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ZHANG KE
CHEN WEI

Morphological ATLAS of the Urbanization of a Chinese City

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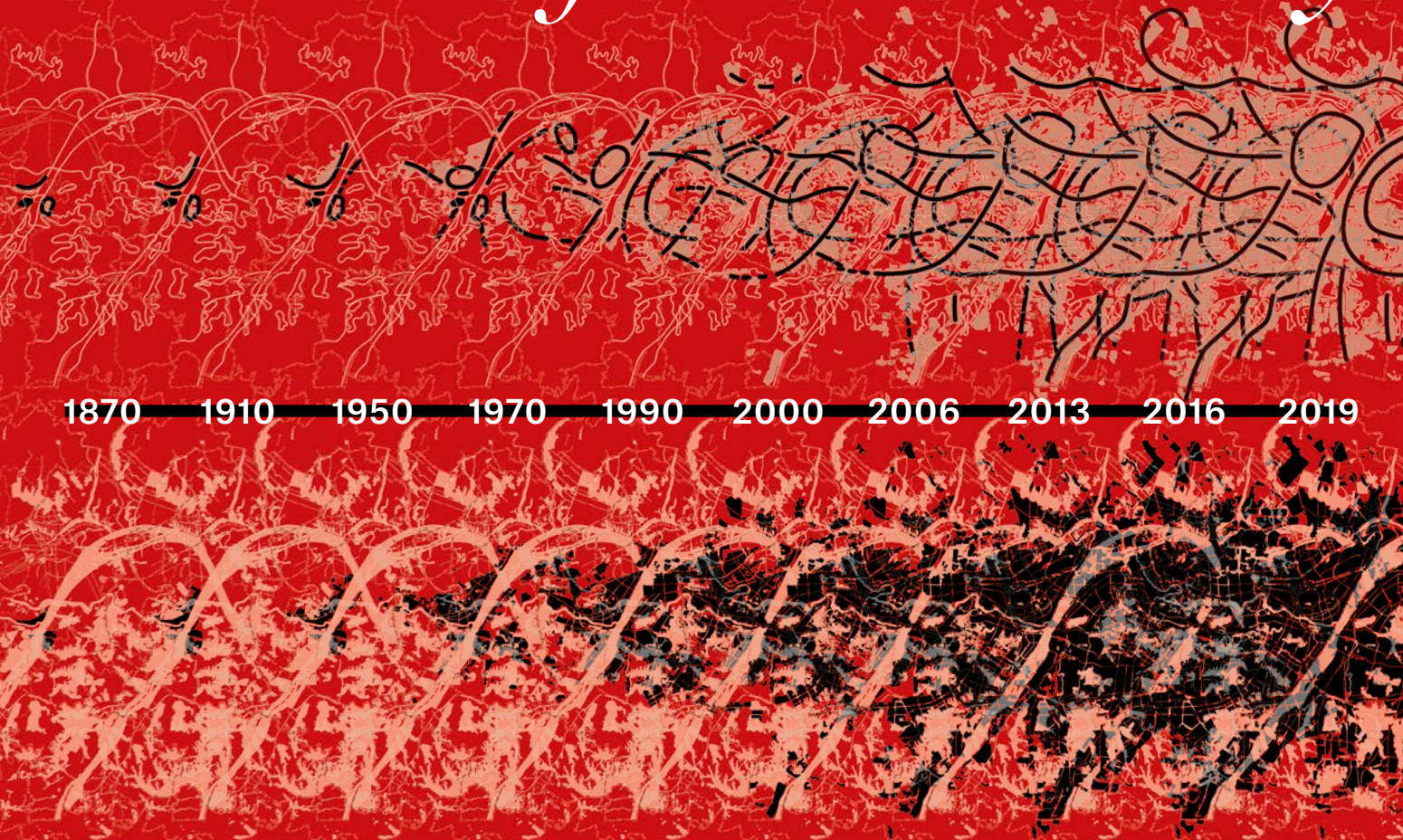

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1870 1910 1950 1970 1990 2000 2006 2013 2016 2019

COLOFON

MAPPING WUHAN
Morphological ATLAS of the Urbanization of a Chinese City

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Culture is not owned by anybody.
We are users, not owners.

—Tommy Wieringa

In life, we are carrying on our backs
as it were a huge 'cultural reservoir'.

—Haruki Murakami

[–] facts do not exist, only interpretations.

—Friedrich Nietzsche

Preface

Mapping Wuhan—Morphological ATLAS of the Urbanization of a Chinese City is unique in two ways. It is the first morphological analysis of the transformation of a large Chinese city over a century and a half. Furthermore, it is a cooperation between the Department of Urbanism in the Faculty of Architecture and the Built Environment, Delft University of Technology in the Netherlands, and the Wuhan Land Use and Urban Spatial Planning Research Center/WLSP in the People's Republic of China, which commissioned the first version of this research.

This commission came about in an interesting way. As is so often the case, it was as a result of the intersection of different contacts, both personal and professional. As a board member of the International Forum on Urbanism/IFoU, I engaged with a lot of Chinese colleagues and consequently became fascinated by Chinese cities; both their history and—what was left of—their tradition, and their amazingly fast urbanization in recent times. (1) To experience more of this, I undertook a sabbatical, lecturing Bachelor and Master students and teaching a Master Urban Design Studio in the School of Architecture of Tsinghua University in Beijing. (2) Later, back in Delft, CAI Jiaxiu contacted me, expressing her interest in pursuing a PhD, and I gladly became her supervisor. (3) Her doctoral thesis, *Design with forms as well as patterns* of 2018, researches methods of combining the two distinct approaches of morphological analysis and pattern language, intended to strengthen urban design. She obtained her Master of Architecture at the School of Architecture of the Huazong University of Science and Technology/HUST in Wuhan. (4) Together, we were invited to conduct a workshop for students at her alma mater in cooperation with its staff, under the direction of Professor WANG Yuan. (5) While there, through

the contact of WANG Yuan, we received a request to give a lecture from CHEN Wei, at the time Director of the Wuhan Land Use and Urban Spatial Planning Research Center/WLSP. (Now Director of the Wuhan Planning and Design Institute.) I suggested the title, *Permanence in Urban Design*, with a slightly polemical intention, as I would talk about the cultural values of historical and traditional elements in cities and their importance for local identity, and through that the identity of their citizens. (Harvey 1991; Bekkering 2008, 2013) The second motivation behind this lecture was the fact that any urban design is part of a larger whole. This is simply a matter of scale: there are always higher levels of scale that remain unchanged and thus are dominant when viewed from the perspective of the assignment. The setting for the lecture, as I had experienced before in China, was a conference room with exceptional technical facilities. A large table with approximately twenty chairs around it was set up for us and the staff, with a few more, mostly younger members of staff in a second row against the walls. Almost all participants around the central table did not understand or speak English, and since I do not speak Chinese, continuous translation was required. Most of the attendants appeared as though they were obliged to attend; they did not put forward any questions and hardly expressed any reaction. I felt disappointed, and made a decision never to give a lecture under such conditions again.

The next year, however, giving a follow-up workshop at HUST, I was surprised to receive another invitation from Director CHEN. This posed a dilemma, since the School of Architecture at HUST maintains a good relationship with the city, which is important for them. We were aware that in China, it is considered impolite to turn down such a request—or any request for that matter. As a way out of this situation, we offered to show up at the end of the workshop, to discuss the outcomes of the students' work and any questions we had about the transformation of the still largely preserved traditional area that we had studied, which was under a direct threat of destruction. I expected this offer to be declined, as it would require discussing potentially controversial aspects of the ongoing urban transformations in Wuhan, and sharing knowledge that might not be public, or even considered secret. Surprisingly, Director CHEN accepted our offer, and that afternoon we had a lively and open discussion, in which he and several members of staff shared their knowledge and concerns in a manner we expected to be forbidden. It appeared that I had unexpectedly, with my first lecture, gained *guanxi*: personal trust and appreciation. (6)

When Director CHEN Wei visited the Department of Urbanism in Delft several months later, he had two requests: to sign a twelve-year agreement that allowed professionals from his institution to spend a year in the Department, participating in courses and undertaking research, and he requested that I personally propose a combined research project that would serve as a pilot for future cooperation between his institution and Delft University of Technology. This resulted in the research commission for *Mapping Wuhan. A Morphological Analysis of the Spatial Structure and the Urban Transformation of Wuhan*. The research report was delivered in 2015. (Bekkering *et al.* 2015) The results have been incorporated in the doctoral thesis of CAI Jiaxiu of 2018 mentioned above: *Design with forms as well as patterns*. For the present ATLAS the period of research has been extended to 2019.

This is a brief indication of how difficult it can be to bridge differences in cultures. Critics might claim that undertaking research by applying a western method of analysis to an eastern case, is a risk. However, urban analysis is also a professional activity with a theoretical bacskground shared internationally.

A final remark is that cities are of course not only about form. They are predominantly about the people who live in them.* And they are about economics, politics, social, demographic, environmental aspects, and much more. This ATLAS is the outcome of a historical-morphological analysis. The reasoning behind this choice, is our conviction that people derive part of their identity from their environment, and this works best when the environment has an attached meaningful identity which is always—at least partially—based on its history.

—*Henco Bekkering*
December 2021

*
The extreme example of this was the outbreak of the COVID-19 virus in Wuhan early 2020. Concurrently with the writing of this text, the novelist FANG Fang wrote a diary in quarantine in her apartment. Her entry of February 18 2020 states: *Here in this quarantined city the people are anxious, amid the outbreak the people weep*. And on February 19: *The specter of death continues to haunt the city of Wuhan*. (FANG 2020 p 283)

Photocollage 1
Contemporary townscapes

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Summary

Chinese cities have been expanding since the early 1980s under trends of rapid modernization, urbanization and globalization. Since then they have changed dramatically, and have in the process lost many of their traditional environments and spatial characteristics. Urban planners and designers have been and are facing unprecedented challenges in China. They not only have to learn to understand the constantly emerging new urban mechanisms, and seek balance among stakeholders, but they also need to cope with the political pressures and the changing context under often extreme time pressure. In such circumstances, future- and design-oriented analysis based on a designerly *way of thinking is useful—if not indispensable—for understanding the existing city and deciding on its transformations in a responsible and accountable way that is communicable among designers and with the public. This is especially so, in light of the growing awareness, also in China, of the value and importance of local urban identity, that is always—at least partially—based on history. This is what the Delft method of morphological analysis is intended for.*

The research applies the method of the Delft School for the first time to a large city in China: Wuhan. It presents a timeline of ten periods starting in 1870, the earliest year for which reliable maps were found. The timeline condenses towards the present, as the city develops ever faster. The series of maps are all related to a base map of the land use data of 2013 in GIS format, a fully comprehensive data set covering all of the metropolitan area. The maps are made to resemble figure-ground drawings that are traditionally used in morphological analyses. Figure-ground drawings are based on building footprint, showing buildings in black and open space in white. In this research, however, the basic data unit is urban land use. This, too, shows spatial distribution, and as such displays the form of the city.

The analyses are done on three levels of scale: the Metropolitan Area (macro scale), the Inner City (meso scale), and the urban district of Hankou Riverside (micro scale). Central to the Delft technique is the making of reduction drawings that reduce the available map data to so-called *homogeneous areas: areas defined and traced on the map that show a certain internal consistency, and are either different from neighboring areas, or clearly separated from those*.

The results of the research are presented in the middle section of this ATLAS, consisting of five analytical maps series, and in the CONCLUSIONS drawn from the analysis. The transformations of the Inner City and the Metropolitan Area are presented in historical order, from 1870 to 2019, but are sequentially drawn working backwards in time by georeferencing historical maps to the map with the homogeneous areas of the next more recent period. This allows for the deduction of areas not yet built up in the earlier period. The series of the Inner City—made first as there were no urban extensions outside the municipal borders till the early twenty-first century—includes the reconstruction of the 1870 map of the three constitutive towns of Wuhan: Hanyang, Wuchang, and Hankou. The analysis of Hankou Riverside goes down in scale, as an example of the necessary detail needed for the analysis supporting any urban design in practice. The boundaries of Hankou Riverside are chosen to include one of the three original Chinese towns out of which Wuhan developed, the former Foreign Concessions, and one of the most important central business districts of the contemporary city, each with its own spatial characteristics.

The first of the CONCLUSIONS again represents a series of maps following the timeline, on the scale of the metropolis. It characterizes the development of the overall urban spatial structure in sketches on an even higher level of abstraction.

By comparing the maps to one another, they show not only the growth of the city in time, but also the existence and importance—and at the same time the emergence or disappearance—of spatial structuring elements in the urban form. They also show how on the macro scale the city consists of only three types of homogeneous areas, and on the micro scale, looking in more detail at Hankou Riverside, of eight types. The CONCLUSIONS include a short description of the way in which the insights from the analyses can be applied to the decision making in the design processes leading to urban regeneration, transformation, and extension in practice.

Reading guide

The book has four sections.

The first section, INTRODUCTION, consists of two chapters. *Chapter 1* is an introduction of the research project, *Chapter 2* of Wuhan and its landscape and history, including an overview of its planning history and successive periods of development.

The second section, MORPHOLOGICAL RESEARCH, with *Chapters 3* and *4*, describes the different international schools of morphological analysis, and the aim, the method and the technique of mapping according to the Delft School as applied in the research.

The third section, ATLAS, *Chapters 5* through *7*, presents the results of the morphological analysis in series of maps on three levels of scale, both in historical order and working backwards in time. *Chapter 5* is on the meso level of scale of the Inner City, the area of growth of the city until the end of the twentieth century. The chapter includes the reconstructed map of the original three towns out of which Wuhan grew. *Chapter 6* is on the macro scale of the Metropolitan Area, where urban growth only began in the twenty-first century. *Chapter 7* analyses the lower level of scale of an urban district, Hankou Riverside.

The fourth section presents the CONCLUSIONS on the successive levels of scale, *Chapters 8* through *12*. *Chapter 8* shows the urban structure of the city, now metropolis as a whole through history emanating from the research. *Chapter 9* shows the structural elements on the macro scale of all of the Metropolitan Area with the limited number of three types of homogeneous areas on this level of scale and abstraction. *Chapter 10* deals with the meso scale of the Inner City and describes the need to discern an additional spatial element of analysis: secondary connections. *Chapter 11* is on the micro scale of Hankou Riverside, where the number of types of homogeneous areas goes up to eight. *Chapter 12* comments on the relevance and application of the research in practice, and gives recommendations for further research.

The book continues with three APPENDICES. The first is an annotated list of descriptions and definitions. The second gives an overview of the characteristics of the different schools of morphological research in the world. The third lists the selection of historical maps used in the research.

The book closes off with the BIBLIOGRAPHY and the *Curricula Vitæ* of the authors.

Introduction

Photocollage 2
Infrastructure





Preamble

All that is coming, pulls with it what exists.
—Friedrich Nietzsche

The research presented in this ATLAS is rooted in thinking about permanence in urban design. In Wuhan, as in most Chinese cities, the speed of development in the past decades has not allowed for much attention to the existing environment, both urban and rural. Strong and important elements from the past, often essential for local culture, have disappeared and continue to disappear at an alarming rate. In recent years the awareness of the values of local identity and historical continuity is growing. Reading, identifying, and understanding the historical layers in the urban form are essential for urban designers and planners to distill meaning from them. (Bekkering 2013; Cai 2018)

This is not to say that change is not acceptable. New urban designs should support programmatic aspects of a contemporary nature and modern conditions for living, including environmental effects, while at the same time incorporating basic human needs and accommodating daily life in the city—in the great diversity that is required by a living and changing society.

To retain their *longue duré*, cities need sound technical substance and networks to be able to function according to the needs of their citizens. It is equally important for their physical structure to contain meaning, to enable people to connect—mentally—to their environment and thus help sustain permanence, both in a social and in a physical sense. People can only become aware of their identity in a context where they can contrast it to another: their own identity and the identity of a place. They derive part of their own identity from the place where they belong, resulting in a 'sense of belonging', in itself an important factor for social coherence.

In addition, we believe it is important to understand that any urban design is always part of a context, a larger whole. With any urban project much more remains the same than that which changes. This is simply a matter of scale: the scale of the context. Urban designers have a responsibility to be aware of this. They are by no means the only ones responsible; planning is another obvious discipline. We want to state here that in fact all stakeholders share this responsibility, and thus should be taken into account in any process of urban design and planning.

At any moment in time and place, realizable programs for urban development are very much alike, a process strengthened by globalization. This means that the necessary differences that give a place its individual character can only be derived from the specific local characteristics and forces of the context; local qualities that, by definition, originate from the history of the place. By referring to the context the designer distills meaning from the existing situation. The result in any city is layered. As Aldo Rossi remarked: *Every city has a before and an after*. (Rossi 1982 p 126) We would add that both should be visible.

In history, continuity is largely the result of tradition. Contrary to what many might think, tradition in itself is not static. It is a general cultural mechanism in society that facilitates change, in a gradual, prudent way, little by little. Tradition is a way of doing things. It offers support for accommodating changes in the existing environment without causing ruptures and fractures. Legibility of the historical layers results in historical continuity. In the words of the urbanist/historian Wang Ping:

> *The historicity of human life has determined that of tradition as well as the need for its transformation and renewal. Tradition is not an abstract stance beyond change and development; its vitality lies in its development.* (Wang 1997 p 59)

Richard Sennett wrote:

> *'Growth' in an urban environment is a more complicated phenomenon than simple replacement of what existed before; growth requires a dialogue between past and present, it is a matter of evolution rather than erasure.* (Sennett 2017 p 98)

And David Harvey:

> *The preservation or construction of a sense of place is [...] an active moment in the passage from memory to hope, from past to future. And the reconstruction of places can reveal hidden memories that hold out the prospect for different futures.* (Harvey 1993 ch 1)

The above statements indicate why we think it is valuable, and possibly essential, to know and analyze the morphology of the city throughout its history.

The research presented in this book is a specific type of urban studies: historical morphological research. It is limited to the two dimensions of the map, representing urban form as the use of the ground the city is built on. This is intended to give insight in the formal structure of the city, on different levels of scale.

The research does not include the third dimension that is obviously also important for the image of the city. The next page shows three panoramas of the The Hanzheng Street Area that is located in Wuhan where the Han River flows into the Yangtze River. The area is the central part of what is called Hankou Riverside in this research: the lowest level of scale analyzed. (See *Chapter 7*.) It has a history dating back more than five hundred years. It used to be a prosperous domestic and international trade center. Hanzheng Street was one of the earliest and far into the twentieth century the most prosperous street in Wuhan, a traditional Chinese street with many shops along both sides. (See *Figure P1.1*, next page) The neighborhood around had a unique urban tissue, the so called fish bone structure with long streets following the course of the rivers at some distance, and a dense network of alleys more or less perpendicular to the rivers.

Figure P1.1
"Customs and Habits in Hanzheng Street in the Republic of China Era", beginning of the 20th century
(BI, HUANG and HE 2004)

Figure P1.2
Hanzheng Street in 2013
(Hanzheng Street Central Service District of Wuhan Investment Manual 2013)

Figure P1.3
Hanzheng Street Central Service District Core Area, plan
(Skidmore, Owings & Merrill LLP/SOM, 2013)

Figure P1
Birds eye views of the transformation of the Hanzheng Street area

Due to the decline of shipping, and the changes in business models in recent decades, the Hanzheng Street area lost its attractiveness and has become an area with enormous problems. In an attempt to save its role in textile trading, new large scale building complexes replaced the traditional tissue more and more. Monuments and historical buildings are poorly protected, resulting in a broken chain of historical continuity. The area lost its coherence, resulting in many conflicts between the traditional local way of life and small scale urban structure, and the large scale 'modern' building complexes. (*See Figure P1.2*.) Recent years also brought in many large-scale roads to accommodate heavy traffic, further deteriorating the environment for daily life. In response to this, the Wuhan municipal government has expressed a strong ambition to solve these problems by radically transforming the whole area into a new Central Business District and relocating its businesses and residents outside the city. The American firm of Skidmore Owings and Merrill/SOM won the competition for the master plan. This highly top-down imposed development model with a generic character introducing a multitude of free standing towers will lead to a total change of local identity and loss of public life in the streets. (See *Figure P1.3*.)

Though the third dimension is an important aspect of the morphological transformation of the city, our research is limited to the two dimensions of mapping, and because of its level of abstraction is more or less independent of the type of changes described above, except where they change the urban structure on a higher level of scale. This, of course, is not to say that such changes are irrelevant. Monuments and historical buildings, if they are still standing, should be protected and restored, because they allow for identification with the continuity of the city and the life of its citizens.

Chapter 1
Introduction of the Research

On July 21 2013, President Xi Jinping of the People's Republic of China on his southern inspection tour proposed a 'Wuhan Metropolitan Revival'. The year before, in the 10th Hubei Provincial Congress of the Communist Party on June 9 2012, Li Hongzhong, head of the Hubei Provincial Committee of the Communist Party, had also requested the revival of Wuhan. Both political leaders stressed the opportunities for Wuhan in the national development strategy as the center of the Yangtze River Economic Belt.

Research background

These political directives, and their far-reaching effects on the urbanization of the city, are the background for an investigation of the planning and development of metropolitan Wuhan through time. How has Wuhan transformed? What structural elements have formed contemporary Wuhan? How can these insights instruct today's urban planning, design, and construction? This research puts forward some of the answers to these questions. It is a historical-morphological analysis, concerned with the urban form and its development through time. It is the first time that such a multi-scalar analysis of a large Chinese city has been done over a long period of time.

Wuhan is an ancient city, not in its present form, but its origins date back to before 3500 B.C. (See *Chapter 2*.) As a city located in central China, modern Wuhan was affected by the changes in national policies on urbanization, industrialization, and housing. Gu Chaolin, who edited two recent special issues of the journal *Urban Design and Planning* writes:

> *In the socialist city of the 1980s, each work unit organized and built factories and housing, within planning policies such as 'the factory in front of the residential areas' and 'the balance between jobs and housing'. Regardless of each work unit's size and resources, the accommodation provided to each family was broadly the same.*
> (Gu 2015 p 237)

If one adds to this the national rules for building and orientation based on *feng shui*, it explains why so many parts of Chinese cities look alike, as do the cities themselves across the country. Since the Reform and Opening Up policy of 1978, cities became slowly but increasingly aware of the need for taking a position in the globalizing economy. A shared characteristic of all urban planning in China is that it prioritizes economic development (Zhang and Zhou 2015 p 266), often with negative environmental effects. Recently in China, like elsewhere in the world, the quality of the environment and sustainability in general are gaining attention fast, and in addition the awareness of the value of a local identity based on historical buildings and areas continues to grow. Sadly, however, in the past decades a lot of historical urban tissue has disappeared in the processes of revolution, rapid urban growth to accommodate the influx of immigrants from rural areas into the cities, and globalization.

The premise of the research is that; to be able to make new responsible choices regarding urban transformation and expansion, it is necessary to understand the history of a place, and to identify the structural elements that have historic value and can be of value for the future of the city. The ideology behind the Modern Movement in architecture and urbanism that is dominant all over the world, including contemporary China, stresses change and innovation. There is, however, a growing awareness of the value and meaning of continuity, both in a physical sense—regarding buildings and urban patterns—and in a cultural sense—regarding people's identification with the environment of their daily lives. In theories of urban design this is often called 'historical continuity', though this is in fact a tautology, as any continuity relates to its history. This strongly relies on tradition. Tradition is not static. It is on the contrary a general cultural mechanism in societies that facilitates change, be it in a gradual, prudent way. Tradition is a way of doing things. It offers support to accommodate changes in the existing environment without causing ruptures and fractures. Thus, it results in historical continuity.

As for people's identity: people can only become aware of their identity if they can contrast it to another: their own identity and the identity of a place. The collective identity of a place allows for an individual identity within it.

This is not limited to urban design and architecture, and it is not new. An early example of this awareness is the nineteenth century metaphor by the musical composer Gustav Mahler: *Tradition is not the worshiping of ashes, but the passing on of the fire*. The philosopher Friedrich Nietzsche wrote: *All that is coming, pulls with it what exists*.

Aim

The aim of the research is to understand the morphology of the city in relation to its history by uncovering which historical elements have shaped it and are still present or recognizable. Behind this is the growing awareness in Wuhan, and in China in general, of the values—social an economic—of local identity and historical continuity for the city, where history is rapidly disappearing. Urban designers and researchers refer to the term 'historical continuity':

> *Reading, identifying and understanding historical layers [–] are the tangible steps for urban designers to distil meaning from these. The legibility of the historical layers is a prerequisite for historical continuity.* (Bekkering 2013; Cai 2018 p 41)

In other words, the aim of the research is to understand the development process of Wuhan's city form on different levels of scale. On the macro and meso levels the changes in urban form are presented on the appropriate high levels of scale, using reduction drawings resulting in homogeneous areas, revealing the spatial structuring elements and systems in the urban form of Wuhan. On the micro level, the focus is on the development of the block form, the patterns of streets and buildings.

The research is a historical-morphological analysis. It is about urban form as it changes through time. The main results, presented in the ATLAS, are five series of two-dimensional analytical maps showing the urban form at different moments in history using a consistent timeline, and disclosing the transformation of the urban morphology. Short explanations accompany the maps to give background to the kind of changes that the maps visualize.

This means that no extensive research is done in fields like general history, politics, economy, natural science, ecology, demography, sociology, etcetera.

Scope

The largest research scope is the whole of the Wuhan Metropolitan Area; the smallest is the urban district of Hankou Riverside, which includes—the remains of—one of the old constitutive towns of the city, the former Foreign Concessions, and an important central business district. The meso scale is the Inner City within the administrative boundaries of the municipality.

The original research was a pilot project for cooperative research between the Department of Urbanism of the Faculty of Architecture and the Built Environment, Delft University of Technology, and the Wuhan Land Use and Spatial Planning Research Centre/WLSP. It was presented in the unpublished report *Mapping Wuhan. A Morphological Analysis of the Spatial Structure and the Urban Transformation of Wuhan*, by Henco Bekkering, CAI Jiaxiu, Joran Kuijper, ZHANG Ke and others in both English and Chinese. The research was done in cooperation with WLSP staff: CHEN Wei, HUANG Huan, CHEN Wei, XU Zhenmin, HE Lei, JIN Mengyi, and DU Xingyu.

WLSP collected the necessary data, including historical maps, contemporary maps and other relevant base material.

The Department of Urbanism in Delft provided the research methodology and technique, and the overall research framework. The authors analyzed the data, and produced the analytical maps and the report. That material has been expanded into this ATLAS to include more recent developments.

Considerable parts of the research are incorporated in the dissertation of CAI Jiaxiu, *Design with forms as well as patterns*, with Henco Bekkering as promotor. (CAI 2018)

Context

Mapping Wuhan was one of the supporting researches for the *2016 Wuhan Master Plan*. For the research of the transformation of Wuhan's urban form on three levels of scale with a strong perspective towards the future, the Dutch approach of morphological analysis is applied. (See *Chapter 3*.) This approach is design oriented. The results indicate the main spatial structuring elements of the city on different levels of scale in the context of the city as a whole. The studies on the metropolitan and inner city scales provide a background for decision-making in the design of the city: the city's transformation and expansion in the future. The study on the scale of Hankou Riverside provides detailed references for regeneration and historical conservation in that area and serves as an example of the lower scale research needed for application of the method of analysis in the practice of urban planning and design.

Chapter 2
Introduction of Wuhan

Wuhan's corridors and streets are like rays emanating out and shining down into every corner of this nation.
—Fang Fang

Wuhan was earlier referred to as Han. The name Wuhan was established with the integration of three pre-existing towns: Hanyang, Wuchang, and Hankou. The city is located in China's Yangtze River Basin at the confluence of the Yangtze River, the world's third longest river, and the Han River, its biggest tributary. The rivers divide the city into three parts, corresponding to the locations of the three original towns.

Basic facts

The first known settlement in the area of what is now Wuhan has been dated back to the Panlong Town period, nearly 5,500 years ago. The region gave birth to the Yangtze River and Jingchu Civilization.

Contemporary Wuhan is the capital of Hubei Province. The city plays an important role in the national economy: in industry, technology, science and education, and as an integrated transportation hub in Central China. Based on this, in national policy Wuhan is now designated as the most important of the cities in the middle region of the Yangtze River. (China's State Council 2015, 2010) The aim in national planning policy is not only to develop the middle region itself, but also implementing the new paradigm for a source-efficient and environmentally friendly city. As such, Wuhan has an important responsibility to explore a suitable mode of urbanization 'with Chinese characteristics'.

The present city consists of seven Inner Districts, six New Districts, and three National Economic and Technological Development Zones. By the end of 2014, the administrative domain of the city covered 8,494 km² (3,280 sq mi), the metropolitan area 3,261 km² (1,260 sq mi), and the (inner) city 678 km² (262 sq mi). (www.whtj.gov.cn) East to west and north to south the metropolitan area measures about 68 km (42 mi). The inner city measures 34 km (21 mi) east to west and 30 km (19 mi) north to south. The officially registered population of the metropolitan area is now 11,2 million; including the floating population, the estimate is 14 million. The urbanization rate of Wuhan is 79.36% by 2014. (*Ibid.*; Wuhan Statistical Information Network 2015)

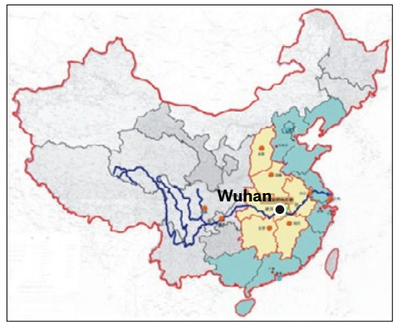


Figure 2.1
Yangtze River in China (Yangtze River Economic Zone Integrated Transport Corridor Planning 2014)

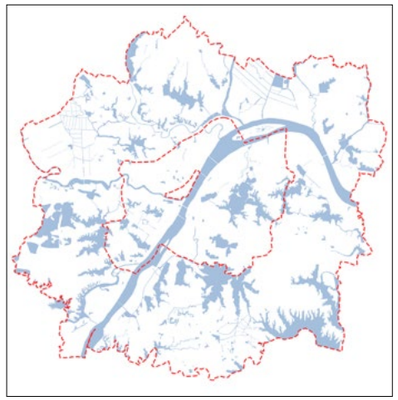


Figure 2.2
Main rivers and lakes in Wuhan (Bekkering, CAI, Kuijper; Wuhan Planning and Design Institute 2015)

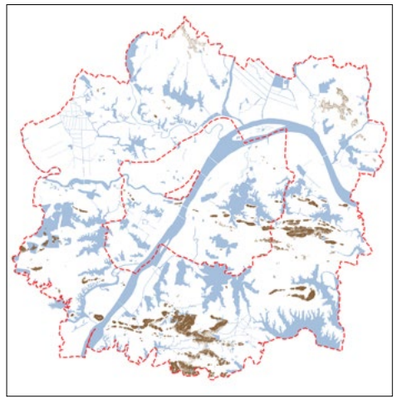


Figure 2.3
Mountains in Wuhan (Bekkering, CAI, Kuijper; Wuhan Planning and Design Institute 2015)

Landscape

The landscape of Wuhan is characterized by an abundance of open water. The urban area is generally flat or lightly undulating, with hilly ridges running east-west in the middle and southern parts of the city.

Rivers

The Yangtze River is the longest river in Asia, the third longest in the world, and it is the world's longest river entirely within the territory of one nation, running through the south of China. Its total length is 6,300 km (3,915 mi). The water of the Yangtze River serves one-fifth of the country and reaches one-third of the population. The average width of the Yangtze River in Wuhan is 1,300 m (4,265 ft).

The Han River is the largest tributary of the Yangtze River, which runs into it in Wuhan south of Hankou. It is 300 m (984 ft) wide with low water, and 400 to 700 m (1,312 to 2,297 ft) with high water.

