

## Article

# A Reflection on the Implementation of a Waterfront Greenway from a Social–Ecological Perspective: A Case Study of Huangyan-Taizhou in China

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**Abstract:** In recent years, awareness has grown of the vital importance of ecological systems, provoking increased research into how to improve their resilience. Here, one popular new technical/management solution is the creation of greenways along riversides. In practice, however, the practical outcomes of such greenways have sometimes been disappointing due to an excessive focus on technical solutions at the expense of a sufficient consideration of the social impact. This study intends to reflect on the problem by looking at the dynamics of land use for ecosystem functions at the macro scale as well as the relationship between the implementation of greenways and the local demand for diverse everyday activities, in particular, recreation opportunities, at the micro scale. Based on this, it aims to reveal practical solutions to bridge ecological usages and everyday needs that achieve better preservation and services of ecosystems. Taking the greenways along the Yongning River (YRG), which runs through the urban–rural areas and the urban–rural interface of Huangyan-Taizhou, as a case study, GIS analysis and anthropology approaches were applied. The results show that the YRG has systematically improved the riparian ecosystems by better connecting the eco-land use and preserving the waterfront. At the same time, its ability to fulfil the large potential for leisure and recreation services needs to improve. Residents living in different parts of the city had disparate requirements depending on their patterns of daily behaviour. We conclude that the successful implementation of greenways in cities should not only consider technological and nature-based solutions but also consider the socio-cultural background. The diversity of local needs regarding everyday activities and recreation will lead to an equivalent diversity in riparian landscape design.

**Keywords:** ecosystem services; waterfront greenway; recreation; nature-based solution; culture-based solution



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## 1. Introduction

Over recent years, sustainable development and resilience have garnered increasing attention across various development agendas and research disciplines. Issues related to sustainable development such as climate change, biodiversity loss, deforestation, pollution, and so on highlight the fact that human wellbeing depends on the preservation of our natural world. Scholars in sustainability science have proposed the integration of action, adaptive management, and policy experimentation, necessitating new methodologies to generate “semi-quantitative models of qualitative data drawing on insights from case studies” [1]. While there has been significant progress in the development of advanced tools, technologies, and market mechanisms to regulate pollution and carbon dioxide emissions, there is some evidence of resistance to these solutions (ibid). This resistance stems from the widespread impact of human activities on the environment, leading to

a growing consensus on the need to explore environmental solutions within a broader spectrum of social sciences, thereby bridging social and biophysical sciences [2].

Simultaneously, an increasing focus on urban issues [3] validates Lefebvre's assumption that "society has become entirely urbanized" [4]. Specifically, the notion of planetary urbanisation posits that spatial transformations within urbanisation processes have repercussions on landscapes, regardless of whether these are classified as urban or rural, central or peripheral [5]. Consequently, the attainment of global development goals, such as the UN's Sustainable Development Goals (SDGs), is increasingly perceived to hinge on the extent of cooperation between agencies and stakeholders to work on a wide range of territories within urbanisation processes.

Against the background, the concept of ecosystem services (ESSs) was introduced to capture this interaction between the environment and human wellbeing in urbanisation processes. ESSs are generally used to describe and assess the benefits that humans obtain from nature [6]. Taken as a critical factor in providing ESSs, riparian ecosystems play a vital role in enhancing urban resilience and sustainability. A riparian ecosystem is the buffer or transitional zone between a river or stream and the upland area. Typical examples are riverbanks, floodplains, and wetlands [7]. Riparian vegetation acts like a sponge, and thus, such areas are important for water conservation, water purification, and rainfall and flood regulation [8,9]. The buffering capacity directly impacts the water and ecological security of nearby urban areas. Riparian buffers also prevent erosion, regulate the local climate, support recreation, and provide habitat and nursery functions for a wide range of aquatic, amphibious, and terrestrial organisms [10]. Riparian areas are prime candidates for use as conservation buffers not just in rural/agricultural areas but also in urbanising areas [11,12]. In addition to enhancing ecological resilience, riparian ecosystems have the potential to offer a range of residential, commercial, leisure, recreational, heritage-related, and artistic uses, thereby yielding a multitude of economic, social, and environmental benefits [13].

Waterfront greenways are an effective way to integrate the social–ecological functions and services of riparian ecosystems. In recent years, many new greenway projects have been established around the world, especially in the Global South and other quickly urbanising countries. China also has actively been exploring strategies to achieve sustainability through landscape planning and spatial transformation. Here, greenways are a practical approach, well received by scholars, government officials, and citizens, and have been widely implemented in numerous cities. Among other benefits, they effectively connect previously unlinked natural resources, establish extensive ecological corridors, enhance the living environment, and integrate nature into daily life [14]. Greenways represent a type of 'spatial product' that fulfils both ecological requirements and recreational needs. However, well-designed greenways that generally cost large amounts of public investments sometimes also witness unexpected outcomes in practice, such as a low frequency of visits, bottom-up transformation in use, and space for unused facilities. This reflects a mismatch in the designed space and the required space.

Therefore, to reflect on the reasons for the above-mentioned mismatch, and improve the efficiency and satisfaction of ecological services such as greenways as well as serve sustained development and human needs better, we selected the greenway of the Huangyan-Taizhou region as a case study in order to address the following key questions:

1. How are forms of land use and ecosystem services—in particular, cultural services (e.g., recreation)—impacted by the process of urbanisation?
2. What forms of everyday activities are performed in different parts of the greenway, specifically in urban and rural areas as well as the urban–rural interface?
3. For more sustainable planning and improved decision-making, how can the social–ecological perspective support a better understanding of human–nature relationships?

## 2. Case Selection and Methodology

### 2.1. Case Selection

To investigate the above key questions, we chose the Chinese city of Huangyan-Taizhou as our research site. This was one of the first cities in China to implement a greenway system, and has been improved and upgraded over time. The greenway on the Yongning riverside (hereafter referred to as YRG) runs from the urban centre through the urban–rural interface into nearby rural and mountainous regions. This provides an ideal site for our study that focuses on two spatial scales: at the macro scale, we investigated the YRG in the Huangyan District to determine the overall ecosystem functions of the greenway and related land transformations; further, at the micro scale, we looked more closely at various sections of the greenway with manifestly different ecosystem services and demands for these. A field survey enabled the mapping of land use characteristics and specific implementation methods of ecosystem functions, as well as people’s activities and the reshaping of the green space.

