient and adaptive spatial frameworks: robust landscape structures for the coherent development of the region (long-term strategy) and at the same time setting the scene for local projects (short-term intervention);
- Creates and regenerates living systems in which (bio)diversity, cultural history and multi-functionality lead to sociologically and ecologically inclusive and water-sensitive urban landscapes.

5.3 Four Key Phases of Landscape-Based Regional Design

Landscape-based regional design is a co-creative process that entails four key phases: (1) diagnosis, (2) strategy making, (3) design explorations and (4) action perspective. This process is supported by a combination of research and design, meaningful stakeholder involvement and imagination (Nijhuis 2022) (Fig. 5.5). In the following, these phases are further substantiated with backgrounds and applications in the PRD.

5.3.1 Diagnosis: Understanding Urban Landscape Systems and Their Dynamics

In the diagnosis phase, stakeholders co-create knowledge and understanding on how the urban landscape system operates and what challenges and opportunities can be identified.

An urban landscape can be viewed as a complex system consisting of subsystems, each within its own dynamics and velocity of change (Meyer and Nijhuis 2013). Maps of landscape systems reveal the spatial conditions that inform adaptive

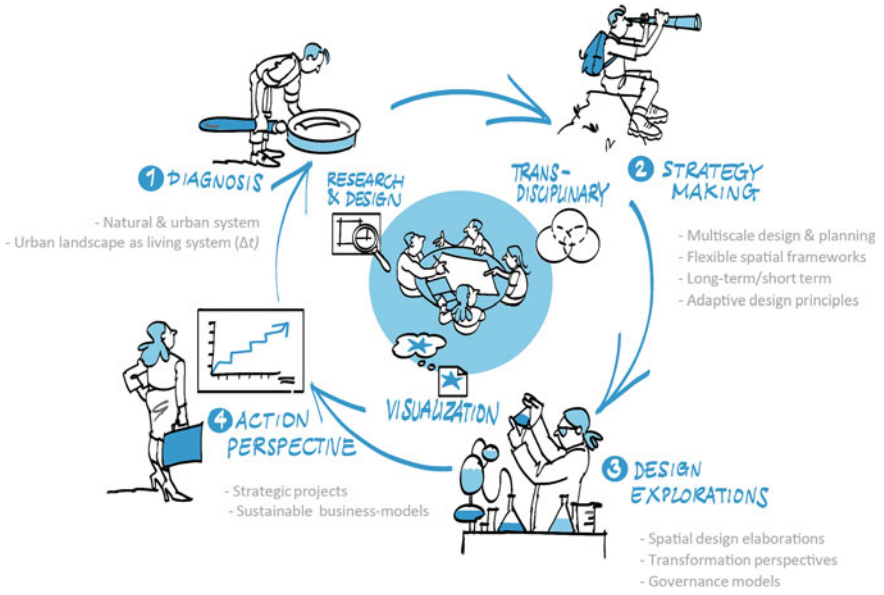

Fig. 5.5 Landscape-based regional design as a process that entails four key phases: (1) diagnosis, (2) strategy making, (3) design explorations and (4) action perspective. This process is supported by a combination of research and design, meaningful stakeholder involvement and imagination. *Image* Steffen Nijhuis, illustrator Shirley Warlich

planning strategies and design principles. Decomposing the urban landscape into layers according to the dynamic of change is a proven method to help understand the urban landscape system (Nijhuis and Pouderoijen 2014). Layers with a low dynamic of change are the substratum (e.g. topography, hydrology, soil) and climate (e.g. precipitation patterns, temperature, wind). These environmental factors, regarded as the most influential conditions for land use, are known as *first-tier conditions.* Infrastructural networks for transportation, water management and energy supply are grouped in another layer, termed *second-tier conditions.* Displaying quicker growth and change than the first-tier environmental conditions, these are also significant conditional variables for land use. Together, these first- and second-tier conditions together pave the way for the development of agricultural land use and urban settlements, resulting in the layer with the highest change and transformation dynamics (Nijhuis and Pouderoijen 2014) (Fig. 5.6).

An understanding of the urban landscapes is thus inherent to the concept of the layers and their relationships that constitute the landscape system. The urban landscape as such is a relational structure that connects and influences scales and spatial, ecological, functional and social entities. The urban landscape is a holistic system and a scale continuum that we can only understand by looking at different spatial scales and their relationships. Thus, the earlier mentioned entities are part of a scale continuum in which relationships are shaped via the attachment, connection and

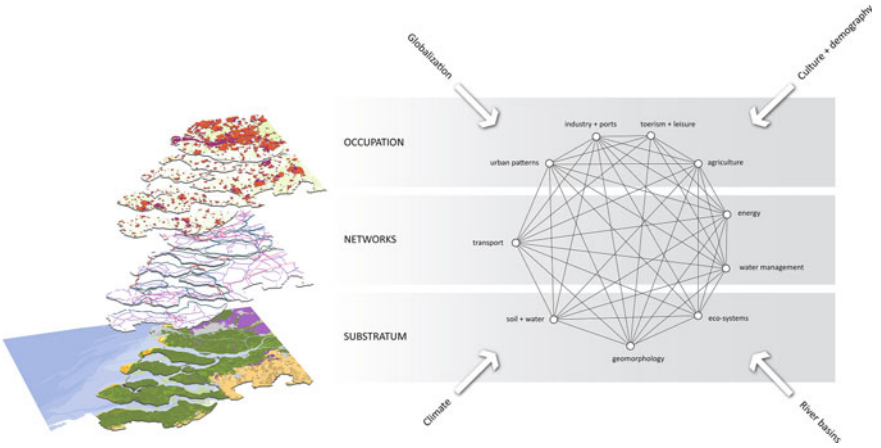

Fig. 5.6 Understanding the urban landscape as a layered and complex system. *Image* Steffen Nijhuis

embedment of a specific site or location into the broader landscape context at different scale levels. We can analyse these relationships at different scales by looking at positional, conditional and operational factors and their interactions (Fig. 5.7). *Positional relationships* refer to the regional scale and is about the location of spatial entities in the natural and urban system. These types of relationships determine the possibilities for land use, such as housing, industry, farming, forestry and leisure. The adjacency to cities, accessibility, value and availability of (new) land and strategic positions in terms of geopolitics and demographics are also important allocation factors. *Conditional relationships* refer to accessibility by road, rail and waterway, as well favourable soil conditions and access to sufficient fresh water, along with natural watercourses such as rivers and streams. The available land and its possibilities for the agriculture, and so on, are also important conditional factors. *Operational relationships* refer to the site conditions that affect the site directly. The availability of water, moisture and nutrients in the soil and microclimatic aspects such as light, precipitation, wind and temperature are important factors, but also accessibility by train, car and boat. At the operational level, the interventions and constructions to enhance the site conditions by roads, highway exits, train stations, irrigation and drainage, fertilisation of poor soils, plantations, grazing, etc., are also of crucial importance. *Sequential relationships* are important to understand the development of the systems and their relationships through time (Nijhuis et al. 2023).