Lakes

The region around Wuhan is known as 'the Province of a Thousand Lakes'. All of the lakes have a regulating function in the water management of the region. Simultaneously, they are important for purposes such as ecological conservation, fresh water storage, and aquaculture. They also provide beautiful scenery and many opportunities for water recreation. Their shores offer a variety of lakeside recreation. Many lakes form the cores of landscape parks. There are 166 lakes in the city, small and large, of which 40 are in the inner city. Open water covers about 10 percent of the city's surface. (Wuhan Planning & Design Institute 2015)

Mountains

There are 158 natural low mountains or hills in the city. (Wuhan Geomatics Institute 2015) These create in specific places a considerably undulating surface for the city. They are mostly part of two ridges that run in an east-west direction across the middle of the inner city and the southern part of the metropolitan area. Their heights in the inner city do not exceed 150 meter (492 ft), with slopes generally less than 30 degrees. As a result of geological forces the mountains have different forms. In the metropolitan area the mountain heights are between 50 and 200 m (164 and 656 ft), generally somewhat higher than in the inner city. The highest is Dingguan Mountain, with an absolute elevation of 200.1 m (656 ft), relative height 154.2 m (505 ft).

Most mountains are not built on. They form parks or natural reserves in the city.

Feng shui

Feng shui is the eastern knowledge or philosophy of choosing the best living environment as it was developed in ancient times. It originated from primitive nature worship. 'Good' environments are those that take advantage of their geographical site to avoid disaster and bring happiness, health, wealth, and power. In time, with experience, *feng shui* became a theory used for the choice of location for tombs and settlements, partly directed to a natural defense: on the south side of a mountain with water in the front. The main *feng shui* rules of location are:

- to rely on a mountain for solid defense,
- to be near the water, as a source of drinking water and a convenient means of transport,
- to build on a terrain suitable for flood control.

The patterns of many ancient Chinese cities originate from these rules. (See *Figure 2.5*.)

Another aspect in *feng shui* is the layout of the city itself. The palace of the—absolute—ruler and the government offices occupy the central positions. The philosophical principles of 'heaven and man unite' and 'round sky and square earth' led to a preference for grid patterns. The rules of layout emphasize axial symmetry reflecting the feudal hierarchies of China's ancient society.

Before the Han River diversion between 1465 and 1487, the location and layout of Hanyang fully met the traditional *feng shui* theory. (See *Figure 2.6*.)

Wuchang deviates from the *feng shui* theory as the city is laid out both to the north and to the south of a mountain range. (See *Figure 2.7*.)

For Hankou the situation is different, as its layout in the late fifteenth century was guided by the rivers to accommodate transport and trade.

Figure 2.4
The *feng shui* pattern
(LIU P 2000 p 49)

Figure 2.5
The example of *feng shui* and Guangzhou in the Qing Dynasty
(DONG J 2010)

Figure 2.6
Feng shui and Hanyang
(Compilation Committee 1998 p 3)

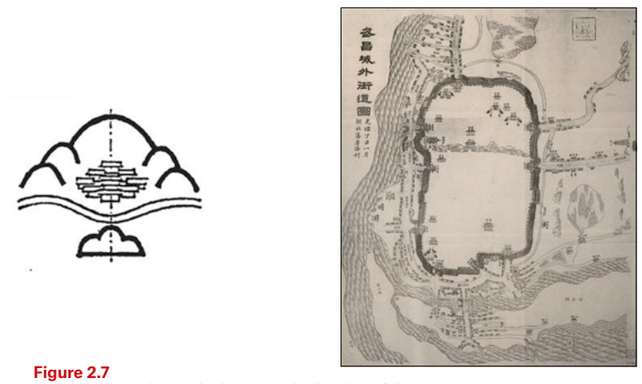


Figure 2.7
Feng shui and Wuchang; the layout on both sides of the mountain range running through the city is not according to *feng shui*
(Compilation Committee 1998 p 23)

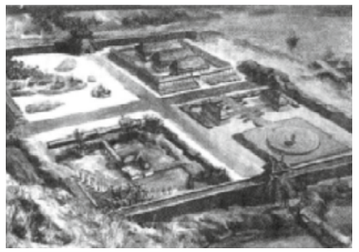


Figure 2.8
Panlong in the Shang Dynasty: (top) Location; (bottom) Reconstruction. The Yangtze River with the large island in it is still recognizable in Wuhan today. ((top) YU 2010; (bottom) www.bbs.cnhan.com)

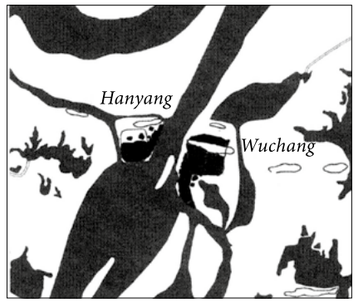


Figure 2.9
(top) Locations of the towns of Lushan and Xiakou at the end of the 3rd century B.C.; (bottom) Locations of Hanyang and Wuchang in the Tang Dynasty, 621 (YU 2011)

A short history

The beginnings of the modern city of Wuhan can only partly be traced back in the city of today, though the locations of the early settlements are identified from archaeological findings. The earliest human settlements appeared in and around the area of contemporary Wuhan more than 5,500 years ago, as evidenced by excavated sites on the north bank of East Lake. The town of Panlong was the capital of the Shang Dynasty before 3500 B.C. It is known as *the root of Wuhan Town, the beginning of the City of the Yangtze River Basin*. (PI 2006 p 26) It was located on the far side of the lake beyond Hankou that was later filled in. (See *Figure 2.8*.)

In the Eastern Han Dynasty, 173–198 A.D., Queyue City became the first military castle in the area, built on the north slope of the Gui Mountain in what became later Hanyang. It was abandoned and broken down in the Three Kingdoms Period, 220–280 A.D., and a new town, Lushan, was built on Gui Mountain. In 221 A.D., the town of Xiakou was built in the location of the present Wuchang. Therefore, one may claim that Wuhan began with these three towns: Queyue, Lushan, and Xiakou nearly 1,800 years ago. Queyue disappeared, Lushan became Hanyang, and Xiakou became Wuchang.

In the early Tang Dynasty, in the year 621, the town of Hanyang was built on the south side of Gui Mountain, followed by a massive expansion of Wuchang on the other side of the Yangtze River. (See *Figure 2.9*.)

In the Ming Dynasty, during the reign of Emperor CHENGHUA, between 1465 and 1487, Hanyang was divided into two parts by the diversion of the Han River. (XU and WANG 1684: *Huguang Annals*; see *Figure 2.10*.)

During the Kangxi Dynasty (1654–1722), the northern part of Hanyang was named Hankou. With the isolation of Hankou, the new pattern emerged again comprising of three towns making up the later Wuhan. (See *Figure 2.11* and *Chapter 5*.)

The gradual emergence of trade by shipping on the Yangtze and Han Rivers, and the building of new houses for the large number of people flowing to the city, resulted in the transformation of the original Hankou settlement to include commerce and manufacturing, and other functions. During the Ming Dynasty it became an important logistics area for the trade in grain and salt from Huai. (FAN 1823 p 18) With changes in the administrative management resulting in the opening up of Hankou in the ZHANGZHI Dong period, mid-nineteenth century, Hankou grew to become one of China's four most important cities in the early Qing Dynasty: Jingde in Jiangxi, Zhuxian in Henan, Hankou in Hubei, and Foshan in Guangdong. (TANG 2010)

Before the establishment of the People's Republic of China, extroverted development policies promoted the rapid growth of the three towns eventually integrated in Wuhan. Each of the social, economic, political and planning factors leading to the present urban morphology of Wuhan is complex and has had spatial effects. The changes in China's national planning policy from the mid-twentieth century onward played a significant if not determining role.

The emergence of planning

Urban planning in Wuhan was initiated in the late Qing Dynasty (second half of the nineteenth century). With the establishment of the Foreign Concessions from 1861 on—in order of appearance, and from south to north: British, Russian, French, German, and Japanese—western planning theory and practice were imported. In January 1927, the National Government moved to Wuhan. The three towns: Hankou, Wuchang, and Hanyang were joined together to become Wuhan. In 1929, DONG Xiujia, director of the Wuhan Construction Works Bureau, edited the *Wuhan Special City Planning Guideline*, in which western zoning theory was applied. At this early date Wuhan was for the first time subdivided in industrial, commercial, administrative, and residential areas. In 1936 the Hankou City Construction Works Bureau published the document *Hankow Metropolitan Planning*. It was the first plan in any Chinese city that addressed 'Traffic Congestion Avoidance'. It proposed to construct Zhongzheng Road (nowadays Liberation Road) 60 m (65 yd) wide parallel to the Yangtze and Han Rivers, which was approved by the National Government and subsequently realized.

As Hankou was an open commercial port, it attracted new urban functions asking for urban expansion, and the city became known as the Chicago of the East. Wuhan had developed dramatically, becoming the second metropolis in China after Shanghai since the National Government moved to Wuhan in 1927, to stay there only till the outbreak of the Anti-Japanese War in 1935. These years are called Wuhan's Golden Development Era. Commercial activities in Hankou exceeded even those in Shanghai. (WANG 2017)

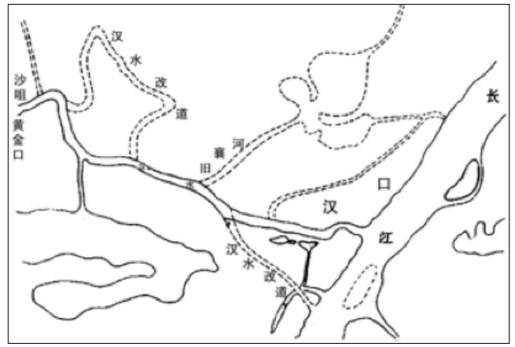


Figure 2.10
The diversion of the Han River between 1465 and 1487; dotted courses have disappeared (Qiaokou National Industrial Museum)

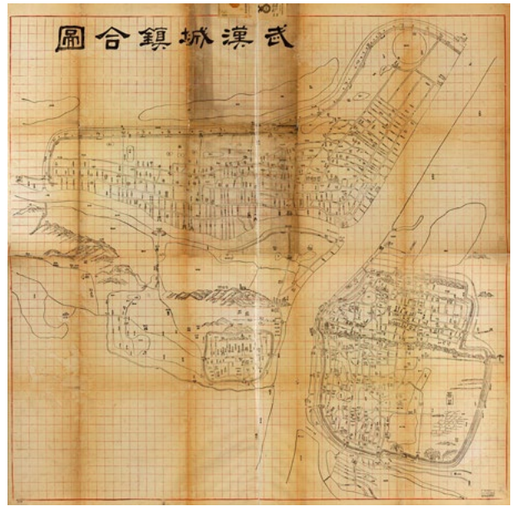


Figure 2.11
Map of the three original towns: Hanyang, Wuchang, and Hankou, 1890 (Qiaokou National Industrial Museum)

Reconstruction Period: 1945–1948

After the Hubei West War the provincial government finished the *Wuhan Metropolitan Planning Draft* in June 1943. (Hubei Provincial Government 1943) Its policy and planning are based on envisioning Wuhan as an international metropolis. The National Government of the Republic of China on September 18, 1945 accepted the surrender of the Japanese army in Zhongshan Park, Hankou. City restoration and construction were listed as fundamental tasks for Wuhan as a national political, economic and cultural node. (Wuhan Urban Planning Administration 1999)

In November 1943, the provincial government published the *Wuhan Regional Planning Committee Organization Regulations* (Hubei Provincial Government 1945) and announced the establishment of the Wuhan Regional Planning Committee, China's first regional planning institution. The publication of the *Regulations* and the establishment of the Committee mark the beginning of the *Mega Wuhan Plan*. The initial intention of this plan was to solve the flooding problem in the city. The areas around the lakes in the eight counties surrounding Wuhan were designated as the main parts of the flood control system. For an effective flood prevention, this plan was extended to the land and water connections between the municipalities in the region. The surrounding villages and towns would develop as small cities, 'satellite cities', or 'garden villages', to support the construction of *Mega Wuhan*, also intended to avoid the complex and boundless character of most big cities. The *Mega Wuhan Plan* proposed to build in total 120 big, medium and small sites to make up the Wuhan Metropolitan Area. These are part of the plan for the *Wuhan City Land Use and Traffic System* of 1947. (Wuhan Urban Planning Administration 1999)

The main towns of Wuchang, Hankou, and Hanyang with the surrounding cities constitute a 'mother-and-child' relationship. While maintaining a considerable correlation between them, without losing their independence and individual character, this development is called 'multi-point development', which can be seen as the main guiding principle for the development of contemporary greater metropolitan Wuhan.

At the end of 1947, the Wuhan Regional Planning Committee was dismissed, which meant the end of the *Mega Wuhan Plan*. Nevertheless, the *Plan* influenced urban development for decades to come.

Four periods of development after 1948

After the establishment of the People's Republic of China in 1948, four main periods of urban development can be distinguished:

- Key Construction 1949–1965,
- Slow Development 1966–1977,
- Reform and Opening Up 1978–1990,
- Rapid Development 1991–now.

Key Construction 1949–1965

In the first Key Construction period, as the result of the major industrial tasks assigned to Wuhan by the national government, and the infrastructure arrangements both of the First and the Second Five-Year Plan, the first *Wuhan Master Plan* of 1954 established the basic patterns of the modern city. For instance, the Wuhan Yangtze River Combined Highway and Railway Bridge was planned and built in 1957, for the first time linking two of the three towns to each other, forming an urban cluster across the wide dividing river. (Liu 2017)

Slow Development 1966–1977

In the second period of Slow Development, from 1966 till 1977, urban development slowed down. Planning policy stagnated.

Reform and Opening Up 1978–1990

The third period of Reform and Opening Up, from 1978 till 1990, focused attention on economic development intended to create a market economy, leading to changes in types of industries and a new urbanization model. Industry changed from traditional to technological, and gradually formed many new clusters. (Li 1989) On the other hand, since 1978 the national urbanization paradigm shifted focus from concentrated urban development to the development of cities in coordination with their surrounding rural areas. The Wuhan administrative area was expanded to 8,494 km² (3,280 sq mi); incorporating four surrounding counties. (Dong J 2009) Meanwhile, master planning focused on the configuration of residential land use and services and facilities supporting daily life.

Rapid Development 1991–now

During the fourth period of Rapid Development, 1991 till now, Wuhan generated its second spur of rapid expansion, following Deng Xiaoping's famous Southern Tour Speech commanding (among many other things) the implementation of the urban growth intended in the national development policy for Shanghai-Pudong and Wuhan. Reform was focused on the construction of a socialist market economy for China, and a shift of emphasis from the southern coastal cities to the central and eastern cities. Together with the new possibility to lease land for commercial development since the 1990 Land Leasing system was installed nationally, this became the catalyst for the strong development of the local economy of Wuhan, as in all of China. The rapidly growing economic and technological development was led by industry in four sectors: steel plate manufacturing, automobile production, high-tech industries, and aerospace.

Chapter 2
Introduction of Wuhan

Nowadays, in the context of China having gained access to the World Trade Organization and the 'New Normal' policy in the beginning of the twenty-first century, Wuhan has become inevitably involved in the globalization process. According to national planning, the urban economy is transforming from monofunctional to multifunctional, while retaining its basic industries based on steel manufacturing. The aim of the *Wuhan 2049 Strategic Vision* of 2013 is to transform Wuhan into a more competitive and more sustainable world city, a dynamic city that has more space, a more green and low-carbon environment, civil communities with higher livability, a more inclusive and richer cultural environment, a more efficient urban transportation system, and an international position in innovation, trade, finance, and modern manufacturing. (China Academy of Urban Planning and Design 2013)

INTRODUCTION

Morphological Research

Photocollage 3
Traditional streetscapes






Chapter 3
Morphological Mapping and the Delft School

In architectural and urban discourses, the function of mapping is to visualize the complexity of the built environment, from the largest scale down to the smallest details. This, inevitably, asks for reduction of information: a map is not the real world. Mapping is intended to convey a better understanding of the world—or the context of a design—and thus to produce better-informed designs. Mapping is seen as a standard design tool for architects and urban designers.

Mapping

Place-Time Discontinuities: Mapping in Architectural Discourse, the 2015 Delft dissertation of Marc Schoonderbeek, demonstrates that mapping as a design tool can be manifested in three modalities; instrumental, operational and conceptual.

- Mapping as an *instrument*: by using a specific notation technique, architectural forms can be generated.
  Bernard Tschumi's *The Manhattan Transcripts* of 1976–81 is a classic example in which a series of scenario mappings was developed as an architectural language. (Tschumi 1995)
- Mapping as an *operation* in an architectural design process can be a way to explore ideas.
  An example is Daniel Libeskind's approach in the Jewish Museum Extension in Berlin of 1999: sketch lines through the urban tissue of Berlin, connecting historic locations where Jewish and German culture relate, form the basis for the architectural design.
- Mapping as a *concept* can help formulate a theoretical position in architecture and urban design by recognizing and defining spatial structuring systems.
  Aldo Rossi's and others' project *Citta Analoga* [Analogous City] in the Venice Architecture Biennale of 1980, *La Presenza della Passato/The Presence of the Past*, is one of the examples, in which 'urban artifacts' were used to map urban patterns and historical lines. (Portoghesi 1980)

(Schoonderbeek 2015)

In urban design, mapping is considered to be a means to comprehensively understand, efficiently present, and reasonably design the built environment on different scales, in all its complexity, working towards a contextually integrated design. The role of mapping can be expanded to:

- *a tool for handling spatial data*
  Different types of data from various domains can be analyzed, integrated and incorporated in the same platform, allowing for interaction and supporting multi-disciplinary research.
- *a tool for presentation and communication*
  Factual information and research outcomes can be visualized, enabling communication among design partners, and with clients and stakeholders.
- *a design tool*
  Mapping as a design tool in urban design also has three modalities: instrument, operation and concept. As an *instrument*, mapping is used to unclose the logic and the physical characteristics in the complex built environment across scales. Mapping as an *operation* implies an explorative experimentation process: creating, developing and testing to generate designs. Mapping as a *concept* contributes to urban design theory and broadens its scope and effectiveness.

In this research, mapping is used as a means for historical-morphological analysis, and is at the same time the representation of the outcome of the research.

Morphology and urban morphology

The term *morphology* was originally introduced by the German writer and polymath Johann Wolfgang von Goethe, 1749–1832. (Marshall and Çaliskan 2011) Goethe pointed out that *morphology [‘is’] a science dealing with the very essences of forms*. (Bullock *et al.* 1988) The objects of morphological research are physical form and structure. (Duan and Qiu 2008) Originally applied in biology, morphology was later developed in different other domains, for instance: in geography in reference to the form of a landscape and its transformations; or in linguistics in reference to the elements and structure of language. The use of morphology in the context of the built environment starts early in the nineteenth century. (*Ibid.*) This is called ‘urban morphology’ and is considered to be the science of urban form and structure. The combined term for typology and morphology is explained by the American researcher Anne Vernez Moudon as follows:

> *Typomorphology [–] considers all scales of the built landscape, from the small room to the large urbanized area. Second, it characterized urban form as a dynamic and continuously changing entity immersed in a dialectic relationship with its producers and inhabitants. Hence, it stipulates that city form can only be understood as it is produced over time.* (Vernez Moudon 1994 p 289–311)

Typomorphology accounts for what the Italian urbanist Saverio Muratori called:

> *an operational history of urban form, because it is a record of actions taken by planners, designers, and builders, both lay and professional, as they mold city form.* (Muratori *et al.* 1959)

The study of the urban form and its structure, urban morphology, is an important part of urban studies. However, a well-developed and widely accepted method of analyzing urban form does not yet exist in China, where the application of urban morphological research is very limited. Where they exist, most studies focus on the forms without attention to their transformation. Additionally, most researches are descriptive, rather than analytical. Though some architects exert themselves to incorporate a morphological approach in their design method, due to the usual abundance of constraints the thus developed insights often fail to be incorporated in the final designs. Moreover, of the generally academic, limited number of urban morphology studies in China, most focus on Beijing and the mega-cities in the coastal area. The studies on cities in the interior parts of China, like Wuhan, are far more limited, if not non-existent.

Main schools of urban morphology

Anne Vernez Moudon (1994, 1997, 2003) and her Dutch colleague Elwin Koster (2001) refer to three traditional schools in the study of urban morphology: Italian, French and British. The British School was first brought into an international context by the spread of the English language across the world. Urban morphology has been adopted by the International Seminar on Urban Form/ISUF, an international organization of researchers and practitioners in the field of the study of urban form. ISUF has since expanded to many ‘schools’, as evidenced in its journal *Urban Morphology*. A Dutch and an American School came up and developed their own interpretations and approaches. The basic concept and knowledge of urban morphology was introduced to China in the late 1980s and early 1990s by a few Chinese overseas scholars. (Chen and Thwaites 2013) Appendix 2 offers a characterization of the Italian, French, British, Dutch, American and Chinese schools of urban morphology.

Dutch approach to design and morphological analysis

The Netherlands is considered a ‘design country’. It is small, yet has extremely influential industrial designers, architects and urban designers. Rem Koolhaas and a subsequent generation of architects and urban designers have influenced

and continue to influence trends in design, and the future direction of architecture worldwide.

Dutch design is characterized by and is famous for; its inventiveness, its creative ways of using materials, and the dynamic, challenging and experimental design process. (CHU 2012; Lootsma 2000) Consequently, the high degree of integration of planning and design and the strong relation between research and design are among the characteristics that have made Dutch architecture world famous.

Integration of planning and design

The high degree of integration in Dutch planning and design is manifest in three ways:

- the integration of different scales and domains of architecture,
- the influence of design and research on one another across multiple scales,
- the comprehensive role of designers in practice.

First, the term *bouwkunde* in Dutch language—and in the Dutch name of the Faculty of Architecture and the Built Environment in Delft: *Faculteit Bouwkunde*—covers everything from small-scale furniture design and interior design to architecture, urban design, landscape architecture, large-scale regional design and environmental design; from architectural technology and material science to structural and civil engineering; from design studies to real estate management and planning which relate to economics, politics, etcetera. Literally, *bouwkunde* translates to English as the 'knowledge' or 'skill' of building. This high integration of related disciplines in architecture over the full range of scales creates designers who understand the complex built environment.

Second, the term *stedenbouw*—as in the Dutch name of the Department of Urbanism: *Afdeling Stedenbouwkunde*—literally translates to English as the 'building of places for humans to live'. In Delft, it refers to both urbanism and urban design, and includes planning and aspects of landscape architecture.

In the Netherlands, the concept of dealing with nature has changed through the centuries from 'fighting against nature' to 'building with nature'. The constant threat of floods made water management and flood control a main concern early on, necessitating civil cooperation and planning. For centuries, city development and urban design have been concerned with and continue to integrate the design and construction of dams, dikes, sluices, polders and so on. This demands designers to comprehensively and systematically think and deal with complex projects across scales. This necessary concern with nature—and protection against it when necessary—also explains why the characteristic Dutch architecture and urban design, and the research methods of the layer approach and reduction drawing have originated from landscape design.

Last but not least, the scope of *stedenbouw* includes the balanced communication and negotiation among users, municipalities, communities and as many stakeholders as can be involved.

Integration of research and design

The strong relation between research and design in the Netherlands forms the basis for experimentation and creativity in practice. It results in an orientation in science and academia towards design practice. Research and design, and their mutual relationship, is the main focus in design education, and this is reflected in practice as well. 'Research-based design' is one of the main characteristics of famous contemporary Dutch architecture and design companies, such as OMA and MVRDV. Additionally, 'research by design' is common practice in Dutch research institutes in the design domain: a type of research with design-oriented features and a high degree of design involvement in the research process, referred to as a 'designerly way of thinking'. (Curry 2017) Recently, the discussion of 'research through design' has been put on the agenda. The Netherlands Organization for Scientific Research/NWO has now set up a specific funding program for the design domain, inviting research proposals on design related topics.

Delft School of morphological analysis†

The two aspects mentioned above—the integration of planning and design, and of research and design—not only lead to the unique position of Dutch design in the world, but also result in the specific characteristics of the Dutch or Delft School of morphological analysis:

- it is strongly design oriented,
- it was and still is being developed in academia, in education as well as in actual design projects,
- starting as a historical research on urban transformation, intended to understand urban form through its historical development, it has a strong analytical character,
- it looks both backward and forward; studying the past to understand the present, with a strong perspective on the future,
- the concerns of landscape architecture led to designing and analyzing across scales, to the layer approach, and to the technique of reduction drawings,
- the recognition and definition of homogeneous areas (see below and *Chapter 4*) reduces detailed information on a map in order to understand the hierarchy in urban structures.

† There are *three* different meanings to the term 'Delft School' (CAI 2018 p 21):
- the *first* refers to a group of professors and architects between the 1920s and the 1950s in the Department of Architecture of the Technical College of Delft, now Delft University of Technology, advocating traditional architecture and conventional urban forms, with a predilection for refined craftsmanship,
- the *second* refers to a magazine of the 1960s edited by a group of young students in the Faculty of Architecture of Delft University of Technology, advocating modernism,
- the *third* occurs from the 1970s onward, when morphological analysis became embedded in the education of the Faculty of Architecture and the Built Environment.

In this book we use Delft School in its *third* meaning.

In the method of the Delft School, according to Leupen *et al.*, the following techniques are applied separately or in combination:

> *reduction, addition, and démontage are used to extract from the plans of projects and urban areas the essential aspects which depend on the analyzed theme in order to reveal a certain logic and structure through the drawing process.* (Leupen *et al.* 1997 p 207)

For the purpose of the analysis of the urban form of Wuhan, specifically the reduction technique is relevant. Reduction is considered to be:

> *the most elementary way of processing a map or a drawing. Its purpose is to visualize the structure of a design. A commonly used technique in design analysis, reduction consists essentially of omitting all irrelevant data from a design drawing so that only information essential to the study remains.* (*Ibid.*)

There are two fundamentally different modes of reduction: morphological reduction and typological reduction.

> *Morphological reduction is a means of uncovering and explaining the spatial structure of an object. The purpose of the analytical drawings is to visualize the spatial characteristics of a building, an area or a city. To do so, they make a distinction between built (i.e. mass) and unbuilt (i.e. space or void). [–] Typological reduction can serve two distinct ends: 1. stripping a design to its essentials leaves a diagram of the underlying structure; 2. by comparing the diagram of a design obtained by reduction with the typological diagram of a type from which that design probably derives, we can get an idea of the changes the design has undergone with respect to the original type.* (*Ibid.*)

In this way, with its clear design orientation, the Delft School of morphological analysis on the urban scale has two main objectives: to analyze a specific area while working towards a design or vision for it; and to analyze a design to understand its original source.

Reduction drawing techniques are deeply rooted in the education of the Faculty of Architecture and the Built Environment in Delft. These techniques are also widely used in Dutch practice in offices like the OMA, MVRDV, Neutelings Riedijk Architects/NRA, Palmbout Urban Landscapes, HKB Urbanists, etc. (For examples see the following pages.)

Reduction drawings can resemble the so-called figure-ground drawings that were developed by Colin Rowe and Fred Koetter with their students at the Massachusetts Institute of Technology/MIT in the United States of America and inspired by the eighteenth century Nolli Map of Rome. (Rowe and Koetter 1978; see *Figures 3.1* and *2*.)

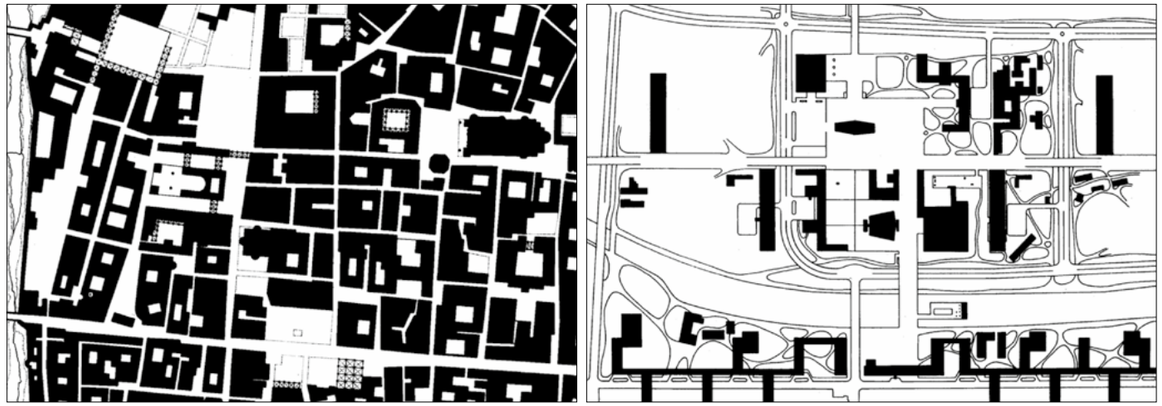


Figure 3.1
Figure-ground drawings: (left) Traditional town: the center of Parma, Italy; (right) Modernism: Project for a New Center for Saint-Dié, France, Le Corbusier, 1945 (Rowe and Koetter 1978 pp 62–63)

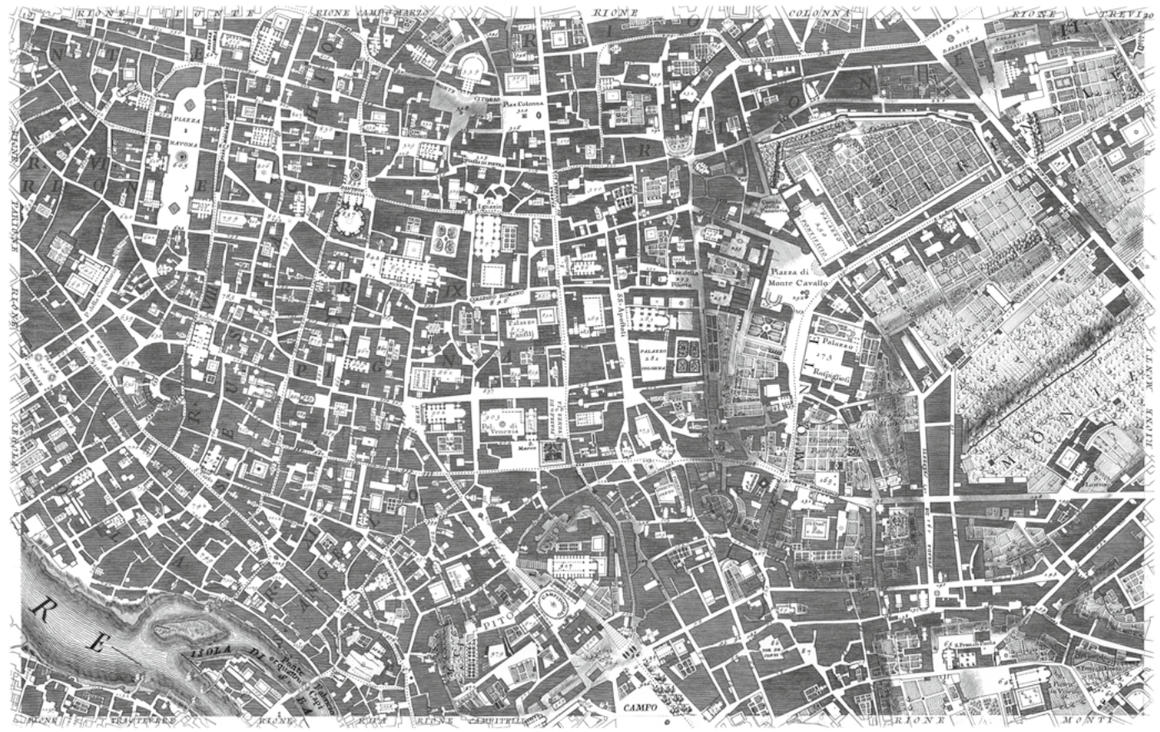


Figure 3.2
Map of Rome, Giambattista Nolli, 1748. The famous map shows public space and building mass, with the public space including interior public spaces in churches and other public buildings. (Wikimedia Commons, public domain)

Examples of the Delft School

The following pages present a series of representative examples of the results of the Delft School of morphological analysis on the urban scale.‡ These give an overview of the range of results of the method, but that does not mean that all aspects presented in these examples have been applied in the research of the urban form of Wuhan.

‡
Other groups in the Delft School of morphological research are in Architecture (Roberto Cavallo, Henk Engel *et al.*); Landscape Architecture (Steffen Nijhuis, Clemens Steenbergen *et al.*); History (Reinout Rutte *et al.*).

Alphen aan den Rijn, the Netherlands: Heeling Krop Bekkering Stedebouwkundigen/HKB Urbanists (Nicola Körnig), 1995

To understand the context of the urban design for the extension of the center of the river town Alphen aan den Rijn in the Netherlands, a series of sketch maps were reconstructed on the bases of the contemporary topographical and historical maps to show the history from Roman times to the present, and identify the formal characteristics of the town.