### 2.2. Methodical Frame-Scheme for Trans-Scaled Research

Mixed methods were applied to obtain an understanding of landscape planning for land transition and the greenway systems (district level), which are designed to improve local ecosystems, at the macro scale, and of everyday activities (e.g., recreation) at the micro scale. The overall aim was to pinpoint the interconnections between ecosystem restructuring at the macro scale and changes in the ways local people use the greenways in the course of their daily lives. The plan at the macro scale guided the use of land and the introduction of functions and services at the micro scale, while in return, people’s everyday use and their initiatives reshaped the designed greenways and further diversified the functions of the YRG. To this end, we employed GIS analysis, archive studies, and anthropological mapping and analysis (See Figure 1). The former two were applied to support our research at the macro scale. The interviews, questionnaire investigations, participatory observations, and workshops supported the anthropological mappings. Drawing on the empirical evidence, this research could help us reach our main goal of nature- and culture-based solutions for greenway plans and designs that avoid spatial diversity merely based on the design of space but instead are based on everyday use.

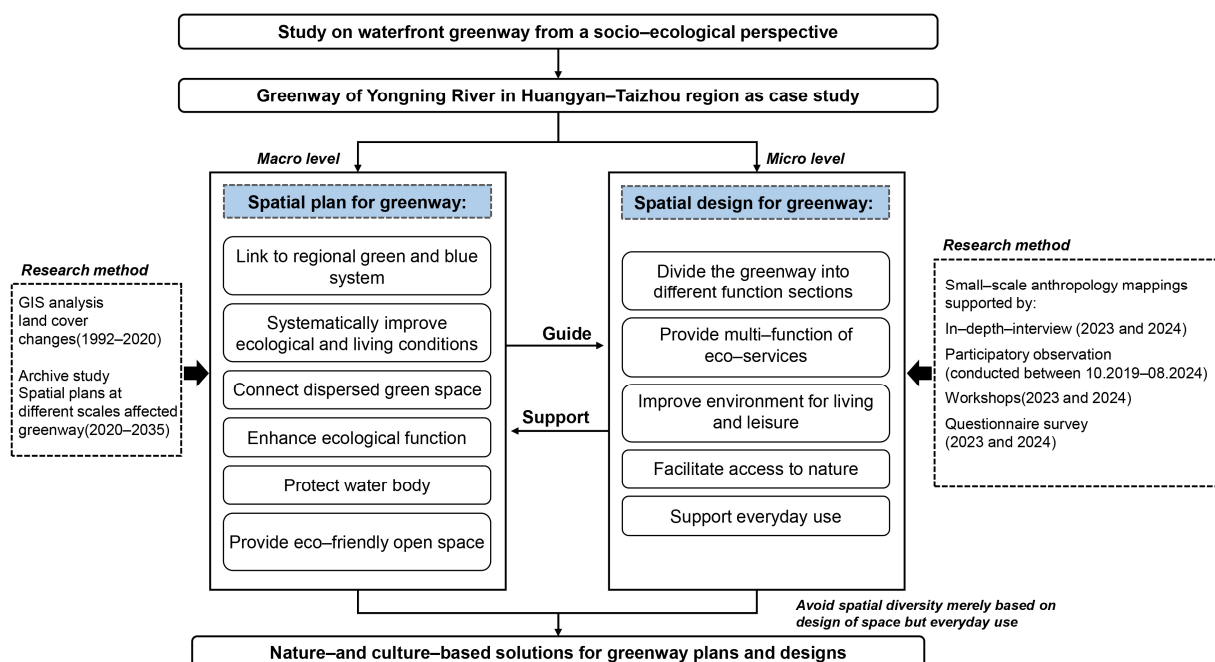


Figure 1. Methodical frame-scheme.

### 2.3. Methods and Data Collection

The GIS analysis was used to process macro-scale satellite data. Specifically, we calculated the spatial and quantitative distribution of the mapped land cover classes between 1992 and 2020 to give a general picture of land transitions and changes in green space. The capacity of ecosystem services was therefore evaluated. We specifically chose the time frame 1992–2020 for two reasons: one is the data availability, and another, more importantly, is that it reflected the era of rapid urbanisation [15,16] mainly in the form of land transformation. In addition, the archive studies were also applied to understand the plans for blue and green system planning, specifically the aims, approaches, and layouts. Therefore, “Taizhou City Comprehensive Land and Space Plan (2021–2035)”, “Planning of Urban Green Space System in Taizhou City (2020–2035)”, “Detailed Urban Design for the Waterfront Scenic Area of Yongning River in Huangyan District (2020)”, “Comprehensive Tourism Development Plan for Huangyan District, Taizhou City (2020–2035)”, “Landscape Design of Yongning Park in Huangyan, Zhejiang (2009)”, and “Ecological Environment Improvement Project for the Downstream Section of Yongning River Greenway (2020–2021)” were studied.

To understand how landscape planning has helped reshape and restructure ecosystems through greenway implementation (in particular, its impacts at the micro scale), we applied participatory observation, in-depth interviews, questionnaire surveys, and workshops. These investigations aimed to reveal diverse activities in specific locations, the differences in their distribution, the possible reasons for these differences, and how they reshaped the landscape for everyday uses. The participatory observations for investigating local usage on the YRG were conducted between October 2019 and August 2024. The specific periods of observation were workdays, weekends, holidays, and during cultural events. We also considered the differences in use at particular times of day, i.e., in the morning, at lunchtime, in the afternoon or evening. The observation of patterns of use in everyday life and changes in the landscape of the YRG focused on those areas close to residential plots. In addition to the formal use of designated areas in greenways, we also looked at informal use and changes in land use due to residents’ initiatives, which may indicate a mismatch between designated use and function needed. This method also helped us understand the social meanings of these changes through everyday activities; in other words, the ways in which locals perceived these new greenways in their everyday lives, and whether this differed from the planning perspective. The observations were recorded as photos as well as in notes and sketch drafts, which were later translated into anthropological maps.

We also conducted in-depth interviews and questionnaire surveys between 2023 and 2024. The questions were focused on the participants’ use preferences of the YRG, such as their personal information, reasons they did or did not go to the greenways, how often they visit there, how long they spend travelling to it and in the greenways, what the most attractive points were, and what could have been improved. This supported the cross-referenced study with participatory observations to analyse the everyday use preferences of the residents and their needs.

Three workshops were conducted between 2023 and 2024 in Huangyan and the neighbourhood close to the YRG, with planning professionals and local authorities as well as residents directly engaged in the transitions or who used the YRG in their daily lives to determine whether such changes were viewed positively. They were invited to map their travelling routes and select their preferred use of greenways. They were also engaged in discussions of what changes could be made to improve the greenways, what the main challenges were, and the reasons for them. The authors played the roles of moderators to make sure the key questions were delivered, to help the participants clearly express their opinions, and to take notes and draw sketches. In doing so, this helped the authors further understand the participants’ everyday routines and pinpoint the reasons for some of the activities and formal/informal use of land identified in the observations.