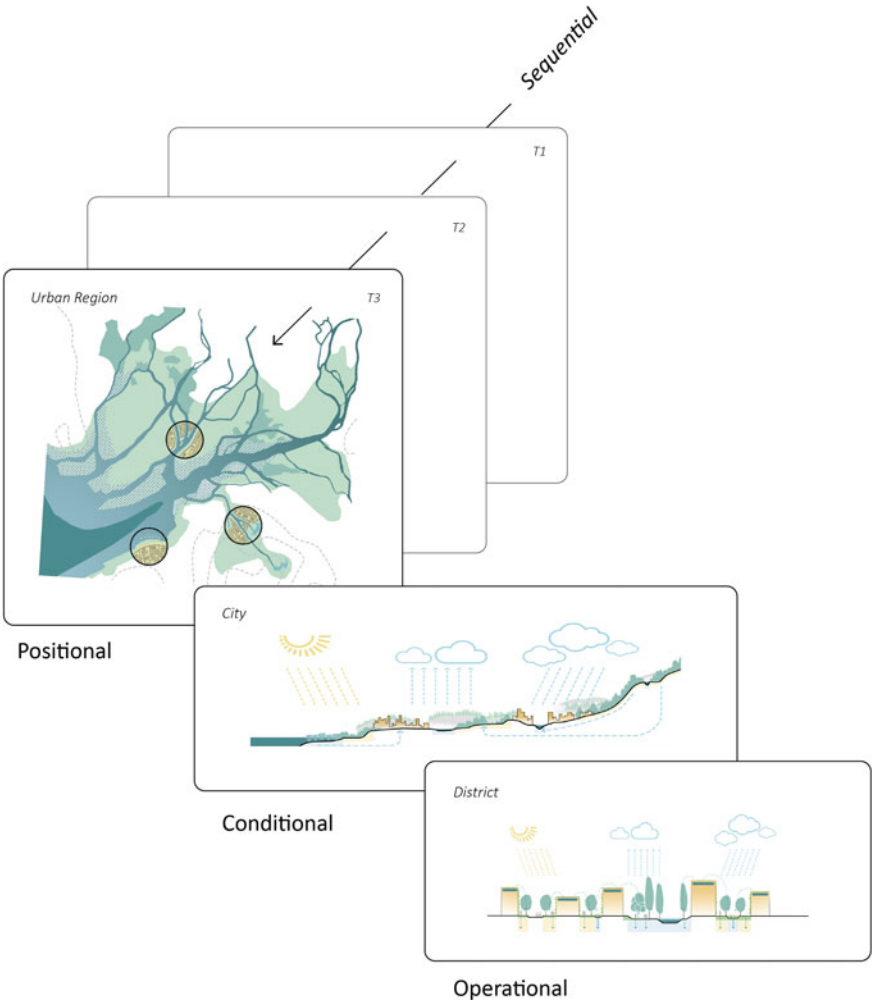

Fig. 5.7 Exploring urban systems at different scale levels and their positional, conditional and operational relationships. Sequential relationships are also important to understand the development through time. *Image* Steffen Nijhuis

5.3.2 Strategy Formation: Envisioning, Backcasting, Adaptive Design Principles

Based on a proper shared understanding of how the natural and urban system functions and the challenges and potentials that need to be addressed, the process of strategy formation and design explorations can start. Strategy formation is about making plans that direct or guide courses of action in the long term into the future (Mintzberg 1994). One could say it is about outlining a path to get from here to there.

Often, these outlines are broadly defined while details are allowed to emerge with them, providing flexibility. Strategy formation is in this regard a planning procedure to help guide design explorations and making plans (cf. Mintzberg 1994).

Strategy formation in landscape-based urbanism entails creating a long-term regional vision or perspective that utilises knowledge of the natural and urban systems to address the identified challenges and potentials. Usually, a regional design is used to envision a desirable future expressing what the urban landscape should or can look like. The regional design provides strength and direction and gives meaning to what stakeholders want to achieve together. It provides a sense of focus and belonging when a vision is shared. Long-term perspectives also should address ways to deal with uncertainty, as we cannot gaze into a crystal ball to see the future. A common way to get a grip on uncertainty in spatial planning and design is scenario study (Veeneklaas and Van den Berg 1994; Schoonenboom 1994; Lindgren and Bandhold 2009). Scenario study combines realism, prediction and imagination to identify robust developments and the 'no regret measures' (Dammers et al. 2013). So, in scenario study, the emphasis is not so much on the differences (expressing the uncertainty), but on the commonalities (most likely to happen), the structures, locations and developments that pop up in every scenario. Based on this understanding, the long-term regional vision can be shaped and spatialized by developing adaptive regional design models, e.g. spatial arrangements that express the desired spatial structure of an area.

When the long-term regional vision in the form of a regional design is established, the next question is 'what do we need to do today to reach this vision and how can we adapt to changing circumstances'? This question can be answered by a process of backwards reasoning—called backcasting (Fig. 5.8). Backcasting allows planners and designers to determine design strategies and principles and to consider what is realistic, but not necessarily what is realistic today (Robèrt et al. 2012). The focus is on the long-term regional vision, not just the current situation, charting the best possible way in the right direction (Robèrt et al. 2012). Adaptive design principles are powerful means in this regard. A design principle refers to a basic idea or rule that explains or controls how something happens or works. These principles represent generalised design knowledge that is detached from a certain context and is applicable to other contexts (Nijhuis and Bobbink 2012). It offers, as it were, a 'toolbox', providing an overview of available design principles with essentials and leaving out particularities (Steenbergen et al. 2008). In that regard, principles are adaptive as they need to be contextualised as well, so they can be adjusted given changing circumstances, while maintaining the focus on the overall objective. So, adaptive design principles can be adjusted according to the context and needs. Design principles can be identified by studying relevant and successful (international) cases. To summarise: the long-term vison in the form of the regional design and the related adaptive principles does not provide a blueprint for the future, but rather guides a more or less open-ended design process in which strategic projects and design explorations play a key role in the achievement of sustainable urban landscapes.

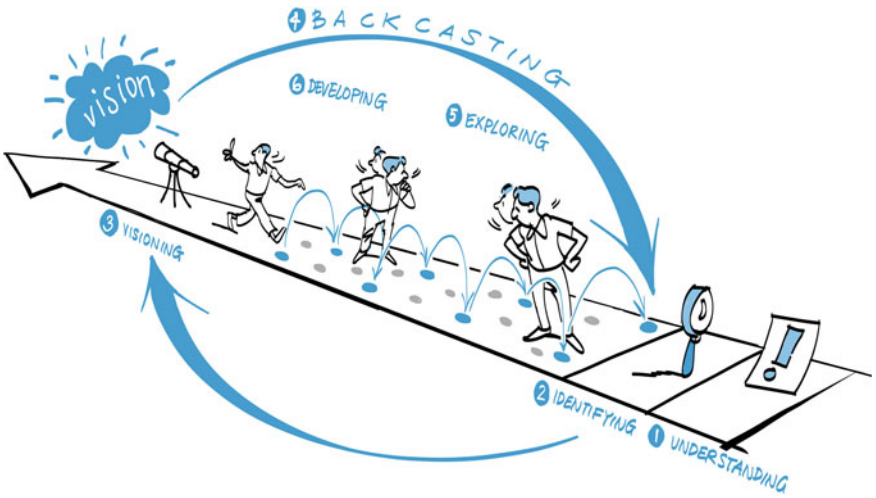

Fig. 5.8 Process of strategy formation and design explorations while utilising knowledge of the natural and urban landscape, developing a vision, backcasting and identifying adaptive design principles. *Image* Steffen Nijhuis, illustrator Shirley Warlich

5.3.3 Design Explorations

Design aims towards invention, that is, finding spatial solutions and 'making them possible'. Spatial design as such translates abstract strategic notions into physical structures and layouts addressing several scale levels. Spatial design is a synthesising activity and is about putting things together rather than taking them apart; integration rather than reduction; it is about relations between things and not the things alone (Meyer 1997; Sijmons 2012). In this respect, design explorations are used as a vehicle to make spatial problems visual, to generate solutions, explore possibilities and to express cultural values by means of spatial form. Design is thus regarded as a process or action that is geared towards exploring and producing. In this process, knowledge from other disciplines, such as ecology, urban planning, cultural history and water management, is spatially translated and integrated (Fig. 5.9). Designing, therefore, plays a role as a thinking/technical tool with which one thinks and acts in a structured way to generate ideas and explore possible solutions. This method is called 'research through design' (Nijhuis and De Vries 2019). In research through design, goal-oriented searching is central in a process where thinking and producing go hand in hand. Mechanisms of research and design are combined with imagination, creativity and innovation (Nijhuis and De Vries 2019). During this process, a conscious or unconscious synthesis takes place that in some way precipitates into a visual form, by drawing, mapping or modelling with analogue or digital media.

Design explorations are therefore a powerful research method with which complex spatial challenges can be approached integrally and creatively. A structured design process will be used in which important aspects are clearly revealed and the tasks

Fig. 5.9 Co-creation of knowledge and ideas for the development of the PRD using a digital map table. *Photo* Steffen Nijhuis

are further translated and concretised in spatial terms. The adaptive design principles as formulated in the strategy formation phase are adapted and applied in the local context. Through these design experiments, knowledge is acquired by studying the effects of actively and systematically varying design solutions in a specific context. Spatial design as such helps to identify challenges and potentials of the urban landscape and to suggest possible solutions. This is done by making matters explicit with drawings and sketching the context in which they can be realised. In this sense, the design explorations can also help to identify how stakeholders think about future developments at different scales. By visualising ideas and programmes of requirements and positioning them in the space, one can identify possibilities and limitations and formulate questions that require further investigation. Design results provide a context for conversations and observations about the importance of landscape structures and elements and allow for the discussion of solutions and measures with their spatial qualities. In the context of landscape-based regional design, design explorations are used as a systematic search for possible solutions to a spatial problem. At the same time, the design exploration makes clear which landscape structures and elements, for example from an ecological of cultural-historical point of view, should be preserved too.