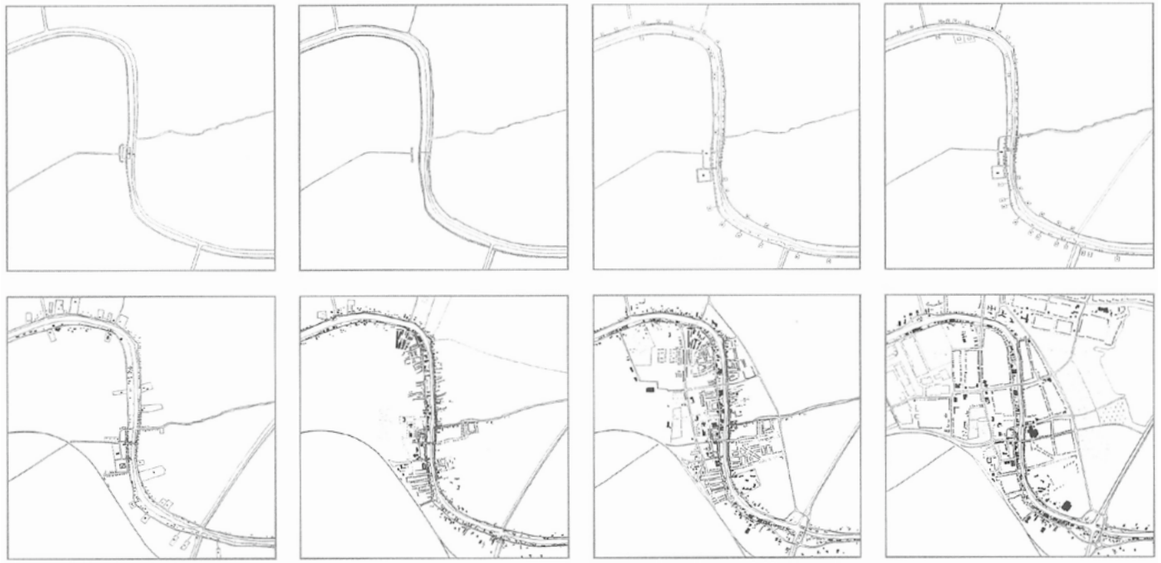


Figure 3.3
Historical morphological development of Alphen aan den Rijn, the Netherlands, 1995. Heeling Krop Bekkering Stedenbouwkundigen/Urbanists (Bekkering 2006 p 32)

The Hague, the Netherlands: Leo Oorschot, 2014

The PhD research *Conflicten over Haagse stadsbeelden* [Conflicts over The Hague townscapes] by Leo Oorschot uncovered from many different archival sources, how the patchwork of neighborhoods with characteristic townscapes in the city of The Hague developed. The map depicting these applies color and graphic patterns to the topographical map, clarifying the formal structure of the city.

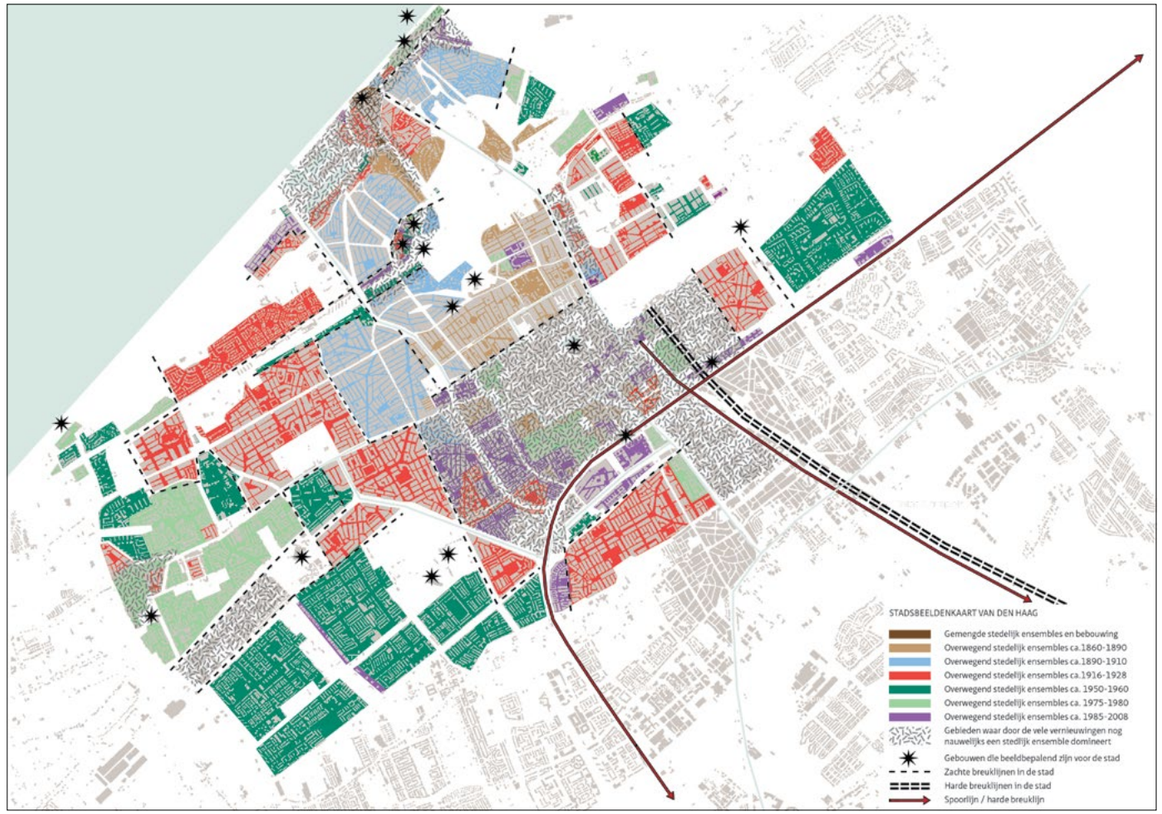
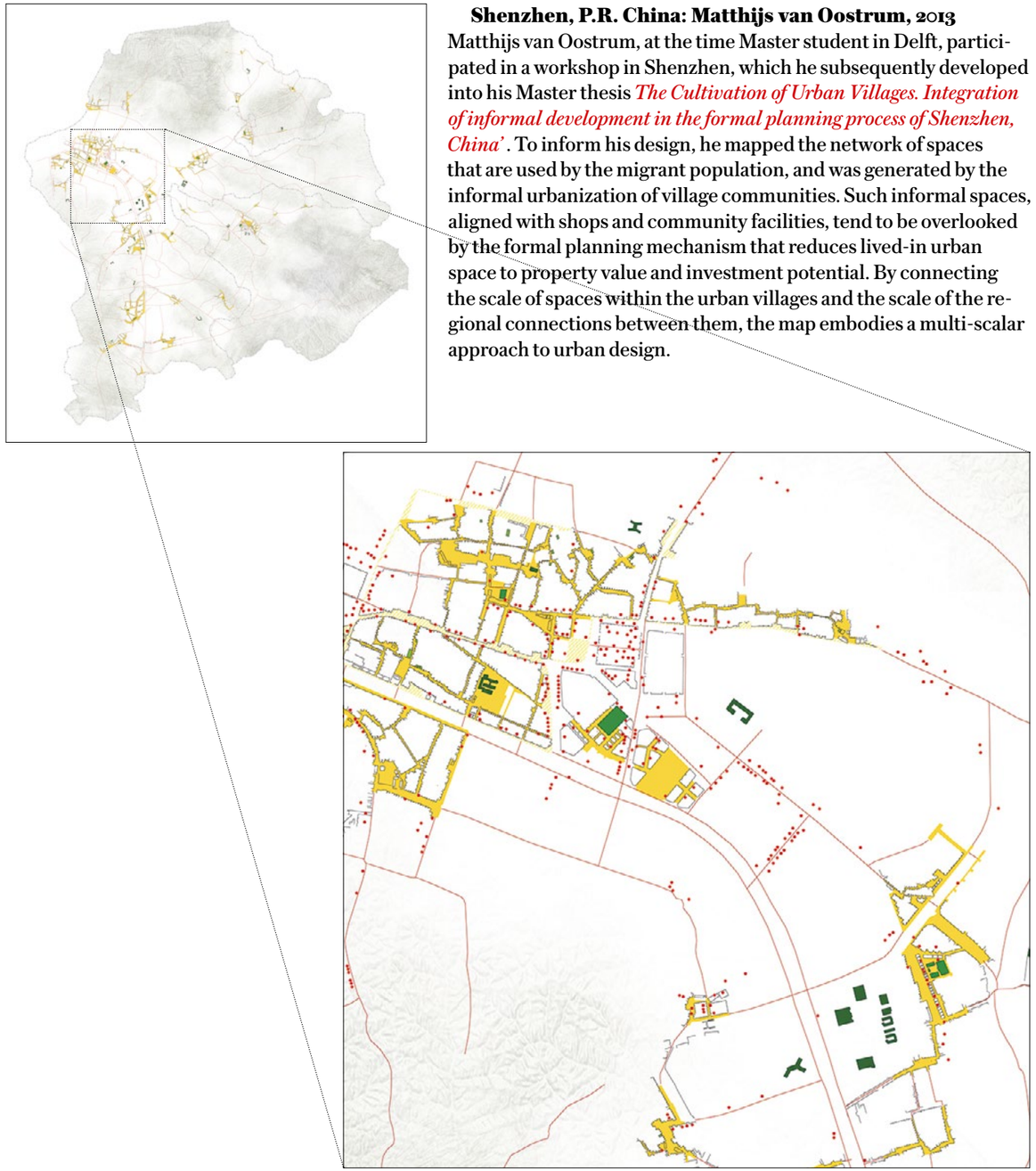


Figure 3.4
Townscapes of The Hague, the Netherlands, 2014. Leo Oorschot (Oorschot 2014 pp 614–615)



Shenzhen, P.R. China: Matthijs van Oostrum, 2013
Matthijs van Oostrum, at the time Master student in Delft, participated in a workshop in Shenzhen, which he subsequently developed into his Master thesis *The Cultivation of Urban Villages. Integration of informal development in the formal planning process of Shenzhen, China'*. To inform his design, he mapped the network of spaces that are used by the migrant population, and was generated by the informal urbanization of village communities. Such informal spaces, aligned with shops and community facilities, tend to be overlooked by the formal planning mechanism that reduces lived-in urban space to property value and investment potential. By connecting the scale of spaces within the urban villages and the scale of the regional connections between them, the map embodies a multi-scalar approach to urban design.

Figure 3.5
Shenzhen West network of interior spaces, 2013. Matthijs van Oostrum (Oostrum 2013)

Randstad, the Netherlands – Bogotá Region, Colombia: Camila Pinzón Cortes, 2009
In her PhD thesis *Mapping Urban Form. Morphology studies in the contemporary urban landscape*, Camila Pinzón Cortes compares the urban form of the Randstad in the Netherlands and the Bogotá Region in Colombia. To do this, she takes a representative strip dissection of each region, and analyzes the patterns within the strips. The images show surprising similarities in the formal characteristics of the constitutive parts of the two regions, even though planning and politics in the two countries are completely different.

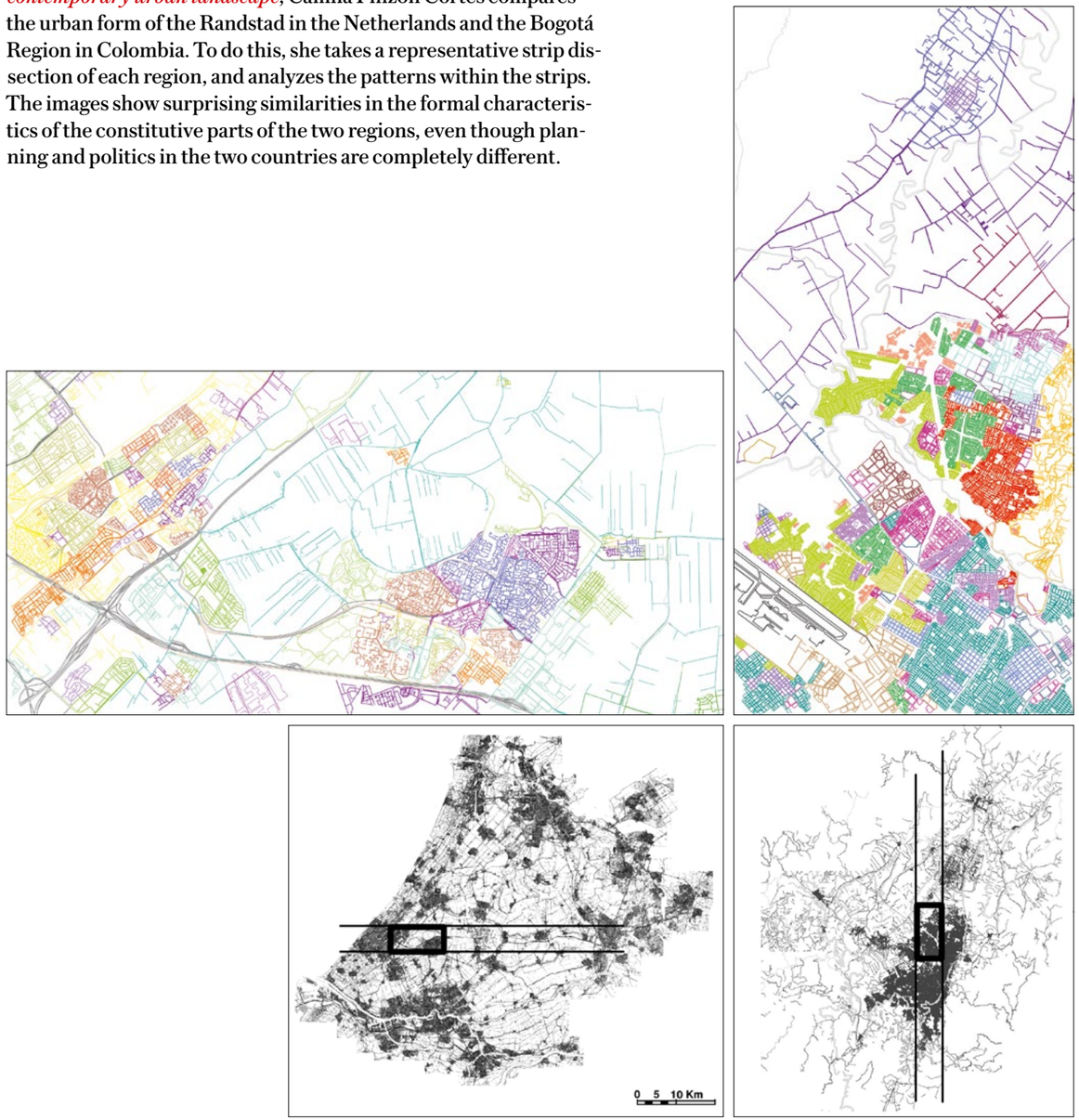


Figure 3.6
(left) The Randstad and (right) Bogotá Region; (bottom) Strips; (top) Morphological analyses within the strips, 2009. Camila Pinzón Cortes (Pinzón Cortes 2009 pp 137, 179)

Delft, the Netherlands: Rein Geurtsen, 1988

The work of Rein Geurtsen, at the time Associate Professor of Urban Design in Delft, was instrumental in developing the Delft School on the urban scale. The example is taken from *Locatie Zuidpoort Delft. Stadsmorfologische atlas* [Location Southgate Delft. Atlas of urban morphology], the analysis of the southern half of the town center of Delft, prepared for a design competition. The reduction drawing (right) clearly shows the formal structure of the city that is much harder to 'read' in the aerial photograph (left). The complete analysis covers a series of important historical development phases of the city, together explaining its present form.

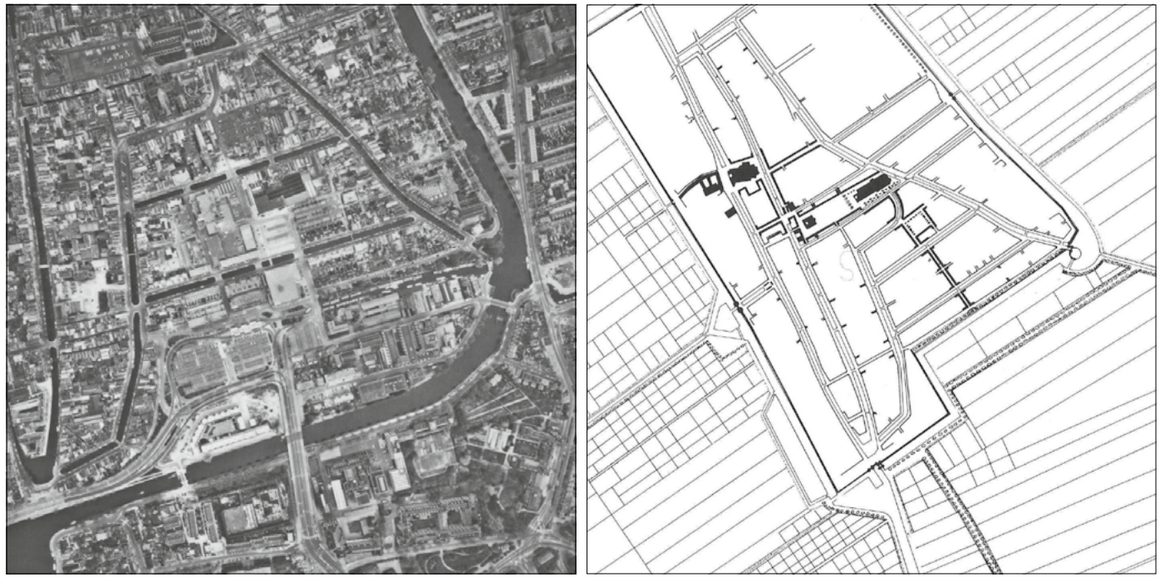


Figure 3.7
(left) Aerial photograph of the town center of Delft, the Netherlands, 1988; (right) Reduction drawing of the same area in the 17th century
Rein Geurtsen (Geurtsen 1988 pp 0, 15)

Amsterdam, the Netherlands: Casper van der Hoeven and Jos Louwe, 1985

The technique of reduction drawings was developed further in Delft by young researchers like Casper van der Hoeven and Jos Louwe. Their Amsterdam example *Amsterdam als stedelijk bouwwerk* [Amsterdam as urban building] takes the morphological analysis one step further by straightening out the city's Canal Zone that is in reality curved, disclosing the regularities and irregularities in its formal structure.

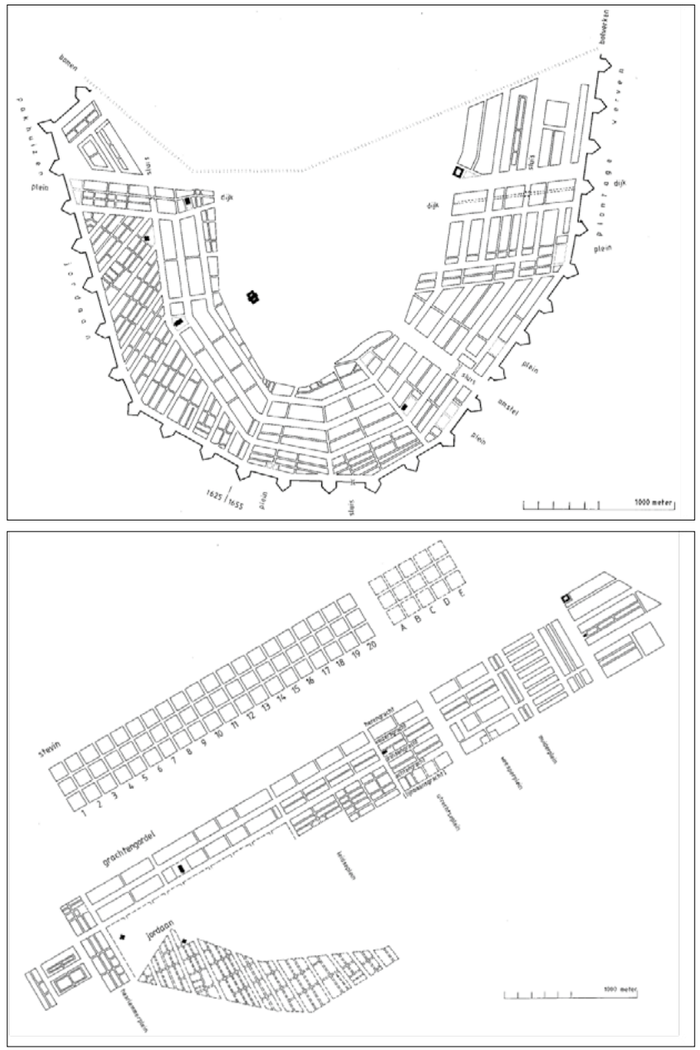


Figure 3.8
(top) Reduction drawing of the canal zone in Amsterdam, the Netherlands;
(bottom) The canal zone 'straightened'
Casper van der Hoeven and Jos Lauwe
(Van der Hoeven and Louwe 1985 pp 62–63)

Rotterdam, the Netherlands: Frits Palmboom, 1987
Frits Palmboom, practitioner and recently Van Eesteren Professor in Delft, made important contributions to the Delft School, integrating the layer approach with the reduction drawing technique. This is illustrated by his analysis of Rotterdam; *Rotterdam, verstedelijkt landschap* [Rotterdam, urbanized landscape]. The city is taken apart in three layers: the underlying landscape, the traffic infrastructure of highways and railroads (the 'traffic machine'), and the built-up areas in between these two. Together, these drawings clarify the urban form of Rotterdam and explain the background of its structure.

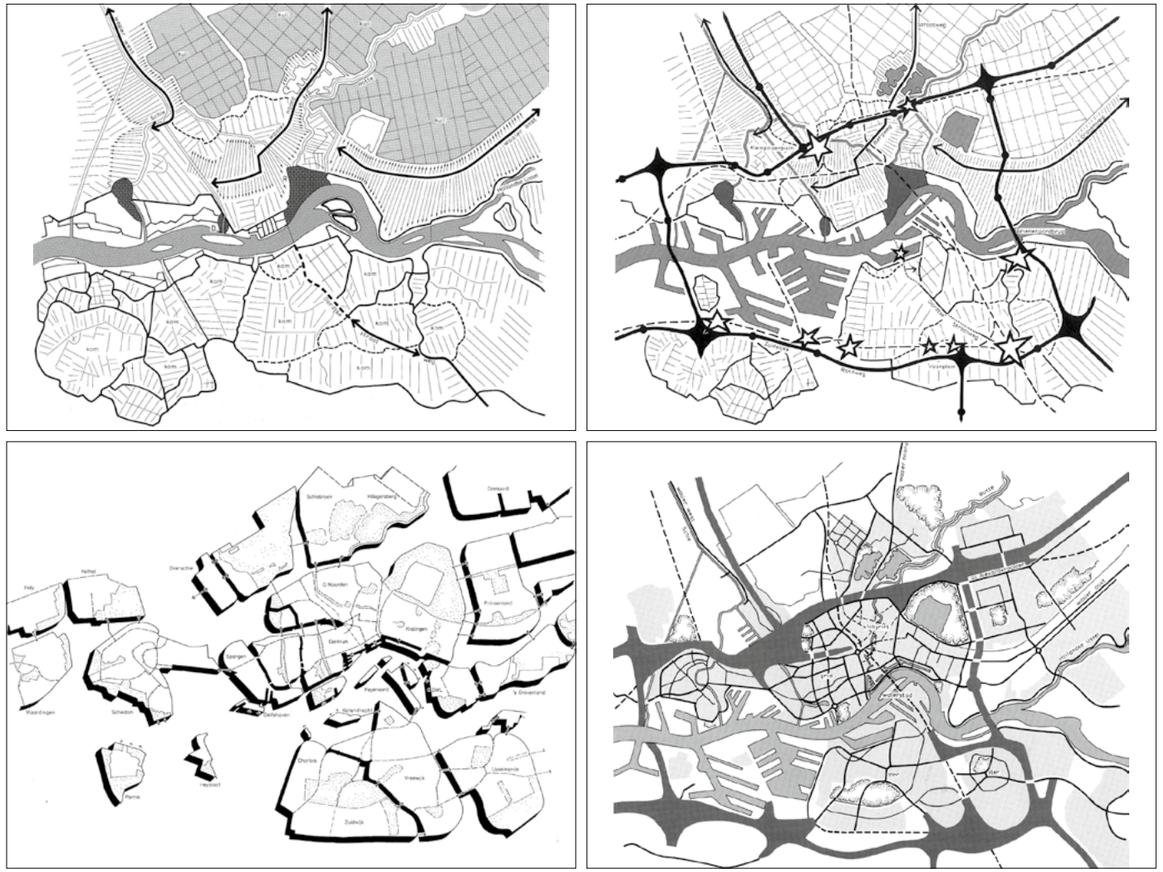


Figure 3.9
Layer analysis of Rotterdam, the Netherlands: (top left) Landscape and parceling; (top right) Traffic machine; (bottom left) Islands of built-up areas; (bottom right) The three layers combined. Frits Palmboom (Palmboom 1987 pp 22, 34, 40, 64)

Detroit, MI, United States of America (1): Henco Bekkering and LIU Yanjia, 2015
The morphological analysis of Detroit, *Mapping Detroit: "The City of Holes"*, done in a sabbatical at Taubman College of Architecture and Urban Planning, University of Michigan in the United States of America, discovers the structuring systems of the urban form, explaining why and how it has become what it is. (See *Figures 3.10* through *12*.) It is a strong example of how cities keep their basic form through long series of urban transformations. Another outcome of the research is visualizing the growth within the municipal borders and in the metropolitan area around it. (See *Figures 3.13* through *15*.)

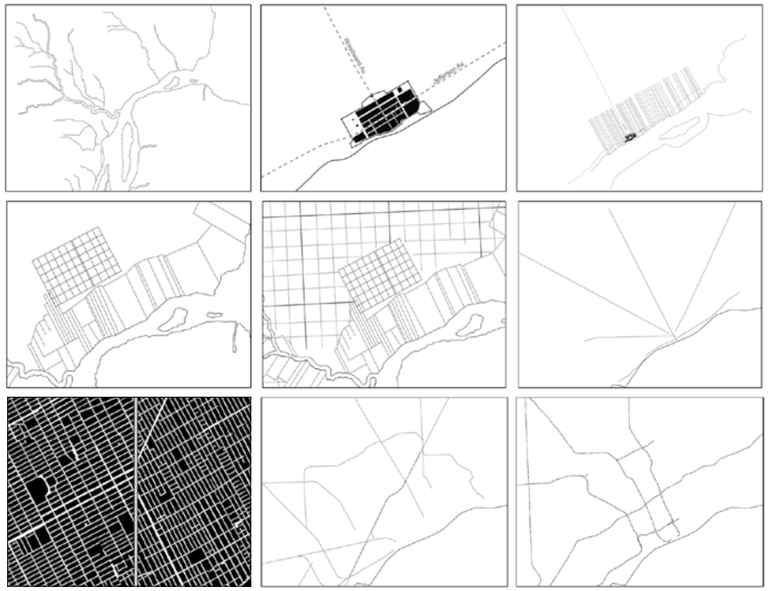


Figure 3.10
The nine structuring systems of the morphology of Detroit, MI, United States of America: (from left to right and top to bottom) Rivers; early fort; Ribbon Farms; Ten Thousand Acres Grid; Jefferson Grid; radial avenues; street grids; railroads; highways. Henco Bekkering and LIU Yanjia (Bekkering and LIU 2015 p 40)

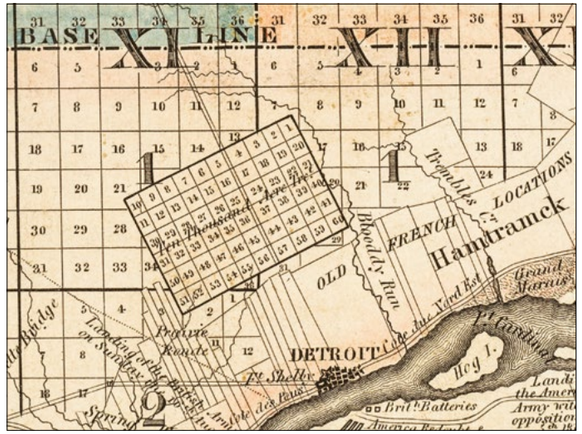


Figure 3.11
Detail of the "Map of the Surveyed Part of the Territory of Michigan by Risdon", showing the so-called Ten Thousand Acre Grid surrounded by the larger and differently oriented Jefferson Grid, and with original Native American trails indicated by double lines. (Dunnigan 2001: William L. Clements Library, University of Michigan)

Figure 3.12
Analytical map of the present city with superimposed in red the Ten Thousand Acres Grid area and the Indian trails, now avenues. Henco Bekkering and LIU Yanjia (Bekkering and LIU 2015 pp 33–34)

Figure 3.13
The growth of the city of Detroit within the present municipal borders from 1835 ▸ 1968. Henco Bekkering and LIU Yanjia (Bekkering and LIU 2015 p 42)

Figure 3.14
Detroit, 2009: "The City of Holes". Henco Bekkering and LIU Yanjia (Bekkering and LIU 2015 p 42)

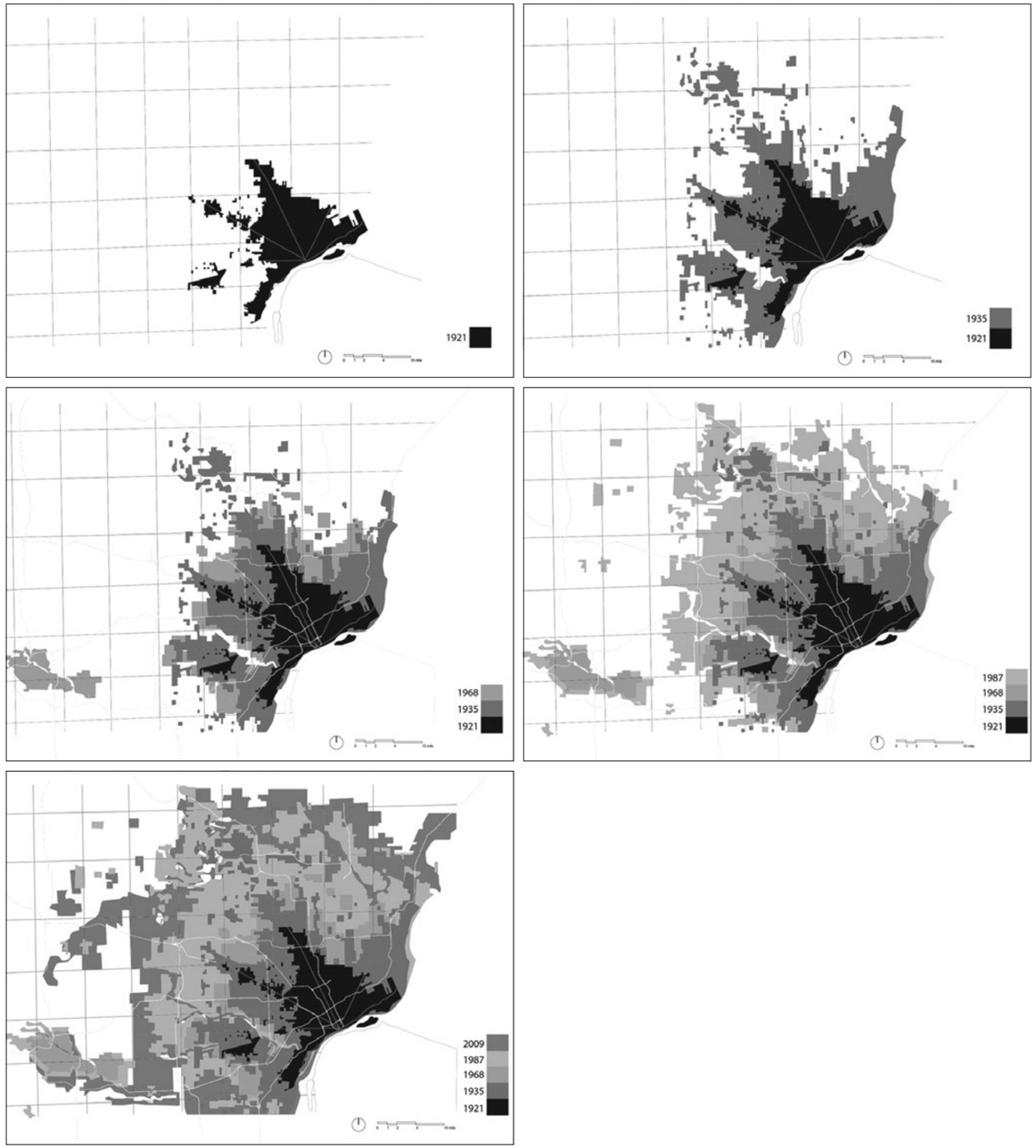


Figure 3.15
The growth of the Detroit metropolitan area from 1921 ▸ 2009. Henco Bekkering and LIU Yanjia (Bekkering and LIU 2015 p 44)