Empirical evidence obtained from these methods was later supported by the map reflecting the everyday use of the YRG, specifically focusing on the commonalities and



differences in various types of formal use as well as informal use that changed the plots of space in the greenways. The mappings emphasise the diversity in uses; therefore, the peak hours of the use of different sections were identified via field investigations and presented in the research (i.e., case study) to support further analysis.

### 3. An Understanding of Greenways from Social and Ecological Interactions

#### 3.1. *The Social–Ecological System*

Greenways are widely applied and adapted to certain urban areas (e.g., where there is insufficient land to provide ecosystem services), to meet specific needs (e.g., the desire for natural areas and a better environment), and to fulfil certain priorities (e.g., sustained use of land) with the overarching aim of achieving sustainability [17–19]. Sustainable development and the improvement to ecosystems are not a problem specific to ecology, the economy or society, but rather can be viewed as a multifaceted issue, one that combines theories of ecology and changes, variants of free market models, values of diversity, and knowledge of community and social organisation [1,20]. However, as each of these theories only provides part of the solution [1], transdisciplinary efforts are required to develop synthesised systems, among which social (including economic) and ecological systems (SESs) have seen the most progress. An SES is a nonlinear system characterised by resilience, adaptability, and social transformability [21] that offers a new perspective on transformation towards sustainable development [22]. Emphasising the integration of humans in nature and links between social and ecological systems, it aims to reveal the impact of human activities on ecological systems and the ability to adapt these activities towards sustainability [23]. Recent studies on SESs have mostly focused on complex relationships and interactions, trans-scale effects, systemic tipping points, as well as transformability [22].

Various approaches have been applied to obtain a more comprehensive portrait of social–ecological interactions. Conceptual frameworks to guide the evaluation of SESs have proposed a range of economic and political settings, resource systems, resource units, and target actors [24] as well as the identification and classification of relevant variables [25]. Moreover, assessment frameworks have been proposed to quantify different aspects of SESs (e.g., resilience, adaptation, and transformation) and render these comparable, though these frameworks and methodologies still need further refinement [26]. Various empirical case studies have also been undertaken to investigate SESs, applying quantitative, qualitative, or mixed methods [27]. In addition to scholarly efforts, the wisdom of crowds (supported by graphical mental models) has been explored to develop a scientific understanding of complex social–ecological systems [28]. Moreover, the research on the general framework of social and ecological systems also supported the study of more complex relationships between space management and multi-functioned ecosystem services [29]. Although knowledge of SESs has been growing, with a better understanding of the limits of technological solutions, there remain practical challenges in decision-making and project implementation. The underlying complexity and uncertainty of SESs still constitute a barrier to co-productive processes and broader participation [22].

#### 3.2. *The Perspective of Ecosystem Services*

There are different types of ecosystem services. Their interactions were revealed to be complex, and their spatial patterns were also shown to be heterogeneous [30]. The four major services of ecosystems to society are usually summarised as supply services, regulatory services, support services, and cultural services. Cultural services are the nonmaterial spiritual and psychological benefits provided by ecosystems, including areas of natural beauty and their recreational and educational opportunities, etc. In recent years, research into EESs has focused ever more on inter- and transdisciplinary cooperation and combined ecological and socioeconomic approaches [31]. The concept and demand–supply of ESSs also help integrate nature protection concepts into decision-making and planning systems to support sustainable and inclusive development [32].

Riparian ecosystems provide a variety of ecosystem services. At a time of rapid changes in land use due to expanding populations and built-up land, greater attention is being paid to human wellbeing in the fields of landscape planning and policymaking. Unfortunately, it is still rare to see any spatial evaluation of ecosystem services or indeed an analysis of interdependencies in socio-ecological systems. Human life is fundamentally reliant on nature, both materially and immaterially, and recent studies have also proven that it serves human mental wellbeing positively [33]. Therefore, greater attention has been paid to this latter factor, i.e., nonmaterial wellbeing, which is usually placed under the umbrella term ‘cultural ecosystem services’ (CESs). These have been defined by the Millennium Ecosystem Assessment 2005 as “the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences” [34].

Compared with other ecosystem services, CESs are determined and shaped by intimate human–nature interactions within the social–ecological system. One empirical study on the management of social–ecological systems revealed that CESs were the most frequently mentioned in a survey of how ecosystem services are perceived, including both social and local ecological characteristics, for example, land use and climate impacts [35]. CESs were also proven to be the only one of the three ESS sections (i.e., provisioning, regulation and maintenance, and cultural) that affected the whole process of urban green space development, though the content has been changing [36]. CESs are not scattered randomly across a landscape, but rather follow specific patterns in terms of their provision as well as the demands of different social groups [37]. The provision of services is related to landscape features and the forms of land cover, such as services provided by protected areas [38]. At the same time, local demands and preferences are not necessarily closely aligned to the supply of any service, especially those of recreation, aesthetic experience, identity, and cultural heritage. Therefore, to thoroughly understand CESs, we must investigate their supply and demand in order to capture the complexity of a social–ecological system [39]. For example, demand–supply analysis is applied to support the research on opportunities for ecotourism, which is an important part of CESs [40].

While cultural services are increasingly spotlighted, the trade-off and synergies between different ecosystem services cannot be ignored. Some publications have pointed out the overlapping of cultural and provisioning services; e.g., fishing and hunting provide both food and recreation as well as the maintenance of traditional knowledge and the cultural heritage [41]. Other research has shown the conflicts and synergies of regulating, provisioning, and cultural services, for example, in the urban–rural interface, where informal vegetable gardens near rivers may impair the water quality at the same time as vegetable planting provides food (provision services) and recreation (leisure activities). One study has shown that among various types of usage related to cultural services, the most prominent are recreation and landscape aesthetics [42].