5.3.4 Action Perspective: Strategic Pilot Projects

The identification of strategic pilot projects is crucial to realise the ambitions as formulated and mapped in the long-term regional design. In this perspective, a pilot project is an initial and relatively small-scale implementation to prove the viability of the approach, principle or idea, which can be a construction project, an urban or landscape development project or a research project. The regional design usually entails many potential projects varying in scale and focus but are needed to translate

ambitions into reality. The pilot projects can be defined based on local 'bottom up' initiatives, usually building on existing initiatives and networks, such as a neighbourhood park, community gardens, a housing project or as 'top down' projects that transcend the locality and need regional coordination, such as river regeneration projects and green–blue infrastructure. What the pilot projects have in common is that they contribute to the realisation of the long-term perspective by short-term actions and implementation. The purpose is to think together, contextualise the adaptive design principles through design and implement the ideas in practice. Through the pilot project designers, policy-makers, citizens, academia and industry are, as it were, united in a 'Community of Practice' (or 'Living Lab') to experiment, co-create and test in a real-life environment, delimited by geographical and institutional boundaries (Maas et al. 2017; Schliwa and McCormick 2017). Experimenting together in a responsible way, monitoring and learning from mistakes, creates an informal space in which innovation is key and everyone is equal (Ahern 2011). This fits well with the social and political conditions needed to arrive at solutions on a policy and practical level. The strategic nature of the pilot projects is expressed by the fact that it should contribute to the realisation of the bigger ambitions in tangible ways, but also in intangible ways by building alliances of stakeholders, to develop governance models that guide and facilitate implementation and leverage innovative business models that are needed for a realistic action perspective.

5.4 Towards Adaptive Urban Transformation in the Pearl River Delta

To achieve a more sustainable urban development in the Pearl River Delta, we implemented the landscape-based regional design approach as described previously. Together with academic and societal partners, such as regional and local governments, international and local planning and design offices, multidisciplinary experts, PhD and MSc students from the involved universities, NGOs and so on, we went through the four key phases of landscape-based regional design in iterative ways. In a collaborative effort, we explored the potential of adaptive urban transformation in the PRD through applying this integrative and multiscale design and planning approach.

5.4.1 Mapping the PRD's Natural and Urban System

In order to understand the natural and urban system of the PRD, three maps were constructed based on available knowledge and input from experts and stakeholders. Drawn up in a participatory process, these maps show the core physical structures and characteristic patterns of the PRD to illustrate the dynamic of the territory, the

natural and urban system and their interactions. Specifically, they show the eco-agricultural system, the urban system, the infrastructure networks and urban tissue and their relationships.

The basic components of the natural system are the climate, landforms, water and rock type. These drive the formation of soils, determine hydrology as well as the distribution of ecosystems, agricultural land use and historical settlements or cities. The PRD can be divided into two geomorphological types. The western part of the delta is a river-dominated plain formed over the course of the past millennia by natural processes such as siltation and deposition. The estuary to the east is tide-dominated (Xiong and Nijhuis 2018) (Fig. 5.10). Almost 90% of the land in the PRD is flat terrain, with the remaining 10% made up of 160 hills and 187 islands spread around the coast (Huang and Zhang 2004). The deltaic lowland is characterised by two sub-deltas and a tidal estuary. The rivers that dominate the PRD are the West River, the North River and the East River. Together, they form a drainage basin of 453,690 km^2 and have a total length of 2200 kms (Zhang et al. 2008). The most important river in terms of discharge and sediment load is the West River (80% of total water discharge, 90% of total sediment load). Seasonal flooding is a common characteristic in the West and North River sub-deltas, primarily in the period from April to September. The estuary also suffers from extreme tides induced by typhoons or storm surges, mainly occurring in the typhoon season from July to September.

The wet and flat topographical features of the PRD provide favourable conditions for wetland ecology as well as urban development and agriculture, confirmed by the long history of extensive agricultural activities stretching back more than 4000 years. This has proven to be a sustainable human–environment relationship in the ever-changing wetland environment that has arisen through frequent flooding and the continual seaward expansion of the land (Weng 2002; Zhao 2010). Due to the wet and flat conditions of the terrain, the local population developed over many years sophisticated multiscale, water-sensitive farming methods in the warm hot plains known as agri-aquaculture. For centuries, this formed the basis of the local economy. One of the most notable of these methods, developed from the fourteenth century onwards in the sub-deltas, is the dyke-pond system in which fishponds are constructed between dykes bearing fruit trees (Ruddle and Zhong 1988). By the early seventeenth century, the fruit trees were replaced by mulberry trees to facilitate silk production while four species of fish were farmed in the ponds. Subsequently, this type of agri-aquaculture pattern continued to grow and prosper until it hit a peak around the 1920s (Ruddle and Zhong 1988). Today, most of these areas still feature fishponds alongside industrial plots and urban settlements, but almost without silk production.

Reflecting the area's large bays and riparian zones, the natural vegetation in the PRD is largely mangrove forest, wetland and wet forest. While individual mountains and ridges have traditionally hosted dry forests, large swathes of woodland were cut down in previous decades; today, the process of replanting the trees has started. At the foot of the slopes, basins have been established for the supply of fresh water as well as for irrigation (Fig. 5.11).

In the pre-industrial period, the region relied heavily on water-borne transportation. From the 1950s, however, the shift from private to public ownership of land

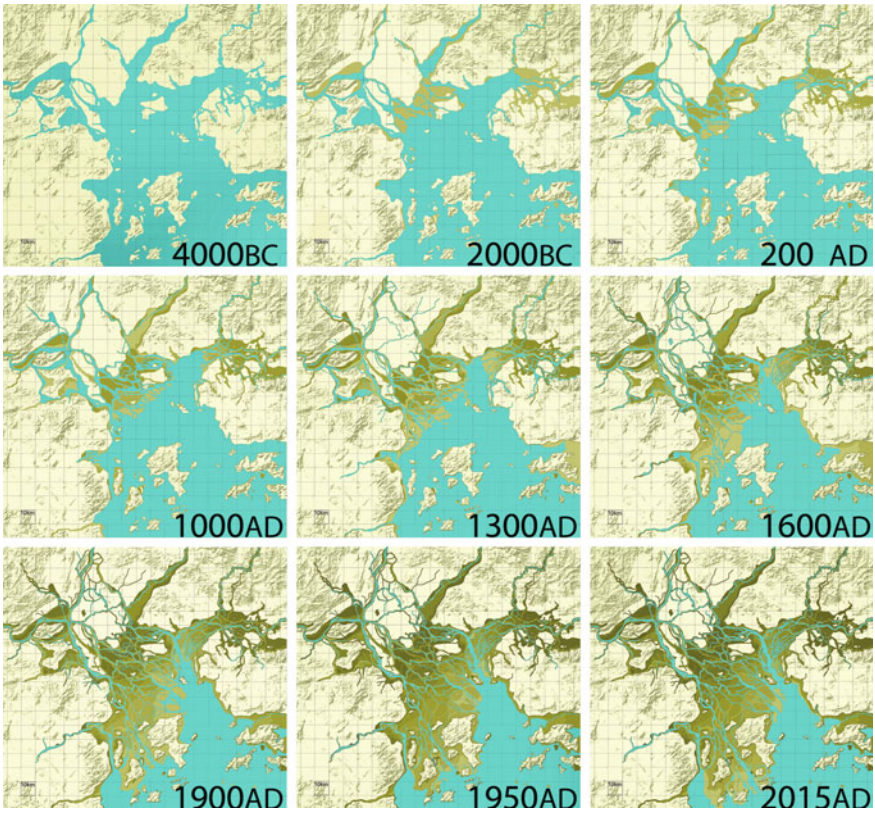

Fig. 5.10 Landscape formation of the PRD from 4000 BC to 2015 AD. *Source* Xiong and Nijhuis (2018)

enabled major infrastructural developments in the PRD. Large-scale dyke reconstructions (Xiong and Nijhuis 2018), the development of a vast network of (high-speed) train connections and an expansion in road infrastructure all helped to foster the region's rapid urban expansion. Well-developed road and train infrastructure can be found in the corridors from Guangzhou-Shenzhen/Hong Kong and Guangzhou-Zhuhai/Macau. The ports of Hong Kong and Nansha are important transportation hubs, as are the international airports of Hong Kong and Guangzhou (Fig. 5.12).