Detroit, MI, United States of America (2): Conrad Kickert, 2019
When at Taubman College of the University of Michigan in the United States of America, Conrad Kickert combined in his dissertation *Active Centers – Interacive Edges* (Kickert 2014) the historical analysis of the urban morphology of downtown Detroit—and The Hague in the Netherlands—with the analysis of the changing locations of its commercial functions. (This leads to interesting and far-reaching conclusions that are outside the concern of the Wuhan atlas.) His later book on Detroit: *Dream City. Creation, Destruction, and Reinvention in Downtown Detroit* focuses on the morphological development. (Kickert 2019)

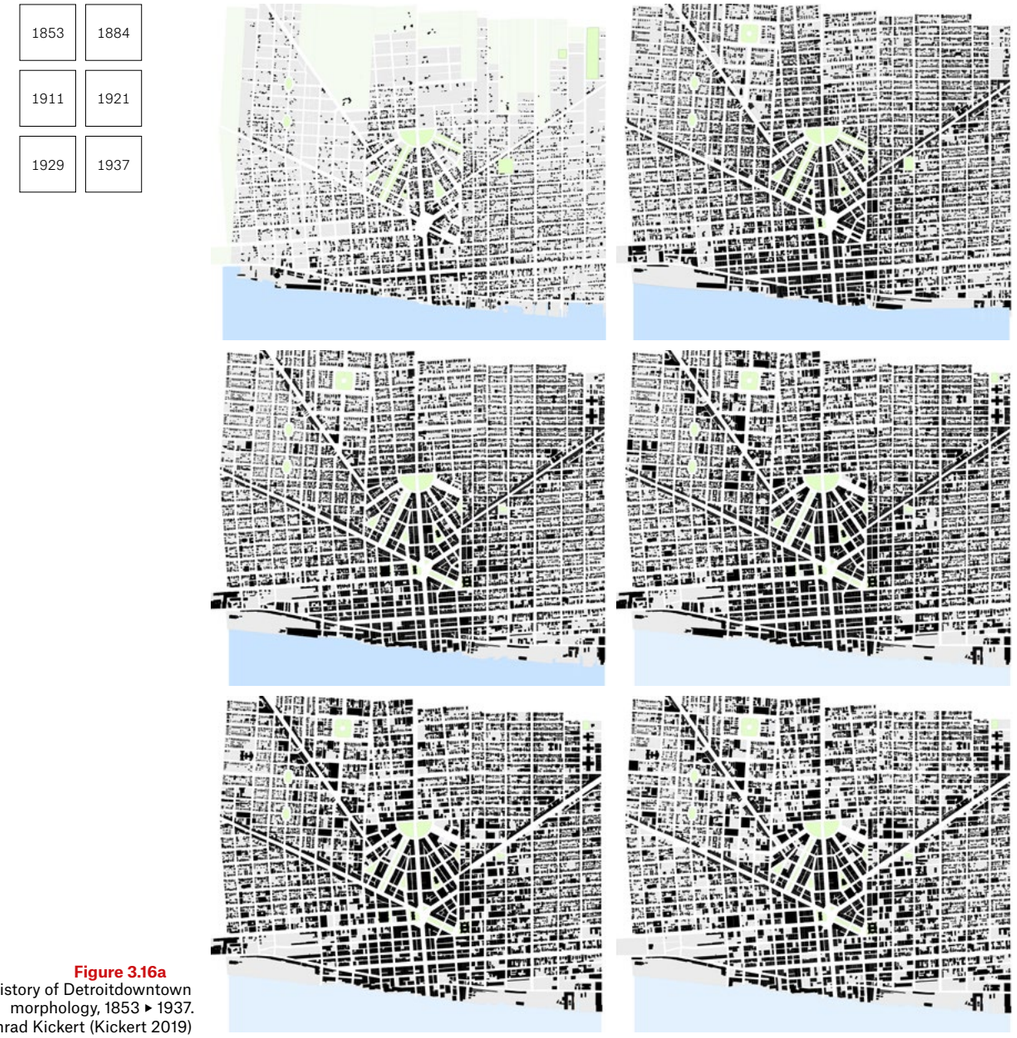


Figure 3.16a
History of Detroitdowntown morphology, 1853 ▸ 1937. Conrad Kickert (Kickert 2019)

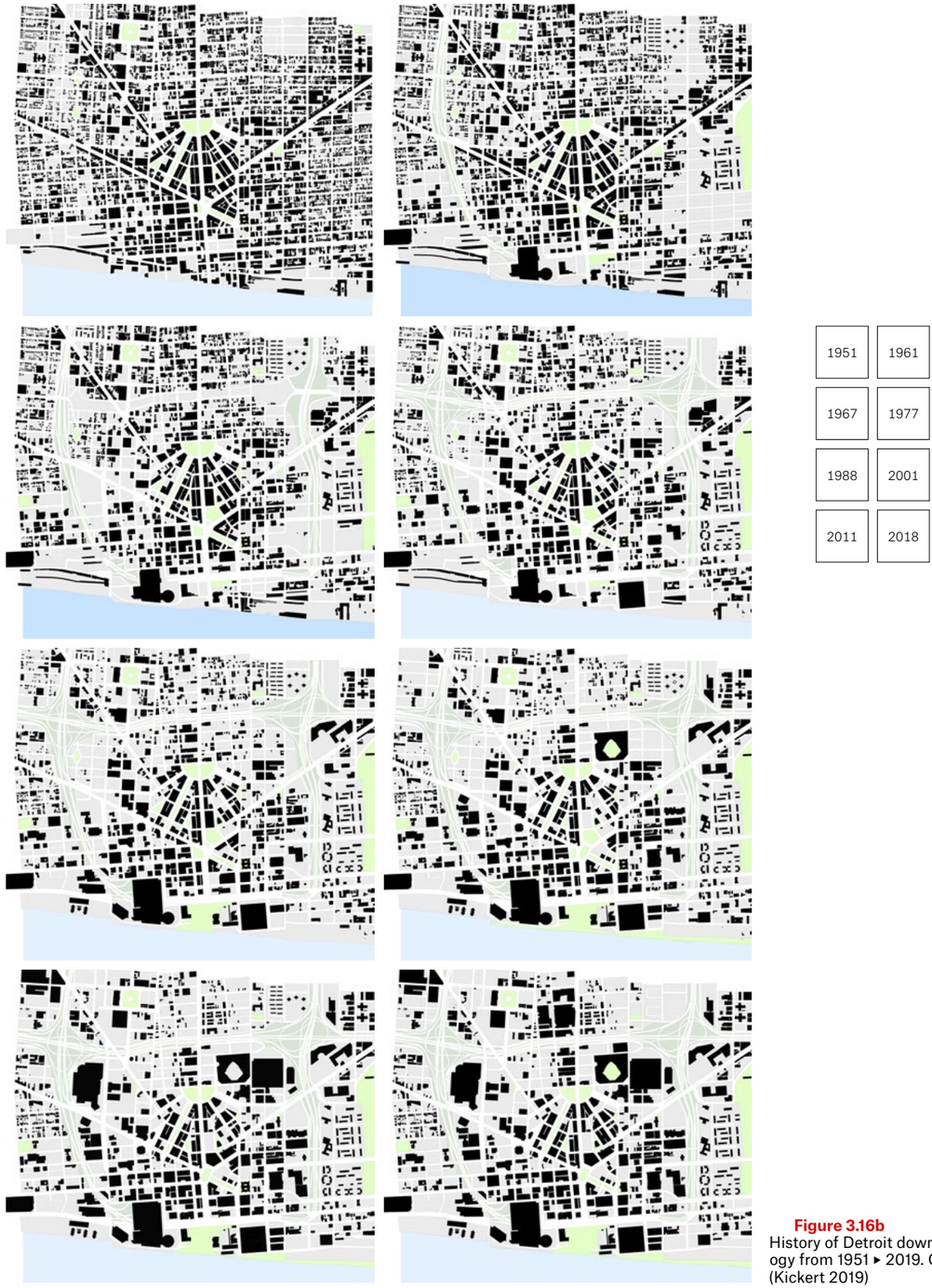


Figure 3.16b
History of Detroit downtown morphology from 1951 ▸ 2019. Conrad Kickert (Kickert 2019)

Los Angeles, CA, United States of America: Jorick Beijer, 2013

In his Master thesis *Los Angeles. The Metropolis and Five Stages of Modernity*, Jorick Beijer applied the Delft method to Los Angeles, drawing analytical maps that show the growth and transformation of the metropolis through history, making its present form understandable. He has done so on two levels of scale, for the same moments in history. In addition, he has analyzed the relations between the urban form, the changing main modes of transportation, and the development of the functional centralities in the city.

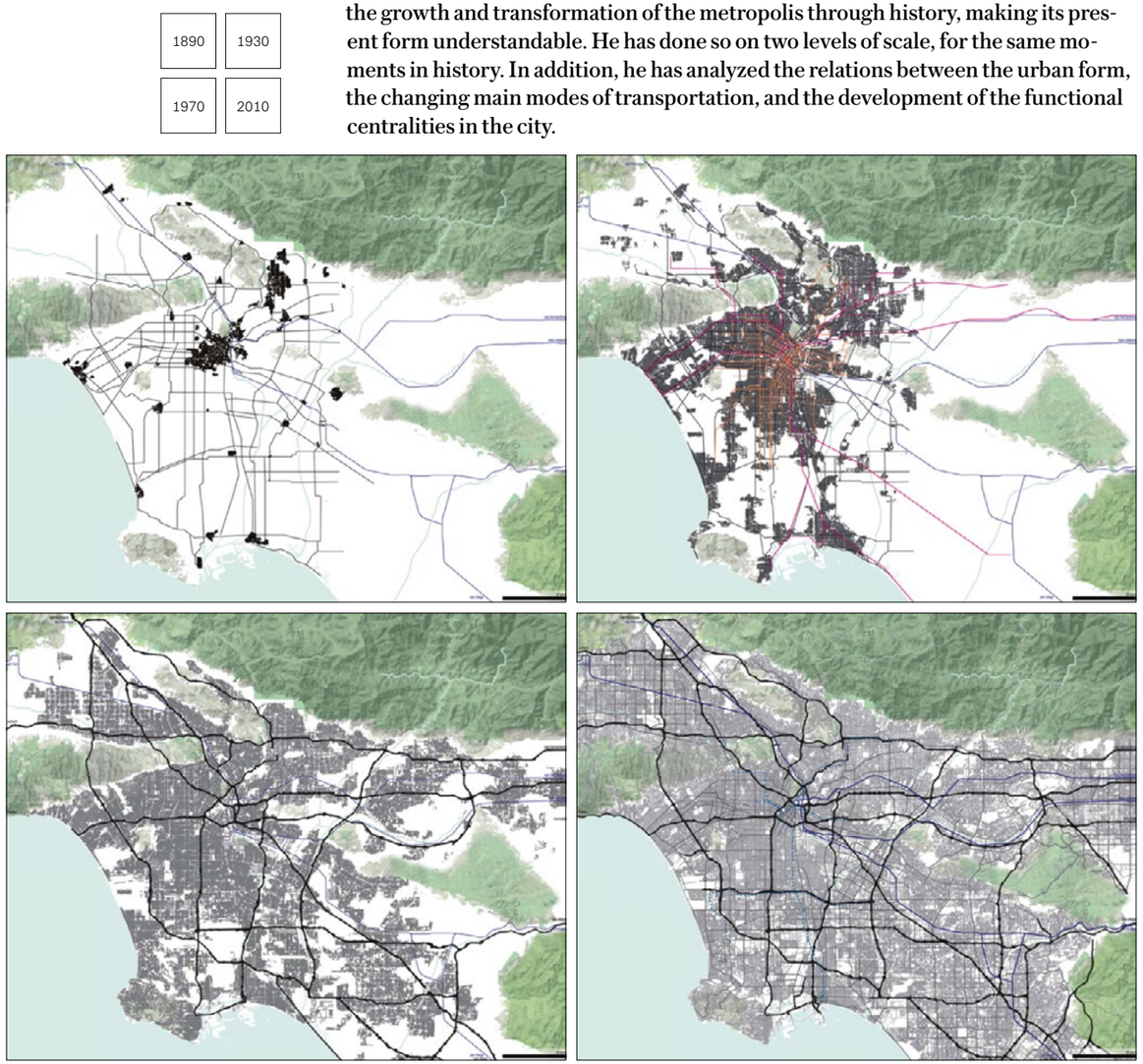


Figure 3.17
Historical morphological analysis of the Los Angeles metropolitan area; red lines: public transport. Jorick Beijer (Beijer 2013 pp 21–23)

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Chapter 3
Morphological Mapping
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Figure 3.18
Historical morphological analysis of downtown Los Angeles; red lines: public transport. Jorick Beijer (Beijer 2013 pp 77–80)

Chapter 4
Research Aim and Method

The aim of the research is to understand the urban form of Wuhan through its history up to the contemporary situation. This is done at different levels of scale, by analyzing historical maps, aerial photographs, the sequence of Master Plans, and contemporary maps and geographical data, all in relation to each other.

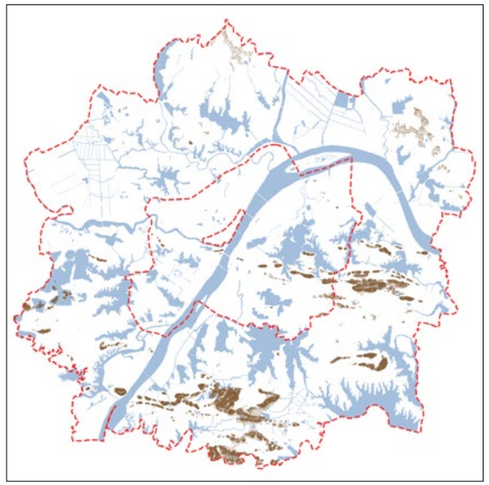
On the macro and meso levels of scale, the Metropolitan Area and the Inner City, the historical development of the urban form is uncovered, revealing the structuring elements as these have developed and disappeared over time. This is useful in the decision-making on the future form of the city, its urban transformations and its extensions. It generates attention to and interest in historical continuity and its elements. On the micro level, with Hankou Riverside as a case study, the focus is on the development of street patterns and block forms, which is useful in deciding on historical conservation and regeneration in the district.

Relevance of the Delft School

Chinese cities have been expanding since the early 1980s under trends of rapid globalization, modernization, and urbanization. Since then, they have changed dramatically, and have in the process lost many of their spatial characteristics. Urban planners and designers have been facing unprecedented challenges in China. They not only have to learn to understand the constantly emerging new urban mechanisms, and seek balance among stakeholders, but they also need to cope with the changing context under often extreme time pressure. In such circumstances, future- and design-oriented analysis in a designerly way of thinking is useful, or even indispensable, for understanding the existing city and deciding on its transformations in a responsible, accountable, and communicable way. This has recently gained importance in light of the growing awareness in China of the value of local urban identity, that is always—at least partly—based on history. This is what the Delft School with its method of morphological analysis is intended for.

(For a description of the different international schools of morphological research see *Appendix 2*, and for examples of the Delft School see *Chapter 3*.)

Research method



mountains

Figure 4.1
Rivers and lakes, and mountains
(Bekkering, CAI, Kuijper)

The method of research is that of morphological reduction drawings of moments of change in the urban form, resulting in series of maps and descriptions that show and explain the development and structure of the urban form. This is the Delft method of morphological analysis, applying a specific mapping technique to fix history in place. The higher levels of scale are treated with stronger reductions. The historical maps are fitted to recent ones to make them comparable.

The main elements of Wuhan's morphology are:
- rivers and lakes,
- hills and mountains,
- built-up areas and open space,
- main infrastructures.

The landscape elements of open water (rivers and lakes), and mountains (hills) are defining elements of the city form. This is especially true in Wuhan with its abundance of open water and the striking effects of the hills on the image of the city. These landscape elements of water and hills are important for the identity of the city and offer strongholds for orientation.

Due to the lack of reliable historical data in this research, water and mountains keep their contemporary form throughout the series of maps. Mountains do not move—even though in Wuhan part of Snake Mountain was excavated in the 1970s and reconstructed more recently. The situation is more complicated with regards to water. The banks of the rivers and lakes have changed through history, both by nature and through human manipulation, sometimes quite considerably. The authors had no access to the data of the water system, as these belong to municipal departments that did not cooperate in the research. Plus, for reasons of security, these data are considered to be of national importance, and thus secret. Ignoring these changes is advantageous in that it is easier to compare the maps of the successive historical periods to each other and to the contemporary map.

The landscape elements, together with the main infrastructure, are also fragmenting the built-up form of the city. They constitute strong borders in the city that are often hard to cross, resulting in disconnection between the areas on either side.

railway
highway
metro line

Figure 4.2
Rivers and lakes, mountains, and main infrastructure, 2013
(Bekkering, CAI, Kuijper)

Research steps

The research is built up in eight steps:
- *Step 1* data collection,
- *Step 2* reading maps and selecting relevant information,
- *Step 3* selecting maps and setting the timeline,
- *Step 4* mapping format, legend, and scales,
- *Step 5* overlaying maps/georeferencing,
- *Step 6* reducing map information to homogeneous areas,
- *Step 7* on the meso level of scale: adding secondary connections,
- *Step 8* deducting spatial structuring elements of the urban form.

Step 1 Data collection

In order to achieve accuracy and depth of research, different types of data are used: historical maps, contemporary maps and GIS-data, aerial photographs, websites, and the sequence of historic and contemporary Master Plans. (For the selection of maps used in the research see *Appendix 3*.)

In many Chinese cities most historical maps and other artifacts have disappeared, often consciously destroyed in the Cultural Revolution. Luckily, in Wuhan, a large number of historical maps has been saved. Three comprehensive and well produced atlases are available with large collections:
- *The Historical Atlas of Wuhan* (Compilation Committee 1998),
- *Planning Wuhan – 100 Years* (WU Z 2009),
- *Atlas of Wuhan* (Editorial Committee of Atlas of Wuhan 2015).

The combined collections allow for the making of a first, rather extensive selection of meaningful historical maps that document many of the major changes in the morphology of the city. Additional maps have been found to fill in missing data in different libraries, collections and archives, in China, the Netherlands, elsewhere in the world, and on the Internet.

Step 2 Reading maps and selecting relevant information

The maps found are read and categorized, and the historical moments selected when main spatial changes appeared in the urban area. In this way, the spatial structuring elements are detected.

Step 3 Selecting maps and setting the timeline

From the collection of maps, in *Step 2* the maps are selected that for the first time show the successive structural spatial changes in the city. These maps are represented on three levels of scale in the ATLAS: *Chapters 5* through *7*. Ironically, more

1870
1910
1950
1970
1990
2000
2006
2013
2016
2019

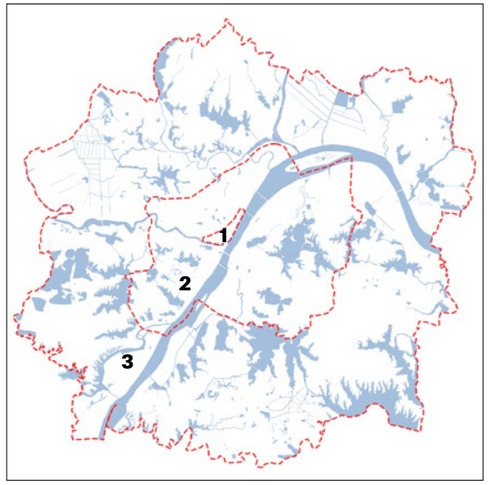


Figure 4.3
The three levels of scale of the research:
1 Metropolitan Area: macro scale, 2 Inner City: meso scale,
3 Hankou Riverside: micro scale
(Bekkering, CAI, Kuijper)

useful maps are available for earlier periods. Problems were encountered during the research when we could not find reliable maps and data from the mid-twentieth century, notably the period of the Cultural Revolution.

The series of the selected maps forms the basis for a timeline with diminishing time lapses between successive periods, in accordance with the acceleration of urban development in time; densifying like the city itself. The timeline starts in 1870. This may seem relatively late, but it is the initial date for which reliable cartographic evidence was found. Close examination of earlier maps indicated that, up until 1870, the overall urban form and tissue of the three constituent towns hardly changed since their foundation.

Unreliable early maps and unavailability of maps of the required dates, have necessitated reconstruction of the maps of the early periods. This involves comparing maps to each other and to the contemporary base map in addition to georeferencing the maps to fit the contemporary base map. (See *Step 5*.) This need for map reconstruction is especially necessary for the early state of the three towns of origin: Hanyang, Wuchang and Hankou.

Step 4 Scales, mapping format, and legend

Scales

The analysis is conducted on three levels of scale (see *Figure 4.3*), to allow for on the one hand an overview of the structure of the Metropolitan Area as a whole, and on the other an increasing depth of analysis and understanding:

- Metropolitan Area: macro scale,
- Inner City: meso scale,
- Hankou Riverside: micro scale.

The Metropolitan Area and the Inner City in this research are in accordance with their respective administrative borders. The borders for the urban district of Hankou Riverside are on the banks of the Yangtze and Han Rivers, and on its former town wall, replaced by a railroad that was later replaced by a main street. This way, the area includes the authentic historical area of the Chinese town Hankou, the former Foreign Concessions, and a contemporary central business district.

Urban development in the Metropolitan Area outside the Inner City has been almost entirely based on detailed urban planning

and design that is realized as planned and has not (yet) been transformed. The morphological analysis on this level of scale is therefore relatively simple and does not need great detail.

The situation in the Inner City is more complex, as its urban form has gone through many transformations in history. For this reason, the scale of analysis needs to be smaller.

The third level of scale in the analysis is Hankou Riverside. It allows for showing the difference in spatial characteristics between the 'traditional' parts of the city with more or less closed building blocks, and the 'modern' parts with freestanding buildings—often slabs or towers—in so-called flowing space. This is an important difference, as Chinese cities since they began to grow in the 1950s have had a long period of building according to the second, modernistic characteristic. This followed the introduction of the *danwei* system of large, enclosed compounds with combined functions of production, dwelling, and facilities for daily life. *Danwei* is usually translated as work-unit, and was inspired by the Russian example. Though the *danwei* system has been abandoned as a form of organizing living, working and facilities in one compound, in many places the spatial characteristics, if not the actual building complexes, still remain. The contemporary way of building large residential complexes with freestanding buildings in compounds is often comparable to its spatial characteristics, though at a larger scale.

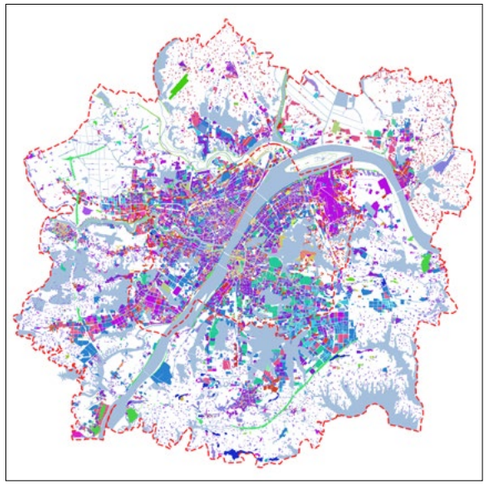


Figure 4.4
Urban land use in GIS format in separate categories, 2013
(Wuhan Land Use and Urban Spatial Planning Research Center; Bekkering, CAI, Kuijper)

Mapping format

Metropolitan Area and Inner City

For two reasons, the format for the mapping on the scales of the Metropolitan Area and the Inner City is GIS. First, the mapping, archiving and monitoring in the municipal planning institutions is in this format, which allows for the integration of different kinds of data. This means on the one hand that the basic data for the research is available in this format, accurately and in great detail, and allows on the other hand for the easy incorporation of the results of the research in the existing mapping and urban monitoring systems. Second, is the availability of the software plugin *Georeferencer GDAL* for GIS, that deforms maps to fit them to each other. Without the help of this software, *Step 5* would be impossible or very complicated and laborious, and the results less precise.

The basic data sets for these scales are land use data (see *Figure 4.4* and following pages).

Figure 4.5
Figure-ground map of Hankou Riverside, 2013
(Bekkering, CAI, Kuijper; Wuhan Land Use and Urban Spatial Planning Research Center)

Hankou Riverside

On the micro scale of the urban district Hankou Riverside, for most of the maps the basic data used is building footprint. (See *Figure 4.5*.) This data is much more detailed and smaller in scale than the urban land use data that is used for the analysis of the meso and macro scales: the Inner City and the Metropolitan Area, though both offer spatial information. The building footprint allows for 'true' figure-ground drawings on the scale of individual buildings in their relation to open space—building footprint in black and open space in white—while the land use data does not indicate open space. Rather, it shows publicly administered space; the space outside the lots with urban land use.

Regrettably, the building footprint data for Hankou Riverside is only available for the years in the timeline after 1970. From 1970 backwards, these maps either do not exist or were not available for the research. The maps from these earlier periods are of street patterns and building blocks, rather than building footprint. Therefore, the series of maps for Hankou Riverside is based on two different map formats. The homogeneous areas on the more recent maps are based on maps of the building footprint at the time, reduced to 'true' figure-ground drawings—building footprint in black, and open space in white. The 1950, 1910, and 1870 maps are based on historical maps of street patterns and building blocks, depicting the composition and hierarchy of the streets. Working backwards in time, this information can also be reduced to homogeneous areas with the same characteristics as when reduced from building footprint. Figure-ground drawings and street pattern maps offer different types of information with different levels of abstraction. The information provided by figure ground maps is more detailed and concrete than that offered by street pattern maps. However, this difference disappears when the data is abstracted into homogeneous areas. (See *Step 6*.)

Legend

The GIS format has direct consequences for the legend of the maps, as the GIS data is based on land use. Traditionally, morphological maps are figure-ground drawings. (See *Figure 3.1*.) That tradition however, is based on analyzing (relatively) small towns or cities (and—one might add—in the Western context). Wuhan is much larger, the Metropolitan Area as well as the Inner City. Because the

analytical maps of Wuhan in this research are based on land use data, they are technically not figure-ground drawings. Because of the way they were drawn, they do resemble figure-ground drawings, as they basically show black for areas with—many different forms of—urban land use, and white for open space, which is different from the building footprint of figure-ground drawings. However, the level of detail of the actual building footprint, if available, would hold too much information, or more information than is needed to understand the form of the city as a whole. (The building footprint data is not available for the Metropolitan Area outside the Inner City, and neither for the entire Inner City.) Using urban land use as the basis for the maps results in a strong reduction of the information, while in its spatial distribution still showing the morphological characteristics of the urban areas on a considerably larger level of scale: their pattern or 'tissue'. (See *Figure 4.6*.)

A third possible type of city map to use in the analysis is the street map. (See *Figure 4.7*.) This, however, offers locational information, and not spatial information. It does not show urban form or even where the city ends and the rural areas begin.

The legend of the newly drawn analytical maps is:

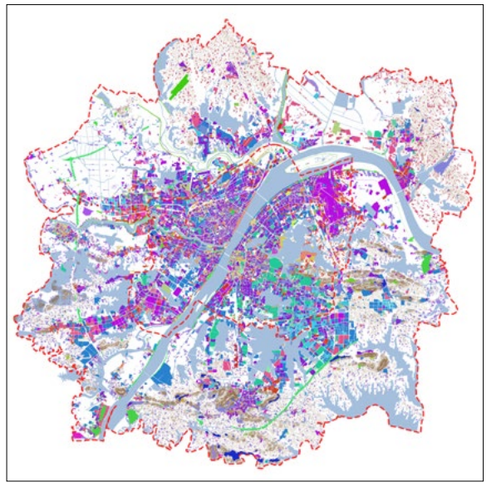


Figure 4.6
Urban land use in GIS format in separate categories, 2013
(Bekkering, CAI, Kuijper; Wuhan Land Use and Urban Spatial Planning Research Center)

black	areas of urban land use with buildings in homogeneous areas (see *Step 6*),
blue	water (rivers and lakes)
green lines	mountainous areas (contour lines)
red lines	large scale transport infrastructure (highways and railroads)
white dotted lines	secondary connections (see *Step 7*)
red dotted lines	administrative borders

The resulting maps are in two important ways different from figure-ground drawings. First, as mentioned earlier, they show plots of land and not the position of buildings. Conversely, in the Chinese

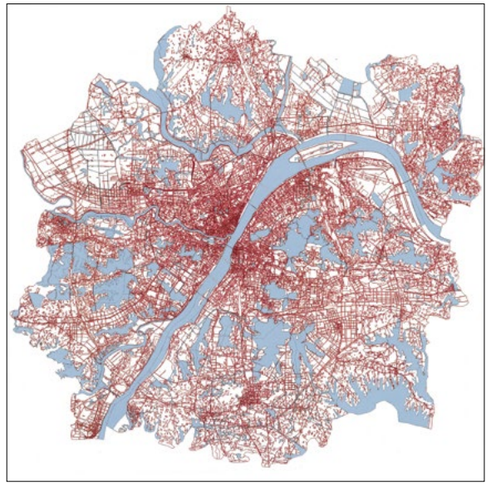


Figure 4.7
Street Map of the Metropolitan Area, 2013
(Bekkering, CAI, Kuijper; Wuhan Land Use and Urban Spatial Planning Research Center)

context, they do not show open space, nor publicly accessible space, but rather publicly owned and managed space. Second, the urban land use includes plots without any building or with few buildings on them. The maps are corrected for this by comparing them to aerial photographs of the same period, as far as these were available. Nevertheless, the maps are morphological maps: on their specific level of abstraction they do show the form of the city.

On the third level of scale in the analysis, of Hankou Riverside, building footprint is available for most periods. This is also more appropriate for the scale of the area researched. On this smaller level of scale, the technique of reduction drawings is used to indicate more differentiated homogeneous areas, thus allowing for categorization of the spatial characteristics of the area in more detail. (See *Chapter 7*.) On the scale of the Inner City (see *Chapter 5*) and the Metropolitan Area (see *Chapter 6*), land use data of many different categories are aggregated, first into urban land uses in general, and then to much larger homogeneous areas. This is intended to show the different fragments of the city that have strong spatial characteristics of their own, differentiating each from the surrounding areas. On the scale of the Metropolitan Area, the data is reduced even further, again aiming to show urban fragments with different spatial characteristics.

By necessity, the series of maps produced holds interpretations and knowledgeable guesses by the authors.

Step 5 **Overlaying maps/georeferencing**

The selected historical maps and aerial photographs are positioned and overlaid on the contemporary base map in the computer, taken from the land use data of 2013. However, the different map projection techniques through time most often result in a misfit when superimposing the historical map on the contemporary base map. This does not necessarily mean historical maps are unreliable. It does, however, create a need for certain degrees of deformation because of these differences. This is done with the application of a specific software: QGIS with the *Georeferencer GDAL* plugin, now fully integrated in QGIS.

The maps of the earliest periods are reconstructions, resulting from a combination of digital techniques and professional insights based on research and experience. These are educated guesses, meant to allow for comparison with the contemporary situation. They show the traces of history that can still be found in the city of today when one knows where and how to look.

To support the correct interpretation of the maps, aerial photographs of the different periods are used as far back as they are available. The aerial photographs show more spatially relevant detail and help identify the homogeneous areas that are the constituting elements of the maps.

Step 6 **reducing map information to homogeneous areas**

To be able to recognize and show formal structure, map information needs to be reduced, often extensively. Analytical maps of the city are drawn, based on the contemporary GIS format map of land use for the entire Wuhan metropolitan area, by applying the technique of morphological reduction. Experience in earlier comparable research (see Bekkering and LIU 2015) has indicated that it is most effective to 'work backwards in time'—a form of reverse engineering—starting with the map of the present situation with reduced morphological information. This visualizes the spatial structure; the morphology of the city on a certain level of scale. For Hankou Riverside it was necessary to combine working backwards and forwards in time to bring out the transformations on this level of scale, as the area showed an extreme intensity of change. (See *Chapter 7*.)