### 3.3. Summary

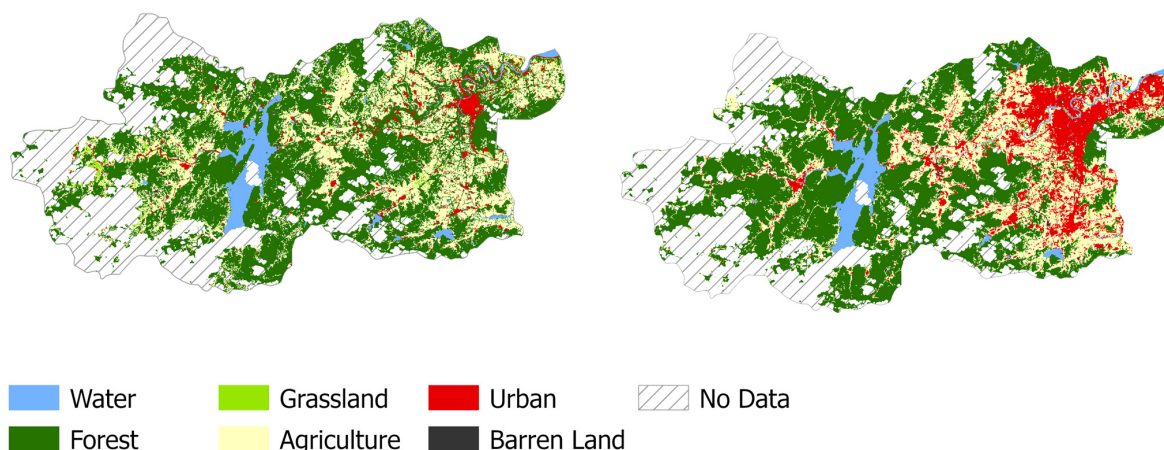
Existing studies have shown the importance of understanding ecological systems and corresponding solutions (such as greenways) to ecological problems from the perspective of ‘humans in nature’. The riparian ecosystem is seen to be useful not just in dealing with climate change and environmental issues but also in the other various services that benefit humans, such as recreation. While comprehensive studies have been conducted to obtain insights into its complex impacts, interrelationships, and functions, further efforts are needed to evaluate ecosystem services from the spatial and social–ecological perspective under an interdisciplinary approach. At the same time, trans-scale investigations are required that make use of both quantitative and qualitative methods.

Drawing on existing studies and considering the research gaps regarding SESs and their various functions, we conducted this empirical study to investigate two key intertwined aspects, namely, human–nature relationships and trans-scale interactions. Our specific research focus is the greenway.

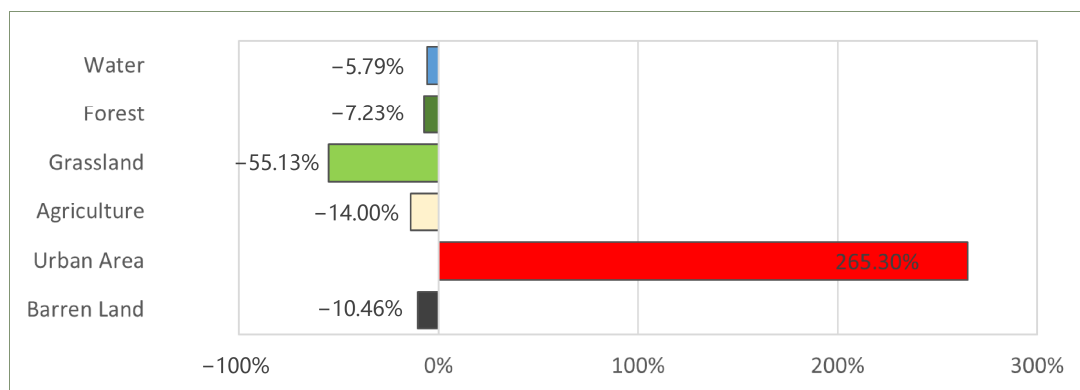
#### 4. Analysis of Ecosystem Services and YRG in Huangyan-Taizhou

##### 4.1. Dynamics of Land Use and Ecosystem Services in Huangyan

The macro-scale maps in Figure 2 show the changes in land cover in Huangyan-Taizhou between 1992 and 2020. In particular, we can see the dominance of forested and agricultural areas, followed by urbanised land. The analysis of land cover indicates continual growth in urban areas, a process which accelerated in the named period. From around 3% of the total area of Huangyan in 1992, the share of built-up land rose to 13% by 2020. Although urban areas accounted for a relatively small share of the total land cover, this proportion grew dramatically in the period 1992–2020, namely, by around 265% (Figure 3).

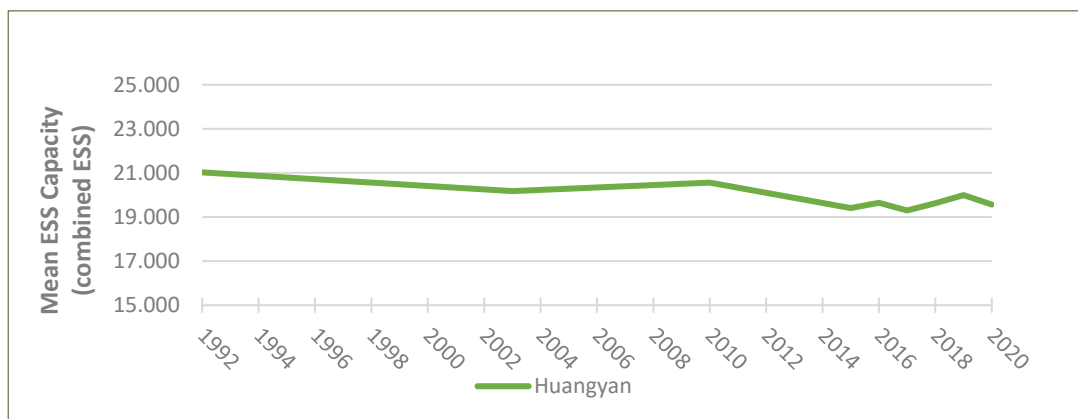


**Figure 2.** Land use and land cover in Huangyan in the years 1992 (left) and 2020 (right). Source: maps by A. M. Haase, IOER.



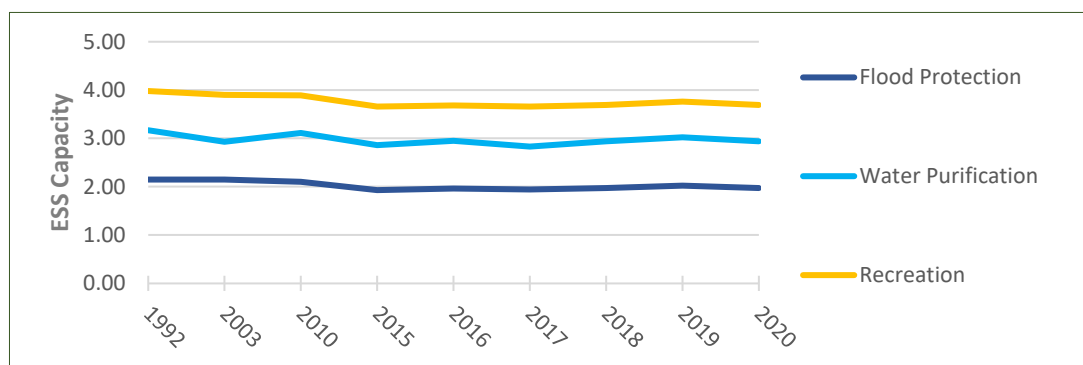
**Figure 3.** Relative change in land cover classes in Huangyan in the period 1992–2020. Source: modified from Xiao et al., 2022.