The histories of ancient cities such as Guangzhou, Foshan and Macau can be traced back more than 2000 years. In Guangzhou, for instance, archaeologists discovered the remains of a large royal garden and palace from around 203 BC, showcasing the rich culture of the Nanyue kingdom (Wu and Chen 2010). It is interesting to note that the historic Lingnan gardens in the Guangdong province, with their traditional architecture, were clearly adapted to the specific climatic conditions regarding site selection, orientation, layout and construction materials, all of which had a positive impact on the microclimate. In general, the cores of these historical cities are all

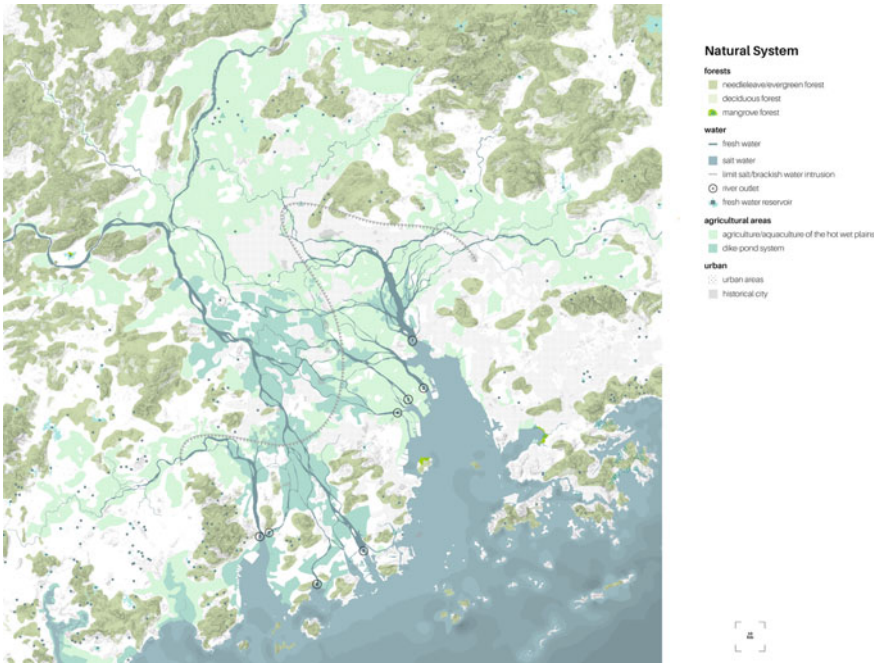

Fig. 5.11 Eco-agricultural system of the PRD. *Image* Steffen Nijhuis, Daniele Cannatella and Liang Xiong, TU Delft

oriented towards rivers and the coast for strategic reasons as well as to facilitate transportation.

From the 1950s onwards, the historical cities have benefited from infrastructural investment. In the 1980s, China created the PRD Special Economic Zone to attract foreign investment, turning the area into the world's fastest urbanising delta (Fig. 5.13). This gave the Pearl River Delta a certain degree of autonomy in terms of customs, finance and taxes. Manufacturing companies opened numerous factories, creating a thriving economy. During the process of urbanisation, large areas inside the polders were transformed from farmland into urban settlement. According to the Guangdong Statistical Yearbook of 2016, there are now 60 million inhabitants in the PRD, a figure expected to rise to 80 million by 2030.

Within this wide-ranging urban development, different spatial patterns can be discerned: in the north, fairly concentric patterns of development are found around the historical town cores; in the east, urbanisation has followed a more linear pattern along the coastline, where new settlement areas are hemmed in by mountain ridges; finally, in the west, we can observe more dispersed patterns, reflecting the traditional polder fields of this area. Today, the epicentre of urbanisation is the urban corridor Guangzhou-Shenzhen, with an important role for Nansha as a connection hub (Fig. 5.14).

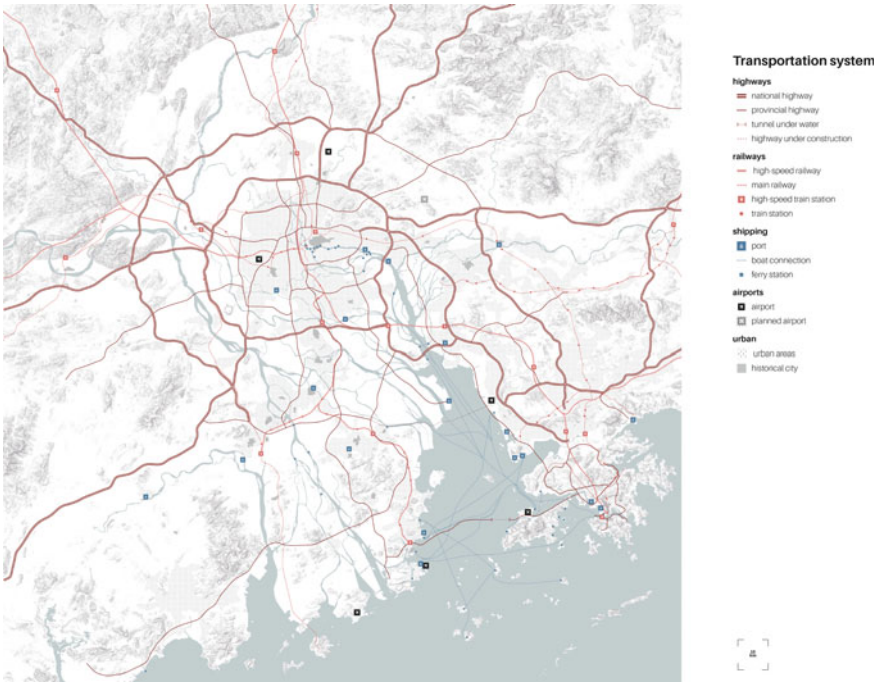

Fig. 5.12 PRD's infrastructural system. *Image* Steffen Nijhuis, Daniele Cannatella and Liang Xiong, TU Delft

Fig. 5.13 Urban development from 1950–2015. *Source* Xiong and Nijhuis (2018)

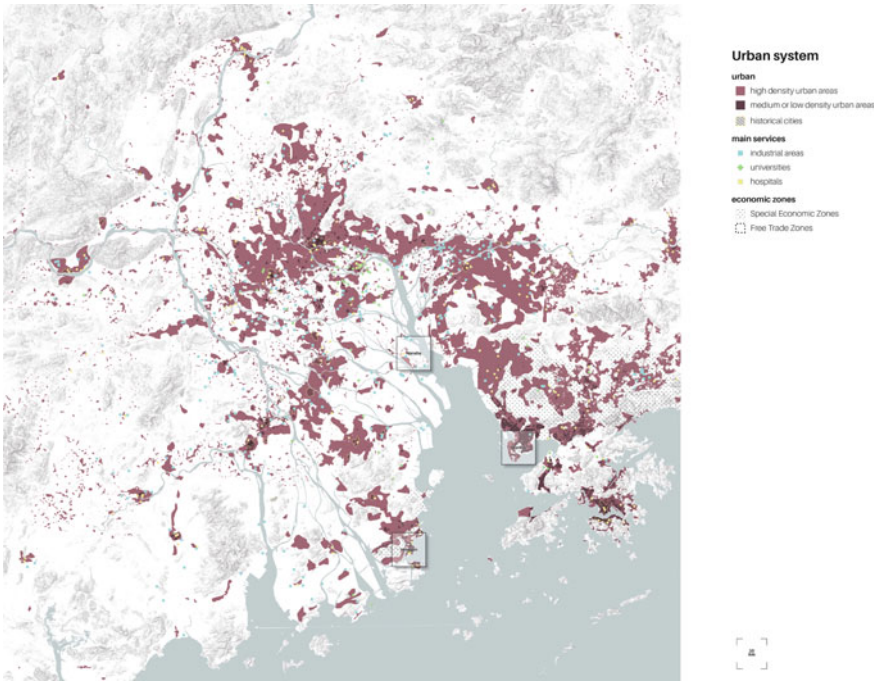

Fig. 5.14 Structure of the PRD's urban tissue. *Image* Steffen Nijhuis, Daniele Cannatella and Liang Xiong, TU Delft

