Understanding Recreational Services of Urban Riverfront Space for Planning Purposes

The Case of Tianjin, China

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I Abbreviations

CBD: Convention of Biological Diversity
EC: European Commission
EEC: European Economic Community
EECONET: European Ecological Network
ELC: European Landscape Convention
EUROPARC: EUROPARC Federation "Federation of Nature and National Parks of Europe"
IBA: Internationale Bau-Ausstellung
IUCN: International Union For Conservation of Nature
KVR: Kommunal-Verband- Ruhr
PDL: Previous Developed Land
PEBDLS: The Pan European Biological and Landscape Diversity Strategy
PEEN: Pan European Ecological Network
POS: Public Open Space
SP: Security Patten
WWF: World Wildlife Fund
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IV Preliminary publication

Interim results of this study have been published in the following articles:


Part I Introduction
Chapter 1 Introduction

1.1 Background, motivation and aims

Vast land use changes occur during times of dramatic socio-spatial transformation, all the economic, political, social and cultural changes of a globalised world have their relation to space (Harvey, 1989). Currently such changes are driven by globalization and urbanisation. Transformations affect water, air, energy resources and, particularly, human populations (Baschak and Brown, 1995). And, at the same time, demands for outdoor recreation grow. The natural and cultural landscape becomes the ultimate resource providing open space for human leisure activity. Urban rivers and waterfront space are part of the urban open space and play important roles in affording urban resilience and health. However, rivers in urban areas have also been modified and canals, dams, artificial levees, etc. have been built instead (Junker, 2008, Reuss, 2005, Ward et al., 2002, Benke, 1990). It is, therefore, urgent and essential to study urban river and waterfront space for the purpose of contributing to a liveable city and as a basis for citizen's well-being and happiness.

This doctoral dissertation research aims at learning to understand how to plan and to design for the interface zones between urban rivers and the land adjacent to these rivers, and how to link the river and waterfront space with other urban space. River, waterfront and open space links should, together, be making a recreational space system that benefits people. The following questions provide starting points for this study: how do citizen use, perceive, and value urban river corridors that consist of the river itself and the river waterfront? Which might be good approaches to establish a spatial structure of urban river-oriented open space that serves citizens' recreational needs?

1.2 Identifying knowledge gaps

1.2.1 Rivers in current research

A wealth of research exists that relates to rivers. Studies include, to consider a small selection: research on riverine landscapes (Ward et al., 2002, Wiens, 2002, Gergel et al., 2002), studies on river and stream corridors (Ryan, 1998, Zhou et al., 2006, Gabr, 2004, Ward et al., 2002) and on so called ‘river-scapes’ (Erős et al., 2011, Gregory and Davis, 1993, Francis, 2008), studies on riparian landscape (Nassauer and Opdam, 2008), on streamside zones (Ladson et al., 1999), on river greenways (Baschak and Brown, 1995), and on waterfronts and riverfronts (Ryan, 1998).

Each of these studies and their findings refer to concepts that are based mainly on the natural ecological structure. River corridors and river (riparian and alluvial) landscapes that are in a natural state are characterised by a diverse array of landscape elements, including dynamic surface waters (a
gradient of lotic and lentic water-bodies), the fluvial stygoscape (alluvial aquifers), riparian systems (alluvial forests, marshes, meadows) and geomorphic features (bars and islands, ridges and swales, levees and terraces, fans and deltas, fringing floodplains, wood debris deposits and channel networks). In other words: the majority of studies use the term 'river-scape' mainly to refer to the aquatic components of a river landscape (Ward et al., 2002). The riparian landscape is, in most of river related research to date, also only part of the river related landscape, while the streamside zone is perceived as the (ecological) link between streams and their surroundings, supplying shade and mediating inputs of sediment and nutrient from catchment sources (Ladson et al., 1999).

‘River Greenway’ is a different concept, one that focuses mainly on the landscape corridor or open space that exists along urban rivers (Declaration, 2000, Declaration, 2006). Greenway studies usually integrate ecologic and social areas of knowledge. With a long history of developing corridors of urban open green space current research pertaining to ‘Greenways’ has increased, mainly regarding sustainable development (Mugavin, 2004, Lackstrom and Stroup, 2009, Oldiges, 2003, Linehan et al., 1995).

‘Riverfront’ and ‘waterfront’ are two important concepts used in research on and for semi-natural and urban rivers. Both concepts integrate land cover, land use and landscape design along such rivers and their corridors (Ryan, 1998). Expanding on previous studies in the urban area, this dissertation puts the focus on the river itself and on the riverfront zone adjacent to urban water courses and rivers.

The main current areas of river related research are discussed below. They relate to i) basic river ecology and theory, ii) ecological river conservation and restoration, iii) sustainable and resilient river management and river greenways, and iv) to the understanding of the perception and aesthetic appreciation of rivers. Among all of these areas, including the last, landscape ecology is at the core; it is the basic framework and research bridge (Ward et al., 2002).

1) For research on basic river ecology the principal research includes the integrating of pattern and processes with spatial data (for example in river corridors) as a means to examine environmental dynamics, interactive as well as spatial heterogeneity (Jepsen et al., 2005). Different landscape metrics may be used to understand and interpret corridor effects (Zhou et al., 2006).

2) A large number and variety of research pertains to ecological river conservation and restoration. Examples are research on biodiversity, riparian habitats, structure and function of buffer strips to manage water quality (Vought et al., 1995), the width of riparian buffers or the stream corridor widths (Gergel et al., 2002), the effects of human impact on spatial structure of the riparian vegetation (Kong et al., 2010), ecological river typology and index research (Ladson et al., 1999, Turak and Koop, 2008), corridor network connections (Erős et al., 2011), landscape assessment (Chen and Lin, 2007), and others. All of these are performed by applying interdisciplinary approaches (biology, ecology, geography, etc.).

3) The development and building up of river management systems and greenways are areas of applied research. Planners use ecological theories and knowledge in their proposals for river conservation or restoration, and to develop viable strategies for resilient river management. A river greenway is meant to be a feasible implementation and spatial planning strategy (Mugavin, 2004) that always integrates the adjacent open space, specifically in urban areas (Wu and Plantinga, 2003).
While perception research emerged during the second part of the 20th century it was during the 1990s that the focus was also placed on perception of rivers and their ecology. House and Sangster (1991) analyzed the selection of sites for use in recreation and found a close relationship between the types of riverscape that are preferably used, by the public, for river related recreation and amenity and that are, at the same time, desired by ecological conservationists (House and Sangster, 1991). Ryan (1998) completed 120 mail surveys of rural property owners living near rivers. Results showed that local residents see the river corridor as four inter-connected zones: the river, woods, farms and built areas; residents' landscape preference related more to their surrounding landscape-type than to the actual distance between their home and the river (Ryan, 1998). Yamashita (2002) has explored adults’ and children’s perception and evaluation of urban water in the landscape scale (Yamashita, 2002). Asakawa and Yoshida (2004), using a questionnaire, surveyed neighborhood residents’ perceptions of the stream corridors. They found stream corridor features that includes (natural) vegetation may positively affect preferences, and they identified five important factors, namely: “recreational use,” “participation,” “nature and scenery,” “sanitary maintenance,” and “water safety” (Asakawa et al., 2004). Junker and Buchecker (2008) have inquired into the relationship between human aesthetic preferences and ecological objectives about rivers, finding that ecological quality, as measured here by eco-morphological criteria, relates more strongly than expected to aesthetic preferences. However, despite apparent relationships between naturalness and preferences stated, due to inconsistencies in definitions of naturalness and ecology (Hagerhall et al., 2004, Kaplan and Kaplan, 1989) general conclusions on perceptual preferences are yet to be made.

1.2.2 Open space in current research

Green space and open space are the main elements of urban landscapes that afford amenity, and that are, for that reason, increasingly recognized as important for recreation (Kienast et al., 2012). For urban societies, green space such as forests or open land around urban and peri-urban areas plays an important role as places for recreation, leisure and contact with nature. This insight increases the awareness of recreation being a key landscape service.

Rivers and waterfronts are crucial parts of urban open and green space1. Not surprisingly, open space and green space are frequently addressed in landscape research. Some studies have put the focus on accessibility and open space utilization (Wright Wendel et al., 2012, Barbosa et al., 2007). Some scholars specifically focus on spatial components of open space and on related user satisfaction (Zhang et al., 2013, Salingaros, 2005, Lee et al., 2008). Some researches investigate the micro-climate as an important open space environmental quality (Lenzholzer, 2012). Additionally, as already mentioned above, researchers are attempting to identify and measure the beauty of open space, considering perception and aesthetic preferences, while trying to objectify and quantify both (Nasar, 1992, Gabr, 2004). And in the interface of socio-cultural disciplines, some scholars put the emphasis on the social and cultural impact of open space (Goossen and Langers, 2000, Germann-Chiari and Seeland, 2004).

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1 In the "standards of classification of urban green space" of the Ministry of Construction of the People's Republic of China, linear green space is one of the 13 sub-types of urban green space. Riverfront green space is included in this category of linear green space.
1.2.3 Research gaps regarding "urban" river and riverfront

The main river related research to date has, as explained above, been on river ecology and on spatial patterns and ecological processes. The settings investigated often are ‘natural’ and ‘semi-natural’ landscapes while the focus is on effects that structure may have on process (Gergel et al., 2002, Turner, 1989). Thus, natural processes and corridor effects that rivers have in their (more or less) natural state have been widely explored. In contrast, in the urban setting, where natural processes have been much subdued, there still is little knowledge on ecological and other functions. The assumption is, however, that the functioning and services of urban rivers are very different from that of natural or semi-natural rivers.

In a natural river, the corridor effect may be understood as it relates to the spatial and temporal distribution of vegetation, by using methods such as the buffer zone analysis (Zhou et al., 2006). The underlying ecological theory can strongly support ecological restoration for relative (more or less) natural areas. However, the same may not be possible for urban areas that lack morphologies and vegetation patterns that are typical for more natural settings.

To try and understand the landscape services of urban rivers, so far, there are results only from some qualitative but of no qualitative analysis. It is not easy to determine reasons why, to date, research has not filled this gap of knowledge about the service that urban rivers have, particularly with reference to concepts that may be described as landscape service or landscape function. For example, some researchers have used the density of buildings to define the aesthetic service that rivers may have in urban landscapes (Braham and Hale, 2006). However, urban areas consist of complex settings where buildings and infrastructure are integrated with social, economic, and cultural factors. Decisions on where, for example, to build a house, are influenced by various reasons. One of the most important considerations when studying urban rivers should, therefore, be how people relate to them.

1.2.4 Research gaps regarding human preference and recreational demand

If both public preferences (demand) and ecological aspects are taken into account in planning for landscape changes, it will be more likely that results will meet with public acceptance and sustained support (Décamps, 2001).

Riverfront landscapes offer a great variety of many different qualities that warrant studying. However, perception research of the recent 20 years has mainly focused on the river itself. Not so much research has concentrated on user demands for recreation preference at rivers and riverfronts. For planning and design purposes it would be important to inquire how an urban river and waterfront space influences the city citizens' recreational activities, and, more specifically, at what distances its services reaches and are felt in a city.

Almost no research has been conducted regarding the landscape recreational services of open space or green space, with specific focus on land use of riverfront space. This is particularly true for China, where, so far, open space research is carried out later than in Western countries. It is of great importance to give emphasis to recreational landscape services with a focus on riverfront space, and to start and provide principles for river related open space planning.
1.3 Research Questions

1.3.1 Object and field of this study

With the aim to fill some of the knowledge gaps mentioned above, this study attempts to pay attention to urban rivers and, specifically, to the human preference and demand that relate to the open urban riverfront space. Conceptionally, the object of this study includes the river and waterfront open space as a sub-area of open space research. The setting is the modern urban landscape of rapidly growing metropolis and large cites. This study takes the landscape recreational service as the main area of concern.

When exploring landscape recreational services of urban rivers, linkages should be taken into consideration that exist between the physical structure and functions of the landscape and the economic, social, cultural, and ecological values that are demanded by its users (Haines-Young, 2000). Approaches should be developed, in order to evaluate the river and waterfront open space that combine user perception, evaluation and action with physical structure and function of the landscape. Additionally, one needs to explore how river and riverfront planning and design might best be done in order to provide optimal landscape services. The field of this study is summarised in figure 1.1 below.

![Figure 1.1 Specific study field of this thesis](image)

Five research questions regarding the river and waterfront open space are:
1. What is the role of rivers in spatial and open space planning?
2. What are the human needs regarding outdoor open space?
3. How do river and waterfront spatial structures affect people's recreational activities?
4. How to define the recreational service of urban river and waterfront open space?
5. How might answering these question change planning and design of urban open space?
1.3.2 Question 1

"What is the role of rivers in spatial and open space planning?"

Starting with question 1, this study first explores the relationship between rivers and open space (urban) planning. The aim is to provide an overview of current knowledge and state of planning related research that relates to (urban) rivers. Results of pertinent literature reviews and analysis of reference examples are presented in chapter 3. Chinese and European experiences are mainly considered. Modern urban planning in Europe is considered, by many scholars and planners in China, as providing an important example. However, the urban development background in China is not the same as in Europe, and it is essential to know the differences for both, international and Chinese readers. Following chapter 3, and aiming to present the status and role of rivers in Tianjin, the city where the empirical research of this study is conducted, chapter 4 gives a historical overview of the urban development and of the open space and river system in Tianjin.

1.3.3 Question 2

"What are the human needs regarding outdoor open space?"

Recreational needs must be understood as part of people's needs in general. In the hierarchy of needs, proposed in his paper "A Theory of Human Motivation" in 1943 (fig. 1.2), Abraham Maslow identifies five levels of human needs (Maslow, 1943). This theory is taken here as reference and knowledge base to interpret human outdoor needs for purposes of planning and design. The research conducted in this study focuses on the relationship between urban planning and design on the one hand, and the user recreational demand on the other hand. Such relationships are explored in the empirical section of this study. The aim is to try and explore the benefits that open space provide, and to understand them based on the fundamental theory of human needs.

![Hierarchy of human needs from Maslow](image)

Figure 1.2 Maslow's hierarchy of needs (McGuire, 2012)
1.3.4 Question 3

How do river and water front spatial structures affect people's recreational activities?

This question leads research to inquire into the recreational service of river and waterfront space. For this purpose the spatial structure of the river and water front space is being looked at in detail and associated with recreational activities. This structural analysis is a crucial part of understanding landscape recreational service of the river and waterfront space. It is also part of the empirical section of this study. It is expected that, by identifying landscape spatial characteristics, explanations might be supported for outdoor recreational activities along the urban river and water front.

1.3.5 Question 4

How to define the recreational service of urban river and waterfront open space?

As linear corridors urban river and water front space provides services in a way where, as one would expect, effects on people are decreasing progressively with distance increasing from the river’s edge. Residents who live nearby the river might, as one would also expect, enjoy the recreational services of a river and water front space more than people who live further away. For nearby residents it is simply easier to access the river than for people who live further away. Using a metaphor, the degree to which urban residents can enjoy the river and waterfront services might be compared to the way how blood vessels transmit fluids, oxygen and other matter to adjacent areas of a body of which they are part. The city river, waterfront and adjacent urban matrix can, again metaphorically speaking, be understood as life sustaining vessel with its (capillary) wall and the adjacent and peripheral tissue. This metaphor may also serve as the general conceptual model to help understand the exploration performed in this research.

The assumption, made for the purpose of this study, can thus be described in this way: the river is felt, in people’s perception, most intensively near by the river, and less so with distances increasing away from the river. Recreational services are also less intensively felt with distances increasing away from the river.

Yue Guang Zong has proposed to use a logarithmic decrement to describe and model such properties of linear corridors, geometrically, where, by starting at the centre, a gradient field a gradual decreases of effects is observed (Guang, 1999). An algorithm is used and in this formula "e" represents gradient efficiency, "D" represents the distance, and "a" is a constant which represents the maximum effectiveness of a corridor. When the distance extends from d1 to d2, the effectiveness of corridors is reduced from "e1" to "e2". This study employs this logarithmic decrement as a possible mathematical expression of the recreational service ability of rivers. On-site user numbers are correlated with living locations of individuals and also with other attributes of the city and riverfront space. This part of the research is also presented and discussed in the empirical section of this study.
1.3.6 Question 5

How might answering these question change planning and design of urban open space?

The five questions that are guiding the thought process behind this study are organized in a way that is shown in figure 1.4. Based on a comprehensive understanding of landscape (including theory and methodology), this study takes the starting point from the understanding of urban open space (as one important part of urban landscapes) to study the specific character and services of riverfront space (as one type of open space), and then narrows the wide array of landscape services down to the specific recreational services (as one type of landscape services) of river and waterfront space. In responding to question 5 this study is attempting to apply the research results to urban open space planning. At the end, as an academic exploration, this study concludes by discussing its contributions to landscape theory and methodology. Approaches and methods used are also discussed for future applications.
1.4 Research strategy, approaches and methods

Figure 1.5 shows an overview of the strategy, approach, methods and tools which are employed in this study.

1.4.1 Strategy

Case study research is treated as a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence (Robson, 2002). This study uses case study research as a strategy to explore the recreational services of riverfront space for planning purposes. In addition, literature review and discussion were conducted for finding answers to research question 1 and 5 (figure1.6).

1.4.2 Approaches

Theoretical and empirical approaches were combined in this study. The theoretical approaches could be described as the process of, firstly, analyzing the state of pertinent research and, second, defining knowledge gaps and the research questions on the basis of a series of literature studies. The empirical
process is one where, first, the research questions and assumptions where taken to design the case study structure, and then to verify the research questions by evidence based investigations.

In the empirical section, quantitative and qualitative approaches and methods are combined. The quantitative approach was implemented by conducting quantitative interviews, and the qualitative approach was implemented by carrying out observations and mappings. A number of methods were selected for the approach described above.

1.4.3 Research methods

The methods used for data collection include literature research, quantitative interviews and observation, and mapping.

1) Methods adopted from the social science: quantitative interviews

A 14-item on-site quantitative interview tool was developed to collect data about the use and appreciation of river corridors. Questions aimed at collecting data on river recreation include use characteristics (frequency of visits, means of transport to reach the site, time spent for transport, time spent for activities during the visit), activities and preferences (activities, reason to visit this open space, social communication, aesthetic appreciation), assessment of open space (likes, dislikes and desired changes, satisfaction.), and demographic information (age, location of residence). A neighborhood pre-interview was done mainly to collect some population information, including population density and age structure in each neighborhood which are separated by urban roads. 267 questionnaires were filled in at four different riverfront sites. There were four pre-tests in the field area before its general application.

The 14 questions included in the questionnaire are.

I. River recreation use characteristics

1. How often do you come to this location in this season?
2. How do you come (travel) here?
3. How much time do you need to arrive at this location from your place of residence?
4. How much time would you normally spend at this location?

II. Activities and Preferences of Open Space

5. Which (recreational) activities do you do at this location?
6. Why do you choose this location for your recreational activities?
7. How often do you communicate with others when you come here?
8. Do you think this open place has beautiful scenery?
9. Is this open place able to benefit and uplift your emotions?

III. Assessment of the open space along the river
10. Does the open space size at this location meet your requirements for your recreational activities? If no, please explain your situation.

11. Do you think the facilities at this location meet your requirements? If no, please explain your situation.

12. Do you feel this is a safe open space for your recreational activities? If no, please explain your situation.

VI. Personal Information

13. How old are you?

14. Please mark your place of residence on the map.

2) Observations of recreational activities

Observation methods are applied in order to help answering the first research question (Question 1). Observation is considered a qualitative method which has roots in traditional ethnographic research. What is learned from observation can help researchers not only to understand data collected through other (including quantitative) methods (Wu and Xiang, 2012), but also provides a better understanding of the phenomenon being studies. Observation can help to better adjust to the cultural relevance and appropriateness of interview and focus group questions (Patton, 1990). In this case observations help understanding data collected and the phenomenon being studied. As a result, only partly were expectations confirmed, and much was discovered that was unanticipated at the beginning of the study. Photography and the taking of notes are additional tools used in this study.

The aim of undertaking pilot observational studies has two aspects. One is to collect information on the activities that occur on the investigated sites, and the other is to identify the spatial attributes of these sites. For activities, seven items of observing site related activities are recorded in a form; included are observations such as "which time", "how long active", "which kind of space used", "which activity done", "how many people active", "how old are these people". For the space attributes, four items related to the spatial properties of the site would be recorded, include "size", "shape", "vegetation cover" and "whether one can see the river from the location". At the same time, groups of photographs about the recreational activities and space were taken during each hour of site observation.

3) Mapping of recreational activities

Observation results were visualized by way of mapping. Temporal and spatial changes of recreational activities in different structures of riverfront space were transferred to maps and these could then be compared. At the same, the spatial structure of the riverfront space was also analyzed in this way.

1.4.4 Supporting tools

Supporting tools applied include the data analysis function in the software EXCEL, and spatial data processing and spatial network analysis functions in GIS. These tools worked well in supporting the analysis processes undertaken in this study.
GIS (Geographic Information System) is employed to conduct data analysis and to prepare spatial visualizations. For example, all locations of people’s residence were marked on a map, by the users, during field work. These data were digitalized and included into the GIS. Thus, the distribution of the places of residence can clearly be visualized with reference to urban streets, residential blocks, etc. Aided by the EXCEL software, it was possible to analyze the statistical data using the tool "Scatter and formulas fitting analysis". The formula of quantifying the recreational service of open space was explored.

1.5 Cases study research decisions

1.5.1 Decision to select TianJin as case study area

Tianjin (old name "Tientsin") is a metropolis in North China and one of the five so called national central cities. It is governed as a direct-controlled municipality, one of four such designations in China, and is thus under the direct administration of the central government. Tianjin has borders with Hebei Province and Beijing Municipality, and it is bordered to the East by the Bohai Gulf portion of the Yellow Sea (figure1.6). As a dual-core city, Tianjin is divided into the old city and the Binhai New Area. In terms of urban population, it is the sixth largest city of the People's Republic of China, and its urban area (Binhai New Area is not included) ranks 5th in the nation, only after Beijing, Shanghai, Guangzhou, and Shenzhen. Tianjin's urban area is located along the Hai River, which connects to the Yellow and Yangtze Rivers via the Grand Canal in Tianjin.

There are two main reasons why Tianjin is the appropriate city for conducting the research of this study. The first one is that rivers and city have a close relationship in Tianjin. The urban development has been and still is, in every historical period, directly related to water courses and rivers. Especially, the earliest city originated at the estuary of three rivers. The second reason is that the centre city of

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2 Tianjin Planning Bureau.
Tianjin is a rapidly developing area (figure 1.7), where the new relationship between river, riverfront space and residents is the result of the process of urbanization. This is important if one is interested in search of evidence for sustainable urban development in metropolitan regions under conditions of transformation.

1.5.2 Selection of the research area and sites

The research area is located in and around the downtown district of Tianjin City. It was selected for a number of reasons. Firstly, this area has, like many other large and old Chinese cities also do, a long history of urban development. Secondly, the river is the one and most important element affecting urban development in this area; in fact, the history of urban planning for Tianjin City is also the planning history of and for its river system. Thirdly, the character of the selected area has, like many other large cities in China, a very high structural and population density. Fourth, the river has great influence on the lives of the citizens’ who are living here. Eight water courses constitute the river system of this part of Tianjin. The Hai River is the largest one and is also the ‘mother river’ of Tianjin. The North Canal and South Canal are part of the historic Beijing-Hangzhou Grand Canal. The other five water courses are the Ziya River, the XinKai River, the Jin River, the Weijin River and the WaiHuan River. Urban river corridors have been segmented, and segments are separated mainly by bridges. Each segment can be considered as an open space. Aiming to include open space examples of typical width and length of river and open space found in Tianjin four segments (or sites) have been selected for the purpose of conducting on-site research area.

1) Selection of the research area

The area of Tianjin central city is large (4334.72 km2); much of this area is still in the process of urbanization. The probability that the urban matrix will be changing in the near future is high and, thus, the relationship between urban residents and their river must be considered anything but stable. Considering this situation (which is typical for China at this point in time), it is not suitable or useful to take the entire central city as the research area. A selection of areas was made within the whole central city. The strategy is to explore, based on the resident’s needs, the landscape recreational services of urban corridors in the selected area, and then, based on results from the river corridor segments, conduct an analysis for the entire central city. The selected research areas are shown in figure 1.7.
Reasons for choosing these areas and sites include the following:

1. Due to the development of urban space and of the river system, the central city is divided into two parts by the axis of the Hai River. The history of urban development in the western part is longer and the urban spatial structure is highly developed. The selected study area is located in the most western part.

2. Most of the residential area in central Tianjin belongs to the category "general urban" area which is dominated by multi-story residential buildings and a small amount of high-rises. The area adjacent and along rivers is, in the selected study area, considered stable residential communities. They are more or less representative of the general spatial characteristics of the urban matrix of this category of city.

3. The area has a high diversity of water courses and waterfront types. It includes the mother river, the Hai River, and a number of typical artificial water courses such as the-Jin River and Wei-Jin River. The riverfronts all have the characteristic topography including a dam, and a mostly flat riverfront area.

2) Selection of the study sites

The spatial characteristics of urban river corridors are not that of a homogeneous and continuous linear space. Bridges cut the linear river space into many segments. Some segments are designed as a rectangular open space. Some of the longer river segments take the form of linear river corridors. For that reason, the analysis begins by investigating a select number of open space or segments, then turns to linear and longer open spaces along the river, and finally looks at all of the system of the city.
Table 1.1 Basic attributes of the 4 selected sites

<table>
<thead>
<tr>
<th>Site</th>
<th>River's name</th>
<th>Width of river</th>
<th>Width of waterfront</th>
<th>Length of waterfront</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zi-Ya River</td>
<td>110</td>
<td>60</td>
<td>400</td>
<td>24000 m²</td>
</tr>
<tr>
<td>2</td>
<td>Jin River</td>
<td>40</td>
<td>30</td>
<td>180</td>
<td>5400 m²</td>
</tr>
<tr>
<td>3</td>
<td>Wei-Jin River</td>
<td>25</td>
<td>30</td>
<td>400</td>
<td>12000 m²</td>
</tr>
<tr>
<td>4</td>
<td>Hai River</td>
<td>110</td>
<td>30</td>
<td>340</td>
<td>10200 m²</td>
</tr>
</tbody>
</table>

Not every part and segment of river and waterfront has the quality of an open space; only river segments with adjacent open space can be used and perceived as such by people. Thus, the first step of selecting study sites is to identify the "possibly available and accessible" open space along riverfronts. "Possibly available" open space means that the area provides spatial space for nearby resident to use for some sort of outdoor activity; in addition, the area should be used regularly, by some people who live in areas nearby, for purposes of recreation. The second step is, by employing three criteria in successive order, to estimate "the width of the river", "the width of the waterfront", and "the length of the open space at the waterfront". As a result of steps one and two, four pilot sites have been selected.
To support the identification of hotspots for nearby recreation, an all-round field analysis was done, based on current Google maps.

1.5.3 Time periods selected for and allocated to field study

The time periods allocated to conducting field studies for this research depends on two factors. The first is the diversity or the possibilities for people to engage in recreational activities. The second consideration is people’s thermal comfort. Climatic conditions and site context are also two of the most essential aspects to consider at the beginning of every design project (Lehmann, 2010).

People engage in different types and quantities of outdoor activities, in different seasons. Hence, comparing the outdoor activities done during different seasons is relevant for this study. The season with the highest diversity of recreational activity is selected and, on this basis, the time periods for conducting the field research were decided on.

There is a myriad of factors that may influence people’s perception of, and thus satisfaction with, the outdoor environment and the perceived thermal comfort is one that most certainly always plays an important role (Lenzhölzer, 2010). In this study, the so called "Efficient Temperature" is taken as the crucial factor which highly affects outdoor activities in Tianjin.

1) Thermal comfort in TianJin

As mentioned above, environmental comfort is a measure that is influenced by physical stimuli received through people’s thermal, visual, aural and olfactory receptors. Thermal comfort includes factors such as air temperature, relative air velocity, surface temperature, radiant temperature and relative humidity (Robinson, 2011). Other factors might also have an impact on human thermal comfort. This study employs the so called Efficient Temperature \( T_E \) to analyze the distribution, over the course of time, of a comfortable climate environment in Tianjin.

\[
T_E = t_a - 0.4(t_a-10)(1-\gamma/100)
\]

\( t_a \): air temperature \( (^\circ C) \); \( \gamma \): Relative humidity; \( T_E \): the efficient temperature related to the temperature and humidity (Tianjin Climate Service Center, 1999)

The Efficient Temperature \( T_E \) was firstly proposed, as an indicator, to predict the thermal comfort in indoor environments. Later it has been widely applied to the thermal environment at large. For the reason that \( T_E \) often leads people to overestimate the impact of humidity at low temperatures and to underestimate the impact of humidity at high temperatures, its application has been simplified or substituted by different measures (McIntyre, 1980). This study is mainly based on the available meteorological data to conduct a general evaluation of thermal comfort and in order to roughly make a decision on time periods for field investigations.
Table 1.2 Efficient Temperature (TE Co) and people’s subjective perception of temperature

<table>
<thead>
<tr>
<th>T_E (°C)</th>
<th>&gt;30</th>
<th>24~30</th>
<th>18~24</th>
<th>12~18</th>
<th>6~12</th>
<th>0~6</th>
<th>0~12</th>
<th>-12~24</th>
</tr>
</thead>
<tbody>
<tr>
<td>People's perception</td>
<td>Very hot</td>
<td>hot</td>
<td>warm</td>
<td>moderate</td>
<td>cool</td>
<td>Slightly cold</td>
<td>cold</td>
<td>Very cold</td>
</tr>
</tbody>
</table>

Table 1.3 Average number TE within each month based on the date from 1981 to 1990 in TianJin (Tianjin Climate Service Center, 1999)

<table>
<thead>
<tr>
<th>T_E</th>
<th>Month</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.3</td>
<td>0.2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>24~30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>4.2</td>
<td>15.7</td>
<td>18.7</td>
<td>17.7</td>
<td>5.7</td>
<td>0.3</td>
<td>0</td>
<td>0</td>
<td>62.5</td>
<td></td>
</tr>
<tr>
<td>18~24</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>7.4</td>
<td>17.3</td>
<td>8.2</td>
<td>1.6</td>
<td>3.3</td>
<td>18.4</td>
<td>10.2</td>
<td>0.1</td>
<td>0</td>
<td>66.7</td>
</tr>
<tr>
<td>12~18</td>
<td>0</td>
<td>0</td>
<td>7.4</td>
<td>12.1</td>
<td>2.7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.4</td>
<td>12.1</td>
<td>6.9</td>
<td>0.2</td>
<td>42.8</td>
<td></td>
</tr>
<tr>
<td>6~12</td>
<td>4.1</td>
<td>10.0</td>
<td>13.6</td>
<td>0.7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.6</td>
<td>13.6</td>
<td>8.8</td>
<td>52.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0~6</td>
<td>20.6</td>
<td>12.6</td>
<td>2.7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.2</td>
<td>16.9</td>
<td>56.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0~12</td>
<td>0.9</td>
<td>0.4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.1</td>
<td>0.9</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-12~24</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As indicated by data displayed in table 1.3, the Efficient Temperatures in January, February and December are too cold for outdoor activities. The Efficient Temperatures in June, July and August are too hot for outdoor activities. The Efficient Temperatures in April and October are particularly suitable for conducting outdoor activities.