Figure 4.8
Rural part of metropolitan area, 2019 (Google Maps 2019)

A consequence of this approach is that the grain of our maps and the way we made them more easily show urban extensions than urban transformations on a small scale. For studying small scale urban renewal in depth, the scale of the research and the data will also have to go down.

The maps are composed of what are called homogeneous areas. Homogeneous areas, that are recognized on the map as (1) having a certain degree of internal formal consistency, and/or (2) in comparison to neighboring areas are either different in formal structure, or (3) clearly separated from each other.

In the outskirts of the Metropolitan Area small size built-up areas indicate villages and farms. These are not represented in the analytical maps, though these areas are not unbuilt. They do not have an urban form, but rather a rural form. (See *Figure 4.8*.)

Step 7 **Adding secondary connections**

After defining the homogeneous areas on the meso scale level of the Inner City, which involved a strong reduction of the map data, secondary connections were added that do two things: they indicate the internal formal structure of homogeneous areas that have such a structure, and they show connections between adjacent homogeneous areas where these exist. (See *Chapter 5*.)

Step 8 **Deducting spatial structuring elements of the urban form**

This step leads to the CONCLUSIONS: *Chapters 8* through *11*.

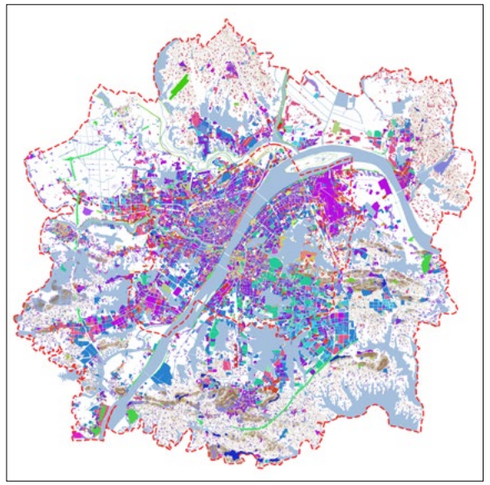


Figure 4.9
Urban land use in GIS format in separate categories, 2013 (Bekkering, CAI, Kuijper; Wuhan Land Use and Urban Spatial Planning Research Center)

The practice of the analysis

The analysis starts with the ground conditions of the urban territory. As mentioned before, the main morphological elements are:

- rivers and lakes,
- hills and mountains,
- built-up areas and open space,
- main infrastructures.

The base map of the land use situation of the original research is from 2013 in GIS format. This data shows too much information, preventing easy recognition of the spatial urban structure; although with an experienced eye and intimate knowledge of the city, it is possible to see the basic structure concealed in this image. (See *Figure 4.9*.)

When in the same database all urban land use is combined into one category and turned black, it becomes clearer, but there is still too much information. (See *Figure 4.10*.) This map may already look similar to a figure-ground drawing, as is usual in morphological research, but as it is based on land use data, it is technically different.

To further reduce the information, the GIS map is traced by hand. (*See Figure 4.11*.) The capacity of the human eyes and brain to together zoom-in and -out allows for interpretation on different scales and across scales simultaneously. The process of reducing map information according to the Delft School of morphological analysis involves—expert—interpretation and abstraction of the map data into what is called homogeneous areas. This is intended to be a simplification, bringing to the fore the spatial structure of the city: the urban form or morphology.

There are three criteria for determining the homogeneous areas:

1. internal spatial consistency,
2. strong difference from neighboring areas,
3. strong borders—that are often hard to cross.

This is the core of the working method of the Delft School. The homogeneous areas visualize the spatial structure: the city's morphology on a certain level of scale. They not only display the 'skeleton' of the city, but also its deep structure, in the relationships between the different homogeneous areas.

The maps represent urban mass rather than networks of streets, to detect the structural spatial elements that determine the city as it is. Even though maps based on urban mass or on infrastructure may superficially look quite similar, they are not the same. The mapping

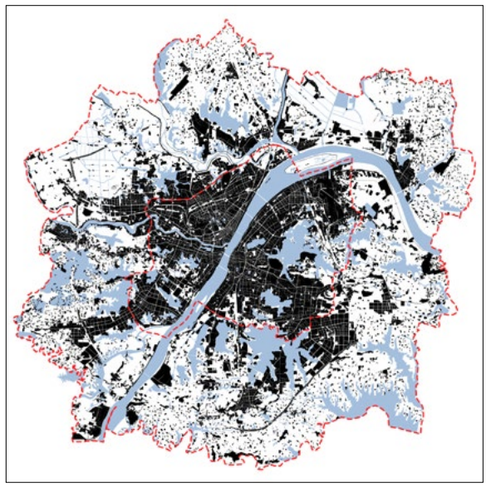


Figure 4.10
Urban land use in GIS format combined, 2013 (Bekkering, CAI, Kuijper)

of urban mass allows for creating homogeneous areas, while leaving out detailed information internal to those areas that is not structural on a specific scale. The mapping of street networks does not easily allow for this. (See *Figure 4.7*.)

It is important to notice that in the maps, some of the more recent parts of Wuhan that have the modernistic characteristics of large secluded compounds (gated communities) with free standing buildings in flowing space, look the same as the traditional areas in the city, that can be considered a continuous mass of buildings with a coherent network of public/open space cut out from it. (See *Figure 3.1*, in which the two figure-ground drawings show this difference.)

Working backwards in time, similar to reverse engineering, describes the order in which the analytical maps are constructed. The first or base map is the contemporary one in GIS format of the land use situation in 2013. This map has the most reliable and generally accepted cartographic projection. For the one earlier map of 2006 in the timeline, the areas with no urban land use are subtracted from the 2013 map. This shows the transformation of the city between 2006 and 2013. Additional attention is given to urban transformation inside the city. And so on for the next earlier map, and so on in nine steps.

The base map in the original report of the research is of 2013. For this ATLAS two time periods are added: 2016 and 2019. This means that the order in which the new maps are made is not working backwards in time: newly built-up areas are not subtracted but added to the map of the previous period. The maps used to determine the changes in the urban form all have the same cartographic projection and perfectly fit to the 2013 base map, and to each other.

As mentioned before, historical maps deviate from the contemporary map in varying degrees—sometimes considerably—because of differences in the cartographic projection applied by the mapmakers of that time. Therefore, by working backwards in time, these cartographic differences can successively be eliminated (in *Step 4* and *5*), and the maps in the series are made directly comparable by overlaying them on top of each other.

Simply explained: for maps of earlier periods of the urban development, areas are subtracted that were not yet built up, retaining the elements that have remained over the time period. In addition, parts of the existing city that have been transformed, are 'restored' to their earlier form. To determine the internal changes in the city, it is necessary to compare the maps with aerial photographs of preferably the same years as those in the timeline. This approach is applied to all three map series on the different levels of scale: the macro scale of the Metropolitan Area, the meso scale of the Inner City, and the micro scale of Hankou Riverside.

This method is effective until the moment when the historical maps prove to be too unreliable. This occurs when the deformation of a map, while attempting to fit it to the contemporary map in the *Georeferencer*, creates an unrecognizable image. Then the method changes into reconstruction of the earlier phases of the city form. (See *Figure 5.58–62*.)

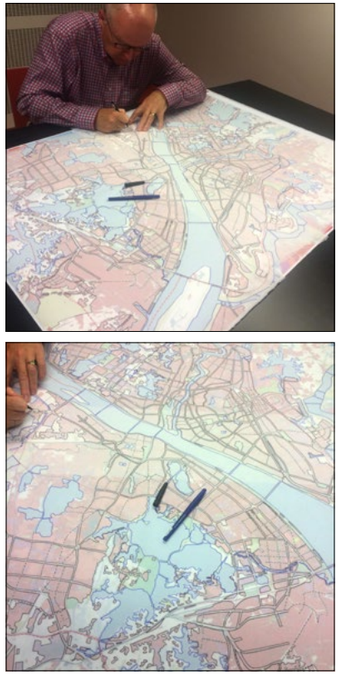


Figure 4.11
Drawing of the homogeneous areas on the Inner City scale by Henco Bekkering

Bringing the research up to date

The above describes the research that was done between 2013 and 2015. Later, we decided to transform the report as delivered to the Wuhan Land Use Urban Spatial Planning Research Center into an atlas that is accessible for the profession and possibly a larger public. Then, in Wuhan started the pandemic of Covid-19.

> *Beginning on January 20, Wuhan [was] gripped by a cloud of fear and anxiety for the next three days as we quickly approached the quarantine order. Locking down an entire city with a population of millions in order to stop the spread of an epidemic was a historically unprecedented action.* (FANG 2020 p 20)

The city went into lockdown, and it was impossible to visit the city as the Dutch authors had done earlier. The municipal institutions were suddenly fully occupied by the emergency. Nevertheless, we gained access to data allowing us to draw two additional maps for each series of the research, extending the timeline from 2013 with 2016 and 2019.

In the two additional periods, the transformations of the city shifted gradually from ever more extending into the surrounding countryside to densifying the city itself. This can result in changes to the form and size of the homogeneous areas. Where this is the case, it shows in the new maps.

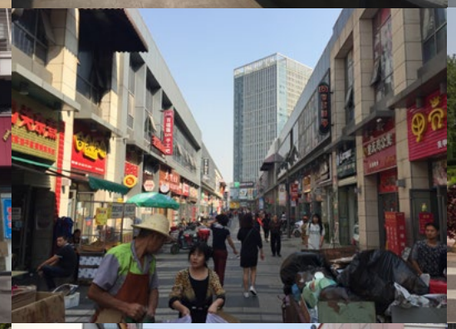
MORPHOLOGICAL RESEARCH

Atlas

Photocollage 4
Contemporary public space

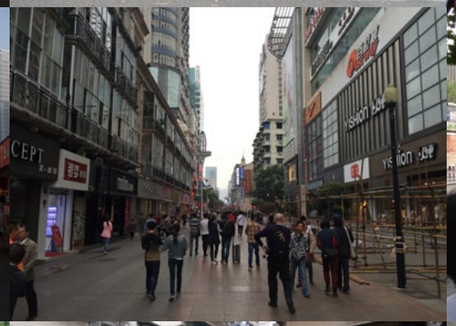











Chapter 5
Inner City: meso scale

The ATLAS starts with the Inner City, the meso level of scale, as up to the beginning of the twenty-first century there was no urban development outside its boundaries, which are the borders of the municipality of Wuhan.

1870

Reconstruction of the Inner City in 1870

The historical maps of the nineteenth century and earlier are more like drawings than actual maps: beautiful but not topographically dependable. (See *Figure 5.1*.) Thus, the reconstruction of the map of the three original towns, Hanyang, Wuchang, and Hankou around 1870, involves comparing these maps to each other and to the contemporary base map.

1870 The origins of Wuhan: Hanyang, Wuchang, and Hankou

A map of 1890 shows the three towns together, with the rivers running between them. (See *Figure 5.2*.) When trying to georeference this map on the contemporary map of the city however, the map is distorted to such a degree that the result is unreliable.

Nevertheless, this map was clearly the base for the 1890 reconstruction map published by W.T. Rowe in his 1989 book *Hankou. Conflict and Community in a Chinese City*. (See *Figure 5.3*.)

1910

1950

Figure 5.1
Hanyang, Wuchang, and Hankou, 1876
(Compilation Committee 1998 p 22)

1970

1990

2000

2006

2013

2016

2019

1870

1910

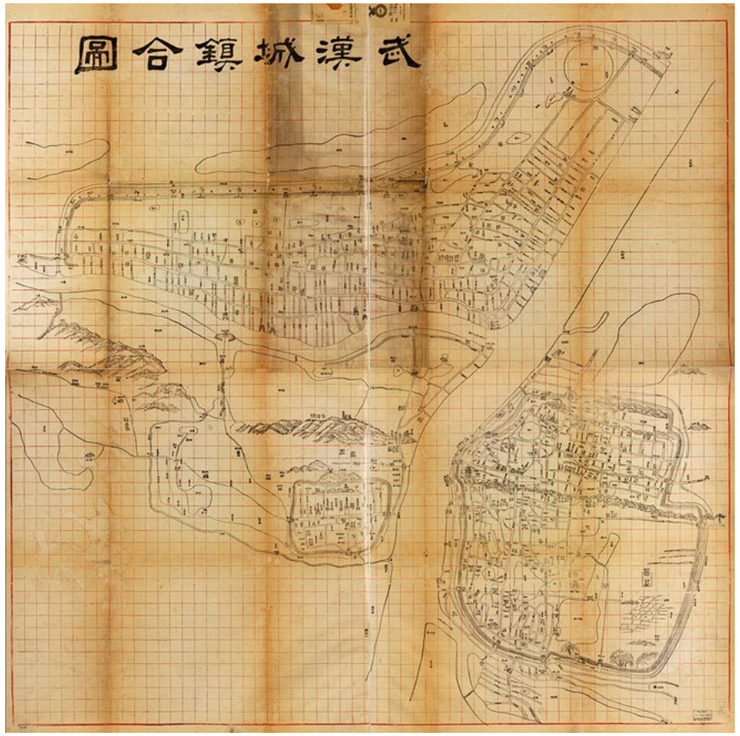


Figure 5.2
The three original towns, Hanyang, Wuchang, and Hankou, 1890
(Qiaokou National Industrial Museum)

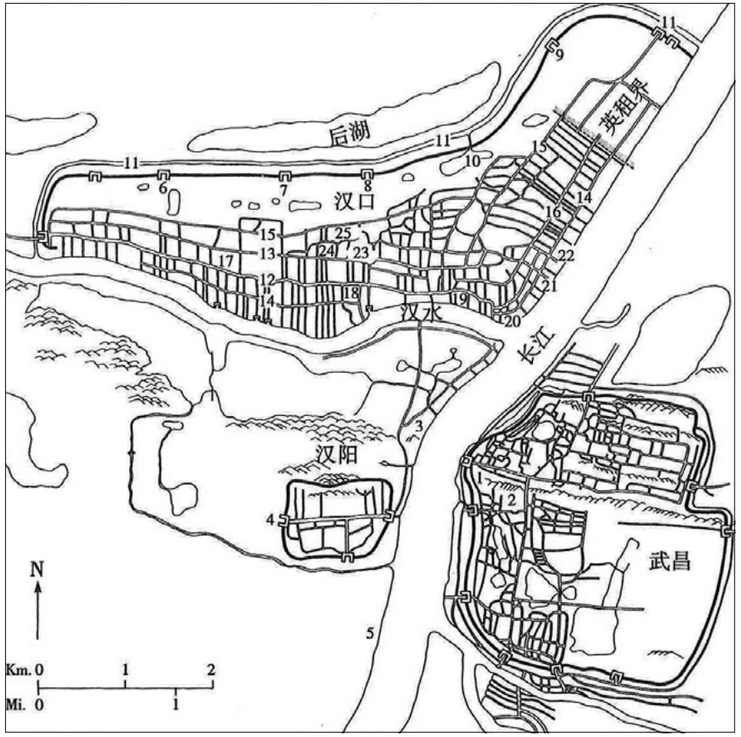


Figure 5.3
1890 reconstruction map of Hanyang, Wuchang, and Hankou by W.T. Rowe
(Rowe 1989 p 72)

1950

1970

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2006

2013

2016

2019

We discovered that it is possible to reconstruct the map in considerably more dependable detail than in Rowe's. Our reconstruction is mainly based on the four historical maps on these pages so as to achieve a much higher accuracy:

- 1909 map of Hanyang (see *Figure 5.4*),
- 1909 map of Wuchang (see *Figure 5.6*),
- 1868 map of Hankou (see *Figure 5.5*),
- 1918 map of Hankou (see *Figure 5.7*).

The dates of these maps are not close to the year 1870, but they are reasonably reliable when compared to the contemporary map. To reconstruct the 1870 situation, these maps were compared to other historical maps, in themselves less geographically reliable, but the comparison made it possible to decide on details. To further check the results, specific elements like gates and main streets are compared to the names of streets and squares in the contemporary city. Often, the names are preserved even when the actual artifacts have disappeared. The four maps are georeferenced on the map of the next period: 1910. (See *Figures 5.69* through *73*.)

Maps on these pages have different scales

Figure 5.4
Hanyang, 1909
(Compilation Committee 1998 p 34–35)

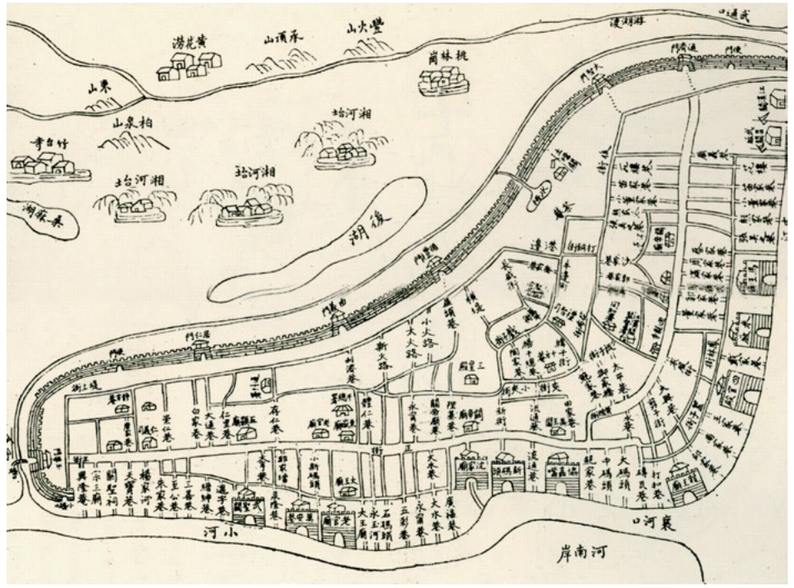


Figure 5.5
Hankou, 1868
(Compilation Committee 1988 p 18)

1950

1970

1990

2000

2006

2013

2016

2019

Figure 5.6
Wuchang, 1909
(Compilation Committee 1998 pp 30–31)

Figure 5.7
Hankou, 1918
(Compilation Committee 1998 pp 48–49)

1950

1970

1990

2000

2006

2013

2016

2019

1870

Like the other maps of the Inner City in this research, this map shows homogeneous areas. These are relatively large since the spatial characteristics of the urban areas at this time were similar. (See *Figure 5.9*.) This way, the map fits in the series of maps of the historical development of the Inner City.

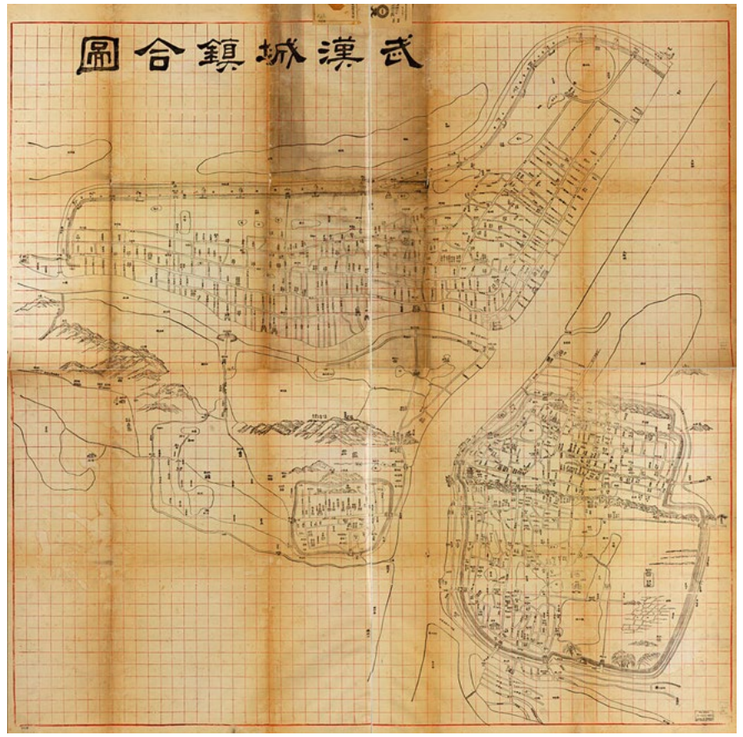
At the same time, the material analyzed allowed for the reconstruction of the map of the three constituent towns around 1870 in considerably more detail than offered by Rowe's map. (See *Figures 5.3, 8* and *10*.)

The three towns are of different age and each has its own characteristics. Hanyang, established in 621, and Wuchang, established in 223, are both protected by a wall and a moat. Their urban tissues are rather alike, but Wuchang is much larger, and has an unbuilt zone running east-west because of a mountain range and a series of lakes and ponds. There is also a considerable area as a military reserve with more open space. Hankou came into existence much later, between 1465 and 1487, after the Han River was diverted from its course south of the town to the north side. The land and buildings on this side became separated from the walled town of Hanyang. (See *Figure 2.10*.) From the beginning, Hankou was a port town, therefore even though it had a wall towards the north and west, it was always open to the Yangtze and the Han Rivers with banks and quays to facilitate trading.

In 1861 the political situation in China after the wars with western countries led to the establishment of Foreign Concessions in the important Chinese port cities, as in Wuhan. Even though it is far from the sea, is was the furthest inland port that could be reached by sea ships sailing upstream the Yangtze River. In Wuhan, the Concessions were located as an extension of Hankou downstream along the Yangtze River bank, towards the north. The town wall was extended to include these specially designated and designed areas.

When represented on the scale of the Inner City, it shows how small these three towns were in 1870 compared to the contemporary city. (See *Figure 5.9*.)

1910



1950

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Figure 5.8
The three original towns, Hanyang, Wuchang, and Hankou, 1890 (Qiaokou National Industrial Museum)

1870

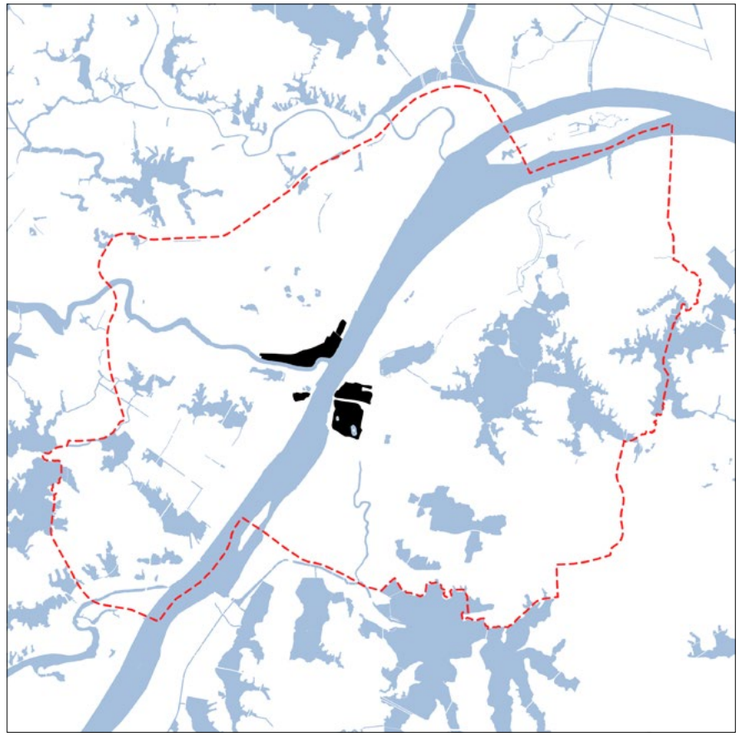
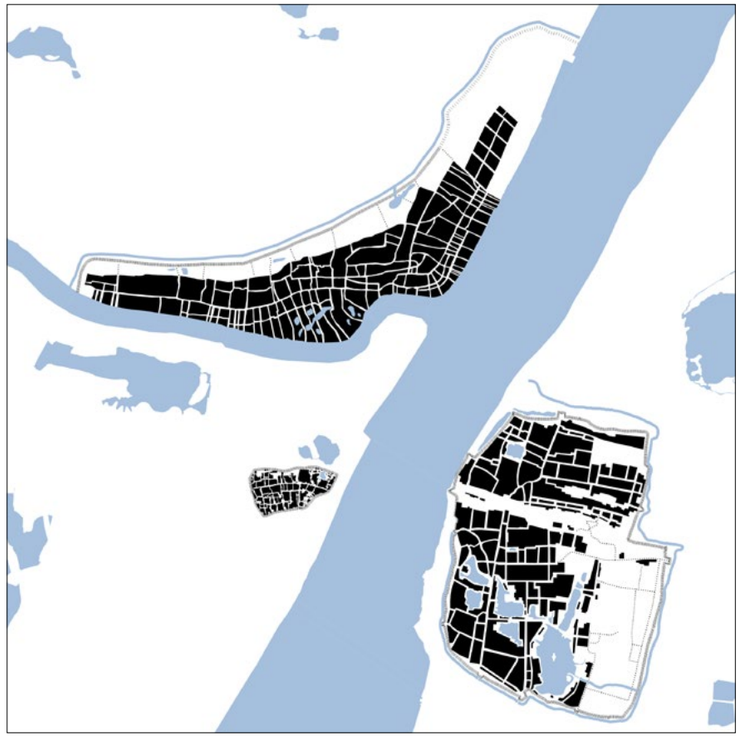


Figure 5.9
Three towns reconstruction map with homogeneous areas on the meso scale of the Inner City, 1870 (Bekkering, CAI, Kuijper)

1910



1950

1970

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2019

Figure 5.10
Three towns reconstruction map of Hanyang, Wuchang, and Hankou, 1870 (Bekkering, CAI, Kuijper)

1870

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2013

2016

2019

A reconstruction plan for Hankou dated 1912 shows how even in the beginning of the twentieth century plans were made that would have required total demolition of the historical urban tissue of the town. The realization of the plan would not only have destroyed the old town, both buildings and urban tissue, but would also have resulted in an urban environment in which it would be hard to find one's orientation, and with a great many inconvenient triangular building plots. (See *Figure 5.11*.)

Another reconstruction plan for Hankou, somewhat surprisingly dated a year earlier, indicates that at that time there was already a discussion on the degree of demolition that would be acceptable. (See *Figure 5.12*.)

For Wuchang, too, a reconstruction plan with an overall grid was made in 1923, requiring complete demolition. (See *Figure 5.13*.)

Fortunately, these plans were not executed and important parts of the local identity have so far been saved.

Maps on these pages have different scales

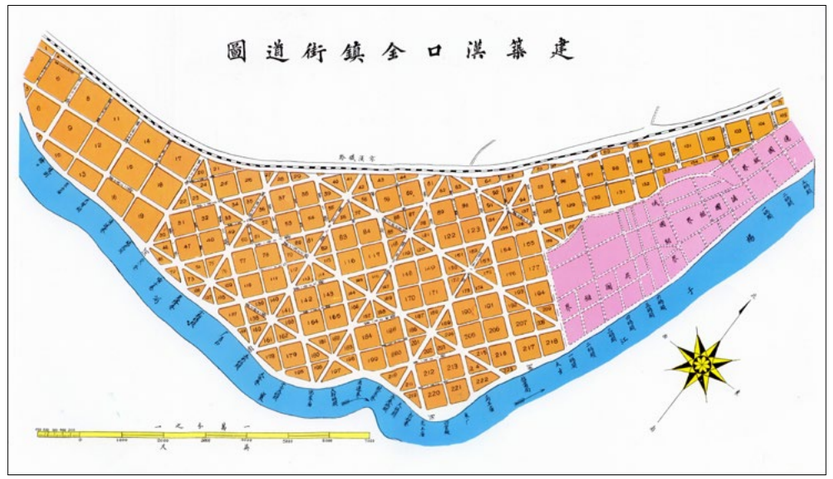

Figure 5.11
Hankou reconstruction plan, 1912 (Wu Z 2009)

Figure 5.12
Hankou reconstruction plan, 1911 (Archives and Special Collections, Library, School of Oriental and African Studies, University of London; reference CWM/LMS/15/14/037)

1870

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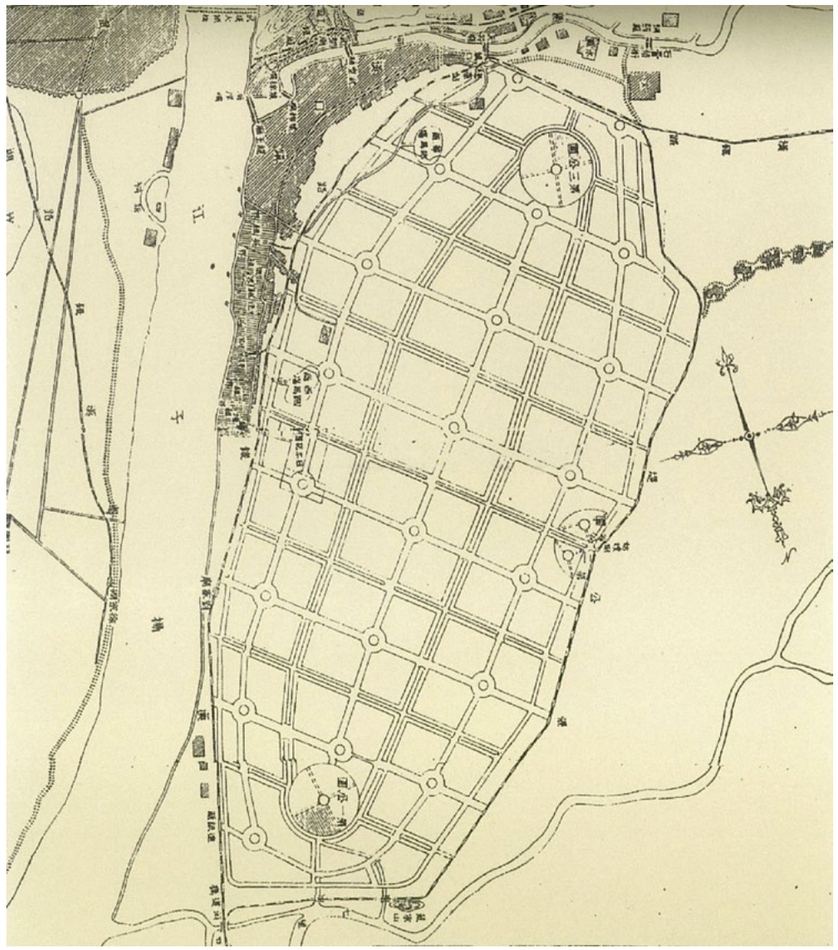


Figure 5.13
Wuchang Reconstruction plan, 1923 (Wu Z 2009)

1870

1910

Inner City in historical order

The series of analytical maps of the Inner City is first presented in historical order. This is not the sequence in which the maps were made: they were made working backwards in time (see *p.96* and following), however, the historical order best visualizes the growth of the city. In the following series of analytical maps, each spread shows three successive maps: the map with the homogeneous areas of the year at the beginning of the period; the map that shows the changes in the urban form during the period; and the map of the situation at the end of the period.

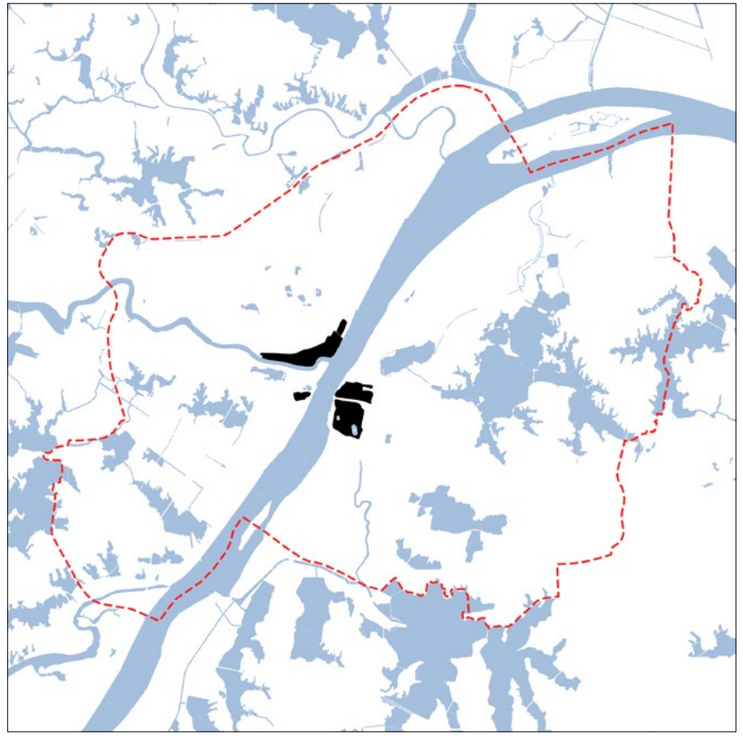
Inner City homogeneous areas, 1870 ▸ 1910

The three towns with their distinctive characters constitute all of the urban area in 1870. Since 1861, Hankou is extended with the areas of the Foreign Concessions.