The synthesis map (Fig. 5.15) shows the urban landscape resulting from the interaction between environmental conditions (e.g. substratum and climate) and the infrastructural networks for transportation, water management and energy. These conditions have paved the way for the development of agricultural land uses and urban settlements, leading to the layer with the highest dynamics of change and transformation. However, the fast pace of urbanisation and climate change has led to some severe problems. Alongside rising sea levels, unpreceded storm surges from typhoons and increased river discharge have resulted in the frequent flooding of urban areas. The risk of flooding has been increased by the canalization of rivers with insufficient capacity to cope with additional discharge. Large farming areas have been transformed into industrial sites and urban areas, thereby greatly reducing their rainwater absorption/storage capacity and thus the ability to mitigate not only the risk of flooding but also water shortages. Natural mangrove forests have been cut down, making coastal areas more vulnerable to flooding. In addition to flooding, the PRD is also suffering from subsidence, saltwater intrusion, smaller areas of farmland (and thus lower food production), socio-economic problems as well as the loss of important ecological and cultural-historical sites. The collective recognition of these challenges and opportunities underlies efforts to realise a more sustainable and inclusive strategy for planning and design in the PRD.

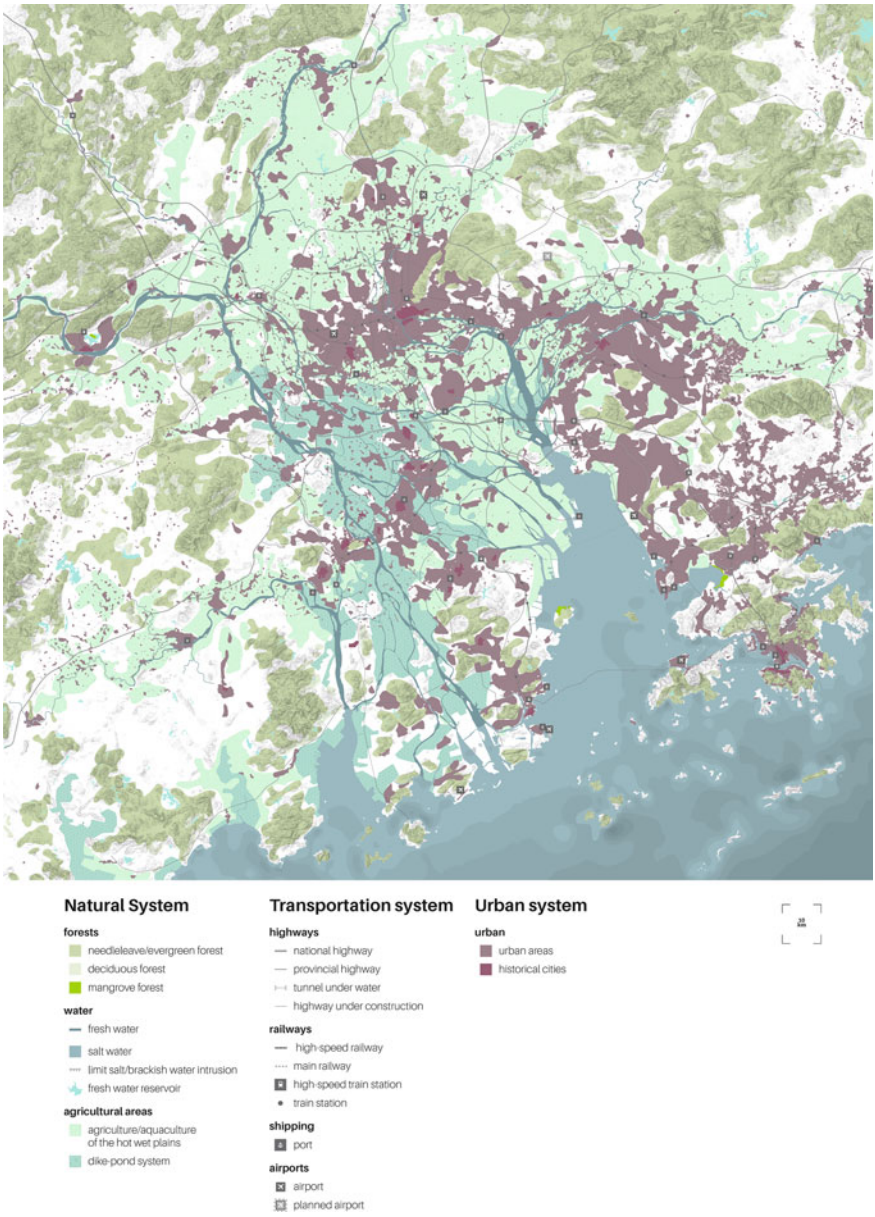

Fig. 5.15 Urban landscape of the PRD. *Image* Steffen Nijhuis, Daniele Cannatella and Liang Xiong, TU Delft

5.4.2 *Towards a Sustainable Future for the PRD*

Adaptive urban transformations form the basis for a landscape-based regional strategy to address the main challenges and potentials of the PRD. In this strategy, natural and urban dynamics as derived from systems analysis must set the pace and nature of adaptation. The plan development and subsequent implementation will focus on the potential of interlinked economic and ecological development at multiple scales. The goal is to facilitate sustainable transformations of old industrial/housing areas as well as the region's agricultural landscape, thereby removing constraints on the expansion of built up areas and thus accommodating continued economic and population growth. These areas, which possess good spatial conditions for long-term economic development, are generally located on newly reclaimed land within the delta's estuaries, featuring a dense network of waterways, vast areas of fishing ponds as well as wetlands and agricultural land; they contain highly sensitive ecosystems and are vulnerable to flooding. In this phase, the possibilities for the development of regional green–blue infrastructure and city-level water networks are identified with the aim of increasing adaptive capacities, ecosystem services as well as water safety. This requires systemic, integral and multilayered solutions combining engineering and multifunctional landscape infrastructures (Fig. 5.16).

Scenario studies have been employed to investigate the PRD's likely future development. Through a combination of empirical data, forecasting and imagination, it is possible to identify critical key locations, driving forces and likely impacts of future events, whether opportunities or threats (Lin et al. 2020). Together with the assessment of urban landscape growth over time and the evaluation of present spatial development projects in the region, several significant factors of future development have been identified, leading to an initial strategic vision for the PRD. This vision is based on the idea that the PRD will develop into China's Silicon Valley, with

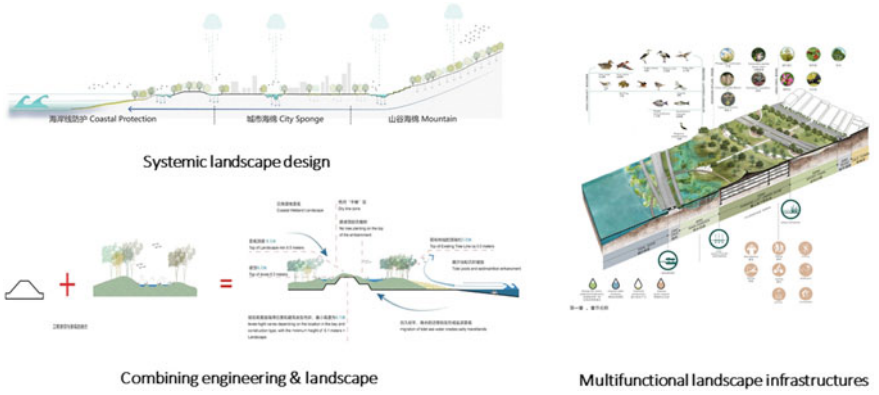

Fig. 5.16 To increase adaptive capacity, develop ecosystem services and water safety requires systemic, integral and multilayered solutions that combine engineering and multifunctional landscape infrastructures. *Images* Steffen Nijhuis and OKRA landscape architects

strongly developed and well-connected urban qualities, robust green–blue frameworks, cultural-historical assets connected to the region and water-sensitive socio-ecological inclusive urbanism. In this vision, the landscape is taken as the basis for future-proof spatial development of the region addressing climate adaptation as a leverage for integral urban development, employing nature-based solutions for sustainability and water safety, strengthening and extending natural resources and nurturing cultural identity. In our vision, the east wing (Guangzhou-Hong Kong corridor) of the PRD will further develop into a well-connected red-green necklace, where strong urban hubs and marinas alternate with robust green corridors connecting the mountains to the sea. With the development of wet plains, the west wing will be transformed into a blue axis featuring water-sensitive ecological agri-aquaculture and considerable flood retention capacity, complemented by strong urban hubs that benefit from transit-oriented development (TOD) (Fig. 5.17).