2) Diversity of recreational activities

The Efficient Temperature in Tianjin indicates how it is usually getting warm and then hot starting in April. High temperatures prevail until early October. The warm and hot temperature period lasts for roughly six months. At times, when it is feeling hot and stuffy indoors, the periods of outdoor activities are increasing. This is the time for enjoying the open space, and the time people spend outside of their home every day is the longest of all of the year. Hence this is also the time when people tend to engage in the greatest diversity of recreational activities (table 1.4). The time for the field survey is decided to last from late May to the beginning of September during the summer time. Two periods of field survey were set in 2012 and 2013 during the summer. In addition, one time field survey was set in 2012 during the winter for the purpose of better understanding the study sites.
<table>
<thead>
<tr>
<th>activity</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>fishing</td>
<td>★★★</td>
</tr>
<tr>
<td>swimming</td>
<td>★</td>
</tr>
<tr>
<td>boating</td>
<td>★</td>
</tr>
<tr>
<td>writing on the ground</td>
<td>★★★</td>
</tr>
<tr>
<td>skiing</td>
<td>★★★★</td>
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Chapter 2 Introduction to Tianjin City

2.1 Background; city development and planning in China

2.1.1 Traditional city and modern Chinese city development

Comparing the contemporary situation with those of historic dynasties there are notable differences regarding the concept and development in Chinese cities. For example, during the Tang and Song dynasties, very large cities existed, with millions in population. However, this concept of city actually stood for a nucleus of high density settlement surrounded by a large rural area; the traditional Chinese city (Xu, 2000). After the Opium War a modern city emerged in China, one that differs from the traditional city. The modern city is large and features high densities everywhere, both geographically and socially; the modern city is driven mainly by economy. This modern city usually has a multitude of different infrastructure and public facilities and space, the contemporary city is mainly the result of political and socio-economic transition and urbanization that occurred in the era that followed the Cultural Revolution of 1978.

2.1.2 Modern city and urbanization in China

Starting with the post-Opium-War-period, the urbanization of cities in China can be divided into three stages (Yeh et al., 2011). The example of Tianjin is presented in the following chapter to illustrate these three phases in more detail.

The first stage is the period that immediately followed after the Opium War and ended before the Japanese invasion (1860-1937). During this time, China experienced a rapid economic development and underwent considerable thrusts of urbanization. Three types of Chinese cities emerged. The first type has been called ‘Concession City’; examples include Dalian, Qingdao, Shanghai, and Xiamen. These cities were basically designed by foreign planners referring to the Western city model. The second type might be called the modern industrialized city; examples include Wuxi and Changzhou. These cities were designed and built by Chinese experts. The third category might be called the ‘Overseas Chinese’ city. Most examples of this type are located in the Fujian and Guangzhou provinces where many Chinese returned to from overseas and constructed their homes here after they had amassed a fortune. Such cities have a common feature as they combine some Western city character with forms of the traditional Chinese city; in some cases almost complete "imitations" of one Western city appear. The city of Taishan, located in Guangzhou province, is a well preserved example.

The second stage of Chinese urban development starts in the 1950s and after the country's liberation. China ushered in a decade of rapid industrialization. China's new cities were characterized by the industrialization driven by large steel mills or a number of different large state-owned enterprises. But such processes of urbanization stood still again for quite a long time later (for complex social reasons).
The third stage of urbanization commences after Deng Xiaoping’s opening up of China, and the economic reforms that were initiated during the 1990s and which are going on during present times. These urbanizations of the third (and current) stage include comprehensive social transition and urban development with unprecedented dimensions of construction going on in the Chinese city\(^3\).

### 2.2 Three periods of urban development in Tianjin

Tianjin is a city that may serve as an example where features derived from ancient planning are combined with features of modern planning. A main characteristic is that these features also relate to rivers. River and water provide the most important geographical background of Tianjin. The Ancient Yellow River, the most relevant river resource in China, has diverted into three channels before it flows into the sea around Tianjin. Its alluvial plain is the area where Tianjin originally started to develop. The Beijing-Hangzhou Grand Canal was constructed in BC 486 and the intersection of the South Canal and the North Canal became the birthplace of early Tianjin. On the 23th of December 1404, water transport finally brought out the establishment of Tianjin, which made Tianjin the only city owing the exact record time of founding in ancient China.

As explained above, there are three periods that mark the development of cities such as Tianjin from the founding of the city to the present times. Social reform, changes in the political environment and the changes of regime made great impact on Tianjin's spatial planning (fig. 2.1). Simultaneously, the urban space and the river system experienced notable changes in structure and in morphology.

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3 Interview with Professor Dihua Li (Peking University, China)
2.2.1 Traditional Chinese city planning in Tianjin, 1404 - 1860

Until about 1860, China is thought of as a relatively stable feudal society. Feudal urban planning is based on traditional cultural values and on ideas for city construction that refer to the theoretical book of "ZhouLi • Kaogongji" (《周礼·考工记》). These traditional concepts had some notable effects on spatial plans made for cities. At that time cities were also developing slowly. Tianjin is no exception.

Before 1860 the city space and river system of Tianjin maintained the typical structure of a traditional Chinese city for a long time. The fortifications of Tianjin were formally established in 1404; the city was bounded by high walls. An artificial moat was excavated outside of these walls as an additional defense barrier. Inside of the high wall, government offices and academic institutes where placed in the center or along the axis of the city (Ren, 2007). The main spatial axis was extending from north to south. This spatial distribution of commercial areas, residential area, temples and other functional area was a fixed arrangement according to the Chinese traditional planning theory mentioned above (fig. 2.2).

![Old city of Tianjin with the first moat](Bureau of Planning in Tianjin and Bureau of Land Resources in Tianjin, 2004)

2.2.2 Changes of planning during the period of unrest, 1860 - 1949

The time period from 1860 to 1949 is marked by foreign aggression and civil war in China. Nine different countries established their concessions in Tianjin. The Hai River area, as one of the concessions, was altered very much. Stimulated by foreign planning practice the Chinese transitional government started to turn away from old feudal planning ideas and to seek innovation by adopting
more modern planning concepts. Urban renewals in Tianjin lead to city development outside of the Hai River area. Spatial planning ideas of the Western world and Japan were introduced to China. The urban texture along river channels became a kind of fusion of Western and traditional forms. Tianjin's development during this time might be divided into three discrete periods as follows.

1) Land use expansion stimulated by foreign powers, 1860 - 1902

In 1860 the Second Opium War broke out. For purposes of defense Tianjin constructed a second trench outside of the original city. This second artificial canal was filled with water and could be considered the greatest urban transformation since 1404. In addition, nine countries established their concessions in Tianjin during 1860 to 1902. It was these concessions that benefited the port. First, in 1860, the British concession was established. The British Captain Gordon implemented a series of preliminary investigations, detailed planning and urban construction. A grid road network was employed for land use and division. Warehouses and docks were established along the river, while administrative offices and commercial and consular institutions were lined up along the main roads. The planning of Captain Gordon is the first modern planning in Tianjin. By 1902, France, the USA, Japan, Germany, Russia, Italy and Belgium also delineated their concessions in Tianjin. The urban built-up area expanded significantly.

As indicated by the figure above, the second trench or moat became the new boundary of urban development. Compared with the old city the urban area and spatial structure was greatly altered by the concessions (fig. 2.3).

2) Further urban planning by occupying powers and Chinese transitional regime, 1902 - 1927

From 1902, each of the sovereign states began to further construct their concession (fig. 2.4). Urban construction soon broke through the boundary of moat and canals and continuously developed outwards. Firstly, the road network, land division, docks and warehouses were further planned and detailed plans were carried out and implemented. Britain, France and Japan accomplished to build relative complete infrastructures after a few years of construction. During the years from 1902 to 1911
the Chinese Qing regime executed a modern urban planning in the Hebei District, the northeastern part of Tianjin. In 1920 the Chinese Northern Government also carried out a detailed construction projects in the entire Chinese precinct (Li and Lv, 2005).

Figure 2.4 Further urban expansion outward second moat (altered from Compilation committee of Tianjin planning, 1994)

Overall, several different planning practices helped to form the city's districts during this period. The respective planning reflected each sovereign state's own planning concepts and ideas. On the account of the concessions, there was no unified planning. The water area was rapidly shrinking due to urban expansion.

3) Early systematic planning and the emergence of a third river boundary, 1927 - 1949

In 1930, the urban planners Liang Si-cheng and Zhang Rui produced the first comprehensive and systematic master plan for Tianjin, which is the third autonomous master plan drawn up in modern China. From 1937 to 1945, Tianjin was invaded by Japan. The Japanese occupational government devised two master plans. These three master plans together include several special planning documents. These make specific statements on functional zones, transportation, municipal infrastructure and parks. Although most of these plans were not implemented, it was an evident trend that the city would expand along the Hai River. In due course, urban planning in Tianjin gradually became rational and systematic.

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4 First and second are Nanjing and Shanghai.
Japan was expelled from China in 1945. From 1945 to 1949, Tianjin was part of the civil war. The fortifications built-up for defence during war times became the third city boundary outside of the first and second moats (fig. 2.5). Now, fortifications were either relying on the expanse of the river itself, or on new artificial trenches and canals. Artificial water courses gradually evolved into urban rivers or urban roads in the process of urban development. New urban areas were, again, identified and delineated by defense trenches and river courses.

2.2.3 Modern urban development in new China, 1949 to present

In 1949, the People's Republic of China was established and, after that, the Tianjin government devised several new master plans. From 1953 to 2006, Tianjin completed 22 drafts of urban master plans and four editions of master plan - 1954 edition, 1986 edition, 1996 edition and 2006 edition (Xing, 2007). Compared to the earlier more chaotic periods, planning was now more independent and also more unified. As China and Tianjin are in the process of high urbanization, open space and river systems underwent enormous changes.

1) Establishment of a modern road system, 1954

The master plan of Tianjin of 1954 had been greatly impacted by Soviet planning ideology. Planning was oriented by industrial projects and a road network was firstly established (three rings and eighteen axial roads). Industrial locations, warehouse, green space, railways, roads and rivers were the main land use types depicted in the 1954 master plan.

2) Fourth river boundary and new district, 1986

The master plan of 1986 was seeking to explore potentials at the port and to develop large-scale

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intensive industries. The Binhai district was established at the end of the Hai River. In the planning documents the classification of land use became more detailed than before (Cai et al., 2007). The innovative planning for the Waihuan River, which surrounded the whole city, now formed the fourth boundary of Tianjin (fig. 2.6).

Figure 2.6 Fourth river boundaries and the fifth potential boundary (adopted from Tianjin master plan 1986)

3) Fifth and potential boundaries, 1996 to present

Figure 2.7 Fifth and potential boundaries (adopted from Tianjin master plan 1996)

In the master plan 1996-2010, Tianjin was positioned as the economic center in northern China. A basic spatial framework was created for the next few decades. The developing trend of integrating the old center city and the southeast coastal area in Tianjin is much clearer. The State Council approved their master plan for 2005-2020 and it is determined for Tianjin to be established as the economic center of the Bohai Sea region with the international port. The plan also includes ideas for an
"ecological city" (such as making provisions for more green space). The city boundary was extended a little bit further in the northeastern parts of the center city (fig. 2.7).

2.3 Feature of urban development in Tianjin

2.3.1 Circle development with river and green belt boundaries

From the historical map shown in figure 2.8, the characteristics of spatial transitions are evident. They might best be expressed as circle-style development. In this ring model, the traditional defense walls and moats surrounding the old city make up the first circle and city boundary. Build during the opium war, the artificial trench with water defending the city against aggressions make up the second circle and boundary. During the civil war, the third artificial trench emerged as the third city boundary. And in the new period of China, the excavations of Waihuan River formed the fourth circle of river and provide a new city boundary. As well as long-term planning in peri-urban areas, urban green belt plays a crucial role in modern urbanization. In each period of urban development, the emergence of new boundary always accompanied with the collapse of the inner circle of boundary. It is predictable that there is a possibility of the appearance of potential rivers or green belt as urban boundary in the future.

Rivers and canals are the most important linear elements of the urban pattern and structure; water courses constitute the city's spatial network. Water system planning in Tianjin particularly has the same significance as road planning. Water courses are the spatial backbone at each period of urban development in Tianjin (fig. 2.8).

Figure 2.8 Collection of historical maps from 1846 to 1996 (Compilation committee of Tianjin planning, 1994)
2.3.2 Great expansion of the built-up areas

In the process of urban development, Tianjin is always expanding. In the period from 1404 to 1860, urban expansion was slow. From 1860 to 1949, the city's expansion is stable and constant despite the chaos of the political and social situation during that time. From 1949 to the present, especially starting from 1980s, Tianjin underwent a process of rapid urbanization similar and the same as many big cities in China. Urban built-up areas are sprawling and the population is explosive in growth (fig. 2.9). Currently and constantly driven by economic development, Tianjin now extends from the old center region to the coastal area (Li, 2011). Every urban expansion includes a new water system planning and construction of artificial water courses. Most of these artificial water courses and urban rivers have parallel traffic roads, and the demising artificial water courses or urban rivers usually is transformed into urban roads.

Figure 2.9 Spatial expansion of built-up area in Tianjin (adopt from historical maps and master plans in Tianjin)\(^6\)

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\(^6\) Tianjin Planning Bureau and Compilation committee of Tianjin planning
Part II Theory
3.1 Concepts of knowledge building through designing

Science is a 'class divided' into the natural and the social. The social sciences may be further divided and some sectors are of special interest to environmental professions (Cuthbert, 2011); here landscape planning and design are defined as part of so called ‘spatial social science’ (Other divisions associate landscape design closer to the Arts, or to Engineering). Within these categories, of which some are made by science theory, urban landscape planners and designers have two areas of knowledge building. One area pertains to the understanding of the ‘city landscape’ as the primary subject of study (see Chapter 3.2), and the other area pertains to the conduct of (spatial) planning and design. Thus, the city is made up of ‘landscapes’ that are inhabited by humans where planning and designing future environments are collective activities, associated with political units, and leading to built form and urban space. Knowledge building occurs in the process of planning and designing through discourse, and by the way of social learning (Bruns, 2014).

Figure 3.1 Perceived hierarchic nature of the built environment (Ericson and Lloyd-Jones, 2001)
In figure 3.1 an overview is presented that provides a structure into which river-oriented spatial planning and design activities may also be conceptually inserted. This overview structure helps to understand how the focus and activities of this research link in with other design activities and with the planning for regional infrastructure, with urban design, physical planning, landscape architecture and architecture. This overview and structure may, ultimately, be employed to discuss whether the result of this research might help extending spatial design activities beyond the boundaries of current practice.

3.2 Landscape concepts and knowledge building

3.2.1 Concepts of landscape

According to the European Landscape Convention (ELC), landscapes are “areas … as perceived by people”, where ‘perceiving’ refers to what people identify and “give value to in their surroundings” (Jones, 2007). Hence, the character of an area “is the result of the action and interaction of natural and / or human factors” (ELC). Landscape is thus a cultural phenomenon that can be described by its three main constituting components: Nature, artifacts and social organization (Ipsen, 2011). In this theoretical model, nature is considered to be everything that is and develops without human intervention. Artifacts include everything physical and material that is and results from human intervention (‘anthropogenic’). Law and order, customs and (vernacular) traditions, and other forms and qualities of common understanding of social conduct are included in the “Social Organization” of space and place (Bruns, 2014).

From the beginning of landscape ecology as a science (mainly in Europe and North America), two elements were of central importance: The role of humans as part of the landscape, rather than being considered an external force, and the focus on landscapes at a scale relevant to human perception and action (Wiens, 2002). However, in China, such concepts are only recently and gradually becoming common knowledge of landscape practitioners. The tradition of treating the landscape as space independent of people might be based on cultural idiosyncrasies (Zhang et al., 2013).

In this research, the human landscape preference and activities were made the object of study. One aim of the study is that results and conclusions may help change the understanding of landscape and the systematization of landscape planning and design in China. Knowledge building may occur based on the following:

- Concepts of landscape and ecosystem services;
- Concepts of resilient city, and of habitability, livability and sustainability;
- Concepts of knowledge-building through designing.

3.2.2 Landscape and ecosystem services

Based on a number of previously established concepts of landscape, such as models of “ecosystem
services”, Termorshuizen and Opdam (2008) have proposed the ‘landscape services concept’ to be used in planning. The idea behind the ‘landscape services concept’ is to build a bridge between the field of landscape ecology and the aims of sustainable development. The authors have elaborated this concept into a knowledge framework, including the ‘structure–function–value chain’, allowing planners to expand from the currently prevalent pattern–process paradigm and to combine values with findings of landscape ecology (Termorshuizen and Opdam, 2009). One intention is to develop the concept of ‘Landscape Recreational Services’ in addition to traditional ecosystem services concepts (de Groot et al., 2002, Fisher et al., 2009). The concept of ‘landscape recreational services’ is highly connected to the idea of landscape ecology linking in with social systems, as briefly explained above.

The landscape services or landscape functions that urban water courses might have for the individual citizen to benefit from refers to the question how the urban spatial structure along rivers might provide landscape and cultural services. To address this question it is necessary to take a closer look at structures of different urban rivers and riverfronts (Prominski et al., 2012). It is also necessary to try and understand the role that such structures have not only in providing landscape services but also to assess if they are doing so successfully. Only after finding answers to these questions will it be possible to discuss future options for planning of the management of urban rivers, as well as for riverfront planning and design. Ultimately, a theory and concept might be developed for urban river development. The "structure –function–value-chain" of urban river corridors might be verified systematically and scientifically with the focus on people’s perception, values and action.

### 3.3 Landscape Related Methodology

#### 3.3.1 Introduction

As stated above, understanding of the city landscape on the one hand, and conducting spatial planning and design on the other hand, are the main two areas of knowledge building that are important in the context of this research. Both relate to landscape, in this case to the urban landscape. It is important to discuss (in addition to concepts and theories) landscape related methods. This brief introduction puts the methodological focus on

- Landscape related approaches and structural models;
- Landscape related planning and design models.

This chapter does not include a discussion of methods that are the subject of planning theory. Methodological discourses that relate to different planning models (such as ‘rational planning’ that may be linked to some of the structural models presented below) are recognized; their detailed introduction would, however important these models are for knowledge building in planning, add little to the building of the foundation for this research.
3.3.2 Spatial Approaches and Models

1) Models of open space planning- a classification framework

In the late 20th century, environmental problems caused by urbanization in metropolitan cities made planning for better living conditions an increasingly urgent task. Referring to the City of London, and as early as 1829, J. C. Loudon published his suggestions for improving livability in cities. At the same time, the emergence of new theories for landscape and planning related research, as well as new implementation tools attracted more scholars than before to put the focus on establishing comprehensive spatial models. Of particular importance are, in the context of this research, spatial models for the establishment and management of urban green systems. Such models include the so-called ‘green networks’, ‘urban ecological networks’, and others; some of these models are discussed in more detail below. In 2007, Tseira Maruani and Irit Amit-Cohen produced a classification of the main open space planning models. This classification is mainly based on the potential use of urban open space. The two major categories created are: provision of recreation and other services to society on the one hand, and conservation of natural values on the other hand (Maruani and Amit-Cohen, 2007). However, in the metropolitan area where open space is scarce, and also when considering the residents' outdoor recreational needs, the latter appear rather more important and urgent than placing the focus only on ecological factors. In planning there usually is a strong public support for the provision of open space that responds to human need for recreation. In addition to providing for recreational opportunities the acquisition and public management of urban open space is also done for purposes of conservation, and for the shaping of urban form and functions (Myers, 1975) (fig. 3.2). In almost all cases the protection and management of urban open space is directly related to processes of urbanization (Koomen et al., 2008). Where the attention is placed on landscape social services, rivers play a crucial role as it is them that form the backbone and skeleton of many urban green networks and for people's recreations in the city.

![Figure 3.2 Models of open space planning- a classification framework (Maruani and Amit-Cohen, 2007)]
Planning for the purpose of responding to and providing for recreation usually puts the focus on a number of specific parameters that relate to user needs. Such parameters include size and spatial distribution of open space in cities, compatibility of open space with potential uses and activities, accessibility and visibility of open space, and suitability with reference to special needs (Maruani and Amit-Cohen, 2007; Chiesura, 2004).

2) Shape-related models

Several pioneering thinkers of spatial planning and of planning theory have contributed to the establishment of urban green system models. Examples are Ebenezer Howard, Frank Lloyd Wright and Le Corbusier. These, and others, are considered precursors of modern urban planning and planners who share a commitment for social change in the overwhelmingly rapid and large development of metropolitan regions. These thinkers of future planning each proposed their ideal urban spatial models, such as the "Garden City" (of tomorrow), "Contemporary City", and "Broadacre City" (Fishman, 1982). Following these pioneers, other (today also famous) planners explored metropolitan structural models through their planning practice after the middle of the 19th century (fig. 3.3). Patrick Geddes added his ideas of the 'Peleotechnic' and 'Neotechnic' order (Braham and Hale, 2006) while Christaller and Lösch establishment their ‘central place’ theory. The ideas of the ‘compact city’ and of ‘smart growth’ have been used in recent years by European planners and academics (fig 3.4) (van Stigt et al., 2013).

In all the approaches and models mentioned above, shape-related or ideal patterns are advocated for the distribution of city and landscape. In their application to European city regions such pattern thinking has been the subject for more than a century (Kühn, 2003). The drawing of spatial models and the use of shape related analyzing methods added much to the critical thinking in planning and design (fig. 3.5). Drawing patterns and shapes offer good ways to support spatial and strategic thinking, with each of the urban spatial models having their particular emphasis. The planning theory behind each model is distinctly demonstrated through drawing. With these drawings of spatial forms the priorities become easily apparent that are given to different urban objects. Good spatial form and drawing provide an effective form of communication, one that can be applied widely (another example is the "patch-corridor metric" model of landscape ecology). However, it seems that, despite or because of all the rhetoric, and despite or because of all the convincing arguments that speak for using simple spatial models, we have not moved very far in the last 100 years in our ideas of what urban structural planning should be (Thompson, 2002). The emergence of regionalism on the one hand, and the so called ‘Communicative Turn’ are only two (of many) clear indications of paradigm shifts in recent planning. The regional structure has a complex form, one that is less like a solar system and more like a constellation (Calthorpe and Fulton, 2001). To comprehend and discuss the future shaping of complex form requires communication and the exchange of arguments beyond the inner circle of a few planning experts.
3) **River-oriented and shape-related models**

Shape-related models are mainly spatial presentation models. The actual analysis requires a more diverse and intricate process to be followed. For example, based on the Basel City (Switzerland) green space planning, four green spatial models may be defined by taking different perspectives such as that of the natural conditions, of urban physical growth processes, of urban economic development, of social situation, and of the spatial functions (Bauer, 1996) (fig. 3.6). Obviously, planners would draw completely different green structure models depending on which perspective is being emphasized. In
practice one would consider each perspective separately and draw the results in the form of different layers using the so called ‘layer-cake-model’ (McHarg, 1995). In academic planning research, different disciplines (such as ecology, morphology, economy, sociology, etc.) are combined and, together with spatial planning constitute a comprehensive professional field. Urban planning and landscape planning are special branches of this field. Green space systems are significant elements of such planning. Green space systems gain in relevance when emphasizing the role of urban rivers. The question arises how to establish a river-oriented open space model, one that would help meet people needs that only urban outdoor space will be able to fulfill.

Figure 3.6 Green space shape-related models from different perspectives (Falter, 1984)

Not surprisingly, many cities evolved on the basis of and along rivers. Exploring the shaping of urban green space systems by taking rivers as their starting point would be a rational and logical approach, one that might hopefully also lead to sustainable development. For example, the kind of organic approach to developing a regional green space system as adopted (for Hamburg and other German cities) by Fritz Schumacher during the early period of the 20th century may serve as an example of how planners may understand the city with a high respect to the city river (fig, 3.7).
In addition to similar planning studies from Germany, there are several others. For example, a modern movement in architecture and planning developed in Russia, also during the early 20th century that made significant contributions to the idea of the linear city (fig. 3.8). Miliutin, in his writings and in the inter-war plan for Stalingrad, used the linear concept as a flexible and easily extendible form for the city and its region (fig. 3.8) (Miliutin, 1974). This linear concept considered the river to a great extent. There are also many other examples that include ideas for an urban structure with a river, for example, urban structure in Berlin.

In this research, an attempt is made to continue to think about a conceptual spatial model that puts the focus on urban river-oriented open space planning. The aim is to contribute to this thinking based on empirical data, and on conclusions drawn from results gained during systematic study. The aim is to make a contribution also to the methods and methodology of open space planning.
3.3 Resilient city, concepts of habitability, livability and sustainability

“Resilient” urban development has recently emerged as a socially desirable approach to spatial planning, including planning for urban open space (Bruns, 2011). For urban development to be ‘resilient’ includes, among other factors, to recognize the role of spatial heterogeneity in both ecological and social functioning of urban areas (Pickett et al., 2004). Heterogeneity and diversity are thought of as relating to social and ecological patch dynamics, and this originally ecological concept (Forman and Godron, 1986) is thus being adapted to conceptualise landscapes of cities, including urban watersheds. A framework is thus available that provides the basis for consequent perspectives of metropolitan areas to be understood as integrated ecological-social systems (Pickett et al., 2004).

The concept of the "resilient city" is also linked to concepts of habitability, liveability and sustainability. Liveability is a new term that is used to comprehensively express a set of ideas that have long been important but used singularly in urban development (Ley, 1980). The term could be understood as the sum of factors that adds up to what might be appreciated as a community’s quality of life. Included in this liveability concept are the built and natural environments, economic prosperity, social stability and equity, educational opportunity, and cultural, entertainment and recreation possibilities (Partners For Livable Communities, 2000). The term habitability is used to refer to a more general interpretation of demands for development, quality of life, social equality in contemporary cities. Habitability is, in many ways, a new term which is different from, although similar to, the now more commonly used concepts of livability and the quality-of-life and, most comprehensively, the sustainability concepts. Habitability refers to a range of qualities, functions and characteristics of a geographical area and its use in relation to dwelling, work, production and transport practices (Balducci et al., 2012).

3.4 Design process

When investigating the spectrum of methods pertaining to understanding of and planning for urban open space it is somewhat surprising to learn how there are many more structural models than landscape related planning and design models. Apparently, researchers have been more concerned, in the past, with understanding the object of planning, rather than understanding planning and design processes themselves. The field always has been a practice and less a research led area of activity (van den Brink and Bruns, 2014). Some notable examples exist, however, and some are discussed below and throughout this research report.

In China in particular, the concept of a rational design process has gradually entered the field of urban planning. However, in practice, there still is little in the way of systematic exploration with the aim to create better criteria and evaluation approaches. For this reason, and by taking the rational design process as a theoretical foundation, this research also aims to strengthen the rational design awareness in China by, among others, providing supporting tool for open space assessment. For example, in this study, the GIS (Geographic Information System) were taken both as a method and as a tool for identifying useful criteria and for carrying out assessments. GIS helps to sort out categories of
a rational design process. Taking such methods and tools one step further, ‘Geo-Design’ is a design and planning method which tightly couples the creation of design proposals with impact simulations that are informed by geographic contexts (Flaxman, 2010). Geo-Design provides a design framework and supporting technology for professionals to employ geographic information and resulting in designs. Geo-Design highly relies on a rational decision-making process. There are several design process theories that support Geo-Design. Notable examples are Carl Steinitz’s Framework (fig. 3.9) and Herbert Simon’s stages of design thinking, as well as Vijay Kumar’s design innovation process and the integrated design process. Most of these theories have between four and seven design and decision making stages, each with slightly different emphases (Kelleann, 2014) but with a same basic well-defined stages and criteria for making evaluations and assessments.

Figure 3.9 Framework for design (Steinitz, 2003)
Part III Urban development and planning for riverfronts
Chapter 4 River-oriented planning in China and Europe

4.1 River-oriented spatial planning in China

4.1.1 Introduction

This chapter gives an introduction to the development of practice of and ideas about river-based spatial planning in China. The beginnings of Chinese Planning are usually classified according to two main-streams. One of them is a town and architectural type of planning that is known to have followed the theoretical book "Zhouli-Kaogongji" (周礼·考工记). The other stream is a kind of rational planning that is largely based on the interpretation of local conditions while following the planning book "Guanzi" (管子) (Dong, 2004). In later times, after and due to the opening of commercial ports and the establishing of international trading concessions, initially in Tianjin and Shanghai, Western concepts of urban planning were introduced. More recently, concepts of ecological network, regional and open space planning, and others were adopted in China. Chinese scholars and practitioners have worked to help regulate and apply such concepts according to Chinese conditions and situations. All of the approaches mentioned above have one thing in common: they put a strong focus on rivers as one of the main elements of town and country.

4.1.2 Traditional Chinese river-oriented spatial planning

1) Traditional "Feng shui" planning theory

The well-known traditional Chinese "Feng Shui" theory builds on the long Chinese history of paying respect to the effect of rivers and water. Feng shui has had, and still has, a deeply felt impact on Chinese architecture, landscape and spatial planning, and on design. Feng shui also provides fundamental criteria for site selection for living places (Yu, 1990). Thus, the Feng shui theory is not only important in spatial planning and large scales, but it is also relevant in the context of positioning a single building and its design. The two images of figure 4.1 illustrate how a river might determine spatial planning decision at two different scales.

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7 In ancient times, based on long-term careful observations of nature and living experience, a systematic theory was created, in China, about living conditions, site selection, planning and design. This theory is called ‘feng shui’ or ‘geomancy’ (俞孔坚, 1998).
2) Traditional Greenway Planning

Although the Greenway concept that is currently favoured in China has been adapted from the Western World, the Chinese themselves have a history of more than 2000 years of traditional Greenway planning and implementation. Kongjian Yu (Yu et al., 2006) has summarized how three kinds of Chinese traditional types of ‘greenway’ developed. These are ‘Riparian Greenways’, ‘Greenways’ along transportation corridors, and ‘Greenways’ that were extended along farmland lines, for example for purposes of wind protection. ‘Riparian Greenways’ are described as corridors that run along rivers, streams and water channels. They have, in modern times, also evolved into networks of drainage channels. The main functions of these ‘Riparian Greenways’ relate to flood management. Until recently, there was little concern for additional human benefits recreation (such as cycling and hiking).