In the period from 1870 to 1910 the considerable urban growth results from the industrial policy set up by ZHANG Zhidong, a high official in the late Qing dynasty. Among other new factories is the large complex of the Hanyang Ironworks situated north of Hanyang on the Han River.

In Hankou the Foreign Concessions are growing downstream along the Yangtze River as well as land inward. Both Hanyang and Wuchang develop areas immediately outside their walls.

Some of the authentic urban tissue from this time has not been destroyed in 1910—yet. Together with the well saved urban grids of the Foreign Concessions, these areas still contribute to the identity of the contemporary city.



1950
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1990
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2006
2013
2016
2019

Figure 5.14
Inner City homogeneous areas, 1870
(Bekkering, CAI, Kuijper, ZHANG)

1870

1910

Figure 5.15
Inner City homogeneous areas, 1870 ▸ 1910
(Bekkering, CAI, Kuijper, ZHANG)

1950
1970
1990
2000
2006
2013
2016
2019

Figure 5.16
Inner City homogeneous areas, 1910
(Bekkering, CAI, Kuijper, ZHANG)

Inner City homogeneous areas, 1910 ▸ 1950

The relatively modest urban development in the period from 1910 to 1950 is based on the New Urban Theory coming out of the May 4th Revolution of 1919. The emphasis is on solving the housing problem, resulting in the expansion of mostly Hankou. Wuchang also shows further growth outside its wall towards the north. This wall is finally completely destroyed in 1929. Downstream on the Yangtze River a few new sites are developed.

The three towns are increasingly fusing together, also on governance levels, with the first zoning regulations resulting in—among others—business and university districts. Wuchang is designated 'the city of culture'.

1870
1910
1950
1970
1990
2000
2006
2013
2016
2019

Figure 5.17
Inner City homogeneous areas, 1910
(Bekkering, CAI, Kuijper, ZHANG)

1870
1910
1950
1970
1990
2000
2006
2013
2016
2019

Figure 5.18
Inner City homogeneous areas, 1910 ▸ 1950
(Bekkering, CAI, Kuijper, ZHANG)

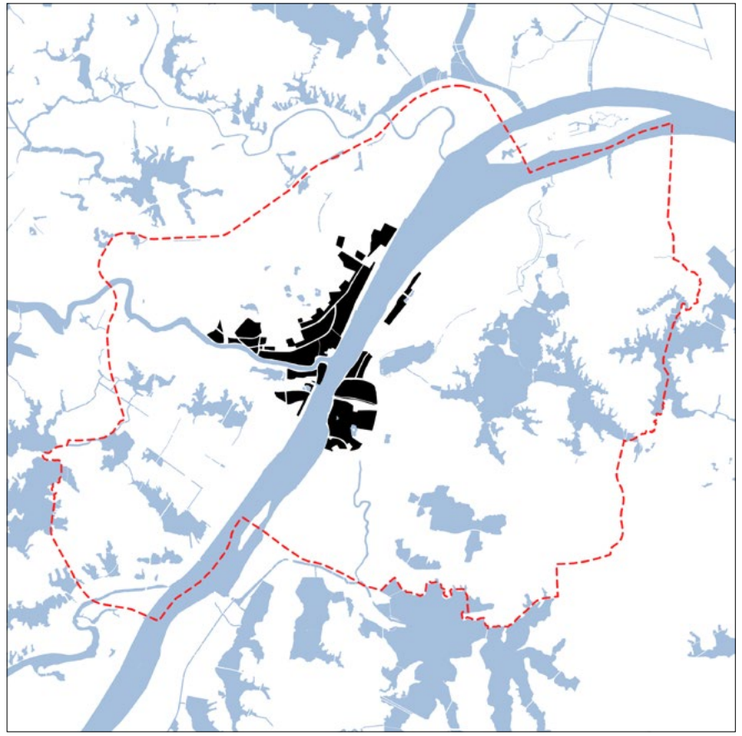


Figure 5.19
Inner City homogeneous areas, 1950
(Bekkering, CAI, Kuijper, ZHANG)

1870

1910

Inner City homogeneous areas, 1950 ▸ 1970

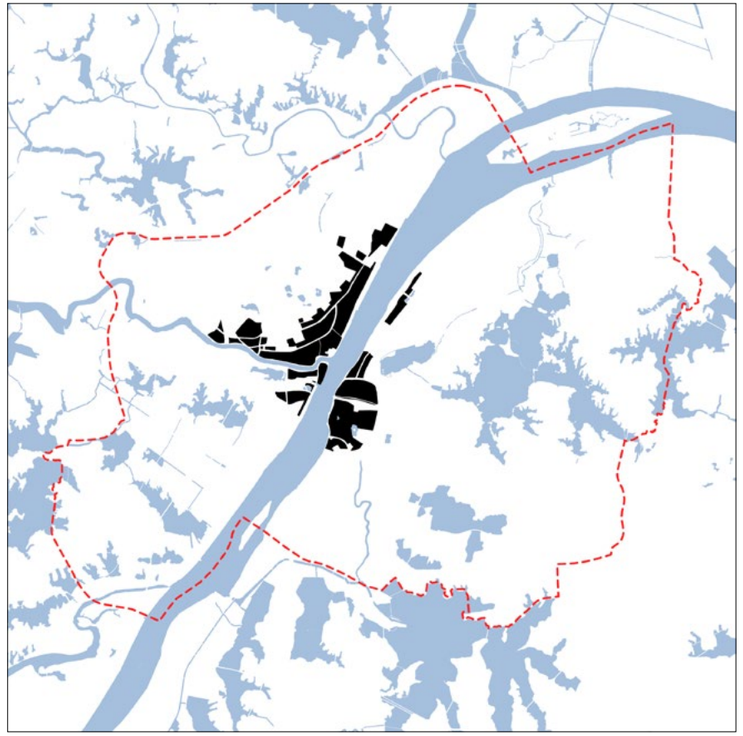
Between 1950 and 1970, coinciding with the so-called Key Construction period, all around the three original towns the urban areas are growing. East of the Yangtze River this occurs at considerable distances from Wuchang to the north as well as to the east. As part of MAO Zedong's Great Leap Forward, important heavy industry is spread over the country for strategic reasons, also to Wuhan. The biggest of these new factories is Wuhan Iron and Steel, built in the 1950s in the northeast at a considerable distance from the city. The strong growth of Wuhan is directly related to the multitude of new industrial activities. The industrial complexes are generally organized and built to include dwellings and facilities for their workers in guarded compounds called *danwei* (work-units), pulling population away from the old town environments.

The planning principle is 'big scattered, small concentrated'. This system is taken over from Russia, as is the form of master planning with strong design features, for instance in the new neighborhood of Hongshan Square with its business center around the central square, and avenues radiating from that. (See *Figure 9.6* middle left.) Many of the elements of this period are still recognizable in the contemporary city, constituting part of its identity and character.

In this period, new large traffic infrastructure is implemented according to the national Second Five Year Plan: the Jianghan Bridge over the Han River in 1956, and the Wuhan Yangtze River Combined Highway and Railway Bridge in 1957, with connecting roads and intersections.

1950

1970



1990

2000

2006

2013

2016

2019

Figure 5.20
Inner City homogeneous areas, 1950
(Bekkering, CAI, Kuijper)

1870

1910

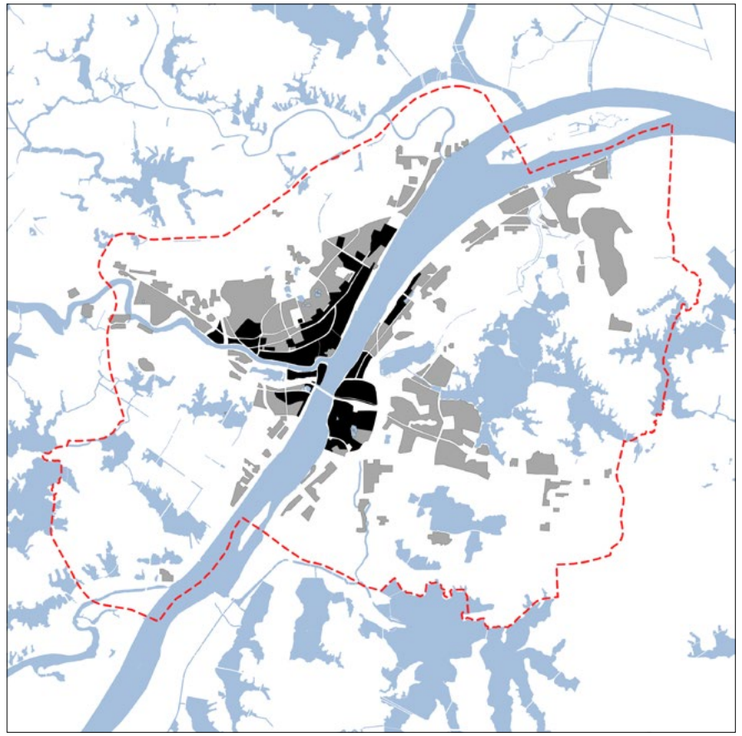
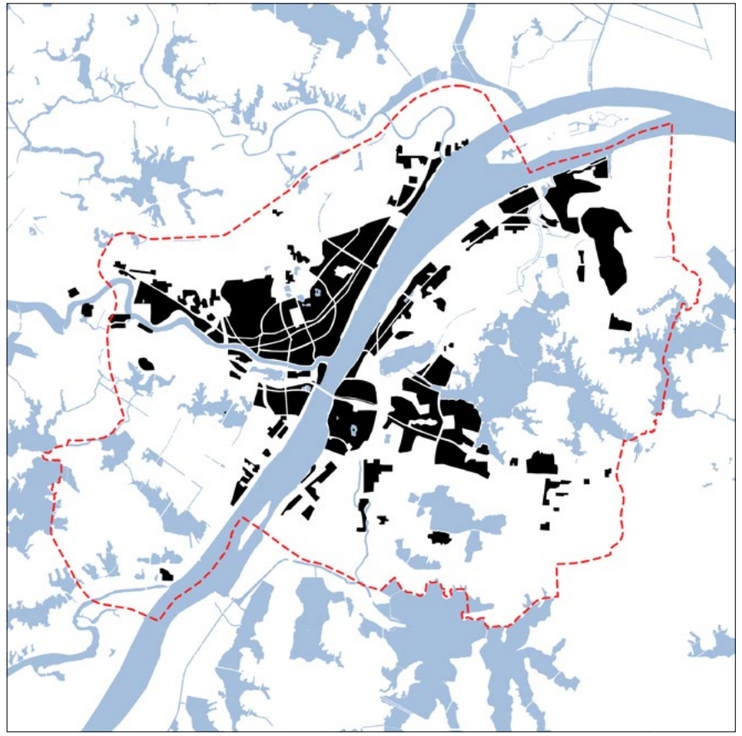


Figure 5.21
Inner City homogeneous areas, 1950 ▸ 1970
(Bekkering, CAI, Kuijper)

1950

1970



1990

2000

2006

2013

2016

2019

Figure 5.22
Inner City homogeneous areas, 1970.
(Bekkering, CAI, Kuijper)

Inner City homogeneous areas, 1970 ▸ 1990

'The first part of this period, up to 1977, is called the Slow Development period. After 1977 growth accelerated again in response to DENG Xiaoping's 'Reform and Opening Up' policy. Fast building initially follows the main roads. Next, new centralities are established and new construction is concentrated around these, like the Zhongbei Road District in Hankou. Most of the development is adjacent to existing urban areas.

At the same time there is an onset to increase large infrastructure, such as the Zhiyin or Concert Bridge over the Han River, built in 1978.

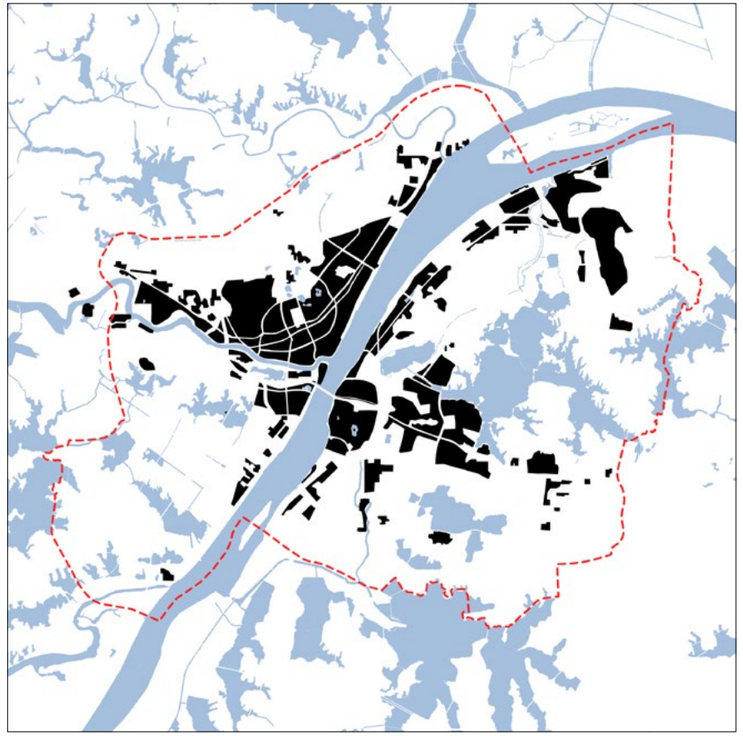


Figure 5.23
Inner City homogeneous areas, 1970
(Bekkering, CAI, Kuijper)

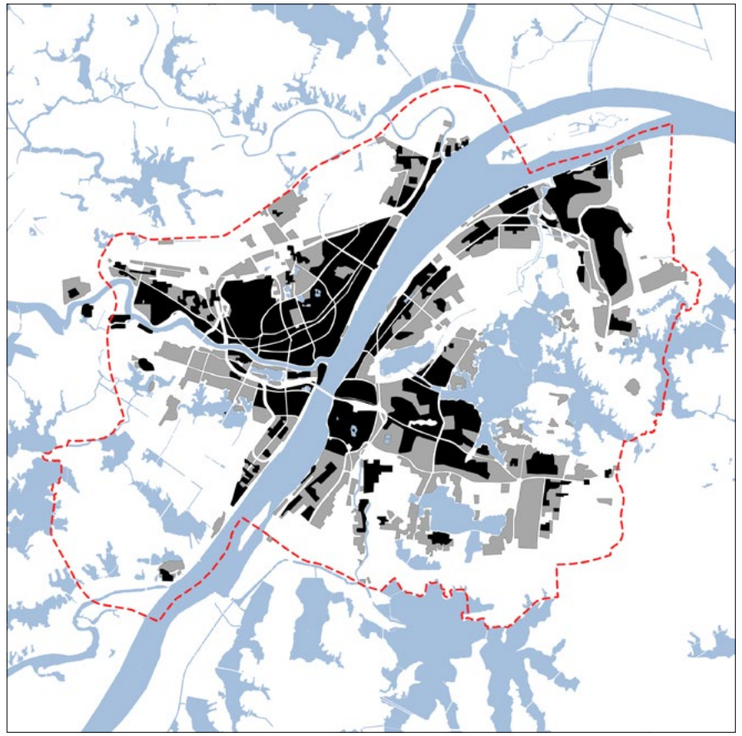


Figure 5.24
Inner City homogeneous areas, 1970 ▸ 1990
(Bekkering, CAI, Kuijper)

Figure 5.25
Inner City homogeneous areas, 1990
(Bekkering, CAI, Kuijper)

Inner City homogeneous areas, 1990 ▸ 2000

In this first part of the Rapid Development period from 1990 to 2000, next to filling in open spaces in the Inner City, new extensions of the city begin to spill over the municipal borders into the Metropolitan Area. This proves to be the start of much larger extensions in the following years. As this period covers only ten years, it shows the acceleration in urban development.

The new service industry is located in the urban centers, strengthening their position. New Economic and Technological Development Zones are created, following national planning policy, and these are driving forces for the expansion.

The first two of a series of new bridges improves the integration between the three areas separated by the two big rivers: the Wuhan Yangtze River Highway Bridge/ Wuhan Yangtze River 2 Bridge in 1995, and the and the Yuehu or Lake Bridge over the Han River in 1998.

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Figure 5.26
Inner City homogeneous areas, 1990
(Bekkering, CAI, Kuijper)

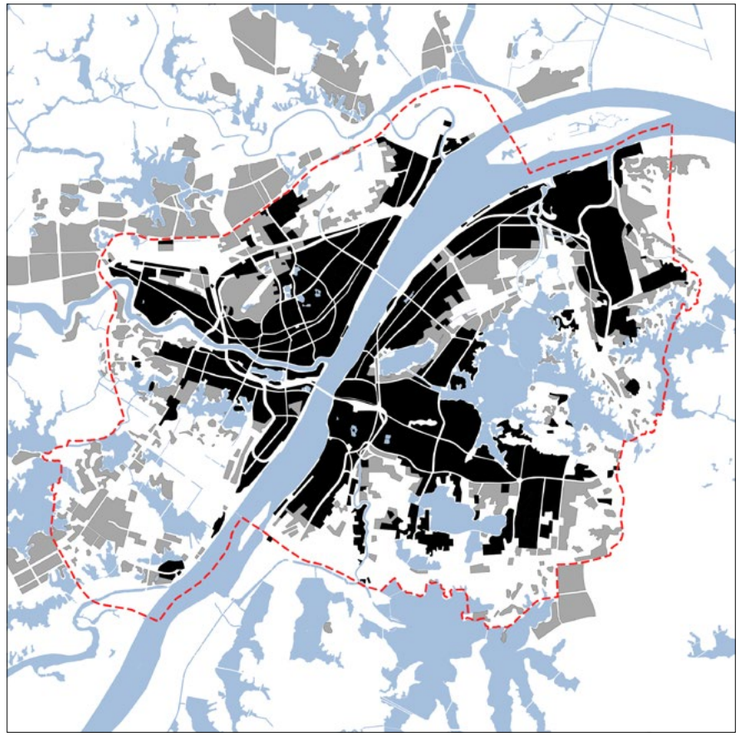

Figure 5.27
Inner City homogeneous areas, 1990 ▸ 2000
(Bekkering, CAI, Kuijper)

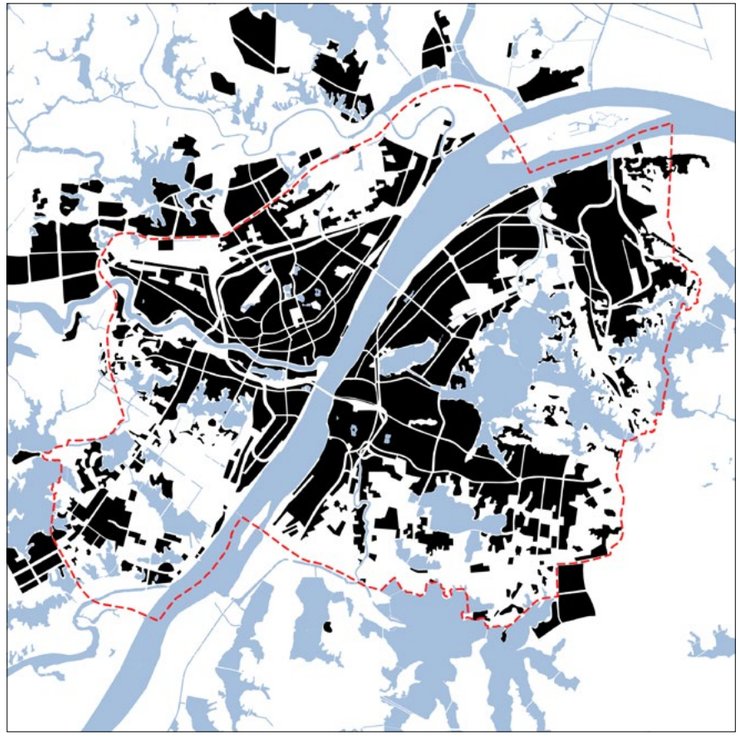

Figure 5.28
Inner City homogeneous areas, 2000
(Bekkering, CAI, Kuijper)

Inner City homogeneous areas, 2000 ▸ 2006

Growth continues in the period from 2000 to 2006, though at a somewhat slower pace. To support this, and the future growth of the city, the spatial structure of 'Ring + Radians' is conceived and realized in the form of new large scale infrastructure. (See *Figure 12.1*.) The first Central Business District is established in the eastern part of the city, and the Economic and Technological Development Zones develop quickly by also moving small industry out of the Inner City to these new areas. Many of the frayed open edges of the Inner City are filled in.

The building of new infrastructure is intensified. In this period four new bridges are built: the Wuhan Baishazhou Bridge over the Yangtze River, and the Qingchuan Bridge over the Han River, both in the year 2000, and the Wuhan Junshan Yangtze River Bridge plus the Changfeng Bridge and Caidian Hanjiang River Bridge over the Han River, both in 2001. Work begins on the metro system. The first section of Line 1 is opened for the public in 2004.

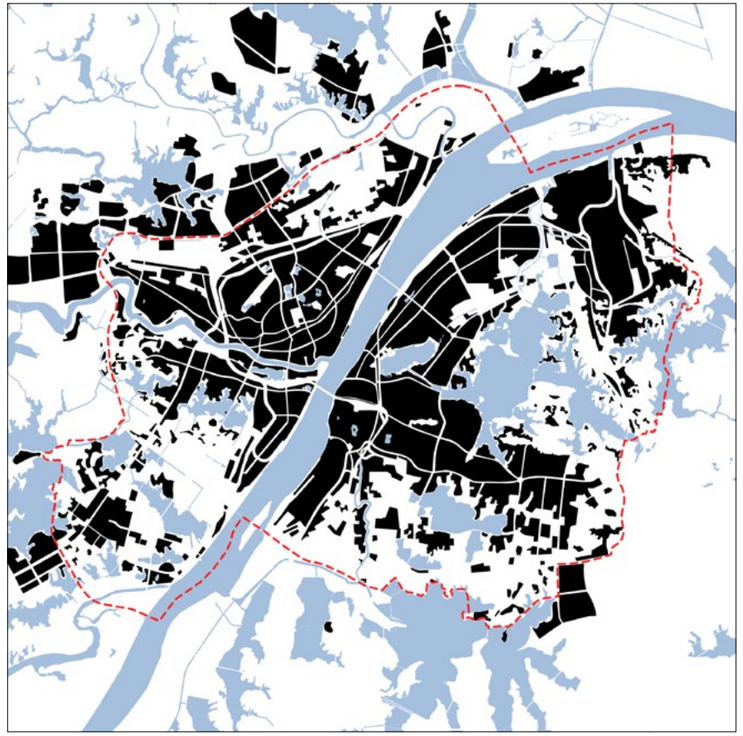

Figure 5.29
Inner City homogeneous areas, 2000
(Bekkering, CAI, Kuijper)

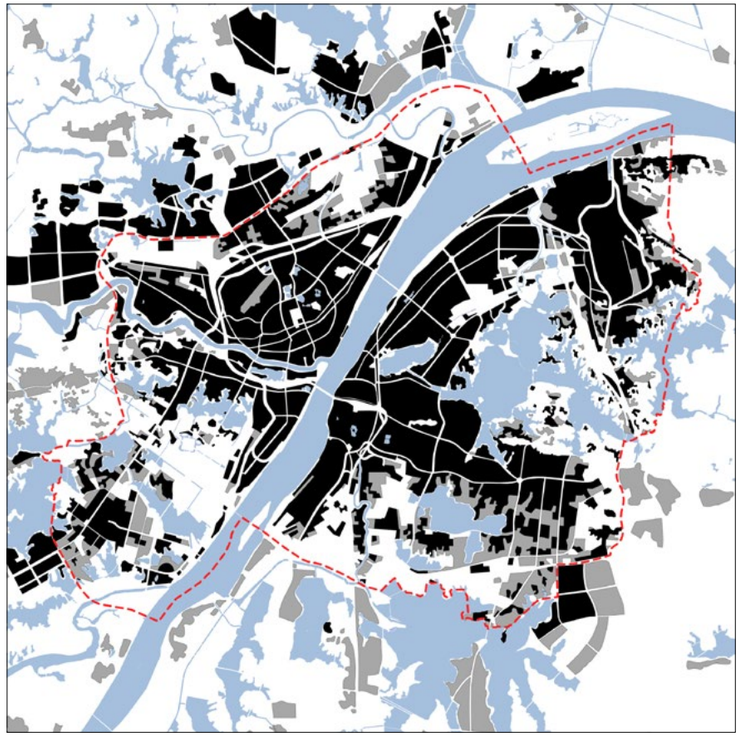

Figure 5.30
Inner City homogeneous areas, 2000 ▸ 2006
(Bekkering, Cai, Kuijper)

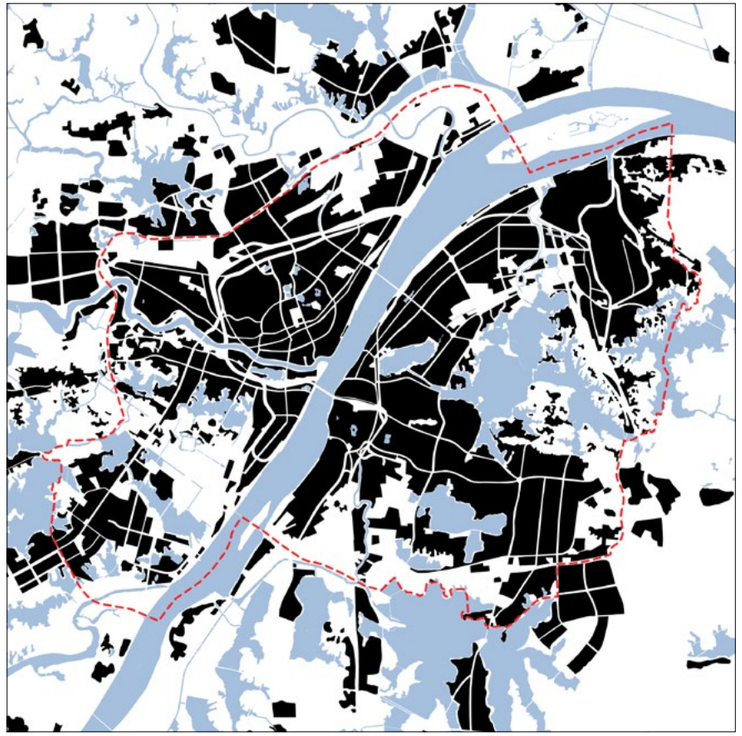

Figure 5.31
Inner City homogeneous areas, 2006
(Bekkering, CAI, Kuijper)

Inner City homogeneous areas, 2006 ▸ 2013

From 2006 to 2013 growth speeds up again, and further intensifies and extends into the Metropolitan Area outside the municipal borders. Inside the borders of the Inner City the last remaining non-urbanized land is developed. The transformation from a mono-centric to a polycentric spatial structure continues.

More large scale infrastructure is realized. New bridges are added: the Wuhan Yangluo Yangtze River Bridge in 2007, the Wuhan Tianxingzhou Yangtze River Bridge in 2009, and the Wuhan Seven or Erqi Yangtze River Bridge in 2011. The Wuhan Yangtze River Tunnel is opened for traffic in 2008. Line 2 of the metro system is operational in 2012.

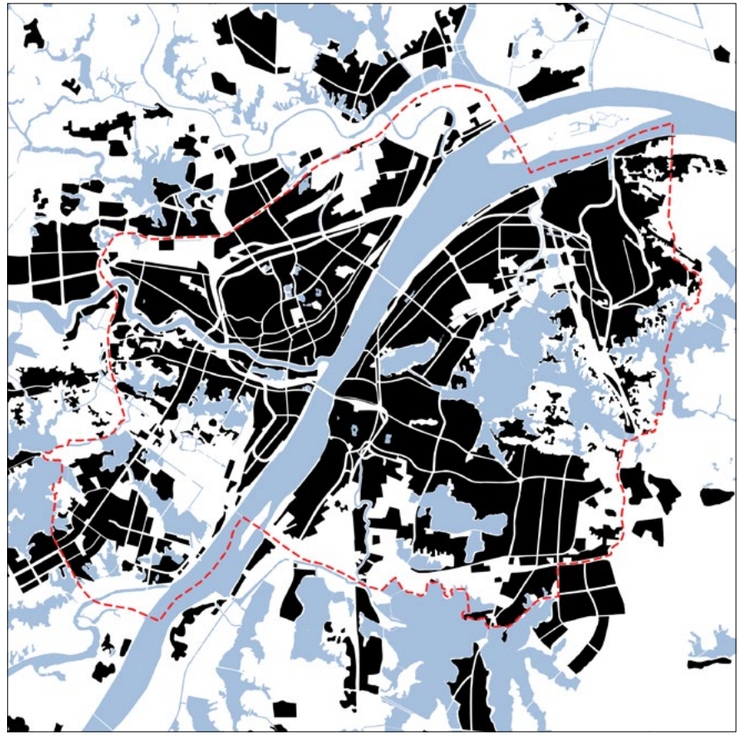

Figure 5.32
Inner City homogeneous areas, 2006
(Bekkering, CAI, Kuijper)

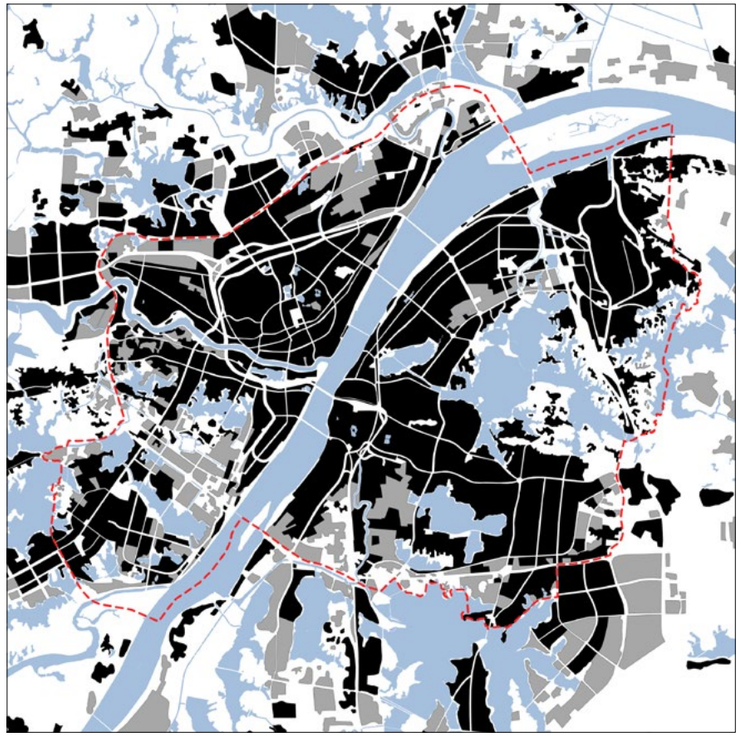

Figure 5.33
Inner City homogeneous areas, 2006 ▸ 2013
(Bekkering, CAI, Kuijper)

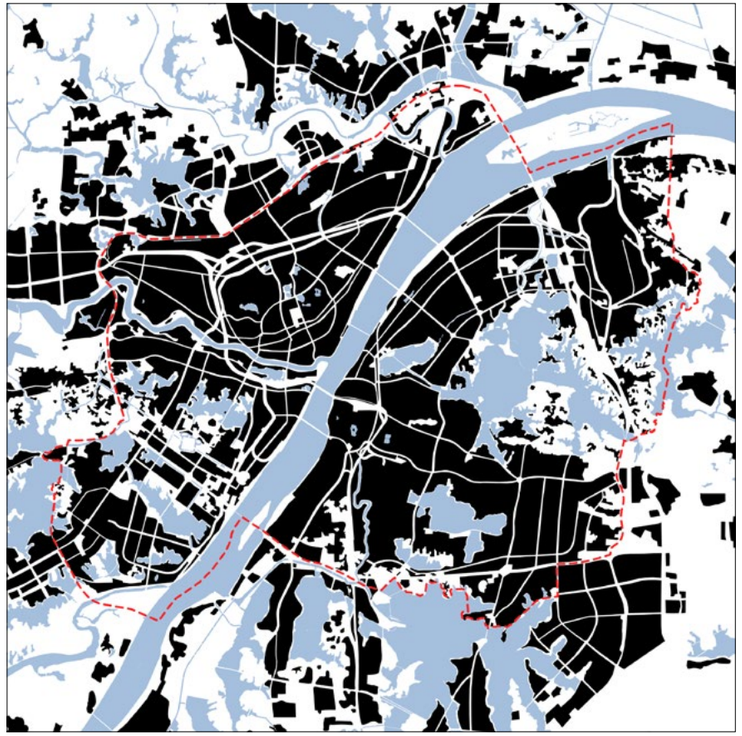

Figure 5.34
Inner City homogeneous areas, 2013
(Bekkering, CAI, Kuijper)

Inner City homogeneous areas, 2013 ▸ 2016

The city continues to grow outward, into the Metropolitan Area. Within the area of the Inner City the very last, smaller pieces of open land that are not in use as parks are now built up with urban functions.