The primary use of the regional strategic vision is to determine priorities in spatial planning and design. Backcasting is used to identify spatial transformation perspectives that help accomplish the objectives set by the strategic plan and guide actions accordingly. The spatial transformation perspectives provide a set of adaptive design strategies that are specific to the challenges and potentials of the territories in the sub-deltas and the PRD estuary. The perspective of each transformation has spatial dimensions: namely, water sensitive and socio-ecologically inclusive, flexible and multifunctional, addressing multiple temporal and spatial scales. We identified and developed the following transformation perspectives regarding:

- Water safety and climate adaptation;
- Ecology and biodiversity;
- Cultural history and tourism;
- Transportation networks and transit-oriented development (TOD);
- Knowledge economy and industry;
- Urban development.

Each of these transformation perspectives are elaborated in regional maps (Fig. 5.18), allocating strategic spatial principles that require local adaptation, but at the same have a regional significance. For water safety and climate adaptation, for example the following strategic spatial principles are indicated: (1) increasing the sponge capacity urban tissue, agricultural land and mountains, (2) multifunctional flood defence and nature-based solutions and (3) building with nature for coastal protection (Fig. 5.19). And for ecology and biodiversity: (1) strengthening and extending natural resources by protecting and creating habitats, (2) connecting ecosystems and making gradual transitions and (3) developing robust urban green–blue multiscale networks (Fig. 5.20). The transformation perspectives also pave the way to more integral ways of thinking and solutions. In the sub-deltas of the PRD for instance, the transformation perspectives are connected to river and rainwater adaptive approaches, resulting in more resilient riverways, integrated agri-aquaculture, sustainable urban transformations, new urban districts, the integration of (historical) villages, industrial transformation and eco-tourism. In the estuary, the transformation perspectives are mainly connected to seawater adaptive approaches, encompassing

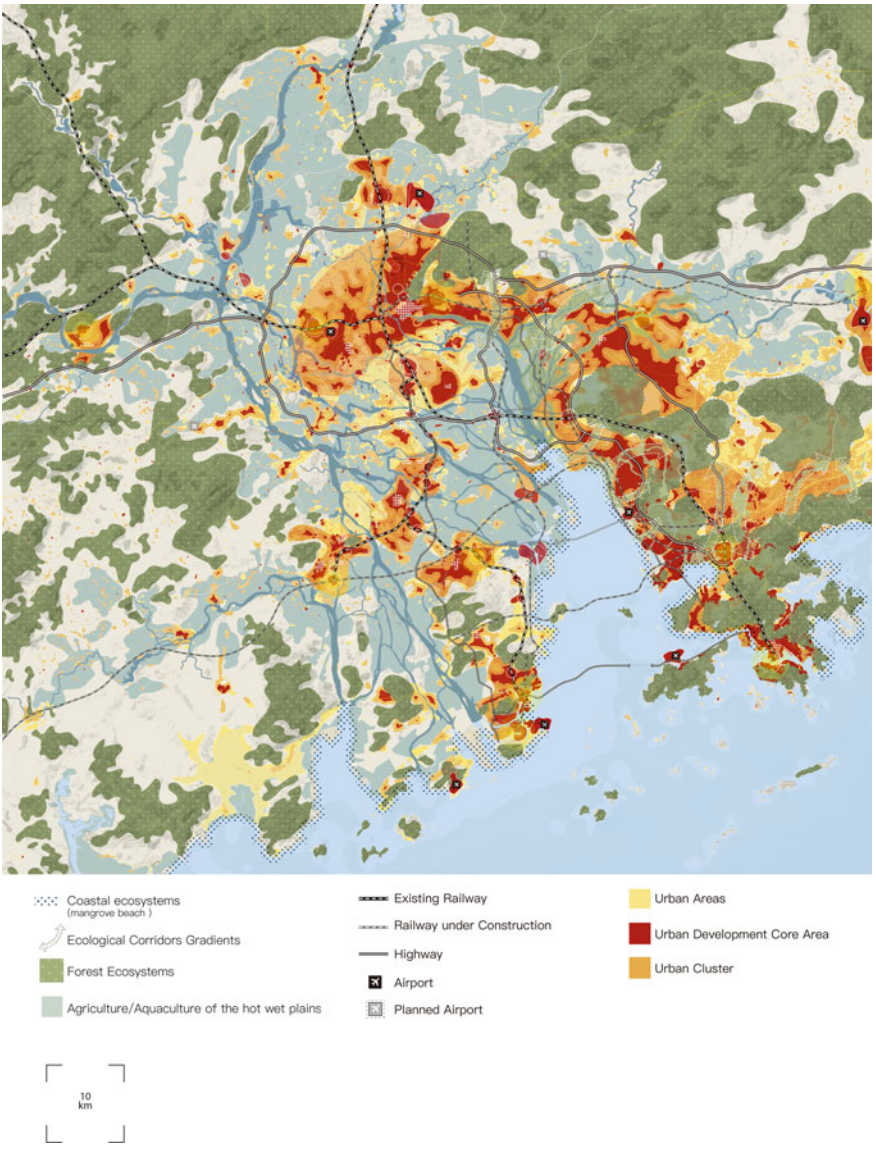

Fig. 5.17 A long-term vision for integral urban landscape development of the PRD. *Image* Steffen Nijhuis, Yimin Sun, Daniele Cannatella and Xie Guangyuan, TU Delft

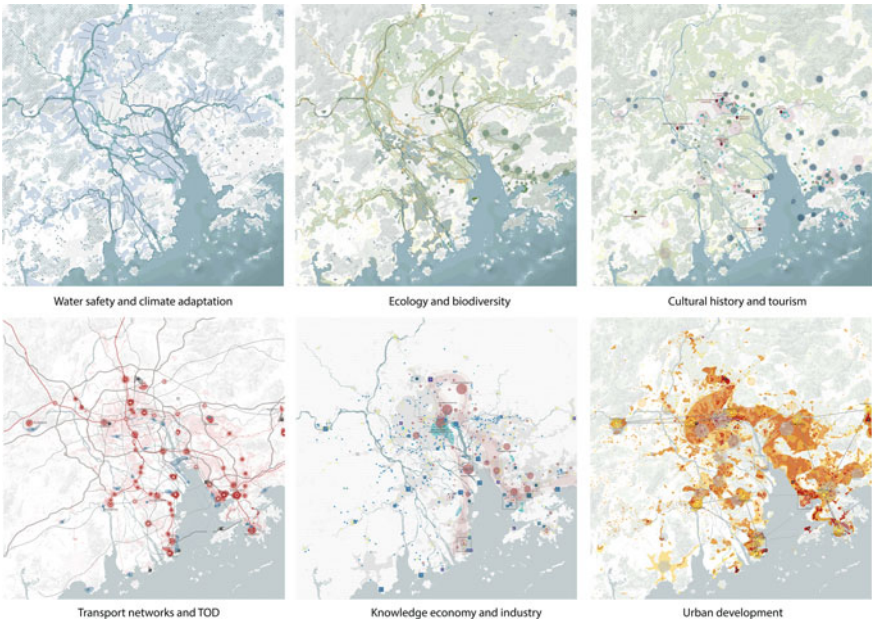

Fig. 5.18 Six transformation strategies for adaptive urban transformation in the PRD. *Image* Steffen Nijhuis, Yimin Sun, Daniele Cannatella and Xie Guangyuan, TU Delft

multifunctional flood protection, harbour and marina development, land reclamation (sedimentation, erosion), the development and transformation of waterfronts as well as the protection and development of mangroves and other coastal ecosystems.