After the establishment of the People's Republic of China in 1949, the Chinese government launched several policies for the purpose of, among others, natural disaster management, prevention of soil erosion and protection of farmland. In order to implement such policy one set of efforts relate to river management and include the construction of drainage lines. Projects to develop Greenway systems along such drainage lines were first launched around the 1980s. Five major drainage Greenway projects were officially initiated by the central government. These drainage Greenway systems, mostly extending from former River and water channel Greenway systems, play a critical role in the construction of Greenway networks at national scale (Yu et al., 2006). Later on, most Chinese river-oriented planning was integrated with the newly introduced concept of ‘Ecological Networks’.

8 Old map showing part of Zhejiang province in 1226-1228, now in the Beijing Library.

9 Chinese people, like others worldwide, have suffered greatly from flooding of large and small rivers. The planting of trees along waterways has, through trial and error, proved to be effective in helping in efforts to manage floods.
4.1.3 Modern river-oriented spatial planning in China

1) National and regional river-oriented spatial planning

In the late 1990s, concepts of ecology provided the scientific basis for ecological networks and other forms of ecological planning when these were first introduced into China, initially by ecologist, and soon by inspired Chinese planners. Both ecologists and urban planners each began with their own research and practice which would then be applied in China. In the process, theories of ecology were mostly applied in the context of natural resources protection and in ecological restoration (for example, in forest rehabilitation), and the word "ecology" became, at least in urban planning, to be used (more or less) as a slogan. After 1990, ecology became more deeply and seriously considered in spatial planning. As of 1991, when the planning ideas of Ian McHarg where introduced into China, methods of how to integrate landscape ecological principles into (regional) land use planning where gradually recognized by Chinese planners (Kuang, 1991).

Figure 4.2 Framework for so called ‘ecological security patterns’ (Yu et al., 2012)

Figure 4.3 ‘Ecological Security’ at national and regional scales (Yu et al., 2012)
Kongjian Yu proposed what he calls “Ecological Security Pattern” for biological conservation during the late 1990s (Yu, 1996); later he extended this approach to the protection of valuable cultural and natural landscapes. With this step he elevated the ‘Security Pattern’ (SP) up to be applied as a multi-objective planning method. On this basis Yu elaborated a scheme for building a Green Infrastructure system which should be conducted at national, regional / metropolitan, and local scales. In this approach, rivers are always taken as the most significant linear elements and are meant to be at the core of a multi-objective ecological network (Kong et al., 2012). In addition to the SP there are other models and attempts for building a green network in China (table 4.1).

<table>
<thead>
<tr>
<th>Objectives and aims</th>
<th>Details and brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single objective: nature conservation</td>
<td>Discipline: Landscape ecology</td>
</tr>
<tr>
<td></td>
<td>Main process: Identifying and protecting linear networks</td>
</tr>
<tr>
<td>Single objective: Pertaining to mitigating urban heat island (Zhou et al., 2011)</td>
<td>Disciplines: Ecology, Climatology</td>
</tr>
<tr>
<td></td>
<td>Main process: identifying ventilation paths and air dispersion patterns</td>
</tr>
<tr>
<td>Multiple objectives: Cultural heritage and biological preservation, flood management, landscape protection, etc.</td>
<td>Disciplines: landscape ecology and other disciplines</td>
</tr>
<tr>
<td></td>
<td>Main process: identifying elements of the ‘Security Pattern’</td>
</tr>
</tbody>
</table>

After 2000, the concepts of ecological networks and greenways gradually penetrated into official regional and urban planning. One important example of ecological greenway planning at regional scale is the Pearl River Delta Regional Greenway in Guangdong province (fig. 4.4). The Pearl River Delta has rich resources that relate to river and water. In this greenway plan, rivers become the backbones of regional greenway construction. Six regional greenways are identified as the main elements of the delta region green infrastructure. Their purpose is to provide ecological services, landscape and recreational services, and also economic benefit.

2) River revitalization in metropolitan regions and cities

In the late 20\textsuperscript{th} century, the concept of ‘urban open space’ was firstly introduced into China. Nearly at the same time, at the end of 1990s, terms such as ‘riverside space’ and ‘urban waterfront’ started to emerge in Chinese academic journals. Theoretical research on and practice of open space and riverfront design soon began thereafter (both overlapping with each other). In the first half of the 2000s, the study about open space and riverfront and riverside space in China mainly put the focus on morphology, or on the spatial layout of design. After 2005 the number of scientific articles and practical discussions about these two themes grew enormously. In the process, themes and topics diversified into many more categories. Especially the transformation of riverfront open space developed into a planning and design strategy with the aim to reshape the city's visual landscape and to attract more economic development. Thus, river landscape and riverfront open space design evolved from pursuing only one single visual and aesthetic aim into a comprehensive planning tool for the multi-purpose revitalization of rivers that include ecology, culture and economy. In recent studies a more detailed integration of human needs and riverfront open space became increasingly important. However, most of even these recent studies remained qualitative in nature. In addition, there still is a lack of research about the rivers and their roles in the whole urban open space and open space system. The example of Tianjin and its rivers provide an example that lends itself to conducting such a study.

Around the year 2000, the city of Tianjin started efforts to revitalize the historic city. A comprehensive regeneration plan for the Hai River was drawn up. The Hai is a kind of mother river of Tianjin. The regeneration plan highlighted the need to recapitalize the cultural and natural asset of the historic city and the Hai River, proposing to transform the urban river corridor, from the industrial waterway that it had become, into a world-class riverfront landscape that helps reconnect the river, the urban fabric and the citizens of Tianjin. Thus, in the process, the riverfront became a main recreational space for citizens and the whole city is also able to attract many tourists. The city gains new strength in all areas of economic competitiveness. Along the river there are now many green areas and patches...
that hold potentials for developing a green open space system.

Another example is the Yangtze River Delta where the Suzhou River is to Shanghai what the Thames is to London and the Mississippi to St. Louis: the most prominent economic and natural feature and a unique source of both commerce and civic identity. In the early 1990s, the city builders of Skidmore, Owings & Merrill (SOM, an architecture, interior design, engineering, and urban planning firm) crafted a proposal for the Shanghai Planning Institute that has become the city's basic document for waterfront redevelopment. In 2002, a renewed waterfront planning and design was implemented for the Suzhou River, which included a flood management system, a transportation system, a heritage and culture protection system, an ‘Ecological security’ system, a visual landscape system and a recreation and perception system. The river and adjacent green space plans provided for large urban open spaces to be linked to waterfront spaces (fig. 4.5). On a greater scale, this design provided for the waterfront to also add more interaction with other parts of the Shanghai metropolis (Zhang et al., 2010).

![Figure 4.5 Suzhou River revitalization and the Green Space System based on this river (Zhang et al., 2010)](image)

In summary, Chinese river-oriented planning began during the 1990s and was, from the beginning, closely related to processes of rapid urbanization\(^\text{11}\). Nearly all of the Chinese city river plans have or would be undertaken with four main aims in mind. The first one of these aims is the cleaning of water and environmental improvement at large. The second aim is the reshaping of urban river landscapes. The third aim is to employ high quality river landscapes as a driving force to foster urban economic redevelopment and urban space redevelopment. The fourth aim is to upgrade riverfront space and urban green space in a way that builds a system of urban green infrastructure, which already happened in Beijing and Shanghai. Several big cities such as Hefei, Nanjing, Wuhan, Harbin, etc. are, already, paying good attention to their waterfront landscape environment and to the cultural value that are linked to them. These cities have conducted a series of waterfront plans and designs. However, in most middle and small cities, the river ecology and environments are still in rather poor conditions (fig 4.6). The supremacy that governments give to the economy makes people continue to sacrifice natural and cultural environmental values.

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\(^{11}\) After the year of 1999, China experienced rapid sequences of urbanization with rates of urbanization exceeding 30%. This era is expected to last around 30 years, until the 2020s.
4.1.4 Summary

In China, ecological planning and modern urban planning began during the 1990s. There are a many potentials to explore in each of these aspects that relate to rivers, particularly considering the Chinese background. In no forms of planning, the roles of river could be ignored.

Towards developing ecological networks, in national, regional and even in some metropolitan scales, the river is one of the significant linear elements for ecological corridor and network identity and construction. Towards regional comprehensive development, the river was and still is treated as the larger structural link for ecology, economy, society and recreation. For recreational service provision in highly urbanized areas, the river is the backbone of open space structures (table 4.2).

Table 4.2 River-based spatial planning in China at different scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>Goal</th>
<th>Concept, approach</th>
<th>Role of river</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>Biological conservation, cultural preservation, natural disaster Prevention</td>
<td>Ecological planning</td>
<td>Significant linear element for multi-corridor identity and construction.</td>
</tr>
<tr>
<td>Regional</td>
<td>Providing recreational service, building regional open space networks</td>
<td>Regional Greenway development</td>
<td>Main corridor linking valuable natural parks, green space and historical heritage, etc.</td>
</tr>
<tr>
<td>City</td>
<td>Reshaping the river landscape, drawing attractions to water fronts, riverfront district development</td>
<td>Waterfront transformation and revitalization</td>
<td>River as the most attractive spatial backbone.</td>
</tr>
<tr>
<td></td>
<td>Forming urban open space system or ecological networks</td>
<td>Spatial planning and urban planning</td>
<td>Linear element for open space network.</td>
</tr>
</tbody>
</table>
4.2 River-oriented planning in Europe

4.2.1 Introduction

Developing strategies and models for the spatial development of city and landscape has a long history in Europe. Visions for improving city regions have been a subject of study and practice for more than a century (Kühn, 2003). European policy makers and planners gained considerable practical experience in the field of river and spatial planning. Several planners and their projects have become precursors that are recognised worldwide. This chapter summarizes relevant river-related planning ideas and presents examples from throughout of Europe. Included are continental, national and regional planning efforts with examples covering metropolitan and inner city areas.

4.2.2 Ecological network planning at continental and national scales

Historic predecessors to ecological networks include landscape axis and avenue designs that started in Europe in the early 1700s. The first axial and circular model proposed for a metropolitan region was for London, England, authored by J. C. Loudon in 1829 (Johnson, 2012). Concepts of arranging for cities to have ‘green belts’ and the idea of the ‘Parkway’ also started in North America during the 1920s. Starting during the 1960s, concepts for greenways and greenway networks were developed in Europe and in North America. All of these efforts provide the background for modern designs of urban open space systems, and also for nature conservation and sustainable spatial planning.

Rapid urbanization and land use change occurred in Europe during and after the Industrial Revolution. These transformations lead to landscape fragmentation, combined with serious ecological damage and large numbers of species declined in number or even became extinct. Environmental degradations also started to pose direct threats to humans and to their environment, including water and air pollution. Hence, while the original intention of devising ecological networks is to protect and foster biodiversity, mainly as a response to fragmentation of land, the compensation for intensification of land use and for environmental degradation also become important aims.

Without including the earliest examples of ‘Green Belts’ the development of ecological networks in Europe has a history of nearly 40 years. A great number of sources exist in the relevant literature that discusses ecological networks. One definition that is widely accepted and quoted is one proposed by Bennett: An “Ecological Network is regarded as a coherent system of natural and/or semi-natural landscape elements that is configured and managed with the objective of maintaining or restoring ecological functions as a means to conserve biodiversity while also providing appropriate opportunities for the sustainable use of natural resources” (Bennett, 2004). Similar to this definition, Jongman defined ecological networks ‘as systems of nature reserves and their interconnections that make a fragmented natural system coherent, so as to support more biological diversity than in its non-connected form’ (Jongman et al., 2004). Whether single purpose (Rob, 1995) or multipurpose, in

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12 Hints for Breathing Places for the Metropolis
both instances the definitions emphasize the need for a ‘system’ and for the network to have a ‘coherence’ that is based on ecological processes. Similarly, a definition from conservation biology simply and straightforward includes ‘a set of ecosystems of one type, linked into a spatially coherent system through flows of organisms, and interacting with the landscape matrix in which it is embedded’ (Opdam et al., 2006). Despite slight variations that may be detected when comparing the visions that are expressed in these definitions of ecological networks, it can easily be recognized that there are very similar elements included into any structural model of ecological networks. There is, to begin with, a widely accepted operational model. This model is composed of (a) core areas, (b) ecological corridors and (c) buffer zones. Some models also refer to (d) restoration areas. In addition to the ‘ecological network’ structural model other concepts exist as well, such as ecological corridor concepts, green infrastructure models, ecological infrastructure models, and also the concept of ‘greenways’. Being only slightly different from the basic structural ecological network model, the so called ‘ecological corridors’ may be considered as being one component of the ecological network model. The ‘green infrastructure’ model focuses mainly on the so called ‘ecological services’. And the ‘greenway’ concept constitutes a connectivity framework in its own right, one that is based on linear landscape structures to be developed and managed for multipurpose use; these may include nature conservation, aesthetic benefits, recreational and cultural purposes. The ‘greenway’ is designed to be mainly a linear landscape. But obviously, the greenway discourses have certainly inspired the development of ecological corridors (the crucial element of any ecological network) in European nature conservation (Jongman et al., 2004).

Based on theories and practices published in the relevant literature, the development of the ‘ecological network’ concept may be divided into three periods. The first period is the initial period of spontaneous initiatives. The second period is the development with a clear concept and specific organizations. The third period is the further implementation and extension of ecological networks.

First period: singular and spontaneous initiatives (around the 1970s to 1980s)

While exploring the beginnings of the ecological network idea most of the literature points at five countries: Lithuania, Estonia, former Czechoslovakia, Denmark and The Netherlands. Pioneers of thinking about ecological network are mainly from these, but also from other countries such as Poland, Germany and the United Kingdom. During this period, ecological network efforts originated more or less spontaneously as singular events. Aims are varied and mainly focus on nature conservation at regional or national scales. Nature conservation is mainly concerned with crucial species and with habitats to be in their natural state. The concept of ecological networks has, during this time, not been generally accepted as a planning and management strategy. Early in the 1970s studies have been carried out that are based on the so called ‘island biography’ concept. On this basis, plans were made in Lithuania and Estonia to combat isolation effects that resulted from landscape fragmentation. In the beginning of the 1980s ecological network planning started in former Czechoslovakia. In the same period the concept of nature corridors was introduced as a relevant part of Danish regional plans and in 1984 the concept of ecological networks was worked out as a national plan (Jongman et al., 2004). At the European level, the Diploma Sites network (1965), the network of Biogenetic Reserves (1976) and EECONET had been discussed (Rob, 1995).
Second period: clear concept and specific organizations (around the 1990s to 2000s)

The end of the Cold War and establishing the European Community provides the political background during this second period. Better academic exchange was now possible, such as about nature conservation in European countries. Projects were started that were based on trans-boundary cooperation and on international protection protocols (such as Natura 2000). It was also the beginning for several major organizations, like EUROPARC, IUCN (International Union for Conservation of Nature), WWF (World Wildlife Fund), and many others. The initial concept for a European ecological network was EECONET (Bennett, 2004). At this period, project cooperation and protecting protocols involved more countries to participate in the construction of ecological networks. Ecological networks as a concept and strategy for conservation have been clarified, and began to spread more widely. Certain conservation models have been proposed, pilot projects have been conducted and the focus increasingly was on the preservation of semi-natural landscapes. However, the theory and practice of ecological network were still in their exploratory period. In 1992, the European Union issued the Flora, Fauna and Habitat Directive which focuses on the conservation of natural habitats and wild fauna and flora (92/43/EEC). It was adopted as an implementation instrument of the 1979 Bern Convention on the Conservation of European Wildlife and Natural Habitats. Together with the Birds Directive (79/409/EEC) the FFH-Directive constitutes the main legal framework for nature conservation in the European Union. Its aim is to contribute to the conservation of natural habitats and wild fauna and flora in the European territory (EC, 2003). In 1995, at the conference of European Environment Ministers, in Bulgaria, 54 European countries endorsed the initiative to establish a ‘Pan-European Ecological Network’ within the next twenty years.

Third period: further implementation and extension (around 2000 and to present)

Increasing urbanization, the deterioration of urban living environments and the emphasizing of spatial structures and functions in landscape ecology lead to the conceptual extension of the ecological network strategy. Primarily, during this period, ecological networks are not only concerned with biological or ecological conservation. The idea expanded to include webs of linkages for several different aims e.g. ecological, social, political, and cultural aims (Bennett, 2004). Additionally ecological networks were now widely integrated into spatial planning. They were also included into sustainable urban development (Opdam et al., 2006). Simultaneously, based on the Natura 2000 efforts from the previous decade, European countries began to gradually implement the network idea at national and local scales. For example, 34 trans-boundary cooperation projects were identified within establishing ecological networks across Germany’s external borders in the period 2003-2005 (Leibenath et al., 2010). The three most important developments in this period pertain to the establishment of the Pan-European Ecological Network, the European Green Belt and the ecological network within the realm of the Alpine Convention. The Pan European Biological and Landscape Diversity Strategy (PEBDLS) was developed under the auspices of the Council of Europe, in order to achieve effective implementations of the Convention of Biological Diversity (CBD) at European level. A crucial component of the PEBDLS is the development of the Pan European Ecological Network (PEEN), which would act as a guiding vision for coherence in biodiversity conservation. The European Green Belt is a project which literally has made use of the former ‘Iron Curtain’. Running from the Barents Sea to the Black Sea it forms a long ‘belt’ with a now predominantly ‘green’ vision.
Not only does this project aim at ecological conservation but it also tackles territorial challenges with special geopolitical and cultural relevance (Terry, 2006).

**Summary: Rivers are part of ecological networks**

In the process of 40 years, the development of ecological networks as a single target conservation strategy evolved into a multi-objective comprehensive strategy that now includes social, cultural and other aims (Bunn et al., 2000). With the concept of ecological network, the green system planning in urban areas has been emphasized, which challenges the urbanization processes and the activities of the infrastructure sectors (Ahern, 1995; Schrijnen, 2000). Rivers have been important elements in ecological networks, greenways, and in green corridors. The river often becomes the core of these strategies. Rivers play important roles in greenways construction, in sprawl control and in rational planning at large. Rivers are one of the five major types of Greenways (Little, 1990, Zhang and Wu, 2007).

### 4.2.3 River-oriented landscape revitalization and the new spatial and regional planning in Europe

After the 1960s and when problems of the fossil energy based economy first started to be noticed and discusses, cities began to explore new options for urban and regional revitalization through spatial planning. The aim was to achieve greater resilience and sustainability. From the perspective of urban development, urban planners and landscape planners were called to use instruments of environmental planning (some inspired by the concept of ecological network planning) to solve the many problems found in old industrial areas. In such regions, rivers are of major importance for running factories (water supply, cooling, etc.) and for transporting both raw material and industrial products. Starting with river restoration and rehabilitation schemes, planning efforts soon expanded into river landscape design at large which, in turn, soon became the focal points for the new type of comprehensive environmental planning.

Two forms of planning at landscape and regional scales may be distinguished. The first type puts the focus on landscape and regional revitalization; examples are plans for so called ‘Landscape Parks’. Here, the main driving force is to foster regional economic development with the support of landscape planning. The second type is what be called modern urban planning. Like the first type, this form of planning also explores the potentials and recreational, social and economic values of open space. Both types of planning employ rivers as linear backbones of (urban) landscapes. These two types of planning are inevitably inspired by ecological theories from the 1990s which continued to be developed further. To illustrate this development, a number of well-known planning cases from Europe are discussed.

The structural and environmental transformation of the Ruhr Region in Germany is used to illustrate the first type of new planning, the one that is often related to the term Landscape Park. This planning example inspired many other similar planning efforts in Europe and beyond. In this example, the scale of region was used to take in the entire areas as a whole and to try and develop the region in balance.
with its cities and towns. The concept of the ‘Regional Park’ emerged, which can be understood, not as a city park or a National Park, but a special kind and image of a ‘park district’ that covers a region and crosses several jurisdictional boundaries. Inside of the Regional Park, a system of linked open green spaces was developed. Both the Regional Park and the open space system serve purposes of nature conservation, regional revitalization and for the renewal in regional sustainable development; both have multiple benefits. Additionally, in the past two decades, it has become increasingly clear that the region at large must be considered as being one entire ecological and cultural entity as well, since most natural and social systems are not restricted to and do not operate at local level alone. Rather, they function at much larger scales, ones that ecologists and designers often call the "landscape" scale. The "watershed" of rivers is one example mostly applied to describe the area referred to as regional landscape (Calthorpe and Fulton, 2001).

The second type of new planning relates to social change and structural transformations that call for innovative and collaborative approaches. The terms "spatial planning” and “regional planning”\(^{13}\) refer to forms of planning that are concerned not only with land-use and spatial policy , but seek for strategies and instruments, including those that help ensure the vitality of open space. These multi-disciplinary types of planning also develop linkages between regional geography, ecology, economy and policy making (van der Valk & van Dijk, 2009).

### 4.2.4 Examples of river-oriented ‘Landscape Parks’ in Germany

**Emscher Regional Park**

The Ruhr Region is one of the main industrial centers of Germany. Its economy has been dominated by coal mining and heavy industry for more than a century, and it was left with enormous ecological and social problems after the industrial transformation of the 1980s. Aiming at providing new orientation and values for the municipalities of the region, and by forging new links and constructing new channels for the redevelopment funds streaming into the area, the concept of the ‘Emscher Landscape Park’ emerged. The Emscher Landscape Park is a project encompassing 17 towns and cities in the region and covers an area of 320 square kilometers of land running from west to east along the Emscher River (Gailing, 2005). The Landscape Park ideas are based on the concept of ‘regional green corridors’ that was established during the 1920s.

The re-development and new planning for the Ruhr Region took three decades to do, and it is still ongoing today. During this first decade (1989-1999), the IBA\(^{14}\) company was established that operated as the mediator and coordinated development. At the same time, the Kommunal-Verband-Ruhr, KVR, was responsible for the master plan of the Emscher Landscape Park.

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\(^{13}\) These terms are translations from the German and Dutch planning terminology (raumordnung, ruijntelijke planning) and an approximate translation of the French aménagement du territoire (Williams, 1996). Such terms are used to emphasize the difference between the traditional (British) approach to town and country planning and the underlying concepts of planning that have been developed in the three countries. The essence of spatial planning is that it is concerned with locations of both physical structures and activities within the territory of the jurisdiction to which it is applied. For this reason, it is preferable to use the term regional planning which is also occasionally used as a translation of the terms quoted above (Albrechts et al., 2001).

\(^{14}\) Internationale Bau-Ausstellung
After the IBA, during the second decade the Project Ruhr (a new company to promote projects in the Ruhr area) took over the task of coordination and project management. The task was to work on the master plan 2010 together with all other participants. The main task of the third decade is the regeneration of the Emscher River System, together with the development of the new Emscher Valley. A multitude of projects were brought together into a plan for 2010, a central theme of which is the integration of open spaces into a network – a “landscape park” – stretching 70 km along the banks of the Emscher River, and branching out at various intervals. If indeed this were a “park”, this park would be the largest in Europe (fig. 4.7). Interestingly, many of the original buffer zones that were introduced in order to maintain open space between growing cities now comprise parts of this park and network (Evers & de Vries, 2008).

In this case, there are two rivers, one is the Rhine River, which skirts the Emscher Region along its western edge, and the other river is the Emscher River, which traverses the region from east to west. With its numerous branches and tributaries the Emscher River drains almost the entire park region. From the figure below it becomes apparent how most of the open space that exists in the region is, in one way or another, attached to the river system. The main forms of open space in this system are city parks, gardens, botanical gardens, zoos and farmland. Traditionally, open green space in the Ruhr area was protected as “buffer zones” between cities (fig. 4.8), first delineated in 1920 by the regional planning authority, the KVR. Later the structure of the open space system was divided into three levels. The first level includes the Regional Park at large, the second level is the regional open space-system within the region, and the third level includes all individual open space projects (Schreckenbach and Teschner, 2006).
At the first level, the spatial structure is derived from the integration of open space and agricultural area along the Emscher River; this integrated structure makes the Emscher Park a regional open space system (Shaw, 2002). At the second level, the Emscher Park is composed of seven regional greenways, or green corridors (called corridor A, B, etc. to G), the corridors are running along north-south axis. Together with the east-west-corridor of the Emscher River Valley these green corridors constitute the basic framework of the ‘Emscher Park’. At the third level, the project level, the relationship between river and open space can be divided into two types. The first type of project is linked to a river as the main axis connecting different kinds of open space. The other type is one where the river itself provides the physical and spatial base for creating potential open space (Genossenschaft, 2006).

In the case of Emscher Park, the Emscher River plays a vital role in the regional ecological and spatial development. Firstly, the open space serves as the buffer zones that run along the Emscher River, effectively help separate the build-up city areas and, similarly effectively connects elements of their open space system (fig. 4.8). All of the attractive points of the region are linked together by rivers. Secondly, the ecological service of the river is emphasized, and the rivers and tributaries have become the framework of spatial development at large. This spatial network based on the water system offers many possibilities for regional sustainable development.

**Other regional parks in Germany**

Other than the Emscher Park, there are also several reference cases of regional park development in Germany. All of them are taking the region as a whole, seeking to plan for an open space structure that is based on a river. One example of many is the ‘Neckar Regional Park’, or also known as the Neckar Landscape Park. The Neckar River is not only the geographic backbone of the Stuttgart Capital Region; it is also the most important river in the state of Baden-Württemberg. On its route across the state, the Neckar River flows through all of its 4 administrative districts, 6 regions, 14 counties and 71 municipalities. The Neckar Landscape Park aims at developing a system of green infrastructure. All of the open spaces, green areas, paths, special attractions, and buildings are included and are, in one way or another, linked with one another. The resulting system affords environments for locals and visitors to enjoy and spend time outdoors. The recreational opportunities of the Neckar Landscape Park provide for a high quality of life in the area. Investments in the Landscape Park and “Green Infrastructure” are considered as important as investments in improving the “grey infrastructure”, i.e. roads, rails, or the new trade fair venue. The strategy of adopting the river and the river watershed as a backbone and developing force for a region is widespread in Germany, and the Neckar Landscape Park is a good example for this approach as well.

**4.2.5 The Randstad examples of river-oriented regional planning in the Netherlands**

During the past two to three decades, the Dutch region known as ‘Randstad’ has become a reference
example for the development of polycentric urban and regional metropolis (Lambegts, 2006). As is the case in most Western and Central European metropolis, the open space of Dutch cities and towns includes not only designed parkland and gardens, but also agricultural and natural areas (Koomen et al., 2008). Currently, despite the advanced nature of urbanization in the country, about 90% of the Dutch surface area can be considered open space. This open space includes about 75% of agricultural land. The Dutch institutional policy framework for the preservation of open space is internationally regarded as successful (Alterman, 1997).

It was the aviation pioneer Albert Plesman who introduced the term ‘Randstad Holland’ (Rim City Holland) in the 1930s while flying across the Netherlands and noticing a belt of cities skirting, at the edge, a nearly circular open agricultural area in the centre (Bart Vink, 2006). The Randstad is a collection of cities in one region. The cities are kept firmly apart by eight green zones (buffer zones) and by a large central open area. This central open space is called the ‘Green Heart’, a green centre that is surrounded by a ring of cities. Since about 1950, the Dutch government has carried out national spatial planning and, during the five times of updating of plans, hopes to maintain the openness of the "Green Heart" while, at the same time, continuing to improve the quality of region and its open space (Wang and Wang, 2006).

![Figure 4.9 Relationships between river and open space in the Dutch Randstad](http://ifou.org/summerschool/2009delft/downloads/Randstad_2040_Structuurvisie.pdf)

Three types of roles of river and open space currently exist in the Randstad region. One type is found where cities are physically separated from each other through an open space that is fixed as an official buffer zone; in many instances, particularly in the Netherlands, such buffer zones include water ways. A second type is found where buffer zones and the Green Heart together shape the pattern of an open space system. As in the first case, buffer zones are composed of agricultural land and natural areas which are maintained along water courses. The rivers also provide the main structure for a green network of the Green Heart itself (fig. 4.9). Finally, the buffer zones and the Green Heart together play the role of providing limitations and barriers aimed at restricting urban expansion. Thus, by implementing a policy of open space preservation which, in the case of the Netherlands, usually relates to river and water policy, the pace of urban expansion has slowed and the buffer zone and the Green

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Heart have been maintained to some extent.

### 4.2.6 The Po River Project, an example of river-oriented planning in Italy

The Po River project is an example where a set of policy programmes, plans and projects where coordinated and developed since 1987. The aim was, and still is, to preserve and enhance the Po River and the river floodplains for purposes of regional social and economic sustainable development. The Po River project may serve as an example to illustrate how the regional scale is, indeed, the appropriate scale for not only dealing with natural resources, but also with economic development at the same time.

The wider context of the Po River project is the Po watershed. This river basin covers an area of 75,000 km², and the river is 652 km long. The river basin is enclosed by high mountains, the Alps and the Apennines. The watershed drains into the Adriatic Sea. It is one of the largest economic and most productive areas in Europe, and it is of great importance for the Italian demographic, social and economic development\(^{17}\). The Piedmont region is part of the Po River basin; it includes 36% of the entire Po River course and 40% of the river basin. Regional planning challenges include hydrological management and flood risk management, water and air pollution, general environmental degradation, and energy production. How the Piedmont addresses such challenges heavy influences the other part of the river basin, and also the Adriatic Sea.

River-oriented planning in this region started in 1987 when the Regione Piemonte initiated the Programmazione economica e pianificazione territoriale. Later the management authority of the River Park was set up, in 1990, for the Po river system and its protected areas. This authority supported both the extension of protected areas and the implementation of the plans and projects inside of the

\(^{17}\) Together with the Dutch Randstad, the Ruhr Region in Germany, and several other metropolitan areas, the Po River Region is part of one of the world’s greatest economic axis. With a population of around 110 million it stretches, as a discontinuous corridor of urbanisation, approximately from North West England in the north to Milan in the south, along some of the main rivers of Western Europe, and it partly follows their curvature; hence the name of this corridor; “Blue Banana”.

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Figure 4.10 Spatial planning of the Po river project (Longo, 2001)
protected areas\textsuperscript{18} (fig 4.10).

4.2.7 River-oriented open space planning in large city regions

Open space is generally positively associated with the well-being of people (Hansmann et al., 2007). Researchers have tried to explain which health-promoting values may be derived from green open space (Hartig, 2008). For example, it has been observed that people who experience mental distress frequently use physical activity such as walking and gardening to reduce stress, and how vulnerability to depression might be compensated through green open space activity. Taking part in outdoor activities might also help to raise people’s general motivation, raise self-esteem, and reduce feelings of isolation (Healey Brown et al., 2011). It is, not the least, for such reasons that large cities make continuous attempts to establish open space systems. Particular benefitting to citizens, it is believed, are open space systems that are based on water courses such as rivers. To develop green space systems along urban water courses means tackling a number of city specific challenges. One of the main urban issues is that almost all land is, or has been, developed and has buildings, infrastructure or hard surface (PDL, previous developed land). Such installations need to be either removed or integrated into the green space design (table 4.3).