At the same time, to accommodate a growing population more and more old urban tissue is demolished and replaced by new construction in higher densities. At the same time, more lakes are infilled partially, claiming more land for building, such as Moshui Lake in Hanyang.

In this period, two more bridges are added: the Wuhan Yingwuzhou Yangtze River Bridge in 2014, and the Gutian Bridge and Chine-France Friendship Bridge Bridge over the Han River, both in 2015. Also, three metrolines were added: Line 4 in 2014, Line 3 in 2015, and Line 6 in 2016.

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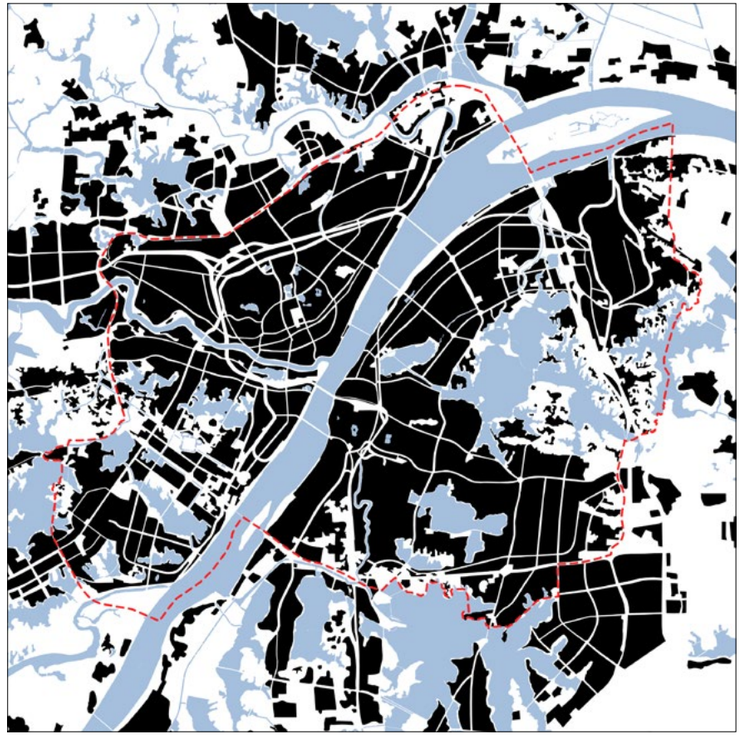

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Figure 5.35
Inner City homogeneous areas in 2013
(Bekkering, CAI, Kuijper)

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Figure 5.36
Inner City homogeneous areas, 2013 ▸ 2016
(Bekkering, CAI, Kuijper)

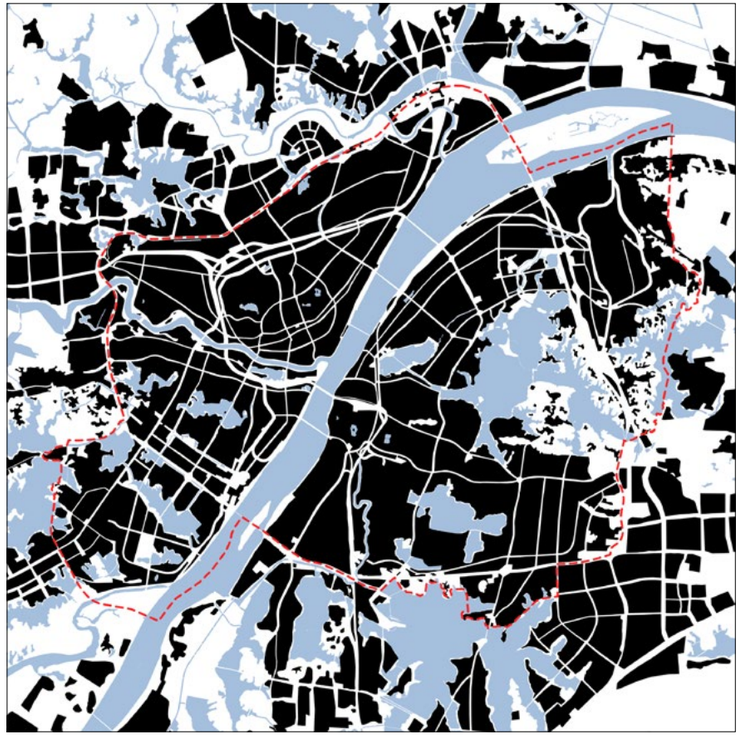

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Figure 5.37
Inner City homogeneous areas, 2016
(Bekkering, CAI, Kuijper)

Inner City homogeneous areas, 2016 ▸ 2019

The many changes within the built up area of the Inner City in this period often do not show in the map, as these have the form of replacement of existing urban tissue with new typologies better accommodating modern life. This can lead to homogeneous areas of larger sizes. When changes are limited to a previously homogeneous area, it does not affect the larger urban structure.

Three more bridges were built in this period: the Wuhan Zhuankou Yangtze River Bridge in 2017 and the Wuhan Yangsigang Yangtze River Bridge in 2019, and the Wuhan Fourth Ring Road Hanjiang Bridge over the Han River in 2017.

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Figure 5.38
Inner City homogeneous areas, 2016
(Bekkering, CAI, Kuijper)

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Figure 5.39
Inner City homogeneous areas, 2016 ▸ 2019
(Bekkering, CAI, Kuijper)

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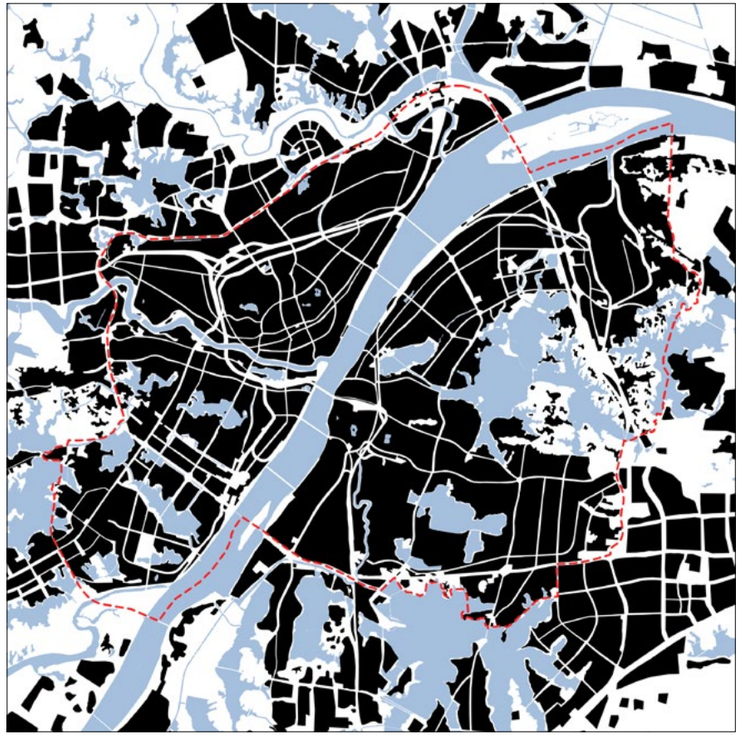

Figure 5.40
Inner City homogeneous areas, 2019
(Bekkering, CAI, Kuijper)

Overview of Inner City homogeneous areas, 1870 ▸ 2019

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Figure 5.41a
Inner City homogeneous areas, 1870 ▸ 1970
(Bekkering, CAI, Kuijper)

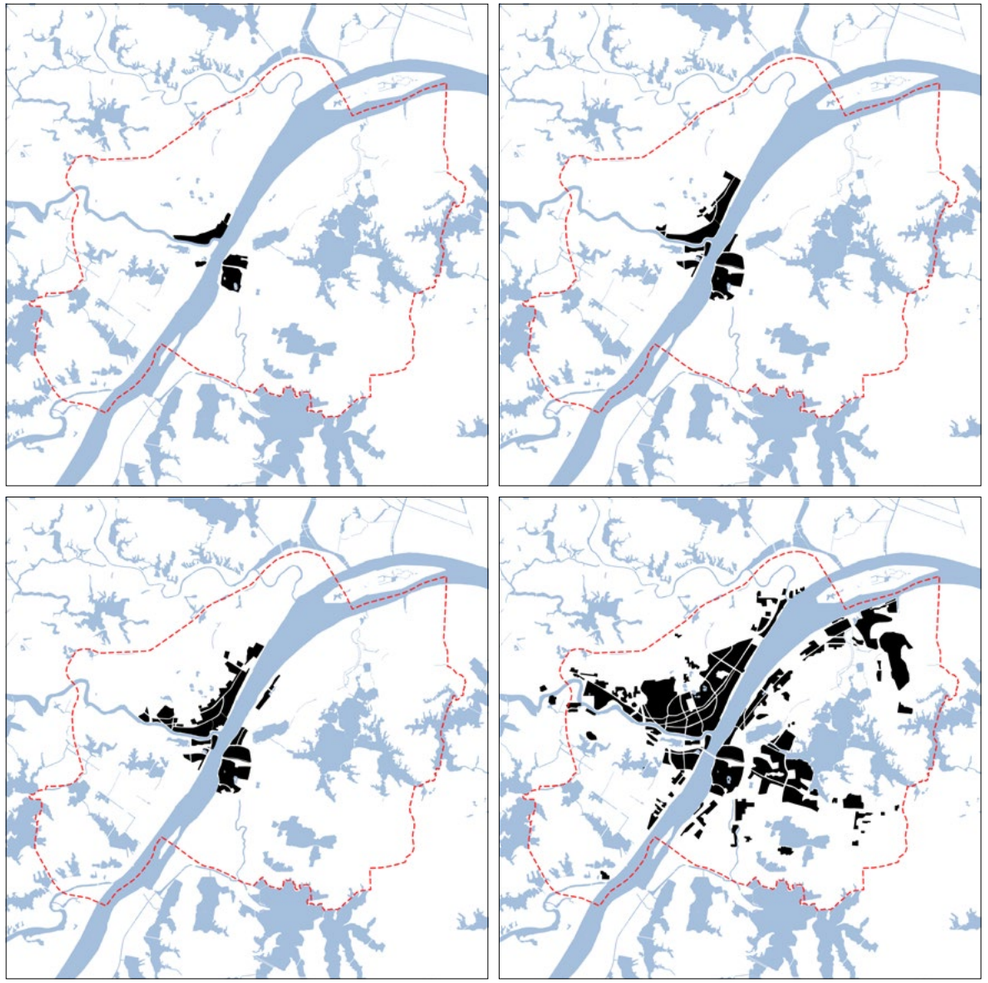
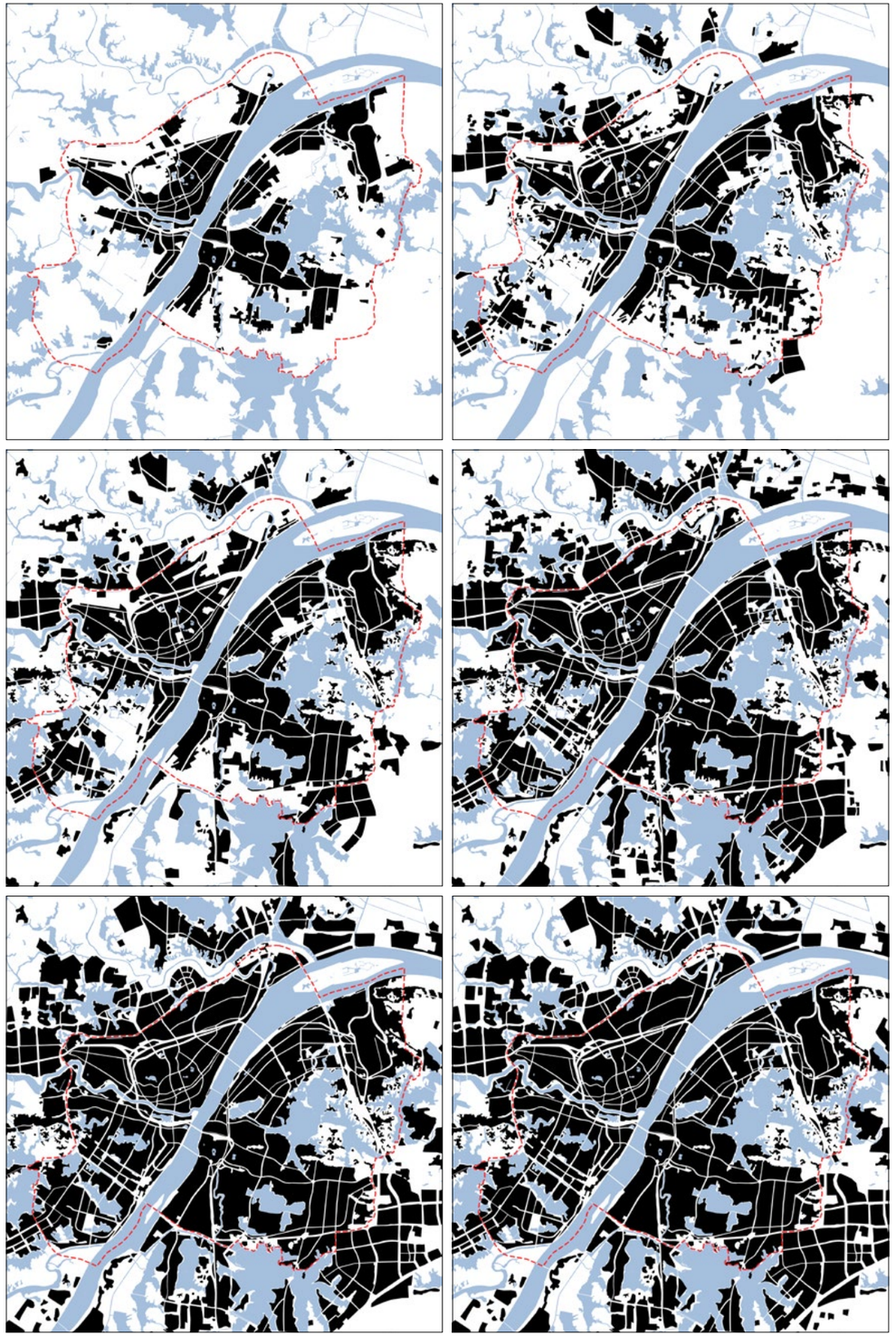


Figure 5.41b [right page ▸]
Inner City homogeneous areas, 1990 ▸ 2019
(Bekkering, CAI, Kuijper)



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Bridges and tunnels

To support the functioning of the growing city, from the 1950s on, a series of large infrastructural connections for traffic and transport crossing the big rivers were built: bridges, and later tunnels for highways, railroads, and metro lines. These are listed here in historical order.

1. 1956 Janghan Bridge (Han River)
2. 1957 Wuhan Yangtze River Combined Highway and Railway Bridge
3. 1978 Zhiyin Bridge (Han River)
4. 1991 Xinhe Bridge (She River)
5. 1995 Wuhan Yangtze River 2 Bridge
6. 1998 Yuehu Bridge (Han River)
7. 2000 Wuhan Baishazhou Yangtze River Bridge
8. 2000 Qingchuan Bridge (Han River)
9. 2001 Wuhan Junshan Yangtze River Bridge
10. 2001 Changfeng Bridge (Han River)
11. 2001 Caidian Hanjiang River Bridge (Han River)
12. 2007 Wuhan Yangluo Yangtze River Bridge
13. 2008 Wuhan Yangtze River Tunnel
14. 2009 Wuhan Tianxingzhou Yangtze River Bridge
15. 2011 Wuhan Erqi Yangtze River Bridge
16. 2014 Wuhan Yingwuzhou Yangtze River Bridge
17. 2015 Gutian Bridge (Han River)
18. 2015 China-France Friendship Bridge (Han River)
19. 2017 Wuhan Zhuankou Yangtze River Bridge
20. 2017 Wuhan Fourth Ring Road Hanjiang Bridge (Han River)
21. 2019 Wuhan Yangsigang Yangtze River Bridge

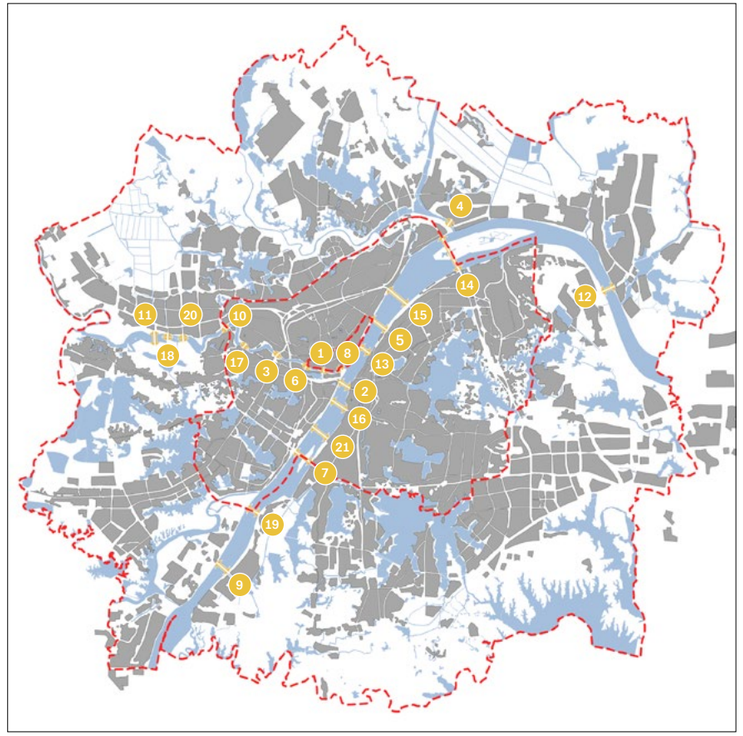

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Figure 5.42a
Bridges over and tunnels under the Yangtze and Han Rivers, 2019
(Bekkering, CAI, Kuijper, ZHANG)

2004 Metro Line 1
2012 Metro Line 2
2014 Metro Line 4
2015 Metro Line 3
2016 Metro Line 6
2017 Metro Line 8
2018 Metro Line 7

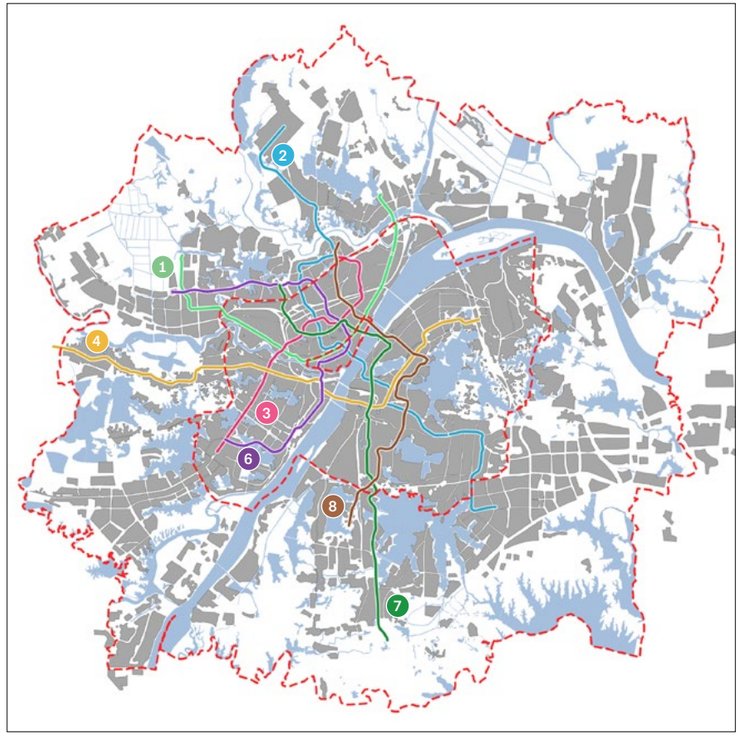

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Figure 5.42b
Metro lines, 2019
(Bekkering, CAI, Kuijper, ZHANG)

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Inner City: georeferencing and working backwards in time

The base map of the research is the GIS format map of the land use situation in 2013. This map has the most reliable and generally accepted cartographic projection. The two years added to the research after the first report (Bekkering *et al.* 2015), 2016 and 2019, have the same system and cartographic projection as the data of 2013, and thus do not need georeferencing. For each earlier map in the timeline, the areas that had then no urban land use are subtracted from the later map. This process shows the extensions of the city in the period between 2006 and 2013, and similarly for each next earlier map. The maps series on the following pages follows this format. To explain the basic way of working in the research, each spread presents: the historical map of the beginning of the period, that map georeferenced on the map with the homogeneous areas of the later period, and the resulting changes in the urban form between the two dates.

Inner City homogeneous areas, 2019 ▸ 2016

The map used for the step from 2019 to 2016 is an excerpt for the Inner City of the Metropolitan Area land use map in the *2016 Wuhan Master Plan*. The high level of abstraction is corrected by checking with the aerial photograph of the same year: checking the forms of the homogeneous areas and the elements separating these. As this is a modern map, there is no difference in cartographic projection, thus no georeferencing is needed.

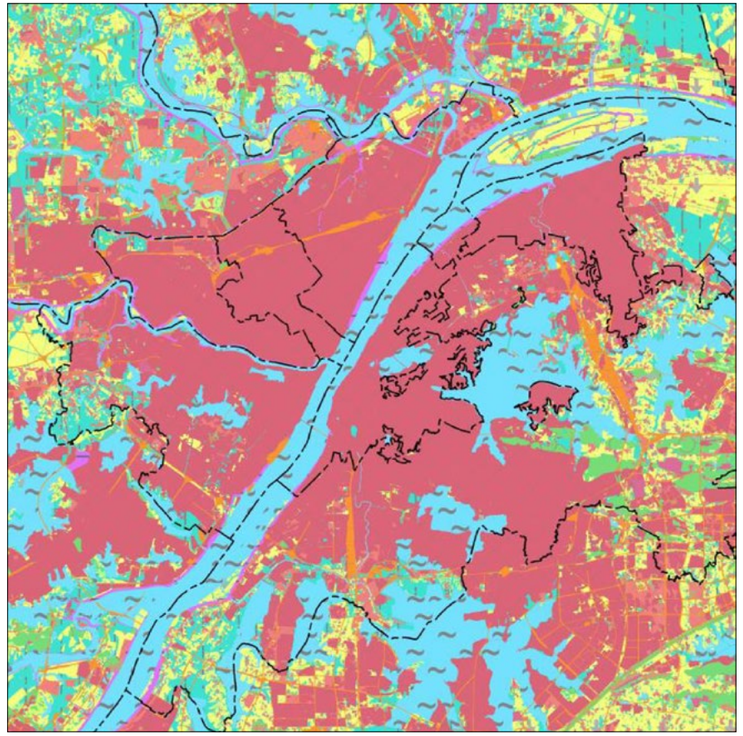

Figure 5.43
Inner City urban land use, excerpt of Metropolitan land use map, 2016 (2016 Wuhan Master Plan)

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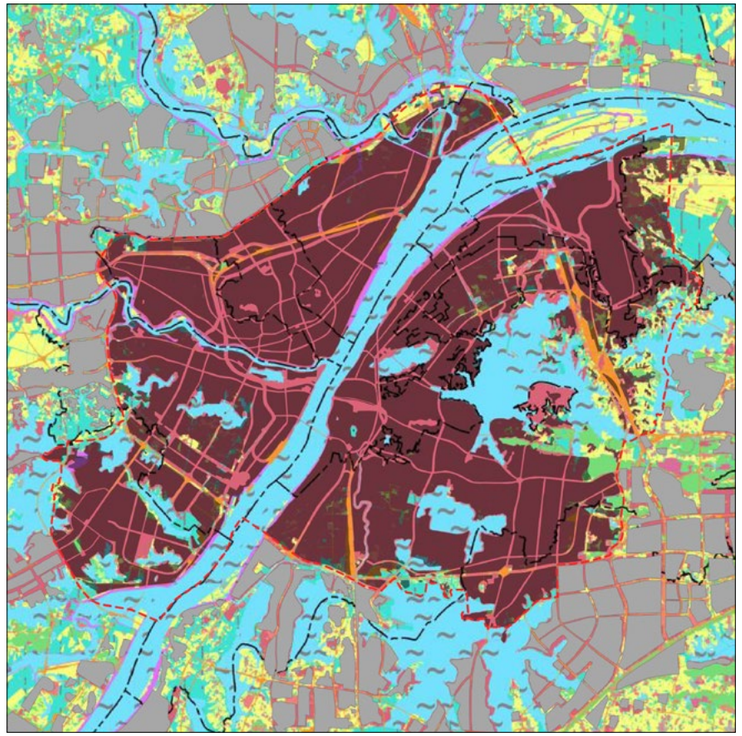

Figure 5.44
Inner City: georeferencing the 2016 map on the homogeneous areas in 2019 (Bekkering, CAI, Kuijper)

Figure 5.45
Inner City homogeneous areas, 2019 ▸ 2016 (Bekkering, CAI, Kuijper)

Inner City homogeneous areas, 2016 ▸ 2013

The 2013 map is the database of the different categories of urban land use, the base map of the original research. No georeferencing is needed.

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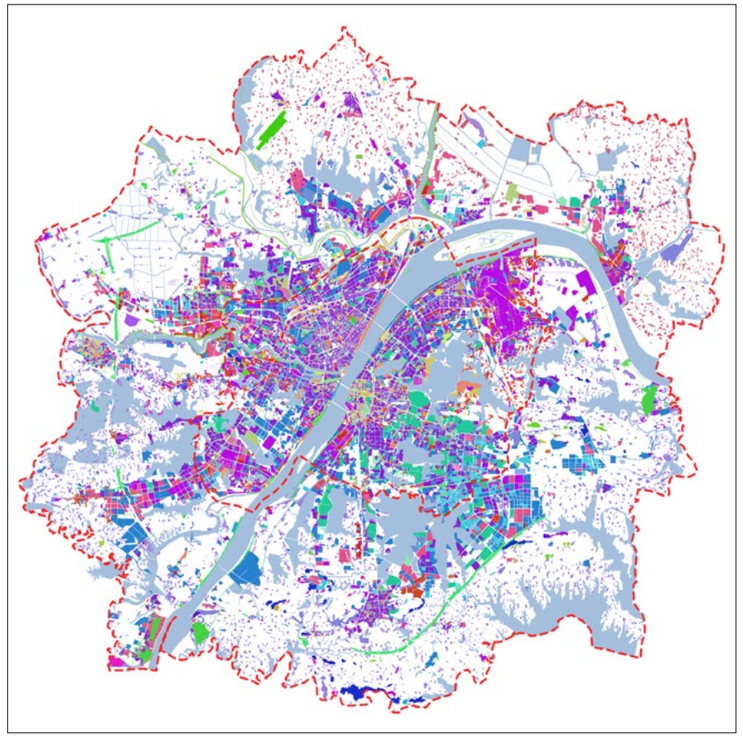

Figure 5.46
Inner City urban land use, 2013
(Wuhan Land Use and Urban Spatial Planning Research Center)

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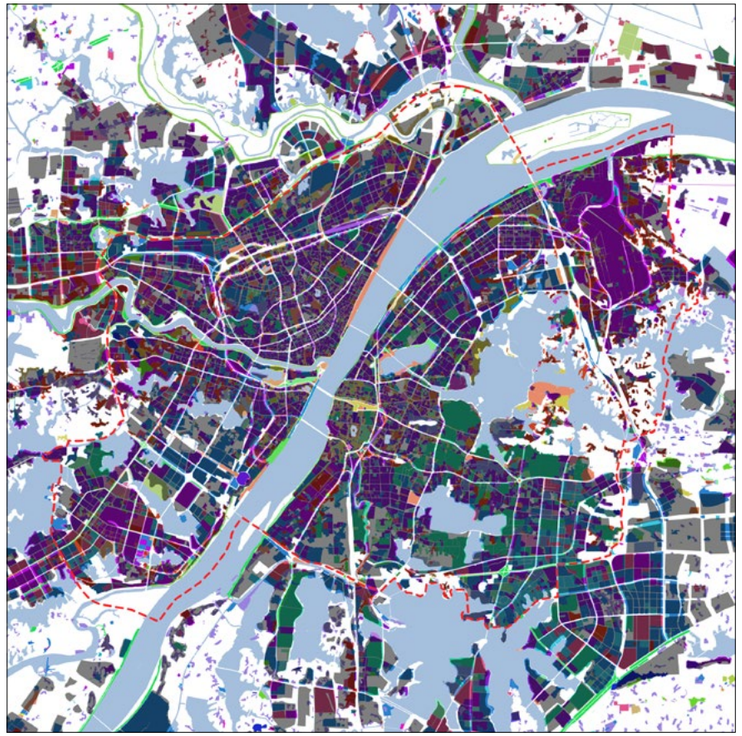

Figure 5.47
Inner City: georeferencing the 2013 map on the homogeneous areas in 2016
(Bekkering, CAI, Kuijper)

Figure 5.48
Inner City homogeneous areas, 2016 ▸ 2013
(Bekkering, CAI, Kuijper)

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Inner City homogeneous areas, 2013 ▸ 2006

The historical map used for the step from 2013 to 2006, is the land use map for the Inner City of the *2006 Wuhan Master Plan*.

As this is a modern map, there is no difference in cartographic projection, thus no georeferencing is needed.