An investigation of the overall capacity of ecosystem services (ESSs) in Huangyan District in the years from 1992 to 2020 revealed a gradual yet distinct decline, with particular decreases in 2015 and 2017 (see Figure 4). This trend is closely linked to the reduction in vegetative areas, particularly woodland. Given that forests cover a significant portion of Huangyan, they play a prominent role in biodiversity conservation initiatives and the assessment of ecosystem service capacity. The diminishing forested area was undeniably a key factor in the decline in ESS capacity during the specified period. The primary cause of the reduction in forested areas can be attributed to urbanisation as well as an increase in cultivated land. This underscores the critical importance of safeguarding and rejuvenating forests and grasslands in the future, particularly within peri-urban regions.



**Figure 4.** Trend in mean ESS capacity in Huangyan in the period 1992–2020. Source: modified from Xiao et al., 2022.

In addition to analysing the overall ESS capacity, we also considered individual ESS indicators. In Huangyan, the ecosystem service with the largest capacity was found to be recreation (Figure 5), while water purification, rainfall regulation, and the provision of drinking water also play important roles. Changtan reservoir in Huangyan is one of the main sources of drinking water in the Huangyan-Taizhou region, and measures to protect water resources and rationalise utilisation here have helped strengthen and improve water purification, biodiversity protection, and ecological recreation. However, the fact that irrigation ditches and the river network around the reservoir lack ecological buffer zones greatly reduces the flood retention capacity and raises the potential risk of flooding. In addition to dredging the river network further, it is imperative to protect and restore the region’s wetlands. Huangyan has a high potential for leisure and recreation services, especially green eco-leisure services, which need to be further upgraded and expanded.



**Figure 5.** Trends in individual ESS capacity in Huangyan. Source: modified from Xiao et al., 2022.

Based on the above analysis at the macro scale, we identified the greenway along Yongning River for a micro-scale study. Running all the way from urban to rural Huangyan, the greenway links areas that have undergone different levels of land transformation and which have varied requirements for spatial function and everyday use by local residents. It also serves as an important project to improve the local environment. Meanwhile, the various sections of the greenway can be viewed as multi-functional spaces that provide both ecological and cultural services.

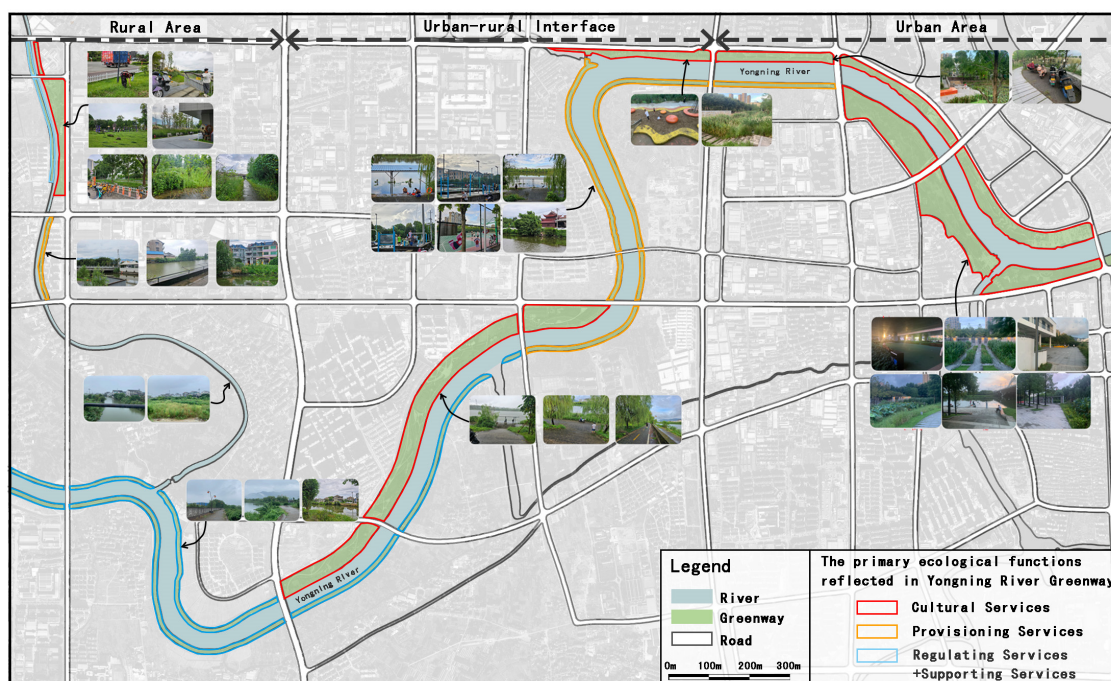
4.2. YRG in the Local Plans for Green Space

There are around 2400 rivers in the main districts of Taizhou, including the Jiaojiang River, Yongning River, and Dongguan River. Covering an area of more than 46 km<sup>2</sup>, these waterways greatly affect the local ecology and the spatial layout of the land cover. The



Taizhou municipal authorities have emphasised green space planning since the 2010s, in particular, promulgating and implementing the “Taizhou City Urban Green Space System Plan (2019–2035)”, which aims to introduce green space into the city, improve the living environment, ensure a completely functioning ecological system, and promote efficient eco-services. The YRG, which runs across Huangyan District, is the highest-level corridor in Taizhou City’s greenway planning, and namely, is a municipal ecological corridor. Running directly through Huangyan City up to Changtan reservoir, the total length of the YRG is 45 km. It features 15 large and small rest stations, 25 rest spots, 23 public sculptures, and 12 guard booths.

Based on the preliminary field investigations and observations, we were able to identify various sections of the YRG, which were then classified into one of three sections according to their geographic location, i.e., urban, urban–rural interface, or rural (Figure 6).