\textsuperscript{18} Source: Plans, programmes and projects for the protection and enhancement of the Po River in Piedmont (Italy). http://www.paesaggiopocollina.it/dwd/premio/description.pdf. on 07.01.2014
Table 4.3 Key benefits of creating open space on PDL

<table>
<thead>
<tr>
<th>Economic</th>
<th>Social</th>
<th>Environmental</th>
<th>Heath</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land value of site and adjoining land raised</td>
<td>Reducing risk to health from contaminated land</td>
<td>Promoting biodiversity</td>
<td>Promoting well-being</td>
</tr>
<tr>
<td>Viable use for retired land and areas</td>
<td>Creating opportunities for sport and recreation</td>
<td>Improving appearance and character of areas</td>
<td>Managing stress and mental health</td>
</tr>
<tr>
<td>Enhancing perception of area; improving potential for investment</td>
<td>Helping to reduce stress levels and improving motivation</td>
<td>Helping to manage the impacts of climate change and supporting</td>
<td>Improving patient recovery times</td>
</tr>
<tr>
<td>Providing a temporary use for a site(subject to creating an exit strategy)</td>
<td>Creating opportunities for social interaction</td>
<td>Air quality management</td>
<td>Promoting active life styles</td>
</tr>
<tr>
<td>Improving community relationships and reducing risks of objections to future development proposals</td>
<td>Supporting cultural activities and diversity</td>
<td>Surface water management and creating space for flood management</td>
<td>Creating opportunities for growing food</td>
</tr>
<tr>
<td>Responding to planning requirements for creating open space</td>
<td>Fostering community involvement and ownership of local environments</td>
<td>Ground stability management</td>
<td>Promoting positive behavior amongst children</td>
</tr>
<tr>
<td>Attracting inward investment to a wider area and improving corporate responsibility reputation</td>
<td>Creating calm spaces in busy urban environment</td>
<td>Creating opportunities to produce zero carbon biomass fuels</td>
<td>Helping to manage micro-climate to help elderly and people with breathing difficulties to cope with hot weather</td>
</tr>
<tr>
<td>Creating job and train opportunities associated with land management and maintenance</td>
<td>Promoting learning about the environment, landscape health and well-being</td>
<td>Reducing negative effects to ecosystems from contaminated land</td>
<td></td>
</tr>
</tbody>
</table>

In addition to addressing fundamental challenges, each city must, when designing open space systems, adjust to its specific natural and cultural background and context. The city’s uniqueness relates to its geology, geography, and other natural processes including water hazards and constraints. For example, a city which is located below a mountain has to pay attention to the mountain river hydrology and ecology, and it will have to accommodate for a specific type of storm water management. Mountain river catchments and hydrology highly influence spatial planning strategies of this city. Such

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19 Previously developed land: Land which is or was occupied by a permanent structure (NPPF Annex 2 p55)
characteristics need to be identified in an integrated way, and they need to be referred to as the main factors in any attempt to construct a city and river classification system. In this study, and starting from the natural and geographical perspective, cities are classified as follows: coastal city, main/big river city, tributary/small river city, city of the plains (without evident river), foothills city with water source (fig. 4.11).

In this system the cities of London, Paris, Cologne, Munich and Frankfurt and Tianjin are all in the same category: one main/big river flows through these cities. London, Paris and Frankfurt have considerable experience in urban green space planning that considers the city river. There are policy prepared for these cities that pay respect to the spatial and natural relationships between the river and urban green structure. Such policy is, in turn, based on studies on morphology, hydrology, etc. These cities provide reference cases for the study on Tianjin, regarding the development of green open space systems. These examples are also employed to establish a conceptual model for developing such open space systems.

1) London

London has a long history of planning practice and there are several plans, in its modern history, including the 1929 plan, the 1943-1944 plan (fig. 4.12, 4.13), the 1951 plan, post-1976 and the 1991 Green Strategy (Turner, 1995). Recently, the East London Green Grid is one of the first spatial frameworks to use a landscape and human-centered green infrastructure approach. The initiative won the Landscape Institute’s Strategic Landscape Planning and President’s awards in 2008\(^{21}\) (fig. 4.14).

\(^{20}\) Base map refer to cross section illustration of water cycle. Photography, Encyclopedia Britannica Image, Quest.

\(^{21}\) Resource: Landscape institute (http://www.landscapeinstitute.org/media/Awards08.php)
Figure 4.12 Famous greater London plan with four rings in 1943 (left) (Forshaw and Abercrombie, 1943)

Figure 4.13 Park systems and corridor network from Abercrombie plan 1944 (right) (Abercrombie et al., 1945)

Figure 4.14 Strategic green networks in East London Green Grid (The ALGG Project Team, 2012)
The aim of the Green Grid is to create a network of interlinked, multi-functional and high quality open spaces that connect with town centers, public transport nodes, the countryside in the urban fringe, the Thames River and major employment and residential areas (see map of Green Grid Strategic Framework in Figure 4.15). All strategic corridors link with the Thames River. The relationship between rivers and open space can be divided into two types; the first type is the river as the axis of connecting the open space, and the other one is the river as the physical base for the creating of potential open space. They present four specific aspects: 1) Extending existing open space to the main stream of the Thames; 2) Finding potentials for new open space which link to the main stream of the Thames; 3) Connecting separate open spaces and link them with the main stream of the Thames; 4) Identifying existing open spaces which, as a line, link to the main stream of the Thames (fig. 4.15).

Figure 4.15 Four specific aspects of rivers and their contribution to organizing and linking open space

2) Paris

The urban open space system of Paris has a somewhat rectangular structure (fig. 4.16). Based on urban roads, the open space system appears to have, when looking at a map, many vertical and horizontal green belts, as well as a radial green network. Simultaneously, attached to the two urban spatial axes, there are several sub-axis, which retain the potential for open space development, and they provide recreational spaces for residents. This kind of structure helps maintain the integrity of the open space with the Seine River and link the green spaces to the buildup areas of the city (fig 4.17).

Figure 4.16 Development of Paris from 1200 to around 1860 and after 1960 (Morris, 1972)
3) Cologne, Munich and Frankfurt

Germany has a long tradition of urban planning and its cities maintain a sound system of green open space structure. The cities of Cologne, Munich and Frankfurt may serve as reference for urban development focusing on waterfront landscapes and open space.

Cologne

The planning ideas of Cologne have had great influence on urban development models in Germany and beyond. For example, the "new city" model was proposed during the 1880s and brought out the model for the spatial structure that was applied for the next few decades (Ladd, 1990). Even today, the wedge-shaped green axis specified in the original model still connects the outside of the built up area and the city center, including the area along rivers. The green space along the old city fortifications link up with the riverfront green space. The Rhine River serves as the backbone of this kind of green structure and contributes much to the identity of Cologne as a city (fig 4.18).

![Image of Cologne open spaces](http://www.lebendige-stadt.de/web/template2neu.asp?sid=404&nid=&cof=380)

Figure 4.18 Open spaces in Cologne in the region, city and inner city

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Munich

"Green between Cities" ("Grün zwischen Städten") is the motto for sustainable development in Munich. A greenbelt system is formed that connects the surrounding areas and the inside areas of Munich. Open green space has always occupied large area of the city and, in many instances; there are conflicts with economic development. However, these valuable green spaces guarantee a good quality for living. In the region, the largest green belts follow along the direction of the Isar River and other river channels that flow through Munich, and also inside of the city. Urban waterfronts have been designed as a wide green space (fig 4.19).

Frankfurt

In the Frankfurt Rhein-Main Region, the green open space system took the shape of the river-based linear park. Rivers provide the backbone of some of the so called "Regionale Grünzüge", aiming to connect open spaces with one another for the direct benefit of citizens and nature. This system also is designed to add to the region’s attractiveness: Companies demand, for their staff, an interesting environment which is increasingly thought of as an additional locational factor. The ‘Regional Park’ is thus designed as a network of routes and places offering recreational opportunities. Routes consist of a path 2.5 to 3 meters wide, typically with a grit surface, enclosed by rims of 10 meters each, planted with trees, flowers, bushes and the like, depending on local circumstances. Within distances of, say, 500 meters from each other, the regional park route will be complemented by regional park places (fig. 4.20). The greenbelt in Frankfurt is a synthesized cycling system with considering also ecology and ventilation (Koenigs, 1991).
4.2.8 Summary

The table below shows a summary about river-oriented spatial planning in Europe at different scales. In each scale of spatial planning and design, the involved professional fields are different. At national scale, the river-oriented spatial planning mainly relates to ecological network development. At regional scale, regional planners emphasize the river and take the watershed as the planning boundary. And in a city, rivers have an importance role for open space planning (table 4.4).

Table 4.4 River-oriented spatial planning in Europe at different scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>Goal</th>
<th>Discipline, concept</th>
<th>The role of rivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continent and nation</td>
<td>Mainly for Nature and biological conservation, and with other multiple benefits</td>
<td>Ecological network</td>
<td>One of the linear corridors for the ecological network; the river network serves to establish ecological networks (Looy et al., 2013).</td>
</tr>
<tr>
<td>Region</td>
<td>Regional redevelopment for environment, society, economy</td>
<td>Landscape park; Special planning in regional planning</td>
<td>Watersheds serve as planning boundaries</td>
</tr>
<tr>
<td>Metropolis and inner city</td>
<td>Recreational service in Urbanizations</td>
<td>Open space system</td>
<td>Water courses serve as backbones of the open space's structure</td>
</tr>
</tbody>
</table>

4.3 Comparison of river-oriented spatial planning in China and Europe

From the perspective of social development, there is a certain distance between China and Western countries. Around the late 1990s, China began a process of rapid urbanization. Many different approaches towards sustainable development and ecological planning were introduced into China, approaches which had already been employed and studied in the Western world for many years. Such approaches are not easily transformed to fit Chinese contexts. The process of learning would last some time, depending not only on the effort of scholars but also on the extent and speed of urbanization of the whole society. Still, there is much to be learned. For example, the European understanding of urban rivers and the urban water front space provides a valuable source for developing urban rivers in Chinese cities. Most importantly, the planning approaches are relevant that emphasize how the role of the river must be considered, and that systems of green open space should be provide for through planning and design.

Table 4.5 Comparison of river-oriented spatial planning in European and China

<table>
<thead>
<tr>
<th>Scale</th>
<th>place</th>
<th>Planning approaches</th>
<th>Start time</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>national</td>
<td>Europe</td>
<td>Ecological network</td>
<td>Late 1960s</td>
<td>A consensus about this approach exists in Europe for over 40 years.</td>
</tr>
</tbody>
</table>

River: Both in Europe and China, rivers are one of the significant linear elements for corridor identification and construction.

<table>
<thead>
<tr>
<th>Scale</th>
<th>place</th>
<th>Planning approaches</th>
<th>Start time</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>regional</td>
<td>Europe</td>
<td>Landscape park; regional planning</td>
<td>1980s</td>
<td>Many cases of regional planning based on river basin exist in Europe.</td>
</tr>
<tr>
<td>regional</td>
<td>China</td>
<td>Greenways</td>
<td>After 2000</td>
<td>The 2010 Pearl River Delta Regional Greenway is the first regional greenway planning project in China.</td>
</tr>
</tbody>
</table>

River: In Europe, regional planning based on river is a multi-objectives planning. River basins serve as landscape boundaries and structural axis. In China, rivers are mainly taken as the corridors linking valuable natural parks, green space, historic heritage, etc.

<table>
<thead>
<tr>
<th>Scale</th>
<th>place</th>
<th>Planning approaches</th>
<th>Start time</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>city</td>
<td>Europe</td>
<td>Open space system; River revitalization</td>
<td>Late 19th</td>
<td>The concept of ‘open space’ has been brought out for a long time and there are many good practices in Europe.</td>
</tr>
<tr>
<td>city</td>
<td>China</td>
<td>Open space planning; River revitalization</td>
<td>Late 1990s</td>
<td>Only few cities in China has done this well.</td>
</tr>
</tbody>
</table>

River: Both in China and Europe, rivers are taken as attractive spatial backbones of open space systems. In China, limited to highly urbanized land use, the connectivity between rivers and other urban open space still need to be developed.
However, this does not mean that every good experience, mechanism and approach found in Europe should be adopted in and for China. First of all, China has a long tradition of planning and design that one needs to build on. For example, the technique used to create squares and parks in London and Paris are not transferable to China because they are based on completely different notions of property ownership and government responsibility. Unlike in China, property development in European cities is based on the interrelationship between owners and renters, both of whom are financially dependent on the quality of public open space. In China, most property owners avoid responsibility for nearby open space (which is, in some way, similar to the situation in the USA). Furthermore, in Europe, parks were and still are thought of as an integral component of the urban environment. In China it is somehow different as parks are thought of as standing in contrast to urban spatial development.

Currently, in China, rivers have become to be considered the most cherished natural resource in urban areas. Many river related projects are on the way. Most of the river plans were begun out of the reason to improve the urban landscape image, to implement environmental restoration policy and to help driving the development of the surrounding areas. In Europe, by contrast, city dwellers were and still are surrounded by green open space sometimes even have access to elaborate gardens. These citizens have, in a way, the restorative powers of nature near at hand. In China, in the old times, people traditionally preferred to live near and with an open field and spend time outside of their building for gardening and doing other outdoor things. But as desirable as this lifestyle still may be, it has gradually passed far away. A multitude of people have moved to cities and, fortunately, the planners and designers in China have started to think about the recreational space for city residents. How to quantify the demand of urban open space and how to quantify the recreational services afforded by riverfront space have remained open questions. To find some answers to these questions and to propose a systematic planning and design approach would be important contributions to urban open space system planning in Chinese cities.
Chapter 5 River-oriented planning in Tianjin

5.1 Multi-temporal analysis of historic river changes in Tianjin

For the purpose of performing a multi-temporal analysis a number of historic maps from various periods were used to investigate how the structure of water systems in Tianjin changed in the course of time. The maps are all of different quality. In order to compare one with another all maps were digitized and fed into a Geographic Information System, GIS. In the historic maps used for this study, water courses including rivers can be identified and then also related to the built-up area for each time period. Both, water courses and built-areas were recorded and inserted into a separate map and GIS layer. As a result, figure 5.1 indicates how the evolution of water courses and the water system in Tianjin is accompanied by phases of city expansion. Four features of changes in Tianjin’s water courses appear most prominently. Firstly, artificial water courses are continuously emerging; these water courses are identified as providing urban boundaries, drainage and transportation channels. Secondly, some stretches of rivers were converted into urban roads. Thirdly, originally curved river stretches were straightened out and shortened in the process. Fourth, a large area that once was water disappeared due to urban expansion.

Several periods of city development are marked by changes in its water courses and rivers. The building of moats in the early 15th century are at the beginning, followed by the construction of artificial water channels in the 19th century and then a series of conversion of rivers to roads and to canals.
At the founding time of the city, a moment that according to historians was the year 1404, the moats of the outer defense structure were the first known artificial water courses in Tianjin. The moats spatially separated the inner city from the land outside of the walls. Around 1860, new artificial water trenches were excavated in order to better resist invaders. The outside of the old city thus became a new demarcation border of Tianjin. Since 1987 and into to present there was repeated construction altering the Waihuan River (the course of that river leads around the built-up area). The Waihuan River is now linked up with 15 urban water courses and rivers. The construction of this system highly improved the rainwater and sewage discharge of Tianjin (fig. 5.2). Certainly, all these artificial rivers were formed based on good original water condition.

Figure 5.2 Three significant constructions of artificial water courses (according to old maps of Tianjin)

Figure 5.3 Conversion of water courses and rivers to roads (according to old maps of Tianjin)
Three different kinds of conversion of rivers to streets can be identified. The first type is street building after the river naturally changed is watercourse, such as the re-routing of the Daqing River during 1860-1927 and streets built on the old alignment. The second type is the conversion of artificial moats to urban streets, e.g. during the time when city walls were demolished. The third type of transformation was caused during the time of construction of urban sewage. In the process some water courses and rivers were filled in and the former water course later transformed into a subway line or street (fig. 5.3).

Finally, while aiming to reduce the risk of flooding and to maintain the stability of urban development, many stretches of formerly natural rivers were straightened and turned into canal type water courses. In the process river bends and curves were cut off and the river thus shortened. As a result, the smaller river bed now can hold less water than before and contributes less to flood management then before. Most of these changes occurred during the 1920s (Compilation committee of Tianjin planning, 1994) (fig. 5.4).

In addition to altering water courses the process of urban expansion and the increasing demand for land resulted in the disappearance of numerous of water areas. Many ponds and wetlands were filled in or disappeared for unknown reasons (Bai and Imura, 2001). Again, three phases of disappearance of water area can be identifies for Tianjin. The first phase marks the vanishing of water areas inside of the first city boundary that was delineated by the old moats (fig. 5.5). Water areas disappeared from the inner city mainly at the beginning of 1900s. The second phase is the disappearing of water area from inside of the second boundary that was marked by secondary trenches or moats. This happened during the years from 1900 to 1949 (fig. 5.6). During the third phase the decreasing of the water area occurred
inside of the third borders that are delineated by rivers (fig. 5.7). This took and takes place from 1949 until the present time (Tianjin History Compilation Committee, 1996).

Figure 5.5 Vanishing of water area inside the old moat (according to old maps of Tianjin; Compilation committee of Tianjin planning, 1994b)

Figure 5.6 Disappearing water areas between the first and second moats (according to old maps of Tianjin; Compilation committee of Tianjin planning, 1994b)

Figure 5.7 Water area in 1955 (Yi, 2012), 1983 (Sun et al., 2011) and present
5.2 Challenges and practice of river-oriented planning in Tianjin

For a long time, in China, rivers were mainly treated as a natural resource that serves agricultural production. And, also for a long time, there was no systematic river-oriented planning. In Tianjin, modern forms of river-oriented planning started only several decades after 1949 (the establishment of the People's Republic of China). There were many water related challenges that planners noticed during the 1980s; some of these are presented at more detail below. After the 1980s the water courses and rivers of Tianjin experienced considerable transition; no longer were they subjected to pollution; a new era of flood hazard management was begun; and rivers and water courses were to become the backbones of a city green network system.

5.2.1 Challenge of river development during 1980s in Tianjin

Industrial development along water courses and rivers

During the 1980s, when Tianjin became the northern industrial city in China, the Hai River, the mother river of Tianjin and its essential water resource, was in the middle of major industrial development. Many factories were placed alongside of it and soon people could no longer see the river anymore. Thus, the river had effectively been isolated from the minds of local residents.

Population explosion and sewage pollution

As a result of population growth new residential areas were built and many of these started to encroach on wetlands and ponds. At the same time, there was no storm water and sewage system. Almost all of the sewage was discharged into water courses and rivers. Small and medium size rivers became canals for refuse disposal and soon experienced severe degrees of pollution. It was, at that time, impossible to use accessible water as a place for leisure and entertainment. So terrible were conditions that planners sometimes saw no other option than to place residential buildings in ways to block them from the rivers as they were too dirty and smelly. Again, such decisions made the rivers even more invisible in the city. And people became even less aware of their existence.

Flood risk and storm water management

A third challenge to include is the risk of natural disasters such as flood and storm water. Tianjin's center city is located in a low-lying flat area. Most of the region is at an elevation of about 2.0 to 4.0 m above sea level (Chen, 2010). Flooding occurs frequently and includes charges of heavy storm water. Inundations of waterfront spaces are highly limiting any recreational activities.

5.2.2 Renewal of riverfronts after 1980

Around 1980 a modern urban planning system was established in China. Now, the urban planning system is divided into different levels, including regional planning, city master planning, regulatory planning and site planning. Water system planning is classified as a special type of sector planning. Water related planning not only needs to comply with regional water system planning, but it is also
required to be consistent with city master plans (fig. 5.8) (Xu, 2010). Landscape and recreational services that are the subject of this study are mainly tasks of landscape planning and design which, in the case of water related resources, are part of the city water system planning. Referring to such a planning system, river renewal in Tianjin began after about 1980.

**Figure 5.8 Planning system in China (Xu, 2010)**

**Landscape transformation and new recreational areas along rivers**

In 1999 the Tianjin municipal government began to manage the polluted Jin River (the old name is Qiangzi River) to transform it into a ‘Landscape River’. Pollutions had been cleaned up earlier. A linear open space was designed along the course of the river. In addition, the North Canal, the South Canal and other water courses and rivers in Tianjin had also been cleaned up and a series of special landscape plans and designs were drawn up for most of these rivers to be rehabilitated. Soon after people re-discovered their water and rivers, recreational activities began to appear again at the riverfront space.

**Construction of Waihuan River green river network**

The so called Waihuan River Project was launched in 1987, initially with the aim of using the river to help drain storm water from adjacent farmland. The Waihuan River surrounds the whole city on a course of 71.4 km, and it intersects with the Hai River, the North Canal, the Ziya River and some other major rivers and water courses. In April 2002, a further comprehensive Waihuan River project was implemented and it was completed in July 2006.
In 2002, the plan ‘River and Water Cycling Network’ was drawn up for the central city of Tianjin. The motto of this plan is "one axis, six scenes, eight intersecting rivers with axis, ten water systems, twelve parks" (fig. 5.9) (Zhou, 2004). "One axis" refers to the course of the North Canal and the Hai River (Mother River) which runs through the city from north to south. "Six scenes" refers to six water scenes that are distributed along the urban fringe. "Eight intersecting rivers with axis" refer to the eight water courses and rivers that intersect with the "axis", the North Canal and Hai River. The "10 water systems" refer to the water cycling with pumping. "Twelve Parks" refer to 12 parks that all rely on water and rivers. All of these elements made what became known as the first green river network in Tianjin.

**Hai River revitalization and new recreational areas**

Around the year 2000, a strong commitment of Tianjin City was to revitalize the historic city port. This endeavor includes a comprehensive regeneration plan for the Hai River. The Tianjin Government aspired to recapitalize the cultural and natural asset of the city and aimed to transform the urban corridor from an industrial waterway to a world-class riverfront that reconnects with the urban fabric and its citizens. What followed were the design, development and implementation of 4.9 km riverfront within the cultural heritage district (fig. 5.10). This was the pilot project that helped provide the first publicly accessible riverfront open space while setting up the development framework for urban revitalization. The cultural and natural assets were indeed recapitalized. The whole region of the Hai River was transformed into a world-class riverfront that reconnects with the urban fabric and its citizens.
River has been renewed along the pilot project stretch. And here, the city centre now again has gained multiple cultural, natural and economic values.

Figure 5.10 Four planed districts along the Hai River, each with a different theme (Zhou, 2009a)

As part of this large Hai River revitalization project an open space system was formed along the river (fig. 5.11). This system serves to meet people’s needs of leisure and entertainment. This stretch of river corridor became the spatial axis of the whole landscape in Tianjin. Conceptually, in this planning exercise, the green belt model was well applied. Different widths of green belt and patches were set up on both sides of the river according to the situation of urban space. Green open space planning and urban transportation planning were done in a combined fashion and together they achieved that the distance between subway stations and the riverside remained within 700 meters (fig. 5.12). This strengthened the linkages between the city and the Hai River.

Figure 5.12 Linking riverfronts with adjacent areas along the Hai River (Zhou, 2009b)
5.3 River and waterfront space as the result of river-oriented planning in Tianjin

Historic development and recent deliberate planning have, as explained above, led to considerable changes and transformations in the urban landscapes of Tianjin. The urban structure that is currently found along water courses in this city provides the starting point for the research undertaken in this study (fig. 5.13). For this purpose, chapter 5 closes by presenting a classification of water courses and water fronts. The resulting typology is used to conduct further detailed investigations that are explained in the following chapters.

Figure 5.13 Current forms and size of the main rivers and waterfronts in Tianjin

5.3.1 Topography of rivers and waterfronts

Figure 5.13 shows the current situation of water courses, rivers and waterfronts in Tianjin. These shapes and forms are mainly the result of river-orient planning (as explained above). Normally, the space along the river includes the immediate waterfront space, a slope and revetment, and a parallel street. The information about the combination of these three elements was collected, for purposes of this study, through on-site fieldwork in 2012. According to the characteristics of such combinations, the rivers and waterfront spaces in Tianjin were divided into four categories (fig 5.14). These are explained below. The spatial typography is visualized in figure 5.15-5.18.
The first type is found along the North Canal. This water course is relatively wide (more than 60 meters) and has a relatively high diversity of open space on both of its sides. One end of North Canal extends to the suburbs, and another end links with the city center. There is an obvious transition that can be observed to occur from suburbs to city center.

The second category is found along the Ziya River and Xinkai River. These two rivers are also wider than 60 meters. Most of their waterfronts keep to the topography of the dam; the spatial diversity is less than that of the North Canal, but still maintains much green space. The connectivity of the water course corridor for pedestrians is high.
The third category is found along the Hai River. The river landscape along Hai River is dominated by the most significant buildings and structures in Tianjin, as it located in the central city area. Skyscrapers combined with engineered concrete embankment are the main features of the waterfront landscape along the Hai River.

The fourth category is found along the other water courses and rivers in Tianjin, including the South Canal, the Jin River, and others. With narrow water courses, they have relatively unified waterfronts. The spatial connectivity for pedestrian differs from place to place. Only some parts of these waterfronts are enlarged and designed as the recreational area.
5.3.2 Landscape character of riverfront spaces

Referring to the four types of topography mentioned above the landscape character of Tianjin’s riverfront space can be classified (fig. 5.19-5.22). Big trees and grasses are the main kinds of vegetation in type 1 and type 2. The flat area on the top of dams is the only available place for recreational activities. For type 3, the Hai River type, people are benefitting from the revitalizing project mentioned above. There are fine examples of landscape design to be found along this river. The space for pedestrians along the river is broad and people can enjoy a wide view over the river landscape. In the other riverfront areas in Tianjin, similar landscape designs exist. In all cases, the walking space is closed to motor traffic. In some cases streets make the river inaccessible.

Figure 5.19 Landscape character of riverfront in Type 1

Figure 5.20 Landscape character of riverfront in Type 2
5.3.3 Transects of river and waterfront areas

The transect approach is a standard approach that planners use to organize, as a matter of textual overview, the elements of urban landscapes, such as buildings, streets and other types of land use. Transacts are found to be particular helpful if they are applied in ways that consider and, at the same time, highlight the different types and elements of urban and rural environments (fig. 5.23). These environments can be viewed relative to a continuum that ranges from rural to urban, varying in their level of urban intensity (Duany and Talen, 2002).
The so called 'Belt Transect' is useful to describe not only spatial arrangements but also mirrors temporal aspects in a way that the historic evolution of urban development becomes apparent to some extent. Applying this transect approach to Tianjin, the spatial arrangement of urban riverfronts also holds information of a spatio-temporal character (fig. 5.24). For example, along the Waihuan River, the transect includes the complete range of urban character types found along the corridor, starting at the central city and ending in suburbia. Five sections are selected, along the river corridor, and each represents different degrees of urbanization. On each of these sections the main spatial arrangements and their structural elements (rivers, buildings, green space and transportation infrastructure) are identified from aerial maps.

Starting in the suburbs of the city, the landscape is characterised by farmland and green elements such as grassland and trees. Except for farming, few artificial interventions are present. In the sub-urban area, one storey residential buildings (many with a yard) cover all of the area that stretches along the river. Artificially designed open space is found in the urban area that is characterises by multi-storey residential buildings a few high-rise residential buildings. In the urban centre the spatial structure found along the river is composed of high rise buildings and scattered green open space. In the urban core commercial buildings and larger green space were integrated by deliberate spatial planning and design.
In figure 5.25 the spatial succession of riverfronts is presented in a simplified and conceptual way. The transect illustrates some of Tianjin’s structural and, to some degree also temporal, idiosyncrasies. 1) The built up area and impervious surface along the waterfront increases from suburb to urban centre. 2) The urban transportation corridor is gradually widening from suburb to urban centre. In the “Urban Core”, streets and waterfronts are intentionally separated. 3) The area of open space along the river is decreasing from suburbia to urban centre. In contrast, there is a high portion of green space area in the urban core area.
Part IV Empirical study of urban river and waterfront space and their recreational service
Chapter 6 Results and Findings

6.1 Quantitative and qualitative field investigations

Quantitative and qualitative methods are applied, in this study, in a kind of mixed method approach. In the quantitative part quantitative interview methods and techniques were applied. The qualitative part is based on mapping and observations in the field. This chapter 6 presents the results and finding from field work that was conducted.

6.1.1 Quantitative interview techniques applied in the field

A 14-item on-site quantitative interview tool was developed to collect data about the use and appreciation of river corridors. Questions aimed at collecting data on river recreation include use characteristics (frequency of visits, means of transport to reach the site, time spent for transport, time spent for activities during the visit), activities and preferences (activities, reasons to visit this open space, social communication, aesthetic appreciation), assessment of open space (likes, dislikes and desired changes, satisfaction), and demographic information (age, location of residence). An neighborhood pre-interview was done mainly to collect some population information, including population density and age structure in each neighborhood which are separated by urban streets. The 14 questions included in the questionnaire are:

I. River recreation use characteristics
1. How often do you come to this location in this season?
2. How do you come (travel) here?
3. How much time do you need to arrive at this location from your place of residence?
4. How much time would you normally spend at this location?

II. Activities and Preferences of Open Space
5. Which (recreational) activities do you do at this location?
6. Why do you choose this location for your recreational activities?
7. How often do you communicate with others when you come here?
8. Do you think this open place has beautiful scenery?
9. Is this open place able to benefit and uplift your emotions?

III. Assessment of the open space along the river
10. Does the open space size at this location meet requirements for your recreational activities? If not, please explain your situation.
11. Do you think the facilities at this location meet your requirements? If not, please explain your situation.
12. Do you feel this is a safe open space for your recreational activities? If not, please explain your situation.
VI. Personal Information
13. How old are you?
14. Please mark your place of residence on the map.

6.1.2 Mapping
A Geographic Information System (GIS) is employed for purposes of spatial mapping. Mapping is done for the purpose of identifying typical landscape units; this is the prerequisite for analyzing correlations between landscape structure and recreational activities. The preparations for the analysis include two empirical steps. Firstly, for every one of the four study sites three layers are produced and visualized in the form of maps about land cover, (tree) canopy, and the overlay of these two maps. Secondly, the maps produced during the first step were overlaid with factors of size, shape and plants; in this way the areas of landscape units were extracted. All these layers and maps were digitally stored in the GIS and thus became available for the further steps of the study, such as relating mapped information to that from aerial photographs and additional information gained through field investigation.

6.1.3 Observations
The aim of undertaking pilot observational studies (prior to conducting other field investigations) has two aspects. One is to collect information on the activities that occur on the investigated sites, and the other is to identify the spatial attributes of these sites. Two main findings from the observational study are:

- Spatial characteristics of use in different landscape units and structure;
- Spatial characteristics of use changing with time in different landscape units and structure.

In this case information gained by observations help understanding other data collected and the phenomenon being studied. As a result, only partly were expectations confirmed. Much was discovered that was unanticipated at the beginning of the study. For example, it was not expected that most visitors are aged people; collective recreational activities are more frequent than expected, and the average time people spend in waterfront spaces is longer than expected. With mapping, the temporal and spatial changes of recreational activities in different structures of waterfront spaces are compared.