These are only two examples to illustrate how the transformation perspectives can provide guidance in strategic choices for the long term as well as inform short-term design choices as will be elaborated further in the next section. For each of the strategic spatial principles, sets of design principles can also be developed to provide concrete 'tools' for the urban planners, landscape architects and urban designers to translate abstract ambitions into concrete spatial plans and designs (Fig. 5.21). Local adaptation of the various design principles can be tested by research through design while exploring the spatial possibilities of their application and adjusting the principles according to the context and needs. In the framework of this research, these transformation perspectives are further elaborated through pilot projects in the region (Sect. 4.3), concrete design studies for local governments (Figs. 5.22 and 5.23), research projects (Chaps. 11, 12, 13, 14, 15, 16 in this volume), and MSc student design studios (Chaps. 6 and 7 in this volume; Chongwattanaroj et al. 2022; Van Eeden et al. 2021; Qu et al. 2020; Sun et al. 2019).

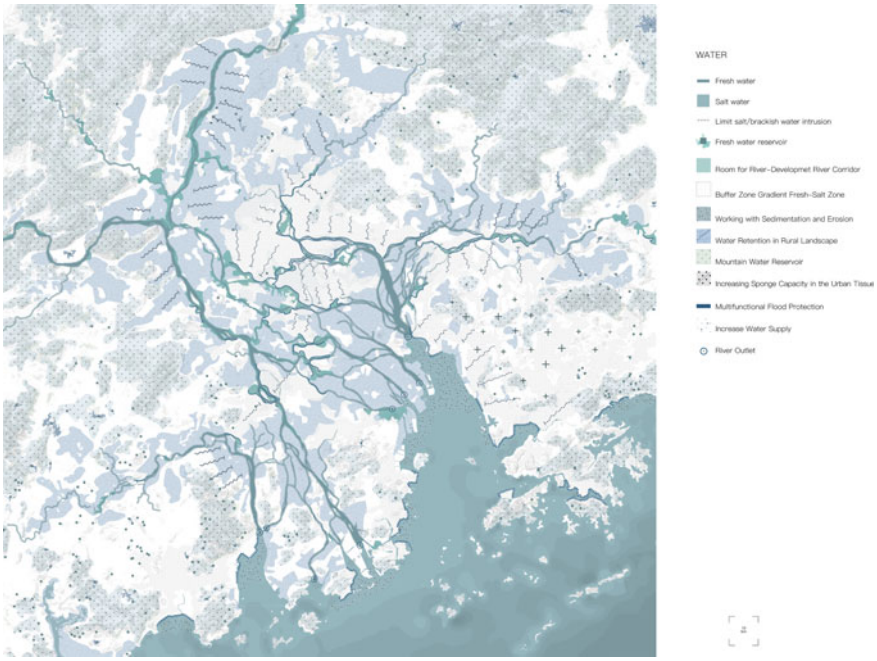

Fig. 5.19 Transformation perspective for water safety and climate adaptation. *Image* Steffen Nijhuis, Yimin Sun, Daniele Cannatella and Xie Guangyuan, TU Delft

5.4.3 Pilot Projects: Nansha Lingshan Island and Pazhou West District

Nansha Lingshan Island and Pazhou West District can be regarded as pilot projects in which designers, policy-makers, citizens, academia and industry experimented, co-created and tested the application of strategic spatial principles as outlined in the transformation perspectives in a real-life environment. The purpose was to think together, contextualise the adaptive design principles through design and implement the ideas in practice and to learn from that. In that regard, we proposed and implemented the 'chief designer system' to transcend the professional boundaries of architecture, urban design, landscape architecture and project development, and to develop an inclusive platform for negotiation and communication, and to implement adaptive design principles in urban projects (transformation perspective urban development).

The development of grand urban projects is at the core of the chief urban designer system as mentioned in Chap. 1. Through the development and construction of urban districts at a mesoscale (measured by kilometres), it can optimise and correct the detailed control plans, explore and design adaptive urban open spaces and establish a balance between economic development, the integration of cultural heritage, the

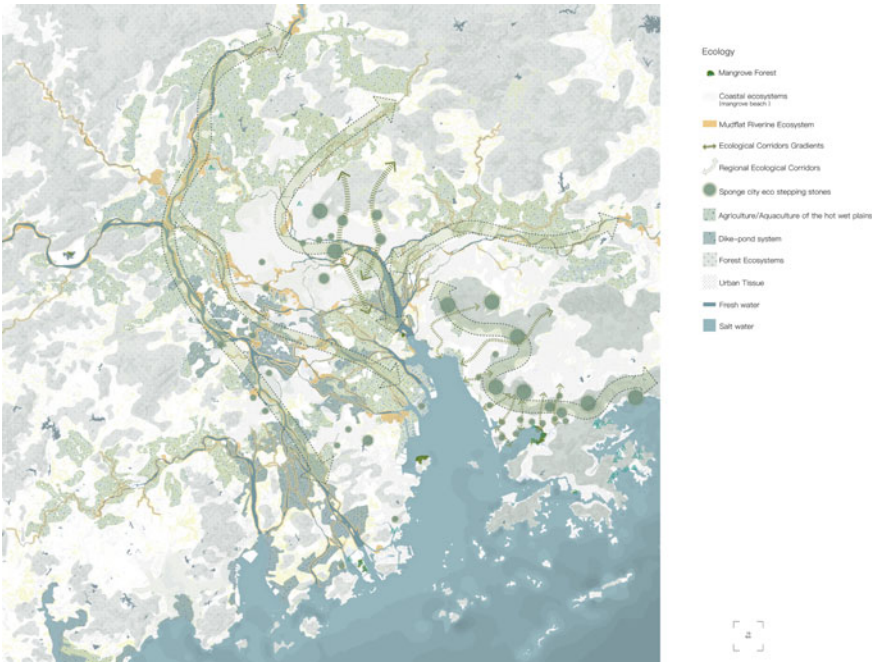

Fig. 5.20 Transformation perspective for ecology and biodiversity. *Image* Steffen Nijhuis, Yimin Sun, Daniele Cannatella and Xie Guangyuan, TU Delft

creation of a green–blue environment and lively public spaces. On the basis of that, the urban design guidelines are therefore incorporated into the legal control, i.e. into the general contract documents of land transactions, legally secures the contractual binding of the fundamental application of the guidelines and avoids various possible negative impacts. Thus, the urban design guidelines would become the starting point for negotiation and coordination amongst multiple parties, and the chief designer team can seek win–win results through negotiation under the premise of safeguarding public interest and environmental benefits.

Nansha Lingshan Island

Lingshan Island is located in the geometric centre of Nansha District in Guangzhou, at the intersection of Jiaomen Waterway, Upper Hengli Waterway, Lower Hengli Waterway and Fuzhou Waterway and Longxue Waterway, with a total area of 103 square kilometres. Nansha District develops into an important city sub-centre of Guangzhou. This CBD is key to the economic development of the region, by introducing financial services, science and technology innovation industries. It has also national significance because it is indicated as a pilot free trade zone, named ‘Guangdong-Hong Kong-Macao cooperation demonstration zone’ (Fig. 5.24).