**Figure 6.** Identified sections of YRG. Source: authors’ own construction.

#### 4.3. Three Sections of the YRG in Huangyan-Taizhou

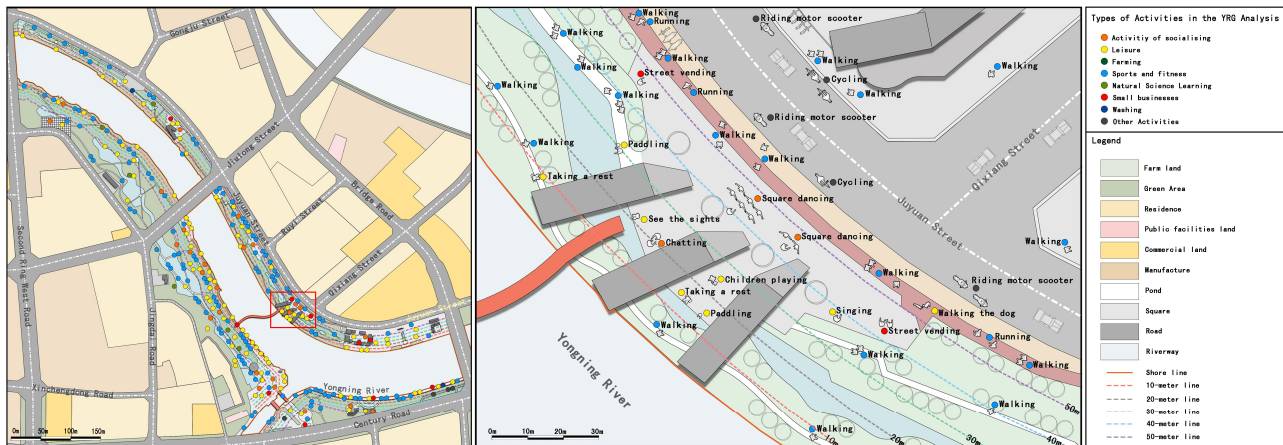
##### (1) The urban section

This section connects Daqiao Road and Jiulong Street of the urban area of Huangyan District. The greenway is 1300 m in length and the average width is about 100 m. The surrounding areas on both sides of this part of the YRG are mainly residential and busy large-scale commercial areas with interspersed small-scale industries and small plots of rural housing. The local administrative offices are also located alongside the greenway. The YRG’s amenities on this section are diverse, including small public facilities (e.g., restrooms and fitness areas) and larger public services (e.g., cultural centres, science museums, and creative parks). The organised activities include large commercial events and cultural activities (e.g., traditional theatre performances and dancing) as well as a wide range of recreational activities (e.g., public square dancing and skateboarding).

The ecological services and social functions, which are highly mixed in this part of the YRG, are characterised by local cultural features. The space was found to accommodate a variety of activities in the course of a day (Figure 7) and is the most dynamic of the three greenway sections. For example, two or three groups gathered at one location for square dancing. Due to the large flow of people on the square at the intersection of the greenway, some vendors set up stalls there. According to the business owners, “It’s lively here, with many people, and good for business” (in-depth interview, March 2024). The number of



people exercising and keeping fit is larger than on the other two sections. One person interviewed on the greenway stated the following: “I live in the neighbourhood. I come here to run four or five times a week, and I run around the entire park each time” (in-depth interview, March 2024).



**Figure 7.** Daily activities on the urban section of the YRG (recorded at 7 p.m. on weekends). Source: authors' own construction.

## (2) The urban–rural interface section

This section of the YRG located at the urban–rural interface of Huangyan is close to the New Town Road. The total length is about 600 m, with a width of approximately 70 m on the west bank, where the public facilities are more diverse, and a width of 26 m on the east bank, which offers much fewer facilities. Rural residential areas and spaces for everyday activities (e.g., farming, businesses, household workshops) are distributed along the greenway. Here, the YRG is largely surrounded by agricultural fields and rural housing. Large- and small-scale manufacturing industries as well as household workshops are distributed in the neighbourhood. According to the local ‘blue and green’ ecological system plans, the main ecosystem function of this section is provisioning, with some cultural functions. The types of activities are diverse: we identified farming and washing vegetables/clothes in addition to leisure activities, daily exercise and fitness, nature education, and small businesses.

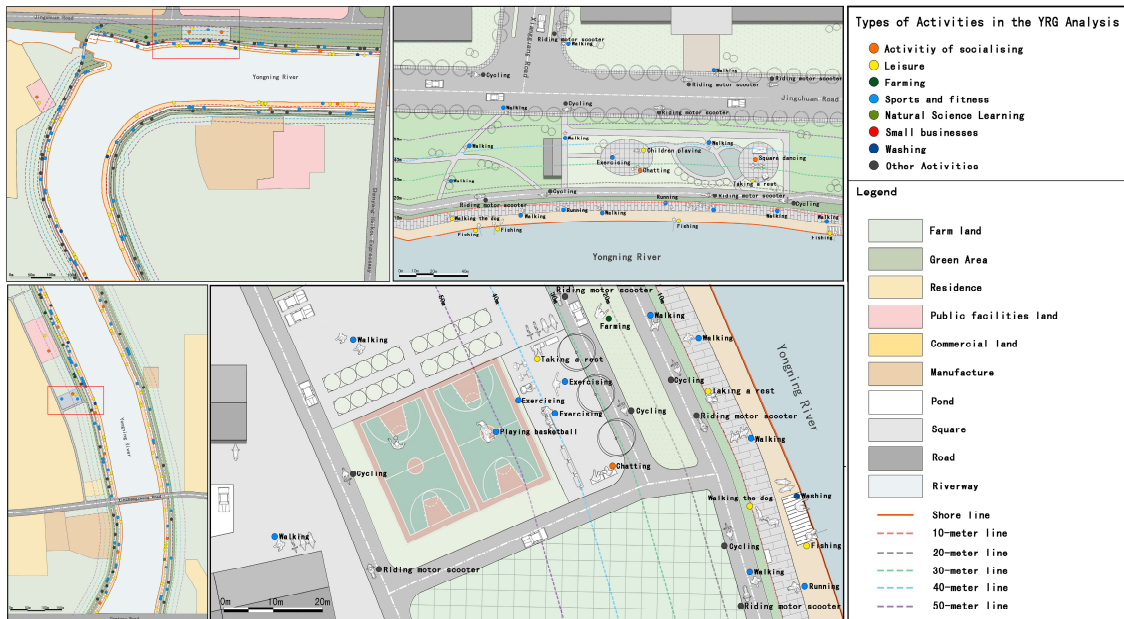
The proportion of people cycling (e-bikes and non-e-bikes) and engaging in sports and fitness activities is relatively high on this stretch of the greenway (Figure 8). Generally, people do not stay here for a long time. Some local residents come here to sit and chat on the seats beside the greenway while others gather in the nearby open space to use fitness equipment and chat while exercising. In addition, some children are brought here by their parents from nearby areas to play. One parent said the following: “We come here almost every day, and we sometimes meet our neighbours here and always enjoy a chat together” (in-depth interview, 2024). One older man playing the Hulusi flute stated the following: “I come here about once a week on average; there are fewer people here, and the environment is good. This puts me in a good mood” (in-depth interview, 2024).

## (3) The rural section

This section of the YRG is located in the west of Huangyan District, close to a so-called ‘smart model town’. The total length is around 700 m, with a width of about 60 m on one bank only. The greenway features an enlarged landscape node, namely, the Smart Model Town Theme Park, which provides facilities for sports, fitness, and everyday leisure. The park also provides free public toilets and parking spaces for e-bikes and bicycles. The tradition of local industries has been reflected and emphasised in the landscape design of this park.