6.2 Results gained by conducting quantitative interviews
In the following chapters results gained by conducting quantitative interviews are presented. 267 questionnaires were filled in at four different river and waterfront sites; 70 at site 1, 67 at site 2, 61 at site 3 and 69 at site 4. The original material was transcribed into spreadsheets and calculated by using tools of Excel software. Results are presented for each question asked; they are grouped according to ‘use characteristics’, ‘activities and preferences’, and assessment of open space. First, a set of demographic information is presented.
6.2.1 Demographic information

In the map below, each dot represents the residences of people who were interviewed. Thus, dot clusters represent the spatial distribution of people’s locations of residence (fig. 6.1). The dots have different colors; the colors refer to the age of the interviewed people. At first glance the colored dots appear to be distributed randomly.

![Figure 6.1 Distribution of residence locations of interviewed people](image)

In the following figure 6.2, a histogram of the population structure is presented of 267 people who were interviewed. The result is somewhat similar for all of the four sites, but there are also noticeable differences. For example, the number of people aged 60 – 70 years dominates at Site 1. Site 2 is the only one who has a good number of people aged 30 – 40 years; as there is a hospital around Site 2, some young nurses and people who take care of their families like to visit Site 2 for resting purposes.

![Figure 6.2 Population structures of users of the four investigated sites](image)
What becomes immediately apparent is that, of all persons interviewed, the old people are the main statistical group using the outdoor space. The group aged 60-70 years is the major group in Site 1, Site 3 and Site 4. Juxtaposed with these three sites, in Site 2, the group aged 50-60 years is the primary users. The group aged 20-30 years appear to use these outdoor spaces rarely (nearly all of them live on a nearby university campus and engage in recreational activities there). The people in the age group of 30-50 years appear to have no leisure time (they need to work many hours). The people who are older than 80 years rarely participate in outdoor activities.

Information about the places of residence is used below for an analysis of the geographic distribution of these places. For planning purposes it is important to know where (location, distance) open space users typically live, and how they travel between home and open space locations. A pre-analysis is done for the quantification of what is called, in this study, the ‘recreational service distance’ (distance between places of residence and an open space that residents use for recreation).

![Figure 6.3 Directional geographic distributions of home locations of interviewed users of the four sites in the study area in Tianjin](image)

To calculate the distance and spatial directional distribution of home locations of interviewed users GIS tools were employed that help perform a spatial statistical analysis. By measuring geographic distributions combined with directional distributions a so called Standard Deviational Ellipse was created (figure 6.3). The result is somewhat surprising; comparing the four sites the trends of spatial distributions of the users' home locations are quite different. In Site 2, for example, the longer and the shorter radius of the ellipse are similar and almost form a circle. The other sites have ellipses with different deviations and directions.

For the calculation of the standard distance GIS tools were used again to perform a spatial statistical analysis. These GIS tools help measuring the geographic distribution of locations and standard distances. The spatial standard distance of home locations of open space users are different for the four sites (figure 6.4). Site 1 has the largest standard distance, which indicates that here the degree of dispersion of homes is greater than at the other three sites and that site 1 also has the largest ‘services

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24 The Elderly Rights Law in People's Republic China stipulate: "Citizens older than 60 are called 'the old people'."

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range’ of the four investigated riverfront open spaces. By comparison, the standard distance of Site 4 is the smallest of all, and this can be understood as the smallest ‘service range’.

In order to understand how many open space users live close to the open space of their choice, and how many live further away, a so called ‘density analysis’ was performed. The geographic ‘density’ of user home locations can be used as an indicator for planning purposes. The statistically calculated divergence of home locates is represented by a point density graph where each home location has one spatial point. GIS tools help perform a simulation of the distribution of home location densities. Point clusters are presented to visualize the results as a shape of the distribution of the users' home locations (fig. 6.5).

6.2.2 Results of river recreational use characteristics

Results regarding the question “How often do you come to this location in this season?” are presented below. The histogram in figure 6.6 illustrates how the majority of interviewed users apparently visit the river and water front space daily, or at least 2-3 times per week. This means that
engaging in an outdoor recreational activity is part of people’s daily life. Comparing the data obtained for the four sites, Site 3 has the highest proportion of people who said that they are visiting this open space "every day". Site 4 has the lowest proportion of people who are visiting this space "every day". These results appear to relate to the distance between residential areas and the site; Site 3 is the closest of all to an adjacent residential area. Site 4 is separated from the nearest residential community by a large urban street.

![Figure 6.6 Frequency of visiting the riverfront space](image_url)

The relationship between the frequency people visit the four open spaces of the study area and the location of their homes are shown in figure 6.7. The results are different for all of the four study sites. For example, some people who live far from the site said that they visit it every day; someone else who lives nearby the riverfront but does not visit it frequently. In other words, for the area investigated in this study, the open space visiting frequency does not obviously depend on the distance between open space and places of residence. In other areas different results might be obtained. In this case, however, the frequency of use must relate to other factors.

![Figure 6.7 Frequency of visits to riverfront spaces and the locations of user homes](image_url)
Results regarding the questions “How do you come (travel) here?” and “How much time do you need to arrive here from your living place?” are presented below.

In this study, travel time and the way of travel were investigated. The majority of users stated that they usually walk to the waterfront space they use. The second most frequently used travel mode was bicycling. Most users estimated the time they took to travel to the site with less than 20 minutes (fig. 6.8-6.10).

![Figure 6.8 Mode of transportation and the time needed for travelling](image)

![Figure 6.9 Mode of transportation to travel to a riverfront space](image)
Results regarding the question "How much time would you normally spend at this location" are presented below.

Most users stayed and engaged in regular recreational activities at the open space for 1-2 hours and 2-3 hours. Only a small percentage of users stayed at any sites less than 15 minutes. This result is illustrated in figure 6.11 and 6.12. However, when considering the question whether people, if they lived closer would stay longer, the distance from the home location to the open space does not seem to have a clear relationship with the time people are staying at the open space. Users who live very close to the open space would sometimes only stay for about 15 minutes (some green points in Site 2 and Site 3). People who live far away from an open space would stay longer at any riverfront (some dark red points far from the four sites). In summary, the average time people are staying at river and waterfront open space is not apparently related to the distance between home and open space.
6.2.3 Results of activities and Preferences of Open Space

Results regarding the question “Which (recreational) activities do you do at this location?” are presented below.

From the result (fig. 6.13) obtained from the responses interviewed open space users provided, it seems that "walking" is the dominant activity in all of the sites, especially in Site 1. In Site 2, “walking birds” is the second most important activity which could be ascribed to the large number of small trees. In Site 3, "resting and chatting" and "dancing" are the favorite activities besides "walking"; this could be due to the high density of residents nearby the riverfront space. In Site 4, many residents state

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25 In China it is very common that people go for walks and take bird cages along, hang them on tree branches and meet with other people, for example by sitting under trees.
that "fishing" is important, as the widest river in Tianjin is near the site; "doing exercise" (exercise the body freely) is the dominate activity as it is a relative comfortable place in the summer along the Hai river.

Results regarding the question "Why do you choose this location for your recreational activities?" are presented below. The options given to interviewed people are

A. close to my home; B. a river is nearby; C. there is enough space for my activities here; D. my dancing teacher and friends are here; E. here it is cooler than at home; F. good scenery; G. there is no other open space available nearby; H. others.

Most people (fig. 6.14) stated that this specific location is "close to my home" is the main reason for engaging in recreational activities at the location where the interview was conducted. The next main reasons stated are that this open space is cooler than the home environment, that the attraction of the river plays a role, and that there is enough space and good visual scenery. Fewer interviewed people mentioned that "My dancing teacher and friends are here", but this response does show a certain social need for communication (see next question below). Only 17 responses refer to the fact there is no other open space nearby their home.

Results regarding the question “How often do you communicate with others when you come here?” are presented below.
Question number 7 is about the social interaction that people engage in while they are spending time in the open space where the interview took place. From responses to question number 6 it is found that about 20% of the respondents emphasized the importance of social interaction. Responses to question number 7 help to further explanation the role of open space in social interaction. As seen from the figure above, only a small number of users hardly ever talk with any other people (in all the four sites). Most of the people communicate with others every time they are visiting the open space, or even very often (fig. 6.15).

Results regarding the questions “Do you think this open place has a beautiful scenery?” and “Is this open place able to benefit and uplift your emotions?” are presented below.

![Figure 6.16 Responses to questions No. 8 and No.9](image)

Landscape aesthetics is generally considered an important issue in landscape perception. In the responses give to question number 8, the rating of the perceived landscape esthetics for Site 1 and Site 4 are higher than for the other two sites. Site 4 obtained the highest number of responses for "very beautiful". The responses for Site 2 and Site 3 are mainly neutral. "Not beautiful" is slightly higher than "beautiful" in Site 2 and the opposite situation appears in Site 3 (fig. 6.16). During conducting the field investigations, the question "why do you think it is beautiful here" was supplemented. The interviewed people mentioned "Wide River, broad horizons, big trees and colorful flowers" most often. By comparing the width of the river in the four investigated sites, the width of the river is closely related to the ranking of landscape aesthetics (see table 1.1).

The result obtained from asking question number 9 presents results that appear to differ from what people answered to question number 8. The aesthetic ranking of the visual landscape shows that people see a different landscape beauty at each site. 82 respondents, who selected "good visual landscape" in question 8, were checked again by question number 9 again. From these 82 persons, 11 persons said this site is "very beautiful", 46 persons considered it "beautiful", and 25 people thought of the site as "neutral". In concluding it appears that, when people think of a site's visual quality at least as "neutral" and higher, they would consider that place to be an acceptable open place or even attractive.

### 6.2.4 Results regarding open space use and requirements

Results regarding the question “Does the open space size at this location meet your requirements for your recreational activities?” are presented below.
Surprisingly, the smallest of the four sites (see table 1.1), Site 2, holds the maximum satisfaction as stated during the interviews (fig. 6.17). One factor that needs to be considered is that the area around Site 2 is occupied by a university and students engage in recreational activities mainly inside of the campus. Site 1 and Site 3 are the largest and second largest of the four investigated riverfront spaces, but the satisfaction of users does not correspond with their area. One reason for this discrepancy is that these sites are located inside of the most densely populated residential region in Tianjin. There are many blocks of residential communities nearby these sites. And, as there is a lack of open space inside those residential communities, most people need to engage in their outdoor recreational activities in one or another urban public open space. Although there is a large park in this region, other than Site 1 at the waterfront, the open space shortage is, nevertheless, quite severe.

Results regarding the question “Do you think the facilities at this location meet your requirements? If no, please explain your situation” and “Do you feel this is a safe open space for your recreational activities? If no, please explain your situation” are presented below.

Survey results are consistent with the expectation of the researcher. Toilets and outdoor fitness facilities are the main facilities people demand. In Site 1 and Site 4, which have neither toilets nor outdoor fitness facilities, the number of unsatisfied respondents is particularly high. In Site 2 and Site 3, which have either outdoor fitness facilities or toilets, the number of unsatisfied users is only half of the former. Regarding safety, only in the sites 1 and 4, which have the largest open spaces and widest river sections, several users pointed out that lighting and fences (protecting children) need to be installed. All in all, no big problem with safety was motioned by the majority of respondents.
In addition to requirements mentioned above (related to size of open space, facilities and safety), some additional spatial requirements are mentioned that planners need to pay attention to when looking into individual recreational activities (table 6.1).

Table 6.1 Additional requirements to facilitate additional activities

<table>
<thead>
<tr>
<th>element</th>
<th>requirement</th>
<th>Activity</th>
<th>reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>ground</td>
<td>hard surface playground</td>
<td>dance, gymnastics</td>
<td>better for movement of the body</td>
</tr>
<tr>
<td></td>
<td>bare soil soft playground</td>
<td>Tai Chi / play Diablo / walk dog</td>
<td>Chinese Kung fu requires bare soft playground for movement, is a living philosophy</td>
</tr>
<tr>
<td>trees</td>
<td>trees</td>
<td>walk bird</td>
<td>Birds like environments with tree branches.</td>
</tr>
<tr>
<td>river</td>
<td>broad river</td>
<td>train voice</td>
<td>River could be a spatial buffer for loud noise</td>
</tr>
<tr>
<td>facilities</td>
<td>body exercise equipment</td>
<td>Physical exercise</td>
<td>Physiological need for aged people</td>
</tr>
</tbody>
</table>

6.3 Results of mapping

6.3.1 Mapping the landscape structure of the four study sites

a. Mapping the land cover of the four study sites

Mapping land-use and land cover can be considered the basic mapping exercise that is required for purposes of spatial planning and design. Indicators are being used which reflect landscape conditions, pressures and societal responses (Lausch and Herzog, 2002). ‘Riverfront’ and ‘waterfront’ are the two terms mostly used in research about and planning for semi-natural rivers and urban rivers. Both terms emphasize the land cover, land-use and landscape structure along rivers and water courses (Gabr, 2004b, Ryan, 1998). For purposes of recreational planning, the land cover may be considered the primary aspect of landscape structure analysis. Characteristics of land cover are mapped for the four sites and pertinent data are digitized and integrated into a GIS. Based on these data a number of statistical analyses may be done, rates of shaded areas may be calculated, and so on. Some results are
presented in the following figure and table.

**Figure 6.19** Land cover of the four study sites

**Figure 6.20** Comparison of different land cover of the four sites

**b. Mapping the vegetation canopy of the four study sites**

In natural and semi-natural areas, the riparian zone is defined as the area from the edge of the stream bank to the external visible line of the canopy where an abrupt change in vegetation height, type and amount may occur (Johansen and Phinn, 2006). Riparian areas are among the most threatened habitats in the world, due to human activities and land use in adjacent areas (Fernandes et al., 2011). However, the riparian zones along rivers and waterfronts in urban areas have mostly disappeared. The vegetation canopy is the principal element remaining; it is not only crucial from the point of view of landscape ecology but also regarding people’s senses and human activities such as recreation.

The canopy along Tianjin's rivers and waterfronts is a mixture of artificial and natural vegetation. Some big trees exist that belong to the natural riparian zone. These trees are supplemented by
horticultural plants and flowering shrubs. All of the vegetation covers about 50% of the ground at the four sites (figure 6.21, 6.22). The vegetation adjacent to the rivers is mainly dominated by trees (mainly local trees such as willow and locust). A certain amount of scattered shrubs occupy and cover only small parts of the riverfront open space.

Figure 6.21 Tree and shrub canopy at the four study sites

Figure 6.22 Comparison of the tree and shrub canopy of the four sites

Figure 6.23 Examples of big trees, small trees and big shrubs, and small shrubs
In the canopy map, three categories were defined (fig. 6.23). The tree category indicates that there is a large space under every tree. As to the small trees and big shrubs the category indicates that there is space for only one adult under one plant. As to the small shrubs there is no possibility for recreational activities under any of these plants. This classification is aiming to better analyze the correlation between the space shaped by plants and the human recreational activities that might be possible under or near to them.

c. Mapping and overlaying land cover and tree and shrub canopy

The overlaying of maps of land cover and vegetation canopy provides useful information related to site potentials for recreational activities. For example, the smallest Site 3 offers the largest area of all of the four sites that is accessible and, at the same time, covered by tree canopies. Site 4 has the smallest area of accessible space covered with tree canopy. And for Site 1 and Site 3, in spite of the whole areas being relatively large, they each have a smaller accessible space covered with tree canopy.

These findings are relevant for planning and design in many ways. For example, as discussed in chapter 6, thermal comfort is one of the fundamental physiological human needs. The summers in Tianjin are very hot, and they last from late April to the middle of September. Additionally, the summer time is the most active season for outdoor recreational activities. Trees and their crown provide good sunshades and they are particularly welcome when the sun shine is very strong. By overlaying the area of accessible space (such as urban squares and walking paths) with the vegetation canopy (fig. 6.24), the result would be equal to the spatial distribution of the most frequently used space during daytime, which will be varied in the following study.

Figure 6.24 Overlay of vegetation canopy and accessible open space
6.3.2 Identifying landscape units

In order to learn and understand how spatial characteristics may affect people's utilization of space, it is important to identify the types of landscape and their structure first. In this study "shape" and "designed vegetation" are used as two properties for the purpose of identifying landscape units. Examples for “shape” are linear elements such as foot paths or broader areas such as squares; the former is a space used for passing along, the latter is a space where people may stay for some time. In the study area, a linear path always exists parallel to the urban river, and most people just go through it without stopping for long periods of times. Squares are used by people for carrying out some of their recreational activities. The word "square" is used here as a general description, which could include shapes of a round areas or other irregular polygons.

Examples for “designed vegetation” are plants like trees and shrubs. These are the major components of the third dimension. Trees are the "living construction materials" of landscape design (Bell et al., 2012). Different vegetation contributes in manifold ways to a varied spatial environment. In this analysis, eight types of landscape based on space and vegetation are used (table 6.2 and fig. 6.25).

<table>
<thead>
<tr>
<th>Linear space</th>
<th>Square space</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Surrounded by shrubs and trees, and little river visibility</td>
<td>e. fully covered by tall trees</td>
</tr>
<tr>
<td>b. Surrounded by trees, people can partly see the river</td>
<td>f. Partly covered by middle tree</td>
</tr>
<tr>
<td>c. Partly surrounded by trees, broad vision of river</td>
<td>g. fully covered by small trees</td>
</tr>
<tr>
<td>d. No trees covered, people can easily see the river</td>
<td>h. covered by no trees, completely bare</td>
</tr>
</tbody>
</table>

This study aims to clarify the relationship between the spatial structure and user’s activity also by observation. For this aim, 11 landscape units are identified according to the actual situation of the four study sites. This is done in consistency with the description of the basic types of landscape units (fig. 6.26). Based on such definitions and identifications of landscape structure, the following observations and comparisons were made.
6.4 Results of observations

6.4.1 Spatial uses of different landscape structure

Results regarding the observation of spatial uses are presented below.
Table 6.3 Observation of recreational activities in different landscape structural units

<table>
<thead>
<tr>
<th>landscape units</th>
<th>Recreational activities</th>
<th>Behavior characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Walk/run</td>
<td>Individual moving recreational activities</td>
</tr>
<tr>
<td>B</td>
<td>Walk/run, walk birds, short stop in open part, long halt at the end or node of the path</td>
<td>Individual moving recreational activities or in couple</td>
</tr>
<tr>
<td>C</td>
<td>Walk/run, walk birds or dogs, longer halt facing water</td>
<td>Recreational moving activities mainly in two or three</td>
</tr>
<tr>
<td>D</td>
<td>Walk/run, walk birds or dogs, halt in random time and at random spot</td>
<td>Randomly small groups with moving or halting</td>
</tr>
<tr>
<td>E</td>
<td>Dance, Kong Fu practice Chat, write on the ground, /old people walk the young baby, walk the dog</td>
<td>Big group recreational activities, many small groups engage in diverse activities when are not occupied by big group</td>
</tr>
<tr>
<td>F</td>
<td>Dance, Kong Fu practice</td>
<td>Middle size group engage in recreational activities</td>
</tr>
<tr>
<td>G</td>
<td>Halt with birds, play chess, rest</td>
<td>Small group engages in recreational activities</td>
</tr>
<tr>
<td>H</td>
<td>Dance, Kong Fu practice, fly kite, young children play sports, Chat, /BBQ</td>
<td>Big group in the early morning, Many small groups engage in diverse activities in late afternoon</td>
</tr>
</tbody>
</table>

From the observation, one phenomenon of the physical environment (landscape units) and of user perception was discovered: People would perceive the highly closed linear space as a kind of channel with a very strong sense of closure; there is a frequent movement along this line. In contrast, people prefer to stay in the square and engage in diverse recreational activities there (fig. 6.27 and table 6.3).

6.4.2 Spatial use of landscape units while time is passing

Humans not only structure the landscape through their activities, but their perceptions of nature are affected by the spatial and temporal arrangements (structure) in the landscape (Bell et al., 2012). This observation could not only be found to be true at large scale but also at small scale. In particular, the spatial use is changing noticeably while the time is passing.

1) Users time arrangement and the time spent at waterfront open space

The individual users can be divided into two categories; the regular user and mostly aged people, and the irregular user and mostly young and middle-aged people. While the old people are the main cohort of users of the open spaces observed in this study, this finding is closely related to the Chinese social status and demography. The Chinese retired people usually have more leisure time than others and, in terms of the imperfect health insurance system and aiming at reducing the medical treatment they can be a great pressure on their children. Thus, the old people intensively engage themselves in outdoor recreational activities. Some of them spend all possible time at some open space, except for the time
needed for eating and sleeping. Figure 6.28 shows some extreme time arrangement of old people.

![Figure 6.28 Regular time of old people spend to travel between home and open space](image)

The time users are observed to stay at individual study sites are summarizes in figure 6.29. Tianjin is located in a region which has a hot and dry summer, while winters are cold and windy. The general rule of time spent in an open space is represented by the curve below. As the mid-day in the summer time is intolerably hot, the main outdoor activities usually happen in the early morning, late afternoon and after dinner time. In North China, people have the habit to enjoy the outdoor and relative cool air and go for a walk after dinner. From this habit, the time after dinner is the time of highest utilization of the outdoor spaces. During the cold winter, the temperature is highest around noon; hence, the time before and after lunch are the times of highest utilization for the outdoor space.

![Figure 6.29 Time spent in riverfront open spaces](image)

2) Spatial use considering thermally comfortable microclimate

Pedestrians' environmental comfort is influenced by the physical environment. Relevant are perceptions of thermal, visual, aural and olfactory stimuli, not all of which are currently well understood (Robinson, 2012). In this empirical study, the understanding of how the environmental comfort affects the spatial and temporal changes of use is based on the analysis of results from field surveys of user behavior. Figure 6.30 shows one example how the spatial usage changes during the daytime.
Figure 6.30 Example of the spatial usage changing with time

Figure 6.31 shows the daily changes observed at the 8 landscape units defined above. Within the same open space but at different times, the spatial use pattern is formed distinctively. People appear to have different preference based on the time and their activities.
Chapter 7 Discussion

7.1 Introduction

In this chapter, results obtained through empirical investigations regarding the three research questions of this study are discussed. Results were obtained by employing a number of different methods and tools, such as the filling in of questionnaires, mappings and on-site observations. The three research questions are:

- What are the human needs regarding outdoor open space?
- How do river and water front spatial structures affect people's recreational activities?
- How to define the recreational service of urban river and waterfront open space?

As pointed out in chapter 4.2.7 answering these questions is very important for cities that wish to provide for a healthy human environment and for the well-being and happiness of their citizens.

7.2 Outdoor recreational needs

7.2.1 Introduction to a hierarchy of human needs

Maslow's hierarchy of needs (Maslow, 1943) is taken here as reference and knowledge base to interpret human outdoor needs for purposes of planning and design. The discussion below follows the hierarchy of human needs as presented in figure 7.1. Since safety issues rarely occurred (only in Site 1 and Site 4 some users pointed out that the lighting and fences might be improved, for example for the protection of children), this second level of the hierarchy is not dealt with in detail here. Few people feel they are in a dangerous location while engaging in recreational activities at open space sites near the rivers and water fronts in Tianjin. However, safety is still an important issue for aged people, for children, for disable people, etc. and safety must be considered for purposes of site design.
The following discussions of human recreational needs for outdoor open space are informed by the results gained from responses given to the questions number 6 to 12 (see chapter 6) and the findings obtained through on-site observations.

### 7.2.2 Analysis of results regarding physiological needs

In Maslow's hierarchy of needs, the physiological factors are taken as forming the basis. In this study accessibility, microclimate and (thermal) comfort, and physical (spatial) capacity of public facilities are included.

The distances that people travel between resident homes and the river or waterfront are limited by time availability and physical capabilities. Results obtained by asking the questions 2 and 3 are visualized in chapter 6 (figure 6.9 and figure 6.10). Most residents travel to the open space of their choice by walking, taking travelling times of no more than 20 minutes. These results confirm how accessibility is a significant factor regarding daily recreation.

In addition to accessibility, the physiological needs considered here also include the suitability of the microclimate outdoors. As the results presented in chapter 6 (figure 6.27) shows how the macroclimate is a significant physiological (and psychological) factor and how it is closely related to outdoor human needs. In the summer time, for example, people avoid the hot noontime and prefer not to go outside. Rather, people prefer to go outside after dinner more frequently.

From the results obtained by asking question number 6 (see results from chapter 6 summarised in table 7.1), the need for spatial capacity (size of area, place for activities) is third in rank after the needs for accessibility and thermal comfort.
Table 7.1 Statistical results from the responses' answer to question No.6

<table>
<thead>
<tr>
<th>Needs and factors</th>
<th>Answering options</th>
<th>Respondents' number</th>
</tr>
</thead>
<tbody>
<tr>
<td>social communication</td>
<td>my sport teacher and friends are here</td>
<td>55</td>
</tr>
<tr>
<td>aesthetic need</td>
<td>the visual scenery is good</td>
<td>82</td>
</tr>
<tr>
<td>spatial capacity</td>
<td>I find enough and suitable space for my activities here</td>
<td>82</td>
</tr>
<tr>
<td>thermal comfort</td>
<td>it is cooler here than at home</td>
<td>153</td>
</tr>
<tr>
<td>accessibility</td>
<td>The place is close to my home</td>
<td>192</td>
</tr>
</tbody>
</table>

As illustrated in chapter 6, and also in the figure below, people are most satisfied with the investigated Site 2, and less so with the larger sites. One needs to take the context into consideration, for example the presence and proximity of residential and other areas, and the occupancy of such areas. Sites 1 and 3 are the largest of the investigated sites but the degree of satisfaction does not correspond with their area size. Other than Site 2, which is near to a university campus, these larger sites are located inside of the most densely populated residential region in Tianjin, an area which lacks open space.

A lesson learned from this analysis is that ‘spatial capacity’ alone is not a measure that is sufficiently suitable to express how open spaces may meet needs. Planners must take other information into consideration, most of all the kind of urban context and land use that exist around the open space in question. For example, Site 1 is surrounded by many large residential communities and many people are dissatisfied with the spatial capacity of open space in the area and in Site 1 in particular.

![Figure 7.2 Satisfaction with space and area size and the measured area of the four sites](image)

7.2.3 Analysis results regarding social needs

A lesson learned from the literature (see chapter 3.1.1) social needs can never be given too much attention when planning and designing for urban open space. Results obtained by asking question number 6 (see chapter 6 for results) open space users explained that they visit the open space (where the interview was conducted) at least partly because it is here where they could meet their team teachers, partners and
friends who are also participating in the specific recreational activities people prefer to do. In fact, social communication in the open space can be found to be much more important when also considering the results obtained by asking question number 7, and when also referring to the results obtained through on-site observations. Few people said that they never communicate with others. As learned from observation, chatting was happening all the time, for example with and between friends, partners and even people who do not know much about each other.

In the rural or traditional residential area in China social communication usually happens in the streets and in private courtyards, such as chatting in front of the door and talking to neighbors in the street. These are very common social scenes. In the era of urbanization, courtyards and streets with communicative qualities gradually disappeared and the wide city street is no longer convenient for social conversation. Open spaces take over the role of providing stages for social communication. Meeting people, chatting with people in an urban open space is to promote the mutual understanding; such exchanges reduce suspicion about others and improve social stability\textsuperscript{26}. It is important for planners and designers to remember these findings.

7.2.4 Analysis of results regarding needs of esteem

Esteem is, according to Maslow’s hierarchy, a complex need that includes having self-esteem and self-respect. Esteem, then, also presents the human desire to be accepted and valued by others (Smith, 1992). Many outdoor activities are carried out in the form of group activities and collective participation. During on-site observations there always were some volunteers who brought portable audio equipment and played the role of volunteer organizer. These people taught others who had an interest in, for example, dancing, Tai Chi or other activities. In this case, the need for esteem, and for being respected and achievements are regarded highly and have been met through teaching. The image in figure 7.3 shows a confident volunteer organizer teaching a big group how to engage in dancing. During a short talk, she expressed that she really enjoys dancing and teaching others how to dance.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure7.3.jpg}
\caption{A volunteer teaches dancing with great enthusiasm (Photograph by Kun Zhang)}
\end{figure}

\textsuperscript{26} The relevance of the ‘social capital’ in urban contexts was pointed as early as the 1960s by the Canadian researcher Jane Jacobs (notably in her influential book ‘The Death and Life of Great American Cities’ (1961).
7.2.5 Analysis of results regarding the need of self-actualization

The original definition of ‘need of self-actualization’ that is found in Maslow’s hierarchy was extended and here defined to include aesthetic needs (Chapman and Gale, 1982). The assumption is that an aesthetically pleasing environment can lead to a positive psychological reaction. As a result from this study it was found that not all of the interviewed people had expressed any definite aesthetic need to be filled for self-actualization; and, at the same time, not all of the open space is appreciated in ways that include a rising of a psychological reaction. The human aesthetic need regarding outdoor space is difficult to assess, at least on the basis of findings obtained from the questions asked in this study. From the results obtained by filling the questionnaire, at Site 1 and Site 4 the river is wider than at the sites 2 and 3, and it also received a higher rating of beauty. Apparently, here people have stronger feelings of the river influencing the landscape. This might be taken as indication for the river as the crucial landscape element that raises aesthetic appreciation.

7.2.6 Conclusions

Human needs could, in the discussion above, be distinguished with regard to analyzing different types of open space.

Physiological needs are the basic needs regarding the environmental conditions for outdoor recreational activities. The most significant needs, according to study results, include: geographical accessibility, physical capacity, thermal comfortable and public facilities.

Safety needs refers to environments where no security risk exists for engaging in recreational activities. For example, there are no apparent violence threats, people are safe from the river, and the ground is not dangerous for old people. In this study, not many persons expressed a feeling of danger.

In this study, social needs refer to the needs of social communication. During times of on-site observation and interviewing, people would meet and talk with their friends, families and team members (spontaneously formed recreational group) through sharing and staying in the same space. In China, meeting this need is particularly important as there are many retired and old people who have a great desire for social communication.

In this study, esteem refers to people getting involved in outdoor collective activities and, at the same time, experiencing how they are known and respected by their team members. The team leaders (usually a volunteer) gain respect through achievements, for example, when they successfully organize a collective recreational activity.