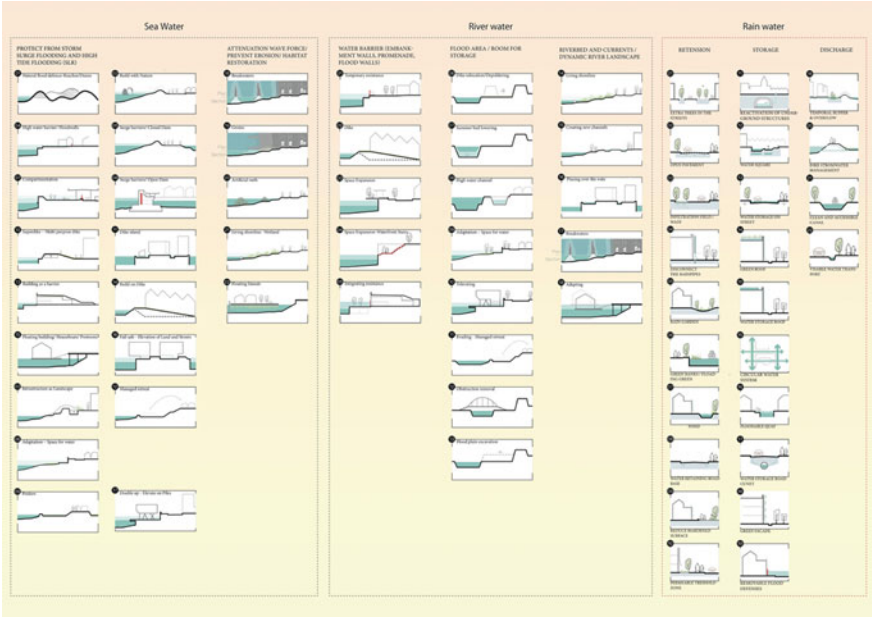

Fig. 5.21 Adaptive design principles for water safety and urban development; sea, rain and river water. *Image* Steffen Nijhuis and Xie Guangyuan, TU Delft

Since 2013, the district administration organised the master planning and design of Pearl Bay and simultaneously carried out the building of infrastructural projects. In 2017, the district authority implemented the chief designer system to develop the tip of Lingshan Island. The chief urban designer and his team (also part of the AUT project) facilitated the full planning and construction process and all-round professional consulting services based on urban design, taking into consideration the existing circumstances. The urban design optimisation plan was developed from September 2017 onwards. The modification of the control plan based on the urban design optimisation scheme was authorised in June 2018 and adopted by the Planning Commission. The urban design standards for the development site were originally integrated into the site planning requirements in October 2018. And the urban design optimisation plan eventually passed the administrative assessment in April 2019. The work system of the primary designer of the full process area of the tip of Lingshan Island was announced in February 2020. So far, the urban design and the chief designer system of Lingshan Island has been running for three years and extended to the Hengli Island tip.

With regards to the regional strategy in the framework of AUT, the project has been optimised in several aspects during the urban design optimisation stage in 2019. Firstly, by understanding, respecting and integrating the geological features of the site, we fully used the potential of building height and volume. For example, by employing the logic of the landscape, the designers made use of the characteristics of the deeper more solid geological substrata (granite/gneiss-layer), in this case 50 m

Fig. 5.22 Design vision for a new urban district in Shantou for the local government co-created in collaboration with national and international experts. *Image* Steffen Nijhuis with OKRA landscape architects

Fig. 5.23 Visualisation of the vision at eye-level with landscape as natural infrastructure. *Image* Steffen Nijhuis with OKRA Landscape Architects

Fig. 5.24 Urban development of Nansha District. *Photo* Yimin Sun

below the surface, to increase the average building height to 150–200 m, instead of the initial plans of 80–90 m possible based on the less stable upper geological layers. Based on this structural rationality, the building volume increased by 40% and at the same freeing up space for green–blue public spaces, nature and water. Secondly, based on the existing road network design, a three-level public space system was created to modify the building scope of the plot. In response to the large and irregular division of the plot since 2013, the public space system of 'public green space–open square within plot–building arcade' was proposed, adding 66,000 m^2 of public green space, about 25,000 m^2 of open plaza and about 24,000 m^2 of continuous building arcade to the Lingshan Island (Fig. 5.25).

Pazhou West District

Pazhou West District is an important portion of Guangzhou's central urban region, Guangzhou compact new CBD, north of the Pearl River, west of Huangpu Chung, east of South China Express, with a total area of 2.1 square kilometres. The area is positioned for the development of headquarters business, the introduction of innovative Internet industry clusters (Fig. 5.26). It is a key site for Guangzhou to establish 'three centres, one system' and achieve the optimisation and adjustment of the industrial structure, as well as one of the ten core platforms of the Guangzhou-Shenzhen Science and Technology Corridor in the Pearl River Delta.

In the framework of AUT, the urban design of Pazhou West was based on the idea that should be developed in a compact, intensive, efficient and integral manner based on a framework of roads and robust green–blue public spaces providing extra space

Fig. 5.25 Urban design optimisation of unit C2 of Nansha Lingshan Island. *Image* Yimin Sun

Fig. 5.26 Urban development of Pazhou West District. *Photo* Yimin Sun

for water storage (e.g. rain gardens), shadow and cooling airflows. Next to that, our team was able to protect ecological valuable features (more than 10,000 m^2), such as wetlands, based on the analysis of the original natural landscape, but also made full use of the existing natural water system and also recovered almost one kilometre of filled river streams. By these actions space for water and nature increased with 38,000 m^2, which is about 10% more than in indicated in the original plan. In terms of energy

use, we advocated energy-saving urban design adapted to the subtropical climate of Guangzhou. In the design optimisation process, simulation software was employed to evaluate the wind flows, temperature and urban heat island effect of proposed urban layouts. This resulted in the implementation of 15 air corridors, 2000 m of arcades on buildings, 10,000 m^2 of underground commercial space, combined with a high-quality public riverfront, a three-dimensional park platform that connects the headquarters of Tencent, Ali and Vipshop 13,500 m^2 (Fig. 5.27).

Because of the regional design approach, local plot boundaries could be transcended. As a result, multiple urban plots were jointly prepared and constructed reducing the cost of, e.g. foundation pit construction by 45 million RMB through sharing underground protective walls and so forth. In terms of land use, the efficiency of land use is actively enhanced through compact development, with the number of development blocks increased from the original 9 to 19, resulting in an increase of 279,000 m^2 of development floor area to 1,164,000 m^2 compared to the original control plan, which increases local government revenue by nearly 3.9 billion RMB based on an average floor area price of 14,000 yuan per square metres. At the same time, more ecological values and space for water could be integrated in the urban development, as well as the much needed and appreciated climate adaptive green–blue open spaces in these high-density environments.

As demonstrated by the application of AUT to the two pilot projects, the regional design approach exemplified by the chief designer system the urban districts could

Fig. 5.27 Urban design optimization of Pazhou West District. *Image* Yimin Sun

be developed in a more coherent and coordinated way. This led to financial benefits on the short term but also contributes to a sustainable and socio-ecological inclusive urban region.

5.5 Conclusion

The PRD's urban landscape is the result of various processes and systems that display different dynamics of change and which impact each other. The ability to interrelate systems through spatial design has become increasingly important, as the interconnection of different systems, and their formal expression is a fundamental aspect of contemporary regional development. Here, we have advanced a landscape-based regional design as an inclusive planning and design approach for the adaptive transformation of the PRD. In this approach, the interrelation of urban landscape systems and governance through planning and design was helpful to achieve more integrated and resilient governance of deltas. At a time of complex challenges, the development of alternative approaches such as this offers a pathway to realising socio-ecological inclusive design processes as well as modes for collaboration amongst disciplines and stakeholders. This will help to increase the adaptive capacity in urbanising deltas by institutional, cultural and financial innovations that are needed in territorial governance to steer the development of urban and rural areas to achieve more integrated and resilient futures for urban deltas such as the PRD. Landscape-based regional design as an approach proofed to stimulate cooperation between designers, experts, policymakers, industry and other stakeholders. This led to co-creation of adaptive spatial development strategies and build support for suitable interventions and measures through interactive communication and decision-making in design, planning and management. As a result, established and regular urban transformation processes are used as opportunities to adapt systems in urbanised deltas at relatively low costs.

As demonstrated by the application of this approach, through the chief urban designer system in the pilot projects, this results in cost-saving plans by coordination of actions and joint efforts, as well as considerable financial revenue on the short term by optimisation of the design employing the natural characteristics of the site. More importantly, this adaptive urban transformation led to protection and development of regional green–blue infrastructures and city-level water networks that increases the adaptive capacity of the region, ecosystem services as well as water safety, which will also save cost on the longer term.

In sum, landscape-based regional design brings new operational power to spatial design—as an integrative, creative activity—and recognises the regional urban landscape as a significant field of inquiry, one that is context-driven, solution-focused and transdisciplinary. Furthermore, as an inclusive design approach, it establishes relationships between ecological and cultural factors, between process and form, between long-term and short-term developments as well as between regional strategies and local interventions. As such, landscape-based regional design is a powerful vehicle for guiding territorial transformations in a process of creating local identity

and safeguarding regional relationships, while simultaneously linking ecological and social processes to urban forms. The application of landscape-based regional design offers a way of resolving the conflicts and threats that arise between economic development and environmental recovery, as well as reducing the negative repercussions of climate change.

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