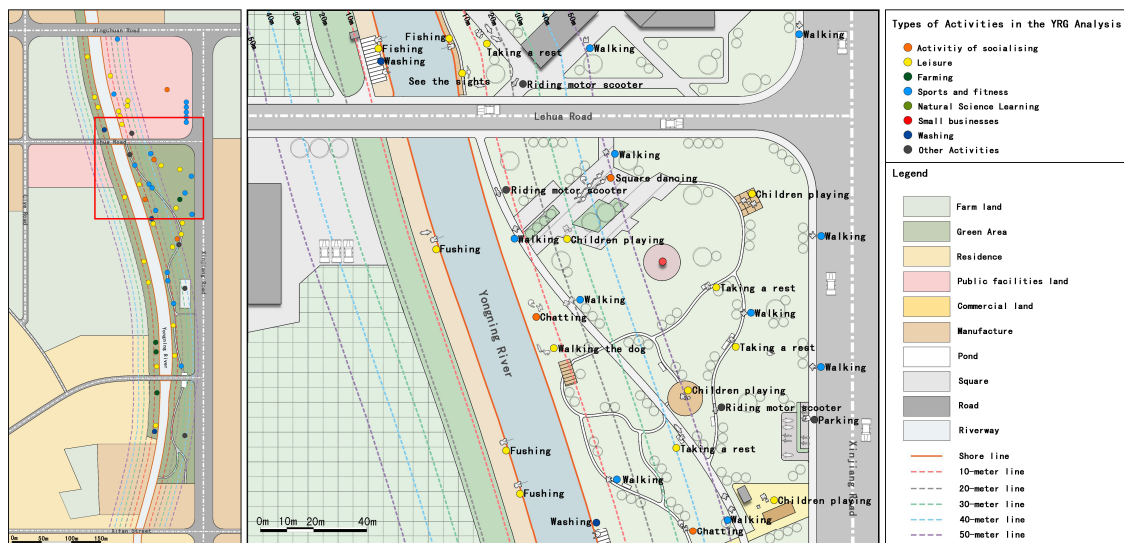
While physical activities such as walking and doing sports were identified in this section, the number of people engaged in these was smaller than in the urban section.

Additionally, we identified activities such as picking wild herbs, fishing and farming in the greenway grassland.



**Figure 8.** Daily activities on the urban–rural section of the YRG (recorded at 4 p.m. on workdays). Source: authors’ own construction.

The majority of users in this section of the greenway are delivery riders on their breaks and children playing (see Figure 9). Many people also rest on the seats beside the greenway, while others (mainly local villagers) fish by the river. One person angling by the riverbank said the following: “I often come to fish, about once every two or three days on average, even if it’s raining” (in-depth interview, 2024). In this section of the greenway, compared to the other two, there was a noticeable increase in activities such as transforming the landscaped green areas into vegetable plots and picking herbs over the period of observation. Most of the cultivation and herb-picking activities are carried out by elderly people. One elderly person picking herbs along the greenway said the following: “I usually move around nearby, and if I see herbs here, I’ll pick some” (in-depth interview, 2024).



**Figure 9.** Daily activities on the rural section of the YRG (recorded at 3 p.m. on workdays). Source: authors’ own construction.

## 5. Results

At the macro scale, the GIS analysis showed a drastic decline in grassland, and the ESS analysis supported by a field investigation also showed a slight decrease in the overall capacity as well as individual capacity for activities such as water purification and recreation. In addition, the archive study also showed that a more connected 'Blue and Green' ecological system has been emerging and has great potential for a CES. And the waterfront greenway plays an important role.

At the micro scale, the maps of the YRG show the various typical activities on the three sections of the urban, urban–rural interface, and rural areas at representative times (i.e., peak hours of use) of the day. An analysis of the maps combined with a field investigation revealed both similarities and differences in the usage and requirements of the urban, urban–rural interface, and rural areas of Huangyan.

The similarities are largely reflected in the type of leisure activity, the frequency of use, and the interconnections between the use of the YRG and the forms of land use in the neighbourhood. (1) Regarding activities, many people fish along the waterfront of the greenway and also use the river water to wash vegetables, clothes, etc. (2) Regarding the frequency of use, the number of people present varied significantly at different times of the day; around dinnertime was a popular time for people to relax in the greenway. (3) The use of the YRG was closely linked to the type of surrounding area, i.e., sections of the river running close to residential areas have relatively high usage rates and a wide range of activities occur there.

Differences between the three sections of the greenway are also reflected in the usage rates, duration of stay, peak time of use, and the informal use of spaces. (1) Among the three sections of the greenway, the urban section has the highest usage rate and the longest duration of usage. (2) The urban section is the only part where people stay for longer periods. (3) The urban section of the YRG also shows the most diverse types of activities, while the other two sections are mainly used for sports, fitness, and short breaks. (4) Apart from residents and local workers, the urban stretch of the greenway also attracts visitors from elsewhere, while most users in the other two sections are local residents. Delivery riders also rest here on weekdays. (5) There are some differences in the peak usage periods at different parts of the greenway. For example, the peak in the urban section is from 6 p.m. to 9 p.m. (after dinner), as well as in good weather in the holiday season, when people start to gather on the greenway in the afternoon. In contrast, the peak usage for the rural section is in the afternoon and after dinner. (6) More informal usage of the greenways was observed in the rural parts and at the urban–rural interface, and in particular, the transformation of landscape grassland into agricultural areas for vegetables.

## 6. Findings and Discussion

The identified similarities and differences in the usage of the YRG reflect the various requirements of people residing (and working) in the different parts of Huangyan-Taizhou. This spotlights the fact that, while from the macro perspective of landscape planning, greenways are an integral part of belt space, at the micro scale, they serve complex needs. The disparities in usage are closely related to the land use types in the neighbouring area, the size of the local population as well as the interrelations between the requirements for everyday life and the demands for eco- and cultural services. This diversity also reflects the efforts of local initiatives. Drawing on our maps of the YRG along with the field observations and interviews, we obtained a more comprehensive understanding of the YRG at both the macro and micro scales. In particular, we would like to highlight the following findings:

- a. While the macro analysis of the land cover showed decreasing extents of water, forest, and grassland, the regional greenways by the river improved the living environment and enriched everyday leisure. In the field investigation, we obtained positive statements from local people regarding the ecosystem restructuring: "I don't know if the ecosystem has improved, but I feel the green space has increased. I often take