In this study, self-actualization refers to the perception of landscape beauty, and the appreciation of environmental aesthetics which can be found in the open space.
2) Priority or hierarchy of human recreational needs

There are two kinds of information included in Maslow's theory. The first is the categorization of needs, and the second is the need hierarchisation. It is the hierarchy of needs that relates to basic knowledge required to understand the priority of recreational needs when designing or planning open space. During the interviews most people pointed out how important it is to them that physiological needs are met (geographical accessibility, thermal comfortable physical capacity and public facilities). And from the on-site observation it became apparent how important the social needs for communities to communicate are. Comparing the importance of the aforementioned needs with the apparently less important aesthetic needs and esteem the result is, somehow, confirming the hierarchy of Maslow's pyramid. But for some observed occasional recreational activities, a different priority might be given. The following table 7.2 shows some observed leisure activities in Tianjin that are very important for some of the people.
Table 7.2 Interpretation of special needs regarding recreation (photographer: Kun Zhang)

<table>
<thead>
<tr>
<th>Special recreational need</th>
<th>example</th>
</tr>
</thead>
<tbody>
<tr>
<td>People from the whole city gather for a short time of peach blooming appreciation along North Canal in Tianjin. Blooming along a river is traditional aesthetic scenery in China.</td>
<td></td>
</tr>
<tr>
<td>Parents participating, on behalf of their children, in a blind date (special event in China) at one riverfront open space. They share children specific information with each other.</td>
<td></td>
</tr>
<tr>
<td>Clubs, teams and individual amatures skating on the Ziye River which physically is possible only during winter and spatially available only where a river is wide.</td>
<td></td>
</tr>
<tr>
<td>People gradually gather at the open space along the Hai River, where they find a pleasant microclimate in the late afternoon and evening during hot summer times.</td>
<td></td>
</tr>
</tbody>
</table>
3) Transformation and use of open space

If a landscape does not meet any or one of the needs mentioned above, people might transform a site to better fit their purpose. Examples were observed during on-site research visits, for example at the Site 4. A field with grass was used here as an exercise field. Since that kind of existing grass surface was not seen to be very suitable for the kind of body movement done during the exercise, the surface was changed into a plane without grass (figure 7.10). This phenomenon perfectly explained how users know what exactly they need and how they desire to create their open space design to meet their needs.

Figure 7.5 Landscape re-design by users (a) "surface with grass" and (b) "without grass"; (c) "plane without grass" (Photographer: Kun Zhang).

7.3 Discussion the relationship between recreational needs and spatial attributes for design

7.3.1 River and waterfront spatial structures affecting people's recreational activities

"How do riverfront spatial structures affect people's recreational activities?" is an issue that pertains to spatial attributes and recreational activities. It includes two aspects. The first aspect relates to the question, which landscape structure could lead to the optimal utilization of space for human recreational activities. The second aspects relates to the question, how the width of waterfronts affect the recreational service of the open space. Figure 7.11 illustrates how these and other aspects are linked.

With reference to the discussion above, planners must consider many recreational needs for outdoor activities. It is not easy to detect, in every single case, how to meet all the different needs in a specific recreational space. In this discussion, the focus is on the physiological needs for recreational activities, as they are at the basis of the hierarchy. "Spatial capacity", “diversity of outdoor activities”, and “available time for recreations" are taken as the main parameters to evaluate the landscape structure and the width of waterfronts. And to the spatial structure, 8 typical landscape structural units are defined by "size", "shape" and "plant canopy" These three spatial properties are correlated and
analyzed. Size and shape usually determine the spatial capacity (the maximal number of people who could engage in recreational activities at the same time) and the diversity of activities. The vegetation is used to determine whether people might choose a particular space or not during Tianjin's hot summer for seeking thermal comfort.

Figure 7.6 Framework for analyzing correlations between landscape structure and recreational needs

7.3.2 Landscape structure analysis of riverfront open spaces

The Diversity of recreational activities in the structural landscape units are presented in figure 6.23 in chapter 6.

On-site observations indicate how people prefer to choose linear spaces for recreational activities of high mobility even in cases where the width of the linear space is insufficient to allow for some halting and stopping. When the linear space is semi-open towards the river, it appeals to people differently and encourages more recreational activities that include stopping and halting. When the linear space is opened even further, it again leads to more halting behavior and related activities. By contrast, activities without linear travelling activity are mainly found in structural and spatial arrangements that resemble that of the square.

Regarding issues of capacity, and gain from observations made during the daytime (and without
considering thermal comfort) the structural landscape unit type "e" always attracts most visitors for engaging in recreational activities. Some sources say that, in order to not prevent pedestrian traffic, there must be at least 2.5 m height “net free space” under plantings (Sonmez, Turel, et al., 2007) As in landscape unit type "e", there is enough room under the lowest branches, which may be the reason why there is a greater capacity here. At the same time, the coverage of the canopy that big trees provide helps people to recognize the space as a good recreational space with edge. In contrast, in landscape unit type "g", there is not sufficient space under the small trees, and the capacity is smaller than that of landscape unit "e"; only some space between the adjacent individual trees is available for two or three persons to engage in some sort of activity. In the landscape unit tape "f", people prefer to stay alongside of the trees as people do not want to be watched in the center of such space. In the landscape unit type "h", there also are diverse recreational activities, as it is also perceived as a unified space.

Regarding the need for thermal comfort the patterns of spatial use are quite distinctive (see figure 6.27 in Chapter 6) and, within the same open space, such changes occur with the passing of time. Apparently, people choose the time for engaging in recreational activity based on their preference for thermal comfort. Trees play a great role in relation to thermal comfort. Especially big trees seem to be beneficial for people to engage in recreational activities (figure 7.7). From the above, and resulting from on-site observations, it appears as if the landscape unit type "e" offers optimal thermal comfort for the entire course of a long daytime. A space without trees (part of type "f") and the whole area of type "h" appears to offer the best thermal comfort at the evening time.

![Figure 7.7 Temperature changes depending on plant canopy (McClenon, 1977)](image)

**7.3.3 Recreational activities in relation to the width of riverfronts**

Table 7.3 provides an illustration of relationships that seem to exist between the diversity of recreational activities that people engage in on the one hand and the width of the river and waterfront on the other hand. The wider waterfront in Site 1 (60 meters) has a higher diversity of recreational activities than the other three sites do (30 meters).
Table 7.3 Width of river and riverfront in study sites

<table>
<thead>
<tr>
<th>Site</th>
<th>River name</th>
<th>Width of river</th>
<th>Width of waterfront</th>
<th>Diversity of recreational activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
<td>Zi-Ya River</td>
<td>110</td>
<td>60</td>
<td>High</td>
</tr>
<tr>
<td>Site 2</td>
<td>Jin River</td>
<td>40</td>
<td>30</td>
<td>Low to Medium</td>
</tr>
<tr>
<td>Site 3</td>
<td>Wei-Jin River</td>
<td>25</td>
<td>30</td>
<td>Low to Medium</td>
</tr>
<tr>
<td>Site 4</td>
<td>Hai River</td>
<td>110</td>
<td>30</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Different types of activities have different demands for space and thus for the width of waterfront open space. Table 7.4 summarized the main recreational activities and their spatial requirements, translated into width of waterfront space. All the numbers given are not results of accurate measurement but based on observations.

Table 7.4 Observed activities and their space requirement at water fronts

<table>
<thead>
<tr>
<th>Activity /requirement</th>
<th>*River</th>
<th>Waterfront space width (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>fish</td>
<td>★★★★★</td>
<td>10</td>
</tr>
<tr>
<td>swim</td>
<td>★★★★★</td>
<td>10</td>
</tr>
<tr>
<td>walk</td>
<td>★★★</td>
<td>10</td>
</tr>
<tr>
<td>dance</td>
<td>★</td>
<td>40</td>
</tr>
<tr>
<td>Tai Chi</td>
<td>★</td>
<td>40</td>
</tr>
<tr>
<td>gymnastics</td>
<td>★</td>
<td>40</td>
</tr>
<tr>
<td>run</td>
<td>★★★</td>
<td>20</td>
</tr>
<tr>
<td>play Diablo</td>
<td>★</td>
<td>40</td>
</tr>
<tr>
<td>walk with bird</td>
<td>★★★★★</td>
<td>20</td>
</tr>
<tr>
<td>walk with dog</td>
<td>★★</td>
<td>20</td>
</tr>
<tr>
<td>play poker</td>
<td>★</td>
<td>30</td>
</tr>
<tr>
<td>play chess</td>
<td>★</td>
<td>30</td>
</tr>
<tr>
<td>train voice</td>
<td>★★★★★</td>
<td>40</td>
</tr>
<tr>
<td>act Chinese opera</td>
<td>★</td>
<td>40</td>
</tr>
<tr>
<td>chat</td>
<td>★</td>
<td>20</td>
</tr>
<tr>
<td>fly kite</td>
<td>★★★</td>
<td>20</td>
</tr>
<tr>
<td>play with children</td>
<td>★★</td>
<td>30</td>
</tr>
</tbody>
</table>

* ★ - river not required, ★★★★★ - river much required

Few activities seem to happen within a width of less than 10 meters. When the width of water fronts is between 10 and 20 meters, several activities like walking and running are observed to happen. When the width of water fronts is between 20 and 40 meters, sufficient space for small group activities is available. When the width of water fronts is between 40 and 80 meters, the space can accommodate one or two big group activities, like Tai Chi. When the width of a waterfront space extends over 80 meters, several big group activities could simultaneously happen there (table 7.5).
Table 7.5 Width of river space and potentials for recreational service

<table>
<thead>
<tr>
<th>width</th>
<th>Recreational service potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10 M</td>
<td>Difficult recreational environment, even for pedestrians.</td>
</tr>
<tr>
<td>10 to 20 M</td>
<td>Space sufficient for pedestrians.</td>
</tr>
<tr>
<td>20 to 40 M</td>
<td>Continuous corridor for pedestrians and small space for other forms of recreation.</td>
</tr>
<tr>
<td>40 to 80 M</td>
<td>Good quality recreational potentials in such corridor and space sufficient for people to engage in several recreational activities.</td>
</tr>
<tr>
<td>&gt;80 M</td>
<td>Greatest potential to provide a high quality of waterfront space for recreation.</td>
</tr>
</tbody>
</table>

Results presented in chapter 6 confirmed current literature sources (Lenzhölzer, 2010) by stating how urban river are able to absorb part of the urban heat, contribute to cooling of the microclimate and to increasing the urban humidity. Thus it is not surprising that water and green ecosystem types have been employed by some Chinese cities to help improve the urban environment. Generally speaking, the greater the area of water is, the greater is also the beneficial microclimatic effect. In the case of a river, a wider river should be able to have a greater microclimatic effect on the waterfront area than a narrower one, mediating the urban heat by air flow (local wind) and increasing the urban humidity. These cause-effect relationships need more research. From this study it was only possible to conclude that, when the river is wider, it might have beneficial effects if there is also a wider waterfront area, and such wide areas will usually attract more people to come to the river to enjoy the river microclimate. The following photo shows how, after sunset, many people come to the Hai River (the widest river in Tianjin) to enjoy the comfortable microclimate at that hour.

Figure 7.8 Many people come to the waterfront along the Hai River after sunset during hot summer days (Photograph by Kun Zhang)

7.3.4 Conclusions

Synthesizing information discussed above for the three parameters, diversity, capacity and availability of thermal comfort, the landscape unit type "e" appears to be the optimal spatial form which mostly meets the requirements of people who wish to engage in some sort of recreational
activity (fig. 7.17).

In its spatial form, the larger size of a space and the greater height of room available under tree would usually benefit people very much when they wish to carry out some sort of recreational activity. Whenever possible, in riverfront design, such kind of landscape type should be given preference over other types. However, this does not mean that the design along the river will need to exclude other landscape types that also may have their special advantages. For example, the landscape unit type "h" is people's favorite kind of place in the late afternoon and during evenings in hot summers, mainly for the reason of seeking and finding thermal comfort there.

In summary, the landscape structure does indeed affect the recreational functions and diverse combinations of landscape units will also allow for increased diversity of human behavior. The recommended waterfront structure is, in this case, the optimal landscape unit "e" and with a combination of different landscape units arranged together along a water course. This recommendation takes the human requirements and need as the fundamental orientation (fig. 7.9).

Regarding the diversity of recreational activities and spatial capacity of waterfronts, discussed above, the conclusion is that, when a waterfront is wider than 40 meters it could provide space enough for some diverse recreational activities and also meet most of people's basic recreational needs. For optimal thermal comfort, the waterfront cannot be seen in isolation from the river. Wider rivers will potentially support more activities that rely on water, like swimming, boating, fishing and skating. And a wider river can positively affect local microclimates. From the aspect of recreation, a wider river has higher potential for recreational activities and will attract more people than a narrow water course. Whether or not the width of a water course can generally be used as an indicator for it to also have a wider riverfront remains to be established, for example by investigating a larger number of comparable cases. In addition, also the quantitative relationship between the width of a river and the opportunities for recreational activities still need more evidences to be proven.
7.4 Discussion of the quantification of space related recreational services for design and planning

7.4.1 Recreational service of urban river and waterfront open space

The research question 4 (How to define the recreational service of urban river and waterfront open space?) is discussed below. First, it is important to remember theories and concepts that provide the basis for and of this study (see chapter 3). Based on these concepts, a four step analytical approach is presented and discussed; this approach is part of the recommendations to open space planners and designers made in this study (see figure 7.10). Finally, conclusions are drawn and discussed.

Figure 7.10 Analytical framework for the analysis of recreational services for research question 4

Step 1: Distribution of home locations
All of the 260 locations of people who were interviewed in this study were initially marked on a map, and then this information was transferred into the GIS. Again, using GIS tools, the distribution of homes in the area around the four study sites were illustrated (fig. 7.11). The distances between homes and recreational open spaces were measure is the next step of the analysis.

**Step 2: Distance measure**
While measuring these distances, two things need to be considered. The first is the distance calculation method; the second is to understand the special characteristics of urban blocks in China in general, and in the study area in particular.

The so called Euclidean Distance \(^{27}\) and the ‘Manhattan Distance \(^{28}\) is two kinds of distance calculation methods. Both are also used in GIS-based models and approaches. The inaccuracy of the Euclidean Distance for purposes of urban spatial analysis has been widely accepted (Apparicio et al., 2008). In this study the Manhattan Distance is employed because with it is possible to best consider the reality of actual urban structures, such as a typical network of city streets. As shown in figure 7.12, the Manhattan Distances from b2 to d1, c2 to d1 and a2 to d2 are not straight-line distances, but rather the shortest path is represented which a person might follow while using the urban street system.

In China, many of the urban residential communities are enclosed, for example with walls. For residents of large enclosed residential areas, the distance from their home building to the community entrance must be taken into account. For example, in the largest residential area of this study, the community A, the average distance from a point inside of the area (called “a1” in this example) to the entrance (called “a2” in this example) is much larger than the distance from “c1” to “c2” in the case of the residential community C. And the distance from a1 to a2 is nearly half of the whole distance people have to cover between point a1 and the entrance to the open space d2. In other words, the size of the residential community cannot be ignored in distance calculations. In this way, the locations of the entrances to open spaces also affect their accessibility. Based on these considerations, the shortest routes were drawn and measured; the GIS data and tools are used to perform this task (fig. 7.13).

**Step3: Statistical analysis**

---

27 In mathematics, the Euclidean distance or Euclidean metric is the "ordinary" distance between two points that one would measure with a ruler, and is given by the Pythagorean formula. The Euclidean distance between point p and q is the length of the line segment connecting them.

28 The distance between two points in a grid based on a strictly horizontal and/or vertical path (that is, along the grid lines), as opposed to the diagonal or "as the crow flies" distance. The Manhattan distance is the simple sum of the horizontal and vertical components, whereas the diagonal distance might be computed by applying the Pythagorean Theorem.
By calculating the length of the routes between open space user homes and the river and waterfront spaces, a statistical result is obtained. Based on these statistically derived measures it is possible to divide any of the measured distances into five equal portions. Taking the "20%" interval in Site1 as an example, the measure in this case means that 20 per cent of the interviewed people are living in homes that are located within the distance of 224.1 meters of Site 1. Taking the percentage of respondents as "x" and the measured distance as "y", an exponential function was obtained by using the tool “Data Analysis” of the Excel software. In table 7.6, the so called “R-squared" is given as an index of the “fitted trend line”. This line reflects the degree of correspondence between the values of the trend line (calculated) and the actual data observed in the field (the closer R^2 is to 1, the high is the degree of fitting and reliability of the trend line). The figure 7.14 shows the regression curves that were derived from these exponential functions.

Table 7.6 Statistical data of distance between location of residence and waterfront space and the fitted result based on exponential formula

<table>
<thead>
<tr>
<th>y</th>
<th>x</th>
<th>20%</th>
<th>40%</th>
<th>60%</th>
<th>80%</th>
<th>100%</th>
<th>Formula</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance in Site 1</td>
<td>224.1</td>
<td>355.9</td>
<td>690.5</td>
<td>1393.6</td>
<td>3162.6</td>
<td>y = 102.22e^{3.3292x}</td>
<td>0.9906</td>
<td></td>
</tr>
<tr>
<td>Distance in Site 2</td>
<td>356.6</td>
<td>458.1</td>
<td>607.2</td>
<td>944.0</td>
<td>2623.2</td>
<td>y = 183.61e^{2.357x}</td>
<td>0.9031</td>
<td></td>
</tr>
<tr>
<td>Distance in Site 3</td>
<td>154.6</td>
<td>260.5</td>
<td>483.1</td>
<td>688.0</td>
<td>1782.0</td>
<td>y = 81.689e^{2.9297x}</td>
<td>0.9795</td>
<td></td>
</tr>
<tr>
<td>Distance in Site 4</td>
<td>439.7</td>
<td>566.7</td>
<td>664.5</td>
<td>873.0</td>
<td>1981.8</td>
<td>y = 277.23e^{1.7216x}</td>
<td>0.8859</td>
<td></td>
</tr>
</tbody>
</table>

After a researcher has managed to fit a linear model using regression analysis, the researcher needs to determine how well the model fits the empirical data. A variety of “goodness-of-fit” statistics is available to perform this testing. In general, a model fits the data well if the differences between the observed values and the model's predicted values are small and unbiased. R-squared is a statistical measure of how close the data are to the fitted regression line.
In the course of this study, it was found that the exponential formula allows for a better expression of the role that distance plays in recreational studies than the logarithmic formula which was originally considered. Since the exponential formula is based on a relative simple mathematical relationship, its coefficients are more easily associated and correlated with spatial attributes. In the fitted formula proposed in this study, there are two coefficients: "a" and "b". In this exponential formula:

\[ Y = a \cdot e^{bX} \]

the coefficient "a" represents the distance between an open space and the nearest residential area. In cases when \( x = 0 \), \( Y = a \cdot e^{b \cdot 0} = a \cdot 1 = a \). This means that, within the distance of "a", there is no possible visitor to the open space who lives in the area. In approximation this could be understood as no residential area exist within this range.

Table 7.7 Distance without residential areas for the four study sites

<table>
<thead>
<tr>
<th>Formula</th>
<th>a</th>
<th>actual situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = 102.22 e^{3.3292x} )</td>
<td>102.22</td>
<td>Site 1: the residential community in the south is separated from the site by the river.</td>
</tr>
<tr>
<td>( y = 183.61 e^{2.357x} )</td>
<td>183.61</td>
<td>Site 2: the hospital in the East and the overpass nearby the open space fill the distance and there are no homes within that distance.</td>
</tr>
<tr>
<td>( y = 81.689 e^{2.9297x} )</td>
<td>81.689</td>
<td>Site 3: the river and wide roads along the riverfront open fill the distance that is without homes.</td>
</tr>
<tr>
<td>( y = 277.23 e^{1.7216x} )</td>
<td>277.23</td>
<td>Site 4: Construction areas and a wide road adjacent to the open space fill the distance and no homes are here.</td>
</tr>
</tbody>
</table>

For "b", the measure is derived as follows:

\[ b = (\ln(Y / a)) / X \]

The coefficient "b" stands for the quality of recreational service and reflects the attractiveness of the open space. In this study, "b" is used as the indicator of recreational service. From figure 7.15 can be
seen how the distance between two circles is increasing and the occupied area becomes larger. This means that the probability of people using the open space is decreasing. This illustration also demonstrates how the effect of how the river corridor recreational service is decreasing with distance. Another feature observed and illustrated in this graphic representation is that about 80% of the visitors of open spaces live in geographic concentrations; the last 20% of open space users are located relatively far away from the recreational open space.

Figure 7.15 Virtual geometric forms of the service radius in four sites

Step 4: Correlation analysis with structure of open space

After clarifying the meanings of the two coefficients, a discussion is possible of how these measures might relate to the spatial structure of the riverfront space and, ultimately, to site design. Three groups of structural attributes are proposed to include into the correlation analysis with these two coefficients. These attributes are 1) form and size of the site, 2) size of the accessible space inside of the sites, and 3) the size of accessible space that have plants.

As known from ecological theory and research, different forms of area have different ecological significance. Similarly, in this research is seems prudent to discuss how the form of an areas might affect its attraction to people with recreational interests. The width of the river corridor, which includes river and waterfront, is the object of study of a number of different disciplines, like ecology, hydrology, etc. From the discussion of research question 3, which is "How do river and waterfront spatial structures affect people's recreational activities?" It was concluded that the width of rivers and riverfronts are closely related to recreational activities. Such close relationships might be verified if relevant spatial site features could also be expressed with the coefficients introduced above. With this aim in mind, the width of waterfronts and rivers were taken into account. In this context, the size of open space is always taken as an indicator for the provision of urban space in and through planning (fig. 7.16).
As shown in Table 7.8, a qualitative description of the four sites can be related to the size of the open space. Certain relationships appear to exist with the recreational service coefficient "b". However, such relationships are not supported by measures from Site 2 and Site 3. One could summarize that the width and size of open space provides some sort of indication for the spatially possible outdoor activities, but that it cannot entirely represent the recreational service potentials. In addition, the width of the river did also not represent the services potentials, even though a wider river indicates a higher rating of landscape beauty.

What follows from this analysis is that a purely rational approach to open space planning cannot simply be done, for example by relying on mathematically derived measures such as the size of land available for open space use. Such simple measures cannot be taken as (the only) standards for planning and design.

Table 7.9 Results gained through statistical analysis regarding the accessible space (unit: meters)

<table>
<thead>
<tr>
<th>Site</th>
<th>path</th>
<th>accessible space area</th>
<th>all accessible area</th>
<th>Coefficient ‘b’</th>
</tr>
</thead>
<tbody>
<tr>
<td>site 1</td>
<td>4627.03</td>
<td>5023.04</td>
<td>9650.08</td>
<td>3.3292</td>
</tr>
<tr>
<td>site 2</td>
<td>680.63</td>
<td>2363.59</td>
<td>3044.22</td>
<td>2.357</td>
</tr>
<tr>
<td>site 3</td>
<td>1218.87</td>
<td>2613.69</td>
<td>3832.56</td>
<td>2.9297</td>
</tr>
<tr>
<td>site 4</td>
<td>984.59</td>
<td>4971.63</td>
<td>5956.23</td>
<td>1.7216</td>
</tr>
</tbody>
</table>
In China, much of the area of public open space might be covered with grass. In many instances such areas are not accessible for recreational activities. It seems prudent to conduct the correlation analysis between the sizes of accessible landscape areas in open space sites and employ the coefficient "b" to this end. With the help of GIS, the accessible area (path plus accessible space) was calculated and the results are shown in table 7.9.

As a result from statistical analysis it found that the coefficient "b" is related closely to the area of all accessible space. The statistically derived numbers of accessible space in sites 1, 2 and 3 are relevant to the values of "b"; the numbers for Site 4 are the only exception (table 7.9). In Site 4 it can be observed that, in spite of the large size of its accessible space, most of this space is bare and open to the sun; this leads to a low utilization of space during the daytime (as seen earlier, visitors much prefer to stay at a place that has a tree canopy cover, particularly during hot summer days). Thermal comfort must, therefore, always be considered when planning and designing for attractive outdoor recreational space.

Tianjin has hot summers and cold windy winters. People may use outdoor spaces and, under the cover of tree canopies evade times of intensive sunshine while engaging in some sort of recreation. One needs to consider such plants when conducting the correlation analysis. In doing so, six types of land cover are drawn, including accessible space without plants, path without plants, accessible space with big tree, path with big tree, accessible space with small tree and accessible space with small tree. Based on these six variables, the calculation can be conducted and a comparison with the coefficient "b" done (table 7.10).

Table 7.10 Results from statistical analysis including features of the open spaces

<table>
<thead>
<tr>
<th>Site</th>
<th>space with big trees</th>
<th>path with big trees</th>
<th>space with small trees</th>
<th>path with small trees</th>
<th>space without plants</th>
<th>path without plants</th>
<th>Coefficient &quot;b&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>site 1</td>
<td>1152.35</td>
<td>1152.77</td>
<td>51.04</td>
<td>8.72</td>
<td>3819.66</td>
<td>3465.55</td>
<td>3.3292</td>
</tr>
<tr>
<td>site 2</td>
<td>1777.12</td>
<td>263.27</td>
<td>47.43</td>
<td>5.80</td>
<td>539.03</td>
<td>411.55</td>
<td>2.357</td>
</tr>
<tr>
<td>site 3</td>
<td>1821.07</td>
<td>736.89</td>
<td>1.79</td>
<td>58.23</td>
<td>790.83</td>
<td>423.75</td>
<td>2.9297</td>
</tr>
<tr>
<td>site 4</td>
<td>367.88</td>
<td>609.56</td>
<td>60.74</td>
<td>29.86</td>
<td>4543.01</td>
<td>345.17</td>
<td>1.7216</td>
</tr>
</tbody>
</table>

There are four possible compositions of these six variables (figure 7.17). Using the regression analysis (in Excel), it is found that "space and path with big or small trees (X1)" and "space and path without plants (X2)" are two suitable variables that closely relate to the coefficient "b" (table 7.11). Based on this result, it is recommended to pay attention to the accessible space with trees when engaging in design for riverfront spaces in Tianjin (particularly keeping hot summers in mind).
Figure 7.17 Four sets of variables for correlation analysis

Table 7.11 Results of regression analysis of correlation analysis

<table>
<thead>
<tr>
<th>Site</th>
<th>X1: space and path with big and small trees (0.01 km²)</th>
<th>X2: space and path without plants (0.01 km²)</th>
<th>Recreational service coefficient &quot;b&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
<td>0.2365</td>
<td>0.7285</td>
<td>3.3292</td>
</tr>
<tr>
<td>Site 2</td>
<td>0.2094</td>
<td>0.0951</td>
<td>2.357</td>
</tr>
<tr>
<td>Site 3</td>
<td>0.2618</td>
<td>0.1215</td>
<td>2.9297</td>
</tr>
<tr>
<td>Site 4</td>
<td>0.1068</td>
<td>0.4888</td>
<td>1.7216</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>P-value</th>
<th>Regression equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.080014</td>
<td>Y(b) = 0.08 + 10.37X1 + 1.09X2</td>
</tr>
<tr>
<td>X Variable 1</td>
<td>0.000143</td>
<td>(R² = 1)</td>
</tr>
<tr>
<td>X Variable 2</td>
<td>0.000303</td>
<td></td>
</tr>
</tbody>
</table>

7.4.2 Conclusions

Responses to the research question 4 (How to define the recreational service of urban river and waterfront open space?), it concludes that urban rivers and waterfront spaces serve as linear corridors that people use for recreation. The recreational service effect of these corridors and their open space is, in a way, decreasing progressively with distance increasing away from the water edge. Local residents who live nearby the river are able to get to the open space near the waterfront; hence, the river is visited most intensively by people who live near the river, and less intensively by people whose homes are located at greater distances away from the river. The recreational service is, expressed in this way, decreasing with distances increasing away from the river.

The provision of accessible space determines how any open space might be able to provide recreational services. The pertinent correlations might be qualified by the following equation:

\[ Y = a e^{bX} \]

In this equation, \( Y \) means the service distance; this is the distance at which people can take advantage of recreational services. \( X \) is an expression of the percentage of citizens who live within the service radius. Coefficient "a" represents the distance between the entrance of an open space and
the nearest residential area (measured for different directions). The coefficient "b" stands for a certain relationships between the sizes of accessible areas and the area that is accessed in reality (taking the local microclimate into account). In the case of Tianjin, ‘b’ relates to the size of accessible area covered with trees and the size of accessible area not covered with trees.

In this discussion it became apparent that, while planners are facing complex urban situations, no mathematical calculation will result in findings that are accurate. However, in this discussion the aim is not to find an accurate mathematical equation that would later be imposed on future design projects. The aim is to help and understand some of the relationships that may exist between space and people. Based on such understanding the results of this study might, ultimately, be helpful in finding more open space potentials that would rationally be applied to the designing and planning of open space.
Part V Exploration of study results for planning
Chapter 8 Applying study results to urban open space planning

8.1 Introduction to open space planning and accessibility assessment

Urban development is a major driving force of landscape change. Effects include landscape fragmentation and a number of different environmental impacts. In some instances the area and accessibility of urban open space are reduced and city districts may even experience a serious shortage at times of rapidly growing populations. The quality of open space, the area provided, and the distribution and accessibility are important issues of open space to fulfil their social and ecological functions in urban environments (Barbosa et al., 2007).

According to research and international standards regarding ecological services, the assessment of quality of urban green space is done by employing a selected number of ecological indicators (Forman, 1995, Gustafson, 1998, Leitao et al., 2006). For the assessment of social services the accessibility and rationality are combined with quality ratings of urban open space (Germann-Chiari and Seeland, 2004, Gobster and Westphal, 2004, Giles-Corti et al., 2005). Both kinds of assessment are also essential in this study.

Social benefits of urban open space are interpreted, in this study, as comprising, among other aspects, physical health, social equity and justice. In the 19th century, the concept of public open space, or POS, was conceived (for example in the United Kingdom and the United States) with the view to improve the health and quality of life of the working classes who, at that time, were living in squatter and crowded conditions (Giles-Corti et al., 2005). One important idea of the time was that well-designed public space (POS) would encourage physical activity which, in turn, was considered a community asset that could potentially contribute to the health of local residents. From that time on, when many sporting grounds and community gardens were first created in greater number, research about open space system planning for urban recreation has constantly been deepened and soon had an essential part in providing evidence and standards for planning practice. Since then, the social services provided by and through urban open space, as well as the accessibility of such places, have always been taken as integrated indictors and measuring standard for the assessment and of the provision and distribution of urban open space.

Space standards are a popular and common planning tool for all kinds of public services that are provided in the urban environment (Maruani and Amit-Cohen, 2007). Service radius is one of the frequently applied standards. Where the process of urbanization makes the use of open space difficult for urban dwellers regulations are usually enacted that include stipulations regarding the minimum distance between urban open spaces and places of residence. The aim is to ensure that equal opportunity exist for all to enjoy the outdoor space. Table 8.1 shows a select number of regulations and acts that include standards regarding the minimum service radius around open space in Europe (including the UK). Together with standards for good accessibility such minimum distance standards have long been taken as guiding principles for urban open space planning.
In this study, the results of the correlation analysis between spatial structure of open space and the recreational service radius (distance between an open space and places of residence) is presented in Chapter 7. These results are now further explored for their application in urban open space planning.

Table 8.1 Regulations or acts about the service radius of open space (Maruani and Amit-Cohen, 2007; Bo et al., 2008)

<table>
<thead>
<tr>
<th>Level</th>
<th>Organization</th>
<th>Regulations description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe (EEA)</td>
<td>the European Environment Agency</td>
<td>people should have access to green space within 15 minutes of walking distance</td>
</tr>
<tr>
<td>Country (UK)</td>
<td>Government Agency; English Nature</td>
<td>People living in towns and cities should have an accessible natural green space available within less than 300 m from home</td>
</tr>
<tr>
<td>City (selected reference examples)</td>
<td>Plan in City Landscpae and open space planning in London (2000)</td>
<td>Open space size (hm2) Service area radius (meter)</td>
</tr>
<tr>
<td></td>
<td>Open space planning in San Francisco (1997)</td>
<td>Big open space in city &gt;60 3200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open space in district &gt; 20 1200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open space in community &gt; 2 400</td>
</tr>
<tr>
<td></td>
<td>Open space planning in Vancouver (2002)</td>
<td>Big open space in city &lt;400 800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open space in community &gt;4 600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open space in Community &lt;4 400</td>
</tr>
<tr>
<td></td>
<td>Open space planning in Newcastle (UK)</td>
<td>Open space in district &lt;40 1600~4800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open space in community 1.2<del>2 500</del>800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urban park 2~6 1000 (In high density area is 500m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Natural/semi-natural space &gt; 2 2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urban Farm &gt; 1.2 1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green space&gt; 0.1 300 (5 minutes walking time)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Playground for infant &gt; 0.1 50<del>100 (2</del>3 minutes walking time)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Playground for children &gt; 0.1 150<del>300 (3</del>5 minutes walking time)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Playground for teenage &gt; 0.1 300<del>500 (5</del>7 minutes walking time)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green corridor and boulevard 1000</td>
</tr>
</tbody>
</table>
In China accessibility criteria are now frequently employed in urban open space planning. Numbers of distinct methods used for purposes of analysing the accessibility of urban open space in China. In this study, the GIS-based 'cost-distance model' was employed to conduct the spatial stimulation for the purpose of accessibility assessment.

8.2 Open space development and planning challenges in Tianjin

Analogous to the urban development, the development of open space planning in Tianjin can also be divided into three periods: 1) During the period of feudal society, before 1860 (Second Opium War), artificially constructed green space mainly include the type of traditional gardens, such as the royal gardens, private gardens and temple gardens; 2) from 1860 (Second Opium War) to 1949 (establishment of People's Republic China), a transition from traditional gardens to modern gardens occurred and the concept of modern open space was introduced by the occupying powers; 3) after 1949 (establishment of People's Republic China), there was a short period of time of a green movement in China (during the 1950s) and from 1980s onwards a large number of public parks and residential open spaces appeared. Finally, modern open space planning and design began. These three periods are explained in more detail below (also see chapters 4 and 5).

8.2.1 Traditional Garden Design from 1404-1860

The location of traditional gardens usually closely relates to water. More than 30 gardens were built along rivers (Hai River and South Canal) and other water locations such as ponds and wetlands (figure 8.1). Inside the old city, commercial and entertainment activities assembled around the temple gardens (one type of Chinese traditional garden) and the spaces at the side of open water (Guo, 2007).

Figure 8.1 Distribution of traditional gardens relying on water in Tianjin before 1860 (Zhao, 2012)
8.2.2 New recreational space and preliminary open space planning from 1860 to 1949

From about 1860 to 1949, Tianjin underwent significant spatial changes. Parks, which emerged in concessions, had an important impact on the urban spatial pattern afterwards (An, 2012). In the several decades between 1880 and 1937 around 10 parks were built, in their concessions by people from Britain, France, Italy, Russia, and Japan in order to meet their recreational needs (fig. 8.2) (Song, 2010; Xu, 2010; Wang, 2010). In the area under Chinese regime the first modern open park was built during this time as well. Chinese and Western architectural style blended in this park. This was the historic turning point from Chinese traditional garden to modern public garden planning in Tianjin (fig. 8.3).
In 1930, the planners Liang Si-cheng and Zhang Rui produced the first comprehensive and systematic master plan for Tianjin. In this plan, the category ‘park’ first appeared as one type of land use. A park system linked by roads was planned (figure 8.3). This was the preliminary planning effort for creating an urban open space network in Tianjin.

**8.2.3 Modern open space planning and planning challenges from 1949 to present**

Several decades after the founding of the People's Republic of China (in 1949), open space planning became a fixed content in all urban planning. However, in the areas of urban sprawl, tremendous demand for urban development areas resulted in a great shrinking of open space. Comparing the four master plan editions from 1960, 1986, 1996-2010 and 2005-2020, the total area of open space has been decreasing (figure 8.4). Now, planners advocate for the present river and water areas to be cherished and preserved as core areas of urban green. All water courses have high potentials of becoming urban green corridors; that is green infrastructure providing ecosystem services. It is seen as urgent to establish an open space system with good accessibility in Tianjin, especially for purposes of everyday recreational activities.

![Figure 8.4 Shrinking of open space during the process of urbanization](image)

Extraordinary population explosions and the delineation of open space lead by high speeds of urbanization have been and still is a common phenomenon in many Chinese cities. It is urgent, for all
the Chinese cities, to find a way to prepare a long vision for open space and have plans prepared that are based on all aspects of sustainability.

8.3 Future planning and design of urban open space in Tianjin

8.3.1 Introduction: the planning and design framework

Referring to research question 5 (How might answering these question change planning and design of urban open space?) this chapter attempts to apply results of this study to urban open space planning in Tianjin. Statistical standards regarding the recreational services (study results presented in chapter 7.4) serve as a criterion and are tested by way of accessibility assessment for urban open space. Additionally, practical methods of planning and designing are proposed and discussed that aim at improving urban open space in Tianjin.

The testing is mainly conducted based on the first four stages of the universally applied “Framework for Theory Applicable to the Education of Landscape Architects” that was established during the 1990s (Steinitz, 1990) and continuously developed further since (Stremke et al., 2012). Thus, following along the lines of this framework, the first step is to describe and present the current urban open space in Tianjin. The second step is to determine and to assess how and to what extent these open spaces provide urban recreational service in Tianjin. The third step is to conduct the accessibility assessment by application of GIS, and to also perform a quality assessment for all current open spaces. The fourth step is to propose alternative design and planning solutions aimed at mitigating any shortcomings regarding recreational needs detected during step three. Steps five and six would include predictive impact assessments (for the purpose of ranking the proposed alternatives) and, based on knowledge gained from step five, suggest which proposed solution should be made official policy and implemented. These two steps are in the realm of political decision making and not the subject of this methodological study.

8.3.2 Open Space Inventory and Assessment

Recording the open space and to establish an inventory of spaces is first step of the method introduced above. This step aims at including all of the current urban open space in Tianjin into an inventory and presenting the result in maps (figure 8.5). All river and waterfront spaces and parks used for recreation are initially considered in the study area in Tianjin, and they were marked in maps using GIS. As most people access recreational spaces by using specific entrance locations, these entrance points were also marked out in the GIS. For the river and waterfront spaces and other recreational spaces which are accessible and open (without border and entrance), the street junctions closest to the open space area were marked as the most frequently used entering points. For the parks and recreational space with closed walls, the locations of gates were marked as entrances.
For step two, the statistically derived results presented in Chapter 7 are used as standards to define the service radius of individual open space areas. The aim is also to establish a network of open space using GIS algorithms based on urban structure data compiled for Tianjin.

“Service distance” between residential areas and open space entrances

Results of the accessibility analysis and standards regarding distances between recreational area (open space) and residential areas are provided as “service distance”; these and their values are described in table 8.2. “Service distances” of the 185 entrances to parks and other open space areas were established by using the tool "location - properties - breaks length" that is available in the GIS network analysis.
Table 8.2 Urban open space service distances in the study area

<table>
<thead>
<tr>
<th>Service distance (meters)</th>
<th>Width of riverfront (meters)</th>
<th>Riverfront space</th>
</tr>
</thead>
<tbody>
<tr>
<td>1400*</td>
<td>60 meters</td>
<td>Site 1 (Ziya river)</td>
</tr>
<tr>
<td>800*</td>
<td>30 meters</td>
<td>Site 2, Site 3, Site 4 and some other riverfront (Jin river, Weijin river)</td>
</tr>
<tr>
<td>300**</td>
<td>10~20 meters</td>
<td>Most riverfront space along Jinriver and Weijin river</td>
</tr>
<tr>
<td>0*</td>
<td>&lt;10 meters</td>
<td>All other riverfront</td>
</tr>
<tr>
<td>Service range</td>
<td>Area (km2)</td>
<td>Parks and open space</td>
</tr>
<tr>
<td>2000***</td>
<td>&gt; 0.25</td>
<td>water park, Nancuiping Park, Xi Gu park, Chang hong park</td>
</tr>
<tr>
<td>1600**</td>
<td>0.03-0.08</td>
<td>Xiangyu park, People's park, NanKai park, Huaxiaweilai children'park, Yinhe square, hongguang park</td>
</tr>
<tr>
<td>800**</td>
<td>&lt;0.03</td>
<td>Tianla lake park, xiyuan park, tianjinwan park, munan park, fuxing park, central park, shuiqu park, Tushan park, children'park, Ziya riverfront space, red bridge park</td>
</tr>
</tbody>
</table>

*) Distance provided based on findings of this study

The study result in chapter 7 has provided a reference for relationship between the width of waterfront and “service distance”. In the study area, only the width of waterfront space in Site 1 is 60 meters; the “service distance” is set as 1400 meters. In most waterfront sections in the study area, the width of waterfront space is around 30 meters (such as Site 2, Site 3, and Site 4); here the “service distance” is set as 800 meters (see chapter 7.4.4, table 7.7 and figure 7.22). When the width of the waterfront space is less than 10 meters, it is rarely possible to provide an accessible space for recreation (results from the field survey); in this case, the service distance is 0 meter.

**) Distance provided based on standards found in directives, professional textbooks and official plans

Any waterfront space with a width that is between 10 to 20 meters the space available for recreation is very small; 300 meters are estimated as “service distance” (by referring to "open space planning in Newcastle" in table 8.1).

For the other open space areas in Tianjin, service distances are roughly estimated. The values are 1,600 meters “service distance” for middle sized open spaces of 0.03-0.08km$^2$, and 800 meters “service distance” for small open spaces <0.03 km$^2$ (referring to the "open space planning in San Francisco", of 1997 and to the "open space planning in Vancouver from 2002 in table 8.1").
For large parks that serve as everyday recreational space in Tianjin with sizes of > 0.25 km², and taking human fitness levels into account, it was found, as a result from field investigations, the majority of users spent less than 25 minutes walking to such sites. This value is used as an indicator for fixing the large park “service distance”. According to "JTGB-2003, a road engineering standard used in China", the average walking speed is about 83 meters/minute. According to this measure 2000 meters (25 minutes * 83 meters/minute = 2075 meters) is a good estimate for the “service distance” for large parks in Tianjin.

Service network (used for spatial simulation in GIS)

Figure 8.6 shows the spatial structure of Tianjin, with a network composed of linear elements, such as urban streets and water courses, and of urban point elements that are mainly located at junctions of network lines. One big difference between Western and Chinese urban structures is that the size of the urban blocks in Chinese cities is larger and equipped with "impermeable" edges. Thus, for purposes of accessibility assessment, buffer zones were drawn around city blocks by using the spatial geometrical distance and by considering the real street network. This study strives to establish a service network by application of GIS simulation that authentically represents the urban matrix pattern of large Chinese cities.

Figure 8.6 Urban structure and open space network scheme (with junctions) in Tianjin

Spatial simulation for open space gap analysis

After the establishment of the urban network (representing the urban matrix in the GIS model) and the setting of “service distance”, the GIS model can be run to perform a spatial simulation The GIS
supported network analysis produces information and visualisations of the accessibility and service radius of currently existing urban open space in Tianjin (figure 8.7).

![Figure 8.7 Results of open space accessibility assessment in the study area in Tianjin](image)

To find network gaps within the existing open space structure of the study area, the current matrix is analysed and reference is made to the density and distribution of the population. In Tianjin, the distribution of urban population closely relates to the residential buildings and their forms. There are three main types of residential communities in Tianjin: high-rise residential communities, multi-storey residential communities and bungalow-type communities. High-rise residential communities have 10-20 floor building. In multi-storey residential communities people live in building of 5-7 floors. And the bungalow-type communities mainly have one floor building with a yard. In the analysis, every one of these three types of residential community represents a different population density. Pertinent information is taken from maps and air photos, transferred to a polygon layer in the GIS, and the density and distribution of urban population can thus be estimated (figure 8.8).
Combining the information about the population density and the result of the open space accessibility assessment, the urban areas are identified that are currently lacking accessible open space (marked by circles in figure 8.8, 8.9). Regarding the multi-storey type communities, four such residential areas in need of sufficient open space; in three of these deficit areas, a high potential exist for improvement if river and waterfront space is developed as green recreational area. In contrast to residential deficit areas, the urban commercial areas along the Hai River, the riverfront open space, together with some other small open spaces, are already providing good recreational services for people live and work there (marked by rectangle in figure 8.8, 8.9).

8.3.3 Proposals for planning and design solutions to meet recreational needs

As mentioned above, the fourth step of the method discussed in this chapter is to propose alternative design and planning solutions. In spatial and landscape planning, alternative solutions are produced in order to help integrate many different interests. In the case of this Tianjin study, solutions are aimed at mitigating shortcomings regarding recreational needs that were detected before. Integrating these with other interests and needs would be next if alternative design and planning solutions were called for. For the purposes of this study, the focus is to propose different measures that help providing more and better open space. In doing so, reference is made to the findings of this study.
Taking advantage of high values of river and waterfront space

Compared with open space without water, people are found to prefer sites with or at water for their outdoor activities. In planning and design, this finding indicates how river and waterfront space is particularly valuable as outdoor recreational space. The potentials of river and waterfront space should be turned into recreational space where ever this is possible. Since rivers are linear they offer spatial continuity. As illustrated in figure 8.10 open space recreational service radius start to overlap when recreational areas are located in close proximity to each other. Along rivers and other water courses, open space service radius merge and extend into a linear form. Not only does the available amount of recreational space increase. There are also longer service areas adjacent to the river. Together, both effects promise a more favourable recreational benefit.

Optimize the quality of riverfront space and of other urban open space

In the analysis presented in chapter 7, the vegetation coverage and the area of accessible space are shown to have considerable effect on the recreational service of urban open space. Based on these findings planners and designers are advised to try and increase the accessible area covered with trees a river and waterfront spaces. In this context experts are advised to take the values found for 8 typical structural units as reference (figure 7.9).

Practical considerations include:

1) Increasing the number of big trees might help blocking the strong sunlight during hot summer days.

2) Reducing inaccessible meadow and shrub areas might help increasing accessibility along rivers and waterfronts, thus also providing more space for users to stay and be active in.

3) Prohibiting the use of motor vehicles might free and open up space for walking and cycling along rivers and waterfronts.

4) Eliminating any obstructions that are located between rivers and recreational space might help guide visitors and make them feel welcome at the riverfront space.
1) Need for larger trees; 2) Need for more accessible space; 3) Need for turning car park strip into accessible space along riverfront; 4) Need for complete re-design and eliminating of obstruction along the waterfront.

**Add small recreational space to urban areas**

To better meet every day recreational needs of urban people, it might be necessary to increase the number of small open space and to design these to serve as recreational spots that are easily accessible. To provide space for large recreational areas is not always possible in a densely build up city. Hence, the provision of small open spaces is crucial for the quality of city life, particularly when respecting principles of equality. A number of small urban open spaces would help, together with the riverfront space, establishing a recreational network which might even compensate, to a certain degree, for the lack of a large park. In figure 8.12 the conceptual idea is presented of adding a number of small open spaces to the urban landscape near a river course.

**Open up recreational space**

As found in this research, the degree of openness of any recreational space determines its potential to provide recreational services. River and waterfront space should always have good accessibility. In
contrast, it was found that many urban parks are not open or offer not enough entrances for visitors to use. As can be seen from the simple graphs in figure 8.13, open space with many entrances have a larger recreational service range than spaces with limited numbers of entrances. The aim should be to open up the borders of recreational spaces.

![Figure 8.13 Different service ranges with different numbers of entrances](image)

**Reduce size of urban blocks and enclosed community areas**

At the same time as opening up enclosed green spaces, the edges of large enclosed residential communities should also be turned into more "permeable" parts of the urban matrix. For example, the border structures of large residential communities might be open up and routes added that for pedestrians may use for passing through. Such measures will reduce the size of impermeable urban blocks and enhance the urban network connectivity and diversity (figures 8.14 and 8.15). Such measures would also provide many more chances for citizens to go to the river and to use the waterfront space for purposes of recreation.

![Figure 8.14 Smaller block has a better connectivity with nearby riverfronts](image)

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30 Many urban parks in China are usually enclosed by walls, and bicycles are generally prohibited inside. With the continuous development of the concept of open space, some large cities in China gradually abolished entrance fees, and started to open up formerly closed parks. But still, much work needs to be done in advocating to open up urban parks.
Improving the green network by including "green" streets

As one result gained on the basis of field investigations conducted in this study, 45% percent of the people interviewed mentioned "walking" as an important recreational activity. 75% percent of the interviewed people go and access open spaces by walking (figure 8.16). Walking is the most important recreational activity and a liveable city is also one that gives high priority to responding to the need for walking and cycling in the city. Thus, the transportation system must give equal importance for pedestrian and cycling traffic as it does to other forms of the urban traffic. Where ever possible land use along streets in Tianjin should be transformed and integrate multi-functional uses of transportation. It is important to provide enough space for comfortable walking and bicycle riding, and also for other recreational activities.
Experience from cities in the Western world might serve as reference. For example, one planning guideline for green streets in the UK is described as "The pedestrian should be following a good pavement, free of obstructions, and lined with trees to make the route as attractive as possible and to define the Green Street as a special route. At every side road junction, the pedestrian would take priority with a direct raised pavement crossing. Meanwhile the cyclists would ideally be following the same route on a lightly trafficked and slow speed road. Road closures would reduce the volume of traffic to a minimum whilst giving cyclists a short cut." (Figure 8.17)

Additionally, it is good to know that most of the urban parks in Tianjin were built based on a natural water resource. Thus, the potentials are high to link all of these parks with water and river and form a recreational network. By the additional help of using "green" streets, a recreational network could be established that would serve as the green infrastructure of Tianjin (figure 8.18).

![Figure 8.17 Diagram showing various arrangements for urban green streets](image)

![Figure 8.18 Open space network building the "green infrastructure" of Tianjin](image)

31 From the greenways guidelines of Sustains.

32 Quote from Sustains, which is a leading UK charity organisation enabling people to travel by foot, bike or public transport for more of the journeys we make every day.
8.4 Conclusion

In this chapter results of this study have been applied to the task of urban open space planning and design. A planning and design framework is presented. Standards for open space accessibility are provided and the setting of service distances discussed. The structural idea of a "point-network" is brought forward and an upgraded model for GIS simulation was employed. The degree of open space availability in the study area was established. Several practical planning and designing suggestions are made and principles outlined for planners to respond to recreational needs in Tianjin. Urban rivers and water courses are suggested to serve as the structuring cores of an urban open space system, and linking rivers and all of the parks and open spaces would help turning the network open spaces into a green infrastructure system.

The conclusion is that the analysis of recreational needs is indeed helpful to provide the evidence required to soundly propose planning and designing ideas for open space improvements. In particular, this research includes evidence for i) designing the riverfront space with considerations for thermal comfort and the need for increased spatial capacity, ii) assessing of and planning for open space accessibility, and iii) understanding and promoting the urban structure to be developed as a recreational network and green infrastructure.
Part VI Conclusion
Chapter 9 Conclusions

9.1 Limits of this research and further research need

9.1.1 Qualitative and quantitative research

Qualitative and quantitative studies are two basic research forms. Both are used in this study. Qualitative research methods were applied to investigate recreational needs regarding river and waterfront outdoor space in Tianjin. The kind of investigations that were conducted lead to findings which give basic guidance to planning and design; these investigations do not produce results that provide the ground for establishing parameterized standards.

The quantitative research performed in this study leads to results that provide detailed information about river and waterfront recreational services. General statistics and data gained by the application of questionnaires made it possible to establish, in a quantitative manner, parameters explaining how the distance between people’s places of residence and the riverfront relate to the number of users of river and waterfront open space. An equation was used to help calculate this relationship: \[ Y = a \times e^{bx} \] (explained in more detail above). However, when applying this equation to any urban space that exists in reality, there remains a risk of gaining results that are not perfectly accurate. For example, in this equation "a" was defined as the distance between a riverfront open space and the nearest place of residence. For purposes of application in practical planning and design, to determine the "a" and "b" factors require a considerable amount of urban spatial data to be available. In many cities in China not all are easy to find (see chapter below on “big data”).

To answer these questions of accuracy and applicability, further explorations would be needed and more study areas included. In this study, four sites were investigated, and that number is not sufficient to firmly establish standards.

9.1.2 Urban open space research in relation to research in other fields

Landscape sustainability is a vast and difficult concept; it also is as slippery and dynamic as landscape itself. In the combination of landscape and sustainability concepts both ideological and political contents are present, as well as the familiar ecological, economic and social contents (Benson and Roe, 2013). In this study, the discussion about urban landscape and urban open space mainly focuses on the recreational aspects; political and economic factors were excluded. Including such factors would have made this research very complex and difficult to handle. Results should be considered with caution, though, because this study might lead to conclusions regarding people’s recreational needs from one perspective only. How such result would be different if urban economic, ecological and other needs were also included should be the subject of further research.
9.2 Review of findings and lessons learned

9.2.1 Research questions

In the beginning of this study, the research motivation (why-question), the objects and aims of research (what-question) were stated and the approach and methods (how-question) were elaborated. A review of findings and of lessons learned marks the end of this study. The five core research questions are:

1. What is the role of rivers in spatial and open space planning?
2. What are the human needs regarding outdoor open space?
3. How do river and water front spatial structures affect people's recreational activities?
4. How to define the recreational service of urban river and waterfront open space?
5. How might answering these question change planning and design of urban open space?

9.2.2 What is the role of river in spatial planning in Europe and China?

Rivers have gained importance in spatial planning and decision making everywhere in the World. In China, ecological planning and modern forms of urban planning started during the 1990s. There is much potential to explore a multitude of aspects related to rivers in China. To start with, the concept of the ecological network is awaiting implementation, not only at national, but also at regional and, in some metropolitan areas, also at sub-regional scale. Water courses such as rivers are among the most significant linear elements with which ecological corridors can be constructed; in many cases water courses provide the network and its identity. A further aspect that emerged as important, as a result of the historic analysis, is that the concept and also the reality of the watershed is often taken as the geographical boundary in regional comprehensive planning and development. At the landscape scale the river system and river basin is understood as the main structural link that integrates aspects of ecology, economy and society, including recreation. It follows, as a third point identified during the literature analysis, that, for purposes of providing recreational services in high urbanized areas, water courses and rivers often are thought of as the backbone of the open space structure. To develop an urban open space system or a network such as of ‘green infrastructure’ the spatial arrangement and distribution of urban open spaces often follows the river system as the main structural framework. In many instances of river related open space planning ecosystem and landscape services are considered in an integrated way, for example by linking hydrological (such as flood management) and recreational issues (such as leisure activities in flood prone lowlands).

9.2.3 What is the human's need for outdoor open space?

For the purpose of recording and analyzing recreational activities and preferences, a categorization
was made that served as a basis for this study. To provide a list of the human recreational needs related to outdoor open space (keeping the special Tianjin situation in mind) reference was made to Maslow's theory of human needs. Such human needs were consequently identified and distinguished while recording and analyzing open space in the field; this system thus constructed might, in the future, also be applicable and useful at different scales and in other cities or countries. In its current form the scale of the river and waterfront related open space is applicable, particularly for the purpose of observing and recording people's daily recreational activities in Tianjin. In this context, human needs are understood as explained in the following descriptions.

**Physiological needs** are considered basic needs; they relate to environmental conditions required for outdoor recreational activities. The most significant of these needs include: geographical accessibility, physical capacity, and thermal comfort. **Safety needs** refer to security; there should be no or at least very low security risk while engaging in recreational activities. There should, for example, exist no threat or expectation of violence, people should be safe from any river related hazards (such as flooding), and the ground should not be dangerous to use (for example by old people). Results from this study suggest that few people had a feeling that the places they used for recreation were dangerous, but that safety issues are still very important. City and site designers must pay attention to issues of river safety and to providing for safety measures that prevent people from falling. In the context of this study the needs of **Love/belonging or social need** mainly focus on the needs of social communication and the exchanging of information. People like to meet and talk with their friends, families and team members (Spontaneously formed recreational activity group) through sharing of and staying in the same open space together. In China, to respond to this need is particularly and increasingly important as there are many retired and old people who have a high desire for social communication. **Esteem** is a category of human needs that, in the context of open space planning, mean that people who are well involved in outdoor collective activities would soon be known and well respected by their team members. The team leader (volunteer) gains greatest respect for achievements when they successfully organized collective recreational activities. The need of **Self-actualization** refers to spiritual resonance, the perception of landscape beautify, appreciation of environmental aesthetics which could be found in the open space and are beneficial in lifting ones emotions.

Maslow's pyramid of needs also includes a basic understanding of priority of needs; this hierarchy might be helpful in prioritizing recreational needs for the purpose of designing and planning urban open space. However, such abstractions must be considered with caution, since general rules might not be completely applicable to every specific context. From results gained during this study, most people pointed out how greatly they value design responses to physiological needs (geographical accessibility, thermal comfortable physical capacity and public facilities). From the observations made in the field, the fulfilling of social needs of belonging to some sort of community was obvious. Compared to physiological and social needs aesthetics need and esteem were mentioned (and observed) to a lesser degree. Somehow, these results seem to confirm the sequence of hierarchy in Maslow's pyramid of needs; the data set is, however, too small to be used as a means of validating this theoretical construct.
9.2.4 How waterfront space spatial structures affect people's recreational activities

For the question, how river and waterfront space affords recreational activities, the results of this study provide some clues for planning and designing for recreational activities. The size and the shape of open space and the plants available (for example as shade giving) have been observed as being most relevant in the study areas. For example, the form of square appears to afford more and diverse activities than other forms. The land structure (tree canopy) appears to have a close relationship to thermal comfort. Different types of activities require different sizes of space; for example, it could be observed how large sizes of spaces allow for the gathering of people who engage in more collective activities. From this perspective, large spaces do have the better potential for recreational services at large, but smaller places might afford specific recreational possibilities as well.

As summarised in figure 9.1, eight landscape types were identified in Tianjin. Synthesizing the research results regarding diversity (activities), capacity and availability (thermal comfort), the landscape type "e" would seem is providing the optimal spatial form which mostly meets the needs for people to engage in recreational activities. In Tianjin, designers of open space might consider and prioritize such kind of landscape or open space type.

However, this does not mean that the design of open space along rivers will, in the future, exclude other types of landscape and open space. Other sizes and arrangements of open space also have their specific qualities and advantages. For example, the landscape type "h" was found to include most of people's favorite places. They preferred such places particularly in the late afternoon and evening during the summer, and mainly for the reason of finding thermal comfort. In summary, the optimal size and quality of open space and landscape structure does not exist as a general rule. In fact, for orientation, a site specific combination and design of different landscape types might be
recommended the best fit when taking the many different human needs that designers wish to respond to along an urban river.

9.2.5 How to define the landscape service of the urban river

Regarding the study of landscape services of urban rivers, the results of this study suggest that the recreational service of river and waterfront open space can be described as follows: river and waterfront are felt and visited most intensively by people who live near the river, and less intensively with distances of residence increasing away from the river. As a result from statistical analysis of data obtained from field investigation, a formula could be established that might be useful to describe the recreational affordance as function of distance. In the equation:

\[ Y = a \cdot e^{bX} \]

Y is an expression of the service distance (between the residence and the river edge), and X is an expression of the percentage of people who live within the service radius. The coefficient "a" represents of the distance between the river edge to the nearest residential area, and the coefficient "b" is a comprehensive capability index refer to the recreational space.

In addition to using this kind of correlation analysis, it was confirmed by results of this study that the riverfront's recreational affordances are also related to the size of the open space used. In particular, under the prevailing conditions of Tianjin, it is the size of accessible area covered with trees, and the size of accessible area not covered with trees, that appear to also determine the riverfront's recreational affordances.

9.2.6 How might answering these question change planning and design of river landscapes in cities?

As explained above, the recreational affordance of river and waterfront open space relates to, among other factors, the distance people need to cover in order to reach recreation areas. In this study, distances were calculated starting from each access point people use when using any of the open space. The distances between access points and points of residence were taken as a value for the spatial analysis. The "point-to-point network" thus allows performing an evaluation of the urban open space provided to people. This is an important tool for planning, and it is possible, through GIS simulation, to calculate which amount of upgrade should be stimulated for improved open space availability. According to the evaluation conducted in this study, the river corridors of Tianjin have an insufficient amount of open space when the currently available area is related to the urban population. Several practical planning and designing tools are brought out that might help remedy this currently insufficient response of Tianjin to the recreational needs of its citizens. The main proposal is that the urban rivers should become the structuring skeleton of a new urban green space system. The rivers and
waterfronts would then link up with all parks and open spaces into an open space system that serves as Tianjin’s green infrastructure. The following practical suggestions for the river-based spatial planning and design are to:

1. Extend the length of river corridors;

2. Add a number of small urban open spaces that will become nodes of the network;

3. Link sections of the network by the including "green" streets;

4. Make borders of recreational spaces more open and accessible;

5. Optimize the quality of river and waterfront space and include other urban open space into a quality upgrading strategy.

9.3 Landscape concepts and knowledge building

9.3.1 Landscape concept

In chapter 3, landscape is described as a cultural phenomenon that can be explained by its three main constituting components: Nature, artifacts (material features of anthropogenic origin) and social organization (Ipsen, 2011). Expanding on this theoretical model, “Social Organization” may be defined as the space and place of specific law and order, customs and (vernacular) traditions, and other forms and qualities of common understanding of social conduct; these closely relate to people’s perception of their surroundings (Bruns, 2014). In this study it was found, through literature analysis and interviewing practitioners, that these aspects of Social Organization, including perceptual aspects, were mostly ignored by modern landscape practitioners. Space use is usually understood, by many experts, as a physical thing. Empirical findings of this study on river and waterfront space in Tianjin confirm that people who are involved in recreational activities are always perceiving and comprehending a landscape as a space that is filled with and used by other people.

According to the European Landscape Convention (ELC), landscapes are “areas… as perceived by people”, where ‘perceiving’ refers to what people identify and “give value to in their surroundings” (Jones, 2007). In this study, many visitors clearly stated that all persons who came to the same river and waterfront space as they did themselves were important to them. To meet people regularly, to talk to them, and to watch what happens was, in fact, a strong motivation for visiting an open space. From this perspective, people and space are closely linked together. Social Organization is thus one of the most relevant components of the landscape concept. Together with "Nature" and "Artifact" the component “Social Organization” makes up the comprehensive understanding of landscape as a cultural phenomenon.