- my granddaughter to play at the riverbank. A place for playing is much closer than before” (in-depth interview, October 2019).
- b. At the macro scale, the greenway efficiently connects local ecological resources and provides forms of recreation for residents. At the micro scale, these recreations were not always ‘designed’, but rather the spaces were reshaped by everyday activities. For example, farmed areas in the urban–rural interface and rural sections of the greenway were initiated by local residents. According to the interviews conducted in 2023 and 2024, people stated that retaining these areas as grassland would be a waste of the riverbank.
  - c. Different patterns of activities could be identified. The spatial distribution of activities can be divided into three patterns: strip distribution, concentrated distribution, and scattered distribution. For instance, walking, fishing, and sightseeing are mainly distributed in strips along the river, while social activities such as dancing are concentrated in the main square. However, the distribution of parent–child interactions, picking herbs, etc. is scattered.
  - d. The distance between activities and water bodies also showed certain patterns. Activities closer to the water body showing a strip distribution can reflect the supply functions of the ecosystem such as fishing and washing, which are generally found along the river activity zone in a strip up to 5 m from the water body. At the same time, larger crowds are normally found within 150 m of the greenway, combined with other functions such as commercial usage.
  - e. People living in urban areas use the greenway for recreation much more frequently than those living in the urban–rural interface and rural areas. Similarly, people in urban areas prefer cycling in the natural environment of the greenways whilst rural residents prefer to ride electronic scooters by the river, an activity that has become restricted in the greenway.

Greenways are receiving a growing amount of attention due to their implications for the sustainable development of 21st-century cities [43]. The YRG, as one of the greenways implemented in a “top-down” manner, was developed against this context. According to the Taizhou Urban Green Space System Plan, the YRG is a municipal-level ecological corridor in Taizhou City’s greenway planning. It is observed to link ecologically important spaces through Huangyan and increase nature-friendly spaces for citizens, which is in accordance with greenways being a critical strategic element of “green infrastructure” for the rapid and extensive urbanisation of China [44]. This also echoes the study that stated that greenways are an environmental concern at the macro level as environmentally sensitive corridors, in that greenways play a vital role in enabling or shaping urban expansion and maintaining landscape integrity [45–47], requiring systematic understanding and plans.

The YRG acts as a “Green Ribbon”, which systematically connects ecologically important spaces and links urban and rural areas, people, and nature. At the macro scale, even though the green space and capacity of ESSs decreased in general in the Huangyan district, people showed positive attitudes toward introducing the YRG at the micro scale. This echoes that greenways can be powerful makers and shapers of urban form at both the macro and micro scales [48] and they work as living networks that facilitates people’s access to open spaces in their daily lives while also linking rural and urban spaces [49].

Greenways are more than just a “strategy” at the macro scale. In addition to environmental concerns, the cultural value of greenways should not be underestimated. During the field survey in Huangyan, the local residents recognised more recreation services of greenways compared to ecological functions. This coincides with Larson’s research that suggested that people value cultural benefits, such as social gatherings and recreation, more than environmental functions [50]. It also reflects the importance of environmental awareness of the local people. Without a sufficient understanding of local needs, it is also hard to maintain the ecological quality of greenways. Our field investigation revealed that the informal planting of vegetables near rivers was conducted on the plots converted from parts of the greenways. This does not necessarily mean there were conflicts between

ecological functions and everyday activities, but it suggested that there is a need for a more 'thoughtful' approach to synergies.

In this light, it is critical to identify the types of greenways. The existing literature identified three major types of greenways: ecologically significant corridors, recreational greenways, and greenways with historical and cultural values [51]. Although, in practice, it is hard to define which type of greenways they belong to as the functions sometimes can be integrated, it is still possible to identify the priorities in planning. Like the YRG, the different sections showed different priorities in ESS functions. In some sections, greenways should mitigate or minimise possible conflicts between recreation/agriculture and conservation. In other sections, greenways should serve human activities better. Greenways, therefore, need to be designed in a way that responds to these variable conditions [52]. Considering the full spectrum of diverse services is important from the urban core to the urban hinterland, from the macro scale to the micro scale. Therefore, the innovative public engagement strategy coupled with neighbourhood "precinct" planning can yield better planning and designs [53]. In this case, different activities identified along the greenways of the Yongning River re-emphasise their "bottom-up" design, which can support synergy rather than the trade-off between different ecosystem services.

## 7. Conclusions

Our study investigates the greenway as a typical spatial feature serving ecological and social uses to discover how land use and landscapes change from the perspective of social–ecological systems. Our particular aim was to understand differences between the functions at the macro and micro scales as well as the interactions between the social and ecological uses.

The macro-level planning and micro-level design of spaces are equally important for greenways to ensure the maintenance of all ecological functions and provision of cultural services. Clearly, socio-ecological change can trigger the development of landscape changes such as a greenways, which, in turn, will be the cause of further socio-ecological change [54]. While physical changes in land use do not necessarily trigger social change, e.g., in behaviour or customs [55], there is no doubt that spaces are constantly being reshaped by local daily activities. To understand the dynamics of ecosystems and land use, it is essential to take both social and cultural factors into account [56]. Landscapes can be shaped by ecological designs that serve to upgrade eco-resilience, but they can also be impacted by social activities [57]. Formally designed urban green spaces such as parks and greenways are becoming increasingly important in urban planning. The informal use of greenways, such as for growing vegetables, presents new challenges for ecosystem services and urban planning. Therefore, the macro-level plans are of great importance for sustainability, whilst the micro-scale practices foreseen by these plans must also enable the local culture to adapt to complex functions.

Clearly, the systematic planning and design of greenways should not be standardised at the micro scale. Rather, diverse spatial designs are required at the micro scale to respond to the various needs and everyday behaviour of people rather than merely applying different techniques and design technologies to upgrade ecosystems. Physical changes in land use do not necessarily provoke simultaneous social changes: people's activities cannot always be 'designed'. In fact, there is no doubt that spaces are being continually reshaped by everyday culture-based usage. Thus, it is important to take such daily practices and cultural backgrounds into account when shaping nature landscapes. Our study, therefore, suggests that green space can be categorised into two types: firstly, space of great ecological value which cannot be used for other purposes; and secondly, green space that can be designed to accommodate local conditions and requirements, for instance as 'urban agriculture' or which can be adapted to other local customs. If landscape planning and designs for ecological systems can also serve recreational purposes that match the needs of residents, then a higher-quality ecosystem can be co-constructed from both the top-down and bottom-up perspectives so as to encompass a range of local initiatives. This will foster sustained



development and help pinpoint better solutions for the preservation and improvement of ecosystems. In conclusion, we can say that this study contributes to the global debate on sustainability by flagging the importance of planned interventions that stress culture- and nature-based solutions to urbanisation processes, especially at the urban–rural interface.

We acknowledge that there are some limitations to our approach. In particular, we have only considered a single case study, namely, one of the most commonly applied ‘spatial products’: greenways. Our empirical findings should now be verified by studies of other locations as well as multi-functional ecological spaces other than greenways to obtain greater insight into the complexity of social–ecological systems.

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