To date, it seems, many Chinese landscape practitioners do not take the part of "Social Organization" and the people as parts of landscape into account (fig. 9.2B); this observation is true also regarding experts who engage with landscape planning and design. This study may help explain, at least partly, what it is in "Social Organization" that Chinese landscape practitioners may want to
explore in the future. Understanding landscape comprehensively and taking it as the cultural phenomenon that it is, the part of Social Organization is particularly crucial for conceptualising landscape identity and place making. To understand the meaning of ‘genius loci’, a term often used by landscape practitioners, one needs to appreciate how no place is the same as any other, and how no landscape designs in the world can be the same in response to not only the physical setting but largely because of the meanings attached to this setting. And, in treating the landscape as a tool to solve urban problems, understanding the "Social Organization" is the main precondition for successfully designing any recreational space with the aim of benefitting citizens. Especially in China, where a high density of population is a common feature of cities, the urban landscape must shoulder a great responsibility to support social stability. Thus, experts should pay more attraction to the people's needs and other social desires.

Looking specifically into the practice of landscape design, experts tend to produce several maps showing two dimensions and, sometimes, three dimensions. By emphasizing the roles of people and Social Organization, landscape experts should be presenting landscape as "space with people" and communicate their ideas in four dimensional presentations. The two dimensional landscape is just a plane, and maps include information such as land use, area size, shape and so on. The three-dimensional landscape is a stereoscopic presentation that may include topography, vegetation, and other third dimensional landscape elements. The four-dimensional landscape is the one that experts have, so far, not paid much attention to; it represents the spatial and temporal changes and, by including not only the material and physical landscape, also presents people's interactivity with their surroundings. The four dimensional landscape is a more comprehensive and systematic understanding of landscape (figure 9.3). In this framework, human beings are included and part of the 4-D-landscape.
9.3.2 Landscape and ecosystem services

Based on a number of previously established concepts of landscape, and also on models of “ecosystem services”, Termorshuizen and Opdam (2008) have proposed the ‘landscape services concept’ to be used in planning. The idea behind the ‘landscape services concept’ is to build a bridge between the field of landscape ecology and the aims of sustainable development. The authors have elaborated this concept into a knowledge framework, including the ‘structure–function–value chain’, allowing planners to expand from the currently prevalent pattern–process paradigm and to combine values with findings of landscape ecology (Termorshuizen and Opdam, 2009). One intention, also of this study, is to develop the concept of ‘Landscape Recreational Services’ in addition to traditional ecosystem services concepts (de Groot et al., 2002). The concept of ‘landscape recreational services’ is highly connected to the idea of landscape ecology, linking it with social systems, as explained above.

In this study, the idea is to extend the so called "structure-function-value" and include it into a comprehensive model. Taking landscape and ecosystem services as the centre, their functions provide services as determined by landscape and ecosystem structure. By recognizing such functions, a subject (person) gives landscapes and ecosystems value and express such value, for example by preferring a specific landscape structure (demand). Thus, the concept of "Landscape and Ecosystem Service" is now explained by linking services not only to ecological, but also to social systems. The "subject", now added, might give a multitude of different values to landscapes and/or ecosystems.
In the context of this study and its specific research topic, landscape functions might be providing different recreational services and these might be made available through different means of spatial design and planning. People might express their recreational needs regarding landscape by “demanding” spatial design and planning that answers to their needs and demands, such as pertaining to restorative affordances of landscapes. Thus, one demand might be of open space visitors to gain health and happiness by engaging in recreational activities.

### 9.3.3 Aged people and their recreational needs towards a resilient city

Seeking for resilience in a metropolitan region, a sound ecological-social system should be the basis while, meeting the needs of restoration and for recreation, policy makers, designers and planners must try and provide for a good quality of life, for social stability, and for entertainment opportunities. With different backgrounds of development, the ways towards a resilient city in various countries cannot be identical. Results from this study are reflected on the background of the great urgency, for landscape...
design and planning in China, to address the discrepancy felt between the high demands for recreational open space on the one hand and the high population density on the other hand. At the same time, open space is constantly being squeezed by urban development in transitional metropolis while demands for more restorative opportunities continue to grow as well. One phenomenon of current transition is the aging of the population at large and that of urban regions in particular.

Especially the old people have high demands for engaging in outdoor activity for purposes of restoration and recreation. The city that has a high proportion of old people must consider whether or not the open space and their recreational services meet older people's needs and afford opportunities for daily outdoor activities. River and waterfront space could be among the best potentials that may be re-used and intelligently planned and designed as recreational sites. Such places, once rehabilitated, would help diverting the city dweller from disease and crime, they could be re-designed to add to the city's identity, and they could act as regional ties for social and economic development at large scales. They also could add to what has been called the ‘ecological security’ at regional and even national scale.

Today, as ever before, conditions are ripe in China for rivers and water to re-enter the urban planning agenda. This is true not only because so much land was developed without considering human outdoor needs to a great extent, and because land has been developed without providing adequate public open space. The time for rivers and water is also, once again, ripe because of recently enacted legislations and policy intended to protect the human environment.

Taking Tianjin as an example, it is the aged who make up the majority of people who express demands for recreational open space (fig. 9.6). Many elderly go out to use and enjoy space along the river every day. The river and waterfront space have become an indispensable fixture in people’s daily life. In 2050, the proportion of the people aged over 60 years in Tianjin is predicted to rise to a staggering 32% of the total population, which means that by 2050 one in three citizens would be aged over 60 years old (table 9.1 and fig. 9.7). The rising proportion of older people would create an even greater demand for suitably designed outdoor space. An adequate distribution and provision of recreational space would provide much benefit to the aged, not only for the sake of physical but also of psychosocial health. Tianjin, with a good condition of river system, has great potential to provide recreational space for old people and make the space easily accessible around the areas where the majority of aged people live.

![Figure 9.6 Result of average time for staying in recreational open space in different age group in this study in Tianjin](image)

Table 9.1 Proportion of the people aged over 60 years in Tianjin in 2050

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20</td>
<td>0.00</td>
</tr>
<tr>
<td>20-30</td>
<td>0.67</td>
</tr>
<tr>
<td>30-40</td>
<td>1.10</td>
</tr>
<tr>
<td>40-50</td>
<td>1.54</td>
</tr>
<tr>
<td>50-60</td>
<td>1.68</td>
</tr>
<tr>
<td>60-70</td>
<td>1.72</td>
</tr>
<tr>
<td>70-80</td>
<td>1.82</td>
</tr>
<tr>
<td>&gt; 80</td>
<td>1.88</td>
</tr>
</tbody>
</table>

Figure 9.6 Result of average time for staying in recreational open space in different age group in this study in Tianjin

Tianjin

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9.3.4 Multi-scale planning and design of river-oriented open space as green infrastructure

The overview presented in figure 9.8 helps to understand how the focus and design activities are usually linked with one another. As a special planning and design activity, and based on results from this study, the element of river-oriented spatial planning and design is conceptually inserted into this overview. This structure is employed to discuss how the results of this research might extend into

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33 Source: academic report of Tianjin's population from the institute of population and development in Nankai University, 2001
spatial design activities that go beyond the current practice.

Firstly, within a city, responding to recreational needs must link to open space design and planning and, together, they become one comprehensive task. Regarding human recreational needs in general, there are three physiological needs for which space capacities must be made available; they are capacity, thermal comfort and accessibility. The need for open places to be accessible translates into a measurable criterion for open space planning. The other two are ‘capacity’ and ‘thermal comfort’, and they are crucial for consideration in open space design. To meet the basic recreational needs, open space design and planning should be combined and together act for an adequate provision of urban open space.

Furthermore, the recreational service is one of several landscape and ecosystem services. The river-oriented open space, in the ecological-social systems of metropolitan areas, is the one most significant part of the green infrastructure. As the river is a unique "trans-scale" spatial element, it links the structuring of green infrastructure, integrating regional and local scale into a multi-scale planning and design.
9.4 Methodological suggestions for landscape planning and design

9.4.1 Understanding urban space and interaction

One of the paradoxes of studying cities is that how the city is to be defined has proven to be as problematic as answering the question of how cities should be studied (Paddison, 2001). Planners, economist and others from different disciplines have sought to explore the size and the structure of the city which affect people's life and try to find out the pattern and criteria that are useful to assess the city and its desirable qualities (Anas et al., 1998). The physical form and spatial structure of urban space determine and relate to the organic operational ways of functioning. In any analysis associated with humans and the urban space, the first thing is to clearly identify and recognize the urban form and structure.

In many attempts of responding to the question how the structural urban space might be defined and classified, the approach suggested by Kevin Lynch is often referred to (this conceptual theory itself refers to traditional approaches of geography, where the main elements are points, lines, and area). As mechanistic as it may appear at first glance, the approach according to Lynch has been widely used to study the urban physical space, and it has also been proven useful while using GIS as a method and tool. Recently, network theories elevate such methods of spatial analysis to even more comprehensive and advance levels. In this study, the description takes the entirety of linear elements as a network and goes...

Figure 9.9 Elements of Tianjin's urban structure as integrated in GIS
on to identify three different conceptual layers for the urban physical structure. They are (1) ‘urban network’, (2) ‘urban polygon’, and (3) ‘urban point’ (fig. 9.9).

1) Urban network. Urban rivers and streets are intertwined and together form an urban network; matter and energy flow in this network. The shapes and the spatial spreading of flows are dependent on the attributes of the network (as analyzed in this section). Comparing with other urban structural layers, the spatial effects of the networks is most evident.

2) Urban polygon. The urban space is divided by urban networks; the pieces are areas (or ‘polygons’ in the GIS terminology) such as residential blocks, individual parks and other areas (also called ‘patches’ by landscape ecologists). The way the network lines are cutting the urban space into spatial polygons has an impact on a number of functions, including the accessibility of urban green space (for example: a line might be the edge of a busy city street).

3) Urban point. Places such as entrances of or to residential communities and open green spaces (such as parks) determine the route along which people move from one area (or polygon to another. Additional examples of urban points are all nodes in the urban network that people also need to notice and consider while moving about.

Using GIS for planning (in chapter 8), accessibility evaluation is conducted within networks which, from the planning perspective, are considered the most significant layer when simulating and analyzing any urban structure. The urban network integrates and reflects the distribution and shape of all urban polygons and points. Intricately woven networks indicate small urban polygons (such as small groups of residential buildings) and a large number of urban points. Looser networks indicate larger urban polygons (such as residential blocks) and few urban points. This kind of deconstructive understanding of urban structure leads to the idea of establish a planning and design model with network.

9.4.2 Planning and design models and conceptualizing multi-functional networks

As a result of this study, one proposal is to establish a multi-functional network and, in it, to combine recreational, ecological and transportation needs.

Open space networks used for recreation are similar to, but not always identical with, the so called ‘ecological network’. In any urban area that features a densely woven network of water courses, the river and the streets together usually combine to form a spatial network where water and transportation lines comprise lines of different quality within one system. Thus, the open space system might mainly be composed of two forms of open space; one is the river and waterfront space (which, in addition to street related open space) could be taken as one form and network element) and the other one is all of the space that is surrounded by the urban matrix (examples are parks and gardens). These two morphologically distinct forms of open space together make up a conceptual image that appears to be quite similar to that of the concept of "islands and corridors" used in landscape ecology theory (fig. 9.10). In this ecological concept areas are important that serve as habitat for plant and animal populations and which they use as their main landscape islands; the biological corridors serve to
facilitate migrations in-between habitat-islands. Based on this conceptual theory of landscape island and corridors ecological restoration aims for habitat fragments to be re-connected. Ecologists will try and establish new corridors to promote environmental de-fragmentation. In this study, which looks at landscape from the perspective of people’s outdoor recreation and their restorative needs, the open space users are, in fact, not at all the same as wild plant and animal species. However, while humans do not need corridors to complete migration cycles or feeding patterns, they still benefit from comfortable ways for walking to and in-between outdoor spaces, and for carrying out certain activities accompanied with social interaction. Thus, these kinds of (linear) outdoor spaces must not necessarily be shaped like a larger park might be, but they could be shaped like a narrow strip of green or like a small open space located near-by people's living areas. The urban open space network provided for urban citizens to experience and enjoy is, therefore, not identical with the network concept used by classical morphological ecology (for example in the context of landscape management for biological protection), but both still hold similarities. In this study, one conclusion is to suggest and combine the 'restorative' open space system and the 'ecological' system together, ultimately within one network.

The consideration of the urban transportation network is also indispensable in the context of the establishment of a multi-functional network; as such network must rely on the existing urban transportation network, in order to avoid or reduce conflicts between different stakeholders.

In this discussion about conceptualizing and modeling multi-functional networks, the emphasis is on the residential community, and the aim is to elaborate to provide an everyday recreational space for people who live in a community. And the aim is also to propose urban open space networks to include, in addition to recreational space, other layers of ecological networks, transportation networks, etc. All together, they add up to build the strategic concept of multi-functional networks (fig. 9.11).
9.4.3 River-based open space model

Following the idea of the multi-functional network, and based on results of this study, a shape-related planning model is proposed. Such a morphological model would be used, in practice, as a conceptual reference for tasks of urban river-based open space planning. In this study, the river landscapes are cherished by the citizens who know of them and who use them. The river and water front constitute great attractions and afford well-being, e.g. through their visual beauty and thermal comfort. Water corridors should be the backbone of any urban space system. Starting at the water edge, the urban open space system feeds into the urban matrix adjacent to water courses. The geographical distribution and availability of open space should, as part of this urban matrix, ideally be evenly distributed and, linked to the river and water edge (e.g. along city streets). In this ideal river-related open space model, a multi-functional street scape would be designed to link the matrix spaces with river and water front space (fig. 9.12). The design would afford street use by and for pedestrians and bicycles (In this study, walking was found as one of the most favorite recreational activities in the city). City streets would, thus designed, together be composed as a network that covers the whole city. People would benefit from access to good urban space for that affords a multitude of recreational activities.
9.5 Practical suggestion for landscape planning and design

9.5.1 Checklist of recreational needs

As one of the practical results of this research a design and planning supporting tool is proposed, that might be particularly useful in the context of landscape related practice in China. A checklist was established based on the exploration of recreational needs in Tianjin. Maslow's theory of human needs provides the reference for the classification of recreational needs used in this study. Thus, the checklist has five parts: Physiological needs, safety needs, social needs, needs regarding respect and achievement, and aesthetic needs (pertaining to perception). Using this checklist will enable experts to systematically recognize "people and space" and how they interact with each other. This tool would help landscape designers and planners to produce rationally derived designs and plans. This checklist is open for adding points and questions as needed.
Table 9.2 Checklist for identifying and evaluating recreational needs and services

<table>
<thead>
<tr>
<th>Physiological needs</th>
<th></th>
</tr>
</thead>
</table>
| **Accessibility**   | ➢ Is this space mainly used by local people, people who live in the whole city or by tourist?  
➢ What is the service distance (distance between homes and recreational open space)?  
➢ Is this space open and accessible? |
| **Thermal comfort** | ➢ What are the details of microclimate?  
➢ What times do people visit here?  
➢ Does space meet thermal comfort need? |
| **Capacity**        | ➢ How many people could use this space?  
➢ Is the size of space large enough? |
| **Facilities**      | ➢ Is there toilet, bench, trash etc.?  
➢ Do any activities need special facilities? |
| **Sanitation**      | ➢ Is place clean and regular maintained? |
| **Children**        | ➢ Is there dangerous for children (e.g. close to deep water)? |
| **Aged people**     | ➢ Is ground safe for aged people? |
| **Disability**      | ➢ Is there any disabled access? |
| **Night**           | ➢ Is there safe during night (e.g. light)? |
| **Environment**     | ➢ Is there any pollution (e.g. river pollution, air pollution)? |

<table>
<thead>
<tr>
<th>Safety need</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children</strong></td>
<td>➢ Is there dangerous for children (e.g. close to deep water)?</td>
</tr>
<tr>
<td><strong>Aged people</strong></td>
<td>➢ Is ground safe for aged people?</td>
</tr>
<tr>
<td><strong>Disability</strong></td>
<td>➢ Is there any disabled access?</td>
</tr>
<tr>
<td><strong>Night</strong></td>
<td>➢ Is there safe during night (e.g. light)?</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>➢ Is there any pollution (e.g. river pollution, air pollution)?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social needs</th>
<th></th>
</tr>
</thead>
</table>
| **Social communication** | ➢ Does this location offer or respond to needs of meditation?  
➢ Does this location offer or respond to needs of small group communication?  
➢ Does this location offer or respond to needs of large group communication? |
| **Esteem needs; Respect, Achievement** |  |
| **Social collective activities** | ➢ Which kind of social collective activities happen here? Does the place meet needs for such collective activities (e.g. dancing, community exhibition, etc)? |
| **Aesthetic needs (perception)** | ➢ Does this place have visual attraction? |

**9.5.2 Planning tool for the management of "big data"**

Currently, in China, there are many discussions about how to conduct urban spatial planning in the era of "big data". In this study, GIS (Geographic Information Systems) were employed both as a method and as a tool for identifying useful criteria and for carrying out assessments. In the analysis (chapter 8), it was found that being able to manage a wealth of urban related data was a crucial factor to succeed in efficiently preparing the basic data set. It is desirable to have open access to relevant geo-data and to share such data with and within professional fields. In China, especially the field of urban planning and design, ‘Geo-Design’ is discussed as a suitable design and planning method (Tang, 2010, Yang, 2013).

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34 There is a platform called "urban data party" in China.
This method allows the creation of design proposals and link design with impact simulations that are informed by geographic contexts. Geo-Design provides a design framework and supporting technology for professionals to employ geographic information (Steinitz, 2012).

In this study, one result was to discover and list which geographic data should be made available for purposes of open space planning and design in a city, particularly with the task of recreational development:

1. Geographic distribution and density of the urban population (residential communities, spatial residential units); this data also provides firsthand information on the amount of human needs to be considered.

2. Data on geographic location and distribution of relevant points, like entrances of residential communities, entrances to urban open space (such as parks); this data provides very useful information in the context of Chinese city planning as most residential communities in China are very large and, like some public open space, are closed or enclosed in one way or another.

3. It is essential to establish data about and regarding green infrastructure. For practical purposes, open access data platforms should be made available that may be used by both citizens and experts. (For citizens, such platforms would help to learn where recreational spaces are located and how to reach them by using the urban walking and cycling network). Data platforms could thus also include social information. For landscape experts (government, planning and design experts) data platforms could help evaluate and manage current landscapes and to conduct landscape planning and designing.

4. Additionally, as learned from the citizens of Tianjin, people wish to be respected by landscape experts such as planners and designers. A social network or information exchange platform might be established where experts could learn to know people’s needs and to respect such needs for purposes of improving the availability and quality of outdoor space. Thus, such platforms as the data platform mentioned above could also support public participation for landscape planning and design.
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Abstract
English Abstract

In the process of urbanization, natural and semi-natural landscapes are increasingly cherished as open space and recreational resource. Urban rivers are part of this kind of resource and thus play an important role in managing urban resilience and health. Employing the example of Tianjin, this doctoral dissertation research aims at learning to understand how to plan and design for the interface zones between urban water courses and for the land areas adjacent to such water courses. This research also aims at learning how to link waterfront space with other urban space in order to make a recreational space system for the benefit of people.

Five questions of this dissertation are: 1) what is the role of rivers in spatial and open space planning? 2) What are the human needs regarding outdoor open space? 3) How do river and water front spatial structures affect people's recreational activities? 4) How to define the recreational service of urban river and waterfront open space? 5) How might answering these question change planning and design of urban open space?

Quantitative and qualitative empirical approaches were combined in this study for which literature review and theoretical explorations provide the basis. Empirical investigations were conducted in the city of Tianjin. The quantitative approach includes conducting 267 quantitative interviews, and the qualitative approach includes carrying out field observations and mappings. GIS served to support analysis and visualization of empirical information that was generated through this study.

By responding to the five research questions, findings and lessons include the following:

1) In the course of time rivers have gained importance in all levels and scales of spatial planning and decision making. Regarding the development of ecological networks, mainly at national scale, rivers are considered significant linear elements. Regarding regional and comprehensive development, river basins and watersheds are often considered as the structural link for strategic ecological, economic, social and recreational planning. For purposes of urban planning, particularly regarding recreational services in cities, the distribution of urban open spaces often follows the structure of river systems.

2) For the purpose of classifying human recreational needs that relate to outdoor open space Maslow's hierarchy of human needs serves as theoretical basis. The classes include geographical, safety, physiological, social and aesthetic need. These classes serve as references while analyzing river and waterfront open space and other kinds of open space.

3) Regarding the question how river and waterfront spatial structures might affect people's recreational activities, eight different landscape units were identified and compared in the case study area. Considering the thermal conditions of Tianjin, one of these landscape units was identified as affording the optimal spatial arrangement which mostly meets recreational needs. The size and the shape of open space, and the plants present in an open space have been observed as being most relevant regarding recreational activities.

4) Regarding the recreational service of urban river and waterfront open space the results of this
research suggest that the recreational service is felt less intensively as the distances between water front and open space user’s places of residence are increasing. As a method for estimating this ‘Service Distance Effect’ the following formula may be used: \( Y = a \cdot e^{bx} \). In this equation \( Y \) means the ‘Service Distance’ between homes and open space, and \( X \) means the percentage of the people who live within this service distance. Coefficient "a" represents the distance of the residential area nearest to the water front. The coefficient "b" is a comprehensive capability index that refers to the size of the available and suitable recreational area.

5) Answers found to the questions above have implications for the planning and design of urban open space. The results from the quantitative study of recreational services of waterfront open space were applied to the assessment of river-based open space systems. It is recommended that such assessments might be done employing the network analysis function available with any GIS. In addition, several practical planning and designing suggestions are made that would help remedy any insufficient base for satisfying recreational needs. The understanding of recreational need is considered helpful for the proposing planning and designing ideas and for the changing of urban landscapes.

In the course of time Tianjin's urban water system has shrunk considerably. At the same time rivers and water courses have shaped Tianjin's urban structure in noticeable ways. In the process of urbanization water has become increasingly important to the citizens and their everyday recreations. Much needs to be changed in order to improve recreational opportunities and to better provide for a livable city, most importantly when considering the increasing number of old people. Suggestions made that are based on results of this study, might be implemented in Tianjin. They are 1) to promote the quality of the waterfront open space and to make all linear waterfront area accessible recreational spaces. Then, 2), it is advisable to advocate the concept of green streets and to combine green streets with river open space in order to form an everyday recreational network. And 3) any sound urban everyday recreational service made cannot rely on only urban rivers; the whole urban structure needs to be improved, including adding small open space and optimize the form of urban communities, finally producing a multi-functional urban recreational network.

Keywords: landscape recreational service, urban river, urban open space, river-oriented spatial planning
Kurzfassung (German Abstract)

Im Zuge der Verstädterung erlangen natürliche und halb-natürliche Landschaften in Stadtgebieten eine immer größere Bedeutung als Freiraumressource für die Erholung der Bevölkerung. Flüsse in Städten sind ein Teil dieser Ressource und spielen folglich eine bedeutende Rolle für die Stadtstruktur, aber auch für die Gesundheit der Menschen. Ziel vorliegender Forschungsarbeit ist, am Beispiel von Tianjin Zusammenhänge zwischen Planen und Entwerfen flussnaher Freiräume einschließlich angrenzender Übergangsbereiche Stadtlandschaften zu untersuchen, um Schlussfolgerungen für den künftigen Umgang mit solchen Gebieten abzuleiten. Darüber hinaus wird ermittelt, wie gewässernahen Landschaften einer Stadt mit anderen Stadträumen verknüpft werden können, um ein Netz von Erholungs- und Freiräumen für die Bevölkerung zu schaffen.


 Aus diesen Recherchen und Analysen wurden folgende Antworten zu den oben angeführten Fragestellungen abgeleitet.


4. Es konnte gezeigt werden, dass mit größerer Entfernung zwischen Wohnung und Fluss die Möglichkeiten flussnaher Freiraumnutzung zunehmend weniger wahrgenommen bzw. Erholungsangebote weniger stark in Anspruch genommen werden. Auf der Grundlage empirisch gewonnener Daten konnte eine Formel entwickelt werden, mit der sich das Erholungs- und Freiraumangebot in Abhängigkeit von der Entfernung zwischen Wohnung (Erholungssuchender) und Fluss beschreiben lässt: \[ Y = a \cdot e^{bx} \]. Dabei stellt \( Y \) die Entfernung eines Freiraumangebotes zur Wohnung dar und \( X \) steht für den prozentualen Anteil der Freiraumnutzer innerhalb bestimmter Entfernungen. \( a \) stellt die Entfernung zwischen dem Freiraum und dem nächsten Wohngebiet dar. \( b \) ist ein Index, der die allgemeine Erreichbarkeit eines verfügbaren und angemessenen Freiraumes beschreibt.

5. Die auf die oben gestellten Fragen gefundenen Antworten haben Implikationen für die künftige Planung und Gestaltung städtischer Freiräume. So konnte für die Bewertung flussnaher Freiräumsysteme aus den quantitativen Untersuchungen heraus eine Methode entwickelt werden, mit denen sich Erholungsmöglichkeiten in flussnahen städtischen Landschaften mit Hilfe eines Geoinformationssystems beurteilen lassen. Darüber hinaus konnten verschiedene Empfehlungen für die Planungs- und Entwurfspraxis abgeleitet werden; die sind anzuwenden, um nicht zufriedengestellten Erholungsbedürfnissen der Bevölkerung durch gute Lösungsvorschläge zu begegnen. Insgesamt konnte gezeigt werden, dass es wichtig ist, die Bedürfnisse der Bevölkerung hinsichtlich der Erholungsfunktionen von Freiräumen zu erkennen und nachzuvollziehen, um daraus angemessene Vorschläge für die Gestaltung und Veränderung von Landschaft und Freiraum ableiten zu können.


1. Die Bedeutung einer Freiraum-Flusslandschaft muss bei Entscheidungen zusätzliches Gewicht erhalten; die linearen Strukturen städtischer Gewässer müssen als Teile öffentlich zugängliche Naherholungsgebiete stärker ausgestaltet werden.
2. Begrünte Straßen und Alleen sind in Verbindung mit städtischen Gewässern und deren angrenzenden Gebieten zu einem städtischen Naherholungsnetz auszubauen, das aus verschiedenen Freiräumen und Freiraumtypen besteht.


Schlagwörter: Landschaftsfunktionen, Naherholungsfunktionen, städtische Gewässer, städtischer Freiraum, flussnahe Freiraumplanung
Appendix
Appendix I: Questionnaire in English

Utility, Perception and Preferences of Urban Rivers and Open Space along Rivers

No.________________Time______________location_______________Recorder______________

I. River recreation use characteristics
1. How often do you come to this location in this season? (      )
   A every day   B 2-3 times/ week   C 1 time/ week   D 2-3 times/ month   E 2-3 times/ year   F others
2. How do you come (travel) here? (      )
   A walking    B bike     C E-bike     D bus      E car     F others
3. How much time do you need to arrive at this location from your place of residence? (      )
   A no more than 10 minutes    B 10-20 minutes    C 20-30 minutes    D others
4. How much time would you normally spend at this location? (      )
   A less than 15 minutes       B 15-30 minutes    C 30 minutes-1 hour  D 1-2 hours   E 2-3 hours   F others

II. Activities and Preferences of Open Space
5. Which (recreational) activities do you do at this location? (                      )
6. Why do you choose this location for your recreational activities? (                      )
   A. close to my home; B. a river is nearby; C. there is enough space for my activities here; D. my dancing teacher and friends are here; E. here it is cooler than at home; F. good scenery: G. there is no other open space available nearby; H. others __________
7. How often do you communicate with others when you come here?
   A every time   B very often   C sometime   D seldom
8. Do you think this open place has beautiful scenery?
   A very beautiful   B beautiful    C Neutral   D not beautiful   E ugly   F not importance for me
9. Is this open place able to benefit and uplift your emotions?
   A Yes, this feeling is very strong   B yes, but a not strong feeling   C no influence

III. Assessment of the open space along the river
10. Does the open space size at this location meet your requirements? If no, please explain your situation.
    A Yes   B No   and your explanation (                                                                )
11. Do you think the facilities at this location meet your requirements? If no, please explain your situation.
    A Yes   B No   and your explanation (                                                                )
12. Do you feel this is a safe open space for your recreational activities? If no, please explain your situation.
    A Yes   B No   and your explanation (                                                                )

III. Personal Information
13. How old are you?
   A Younger than 20 year old      B 20-30 years old        C 30-40 years old       D 40-50 years old
   E 50-60 years old               F 60-70 years old        G 70-80 years old       H older than 80 years old
14. Please mark your living place in the map.
Appendix II: Questionnaire in Chinese

城市河流及沿岸空间的使用、感知与偏好

调查问卷编号____________ 调查时间____________ 地点____________ 负责人姓名____________

一、河流沿岸开放空间的使用习惯
1. 您平均多长时间来这里一次？（ ）
   A 每天 B 一周 2-3 次 C 每周一次 D 每月 2-3 次 E 每年 2-3 次 F 其他________
2. 您是如何到达这里的？（ ）
   A 步行 B 自行车 C 电动车 D 公交车 E 私家车 F 其他________
3. 从居住的地方到这里需要多长时间？（ ）
   A 10 分钟以内 B 10-20 分钟左右 C 20-30 分钟 D 其他________
4. 您在这里一般停留多长时间？（ ）
   A 15 分钟以内 B 15-30 分钟 C 30 分钟-1 小时 D 1-2 小时 E 2-3 小时 F 其他________

二、河流沿岸开放空间使用偏好
5. 你来这河附近一般都从事什么户外活动？
________________________________________________________________________________________________________
6. 为什么会选择这里作为活动空间？可以多选
   A 离家近 B 有河流 C 有足够的场地 D 有老师、队友或朋友 E 凉快 F 风景优美 G 没有其他绿地选择 F 其他_____
7. 您在这块场地活动是否经常和他人聊天，沟通？
   A 每天都会 B 经常 C 偶尔 D 几乎不和别人交流
8. 您认为这块场地的景色是否是优美的？
   A 非常优美 B 优美 C 一般 D 不优美 E 非常不优美 F 优美不优美对我不重要
9. 这块场地是否能对您产生陶冶情操的感受？
   A 是的，这种感受非常强烈 B 偶尔会有类似的感受 C 没有特别的感受

三、河流沿岸空间的感知和评价
10. 场地的大小是否满足了您希望进行的活动的要求？如果没有满足的话，请说明您认为没有满足的情况。
    A 是 B 否 具体情况（ ）
11. 您认为这块场地的设施是否满足了您的要求？如果没有满足的话，请说明您认为没有满足的情况。
    A 是 B 否 具体情况（ ）
12. 您在这块场地活动感觉是否安全？如果您感觉不安全的话，请说明您认为不安全的情况。
    A 是 B 否 具体情况（ ）

四、基本信息
13. 您的年龄？
   A 不满 20 岁 B 20-30 岁 C 30-40 岁 D 40-50 岁 E 50-60 岁 F 60-70 岁 G 70-80 岁 H 80 岁以上
14. 请在地图上标出您的居住的空间位置。
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