Figure 5.49
Urban land use, 2006
(left) Metropolitan Area; (right) Inner City
(2006 Wuhan Master Plan;
Wuhan Planning & Design Institute)

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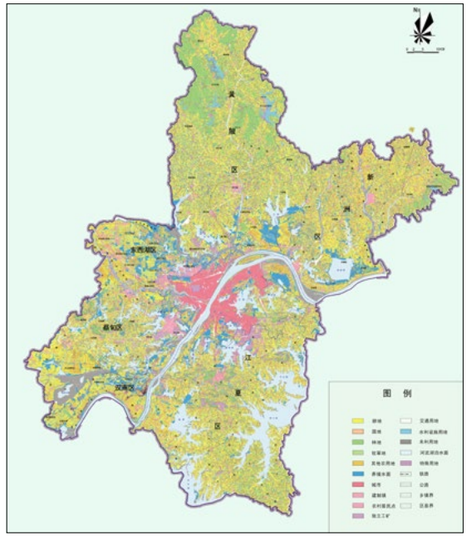

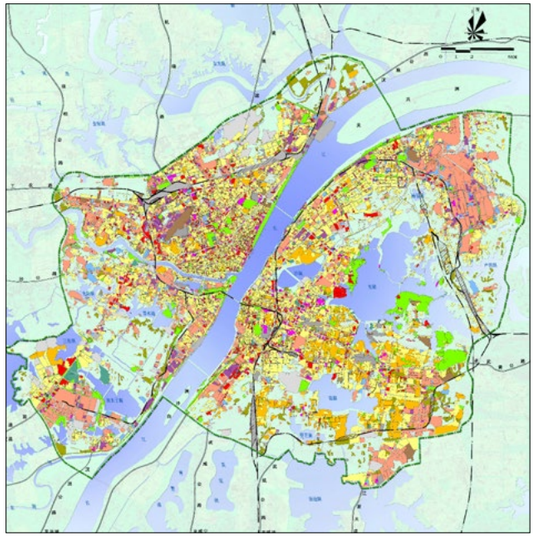

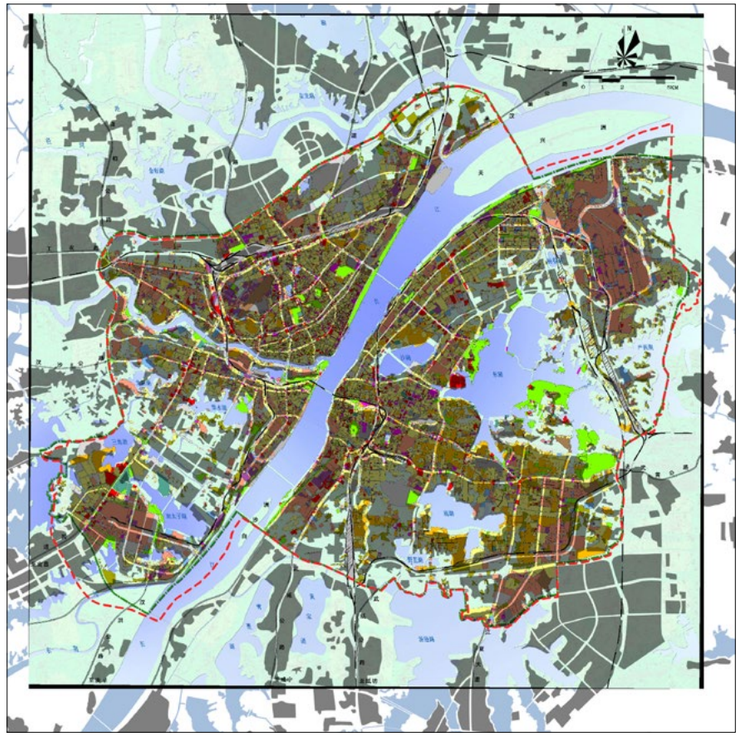

Figure 5.50
Inner City: georeferencing the 2006 map on the homogeneous areas in 2013 (Bekkering, CAI, Kuijper)

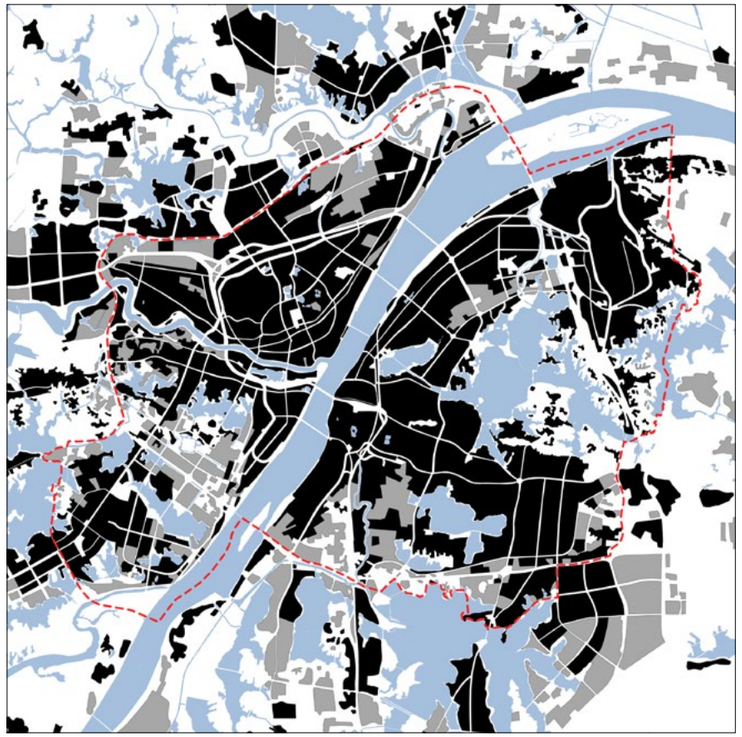

Figure 5.51
Inner City homogeneous areas, 2013 ▸ 2006 (Bekkering, CAI, Kuijper)

Inner City homogeneous areas, 2006 ▸ 2000

No land use data was available for the year 2000. Instead, an aerial photograph is used. This photograph, no doubt constructed from many of smaller areas, proved to comply to the same cartographic projection as on the previous maps.

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Maps on these pages have different scales

Figure 5.52
Inner City aerial photograph, 2000
(Wuhan Geomatic Institute)

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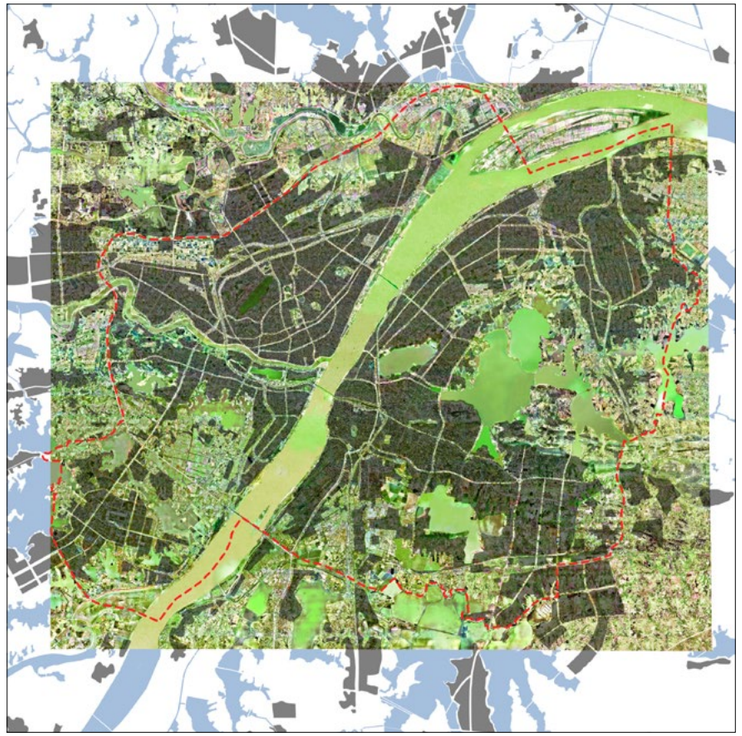

Figure 5.53
Inner City: georeferencing the 2000 aerial photograph on the homogeneous areas in 2006
(Bekkering, CAI, Kuijper)

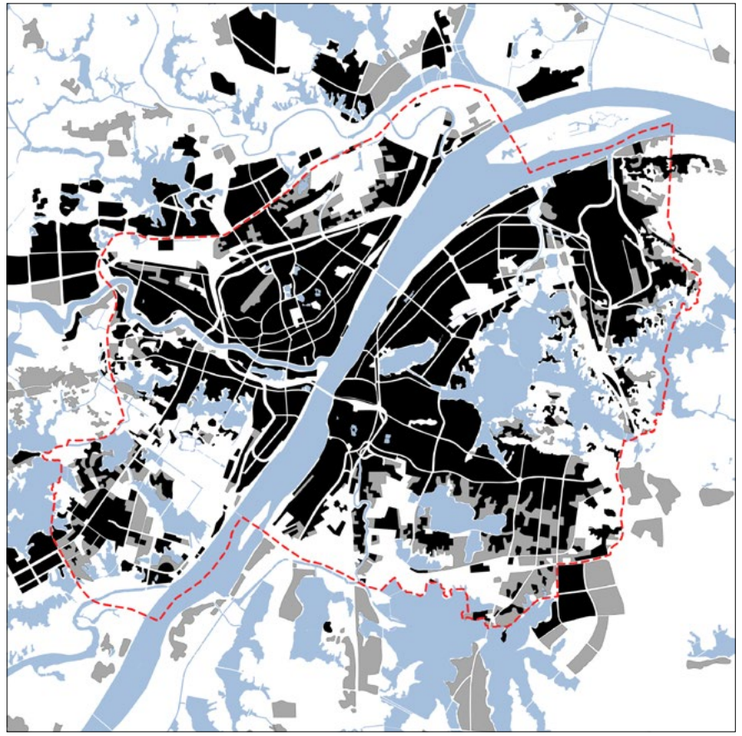

Figure 5.54
Inner City homogeneous areas, 2006 ▸ 2000
(Bekkering, CAI, Kuijper)

Inner City homogeneous areas, 2000 ▸ 1990

A reliable map of the city in 1990 has not been found. As the analytical maps in this research are of homogeneous areas based on urban land use, the rather simple 1989 map is sufficient. It still has the modern cartographic projection.

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Maps on these pages have different scales

Figure 5.55
Inner city, 1989
(Wuhan Construction Archives)

Figure 5.56
Inner City: georeferencing the 1989 map on the homogeneous areas in 2000
(Bekkering, CAI, Kuijper)

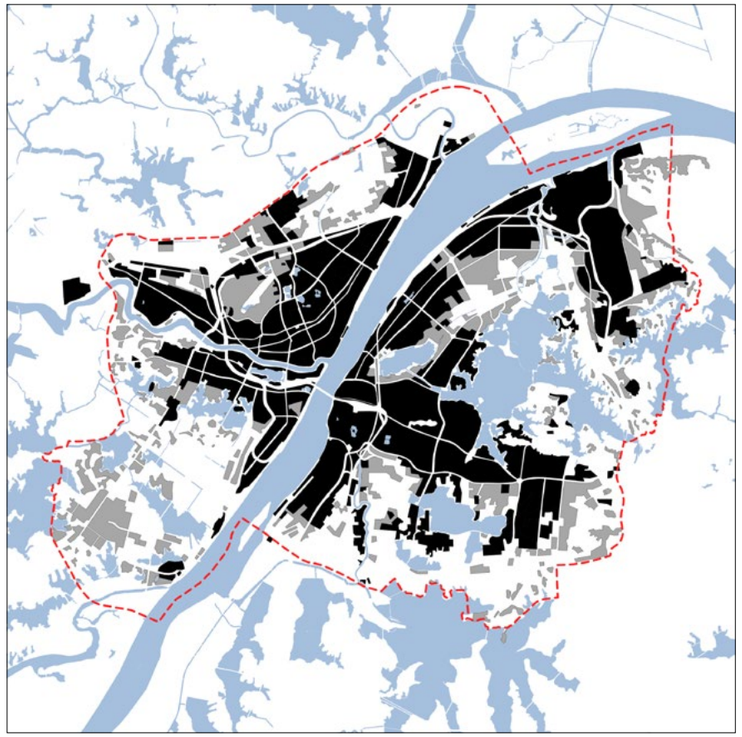

Figure 5.57
Inner City homogeneous areas, 2000 ▸ 1990
(Bekkering, CAI, Kuijper)

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Inner City homogeneous areas, 1990 ▸ 1970 i

At first, the only map found of 1970 is the one in *Figure 5.58*. This map is—maybe intentionally for security reasons—rather unreliable, as is evident from the heavy distortion when georeferenced on the 1990 map. Fortunately, a map of 1973 was discovered later that gave a better result: see next pages.

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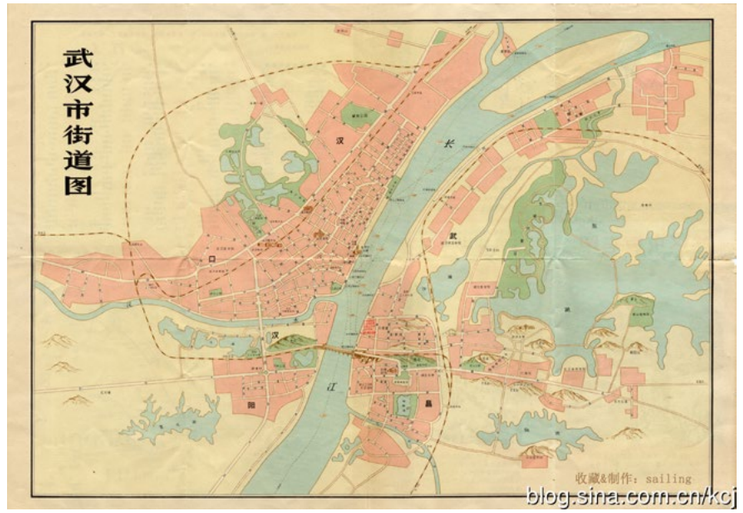

Figure 5.58
Inner city, 1970
(blog.sina.com.cn/kcj)

Figure 5.59
Inner City: georeferencing the 1970 map on the homogeneous areas in 1990
(Bekkering, CAI, Kuijper)

Inner City homogeneous areas, 1990 ▸ 1970 ii

The 1973 map was found in the Wuhan Planning & Design Institute Archive. Georeferencing this map on the homogeneous areas of 1990 gives a much more reliable result than the map of 1970.

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Maps on these pages have different scales

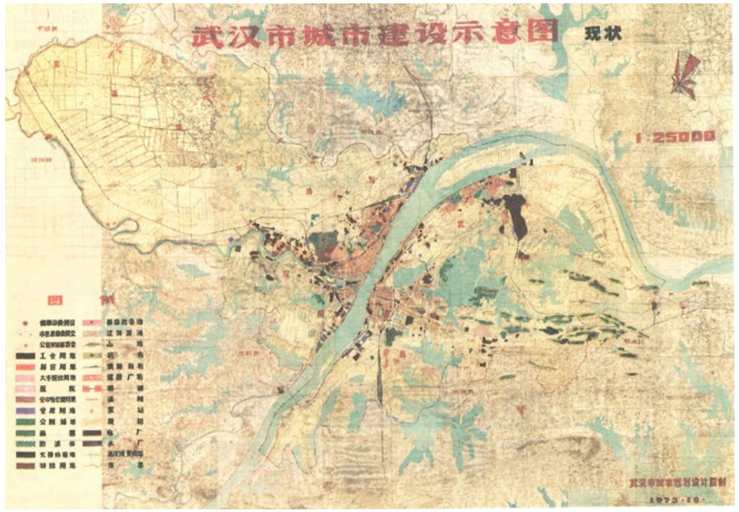

Figure 5.60
Inner city, 1973
(Wuhan Planning & Design Institute)

Figure 5.61
Inner City: georeferencing the 1973 map on the homogeneous areas in 1990
(Bekkering, CAI, Kuijper)

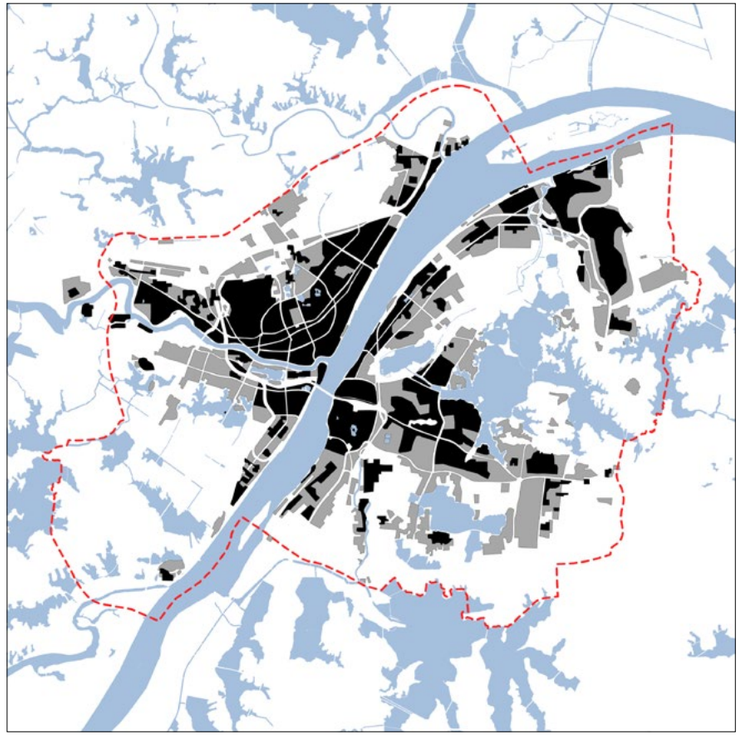

Figure 5.62
Inner City homogeneous areas, 1990 ▸ 1970
(Bekkering, CAI, Kuijper)

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2006

2013

2016

2019

Inner City homogeneous areas, 1970 ▸ 1950

The 1950 map looks like it would be precise, but proves difficult to fit to the maps of later years. This problem was solved by cutting the map over the Yangtze and Han Rivers into three separate parts. The parts then fit quite well.

1870

1910

Maps on these pages have different scales

1950

1970

1990

2000

2006

2013

2016

2019

Figure 5.63
Inner city, 1950
(Compilation Committee 1998 pp 100–101)

1870

1910

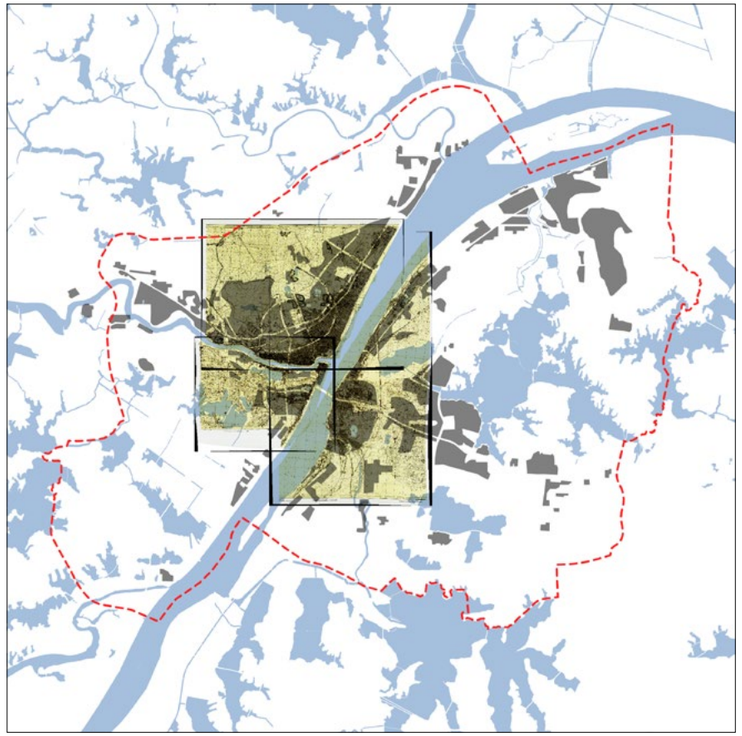


Figure 5.64
Inner City: georeferencing the 1950 map on the homogeneous areas in 1970 (Bekkering, CAI, Kuijper)

1950

1970

1990

2000

2006

2013

2016

2019

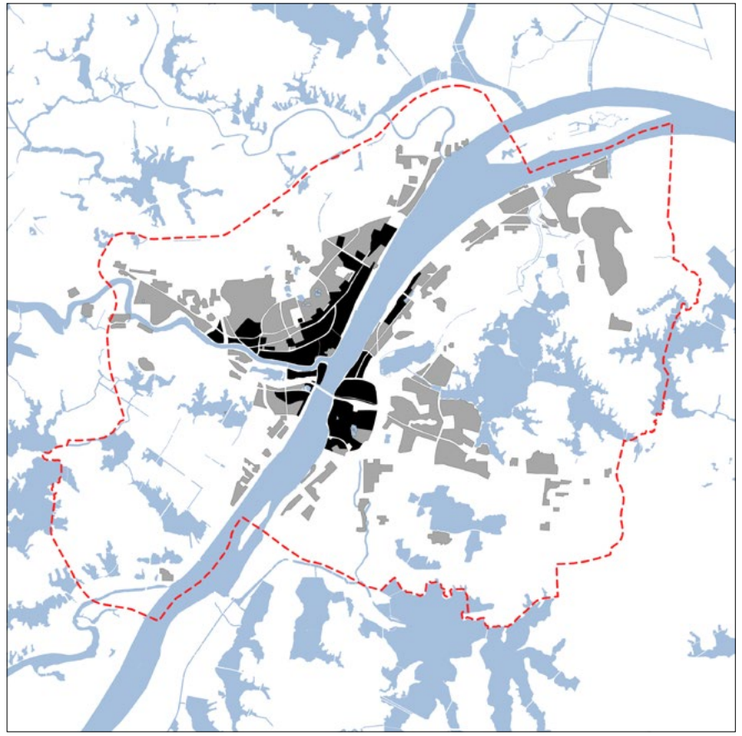


Figure 5.65
Inner City homogeneous areas, 1970 ▸ 1950
(Bekkering, CAI, Kuijper)

Inner City homogeneous areas, 1950 ▸ 1910

The 1922 map shows a remarkably good fit to the maps of later years. A usable map of a year closer to 1910 was not found.

Maps on these pages have different scales

Figure 5.66
Inner city, 1922
(Compilation Committee 1998 pp 52–53)

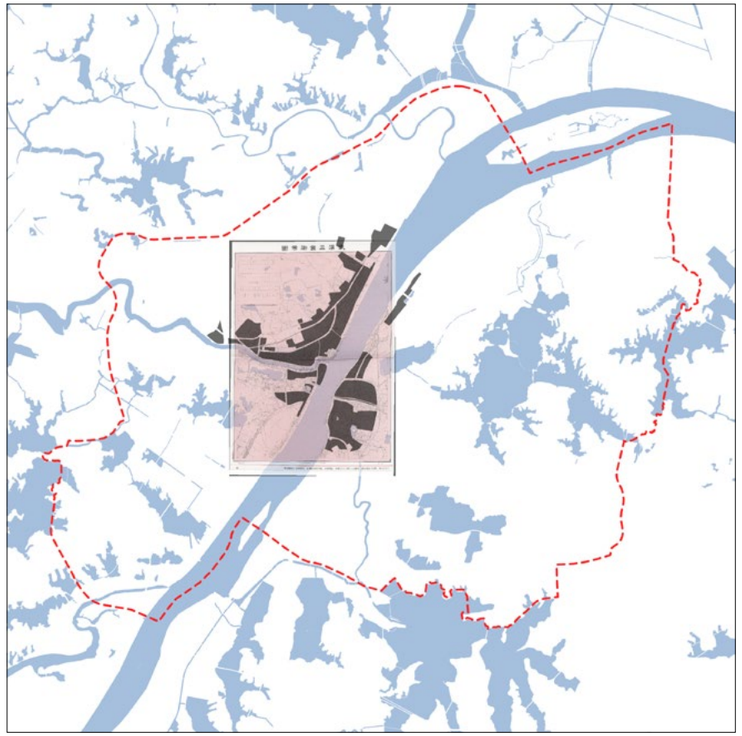


Figure 5.67
Inner City: georeferencing the 1922 map on the homogeneous areas in 1950 (Bekkering, CAI, Kuijper)

Figure 5.68
Inner City homogeneous areas, 1950 ▸ 1910 (Bekkering, CAI, Kuijper)

1870

1910

Inner City homogeneous areas, 1910 ▸ 1870

The reconstruction of the 1870 map of the three original towns, Hanyang, Wuchang and Hankou, is described in the beginning of *Chapter 5*.

Maps on these pages have different scales

1950

1970

1990

2000

2006

2013

2016

2019

Figure 5.69
Hankou, 1918
(pmgs.kongfz.com/detail/85_204011)

Figure 5.70 (left)
Hanyang, 1909
(Compilation Committee 1998
pp 34–35)

Figure 5.71 (right)
Wuchang, 1909
(Compilation Committee 1998
pp 30–31)

1870

1910

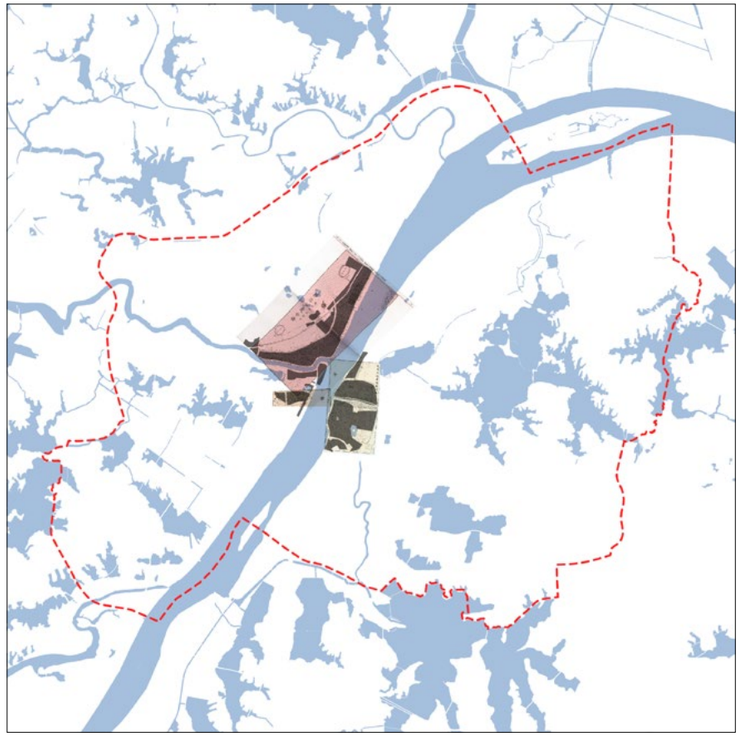


Figure 5.72
Inner City: georeferencing the 1909 and 1918 maps on the homogeneous areas in 1910 (Bekkering, CAI, Kuijper)

Figure 5.73
Inner City homogeneous areas, 1910 ▸ 1870
(Bekkering, CAI, Kuijper)

1950

1970

1990

2000

2006

2013

2016

2019

1870

Inner City: homogeneous areas and secondary connections

As explained in *Chapter 4*, homogeneous areas are defined and traced, that on the map of the urban land use show a certain internal consistency, and are either different from neighboring areas or clearly separated from those. The homogeneous areas visualize the spatial structure: the morphology of the city on a certain level of scale. They display the 'skeleton' of the city, but also its deep structure, in the relationships between the different homogeneous areas.

At this moment in the research, after finishing the series of maps of the Inner City, it appeared that on this meso level of scale it would be valuable—in the sense of allowing for a deeper insight in the spatial structure of the city—to add to the maps with the homogeneous areas, extra elements that we named secondary connections. This is an addition to the usual set of instruments of the Delft School. (Compare *Figures 5.74* and *75*.) They can be seen as the city's middle level of scale, that is so often missing in Chinese cities nowadays. The importance of this is severely undervalued, though by contrast it was definitely an integral part of the design and layout of the traditional Chinese city, where it even had a clear meaning in organizing the city into areas for different social groups. Its general neglection or even total absence in today's Chinese cities results in a multitude of problems with orientation and traffic flow.

1910
1950
1970
1990
2000
2006
2013
2016
2019

Figure 5.74
Inner City
homogeneous areas, 2019
(Bekkering, CAI, Kuijper)

1870

This missing of the middle scale results from two aspects, often in combination. The first is that many of the frequently applied urban grids are historically of a very large scale, with distances between streets of sometimes up to a kilometer (0.62 miles). The second aspect is that large areas (superblocks or compounds), covering often a full field in the grid or a complete *danwei*, are redeveloped as separate entities, turned inward, with no relation to the neighboring areas.

Addition of the secondary connections within the homogeneous areas simultaneously does two things: they show their internal spatial structure—if there is any—and they show the connections between adjacent areas—if there are any. Together, the secondary connections indicate the formal coherence of the Inner City that people use for orientation in, and understanding of their environment in addition to the recognition of the homogeneous areas themselves. Because of this, they can remember places, recognize their relative positions, and attach meaning to their environment, which then becomes part of their own identity, and as such it constitutes a strong social factor.

1910
1950
1970
1990
2000
2006
2013
2016
2019

Figure 5.75
Inner City homogeneous
areas and secondary
connections in 2019
(Bekkering, CAI, Kuijper)

Chapter 6
Metropolitan Area: macro scale

The chapter presents two series of maps on the macro scale of the Metropolitan Area, in the same way as for the meso scale of the Inner City in Chapter 5: in historical order, and working backwards in time.

Metropolitan Area in historical order

As in *Chapter 5* for the Inner City, the following series of analytical maps represents the urban form in the Metropolitan Area in historical order. Each double page shows again three successive maps: the map with the homogeneous areas of the year at the beginning of the period, the map that shows the changes in the urban form during that period, and the map of the situation at the end of the period. The series starts in 2000, as there was no urban development outside the Inner City boundaries earlier.

Metropolitan Area homogeneous areas, 2000 ▸ 2006

Urban growth outside the Inner City boundaries until 2006 continues mostly in linear developments following roads. Some newly built-up areas are extensions of the developments in the Inner City, others have at this stage quite isolated positions in the landscape.

1870
1910
1950
1970
1990
2000
2006
2013
2016
2019

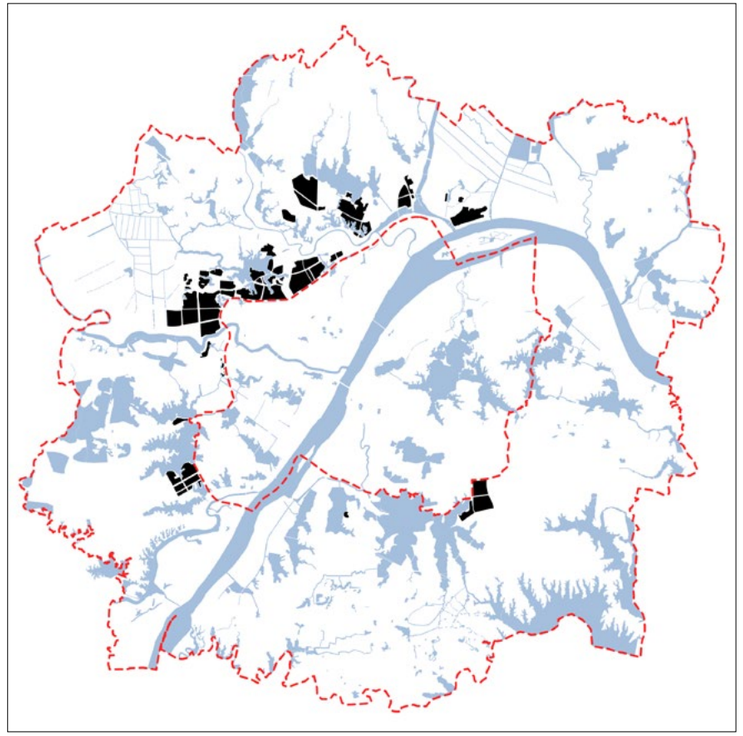


Figure 6.1
Metropolitan Area homogeneous areas, 2000 (Bekkering, CAI, Kuijper)

1870

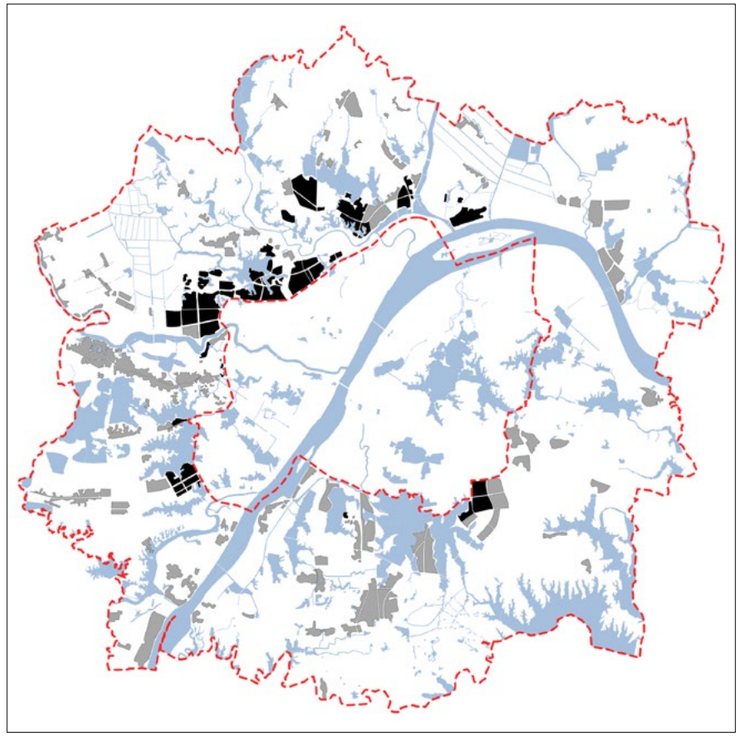


Figure 6.2
Metropolitan Area homogeneous areas, 2000 ▸ 2006 (Bekkering, CAI, Kuijper)

1950
1970
1990
2000
2006
2013
2016
2019

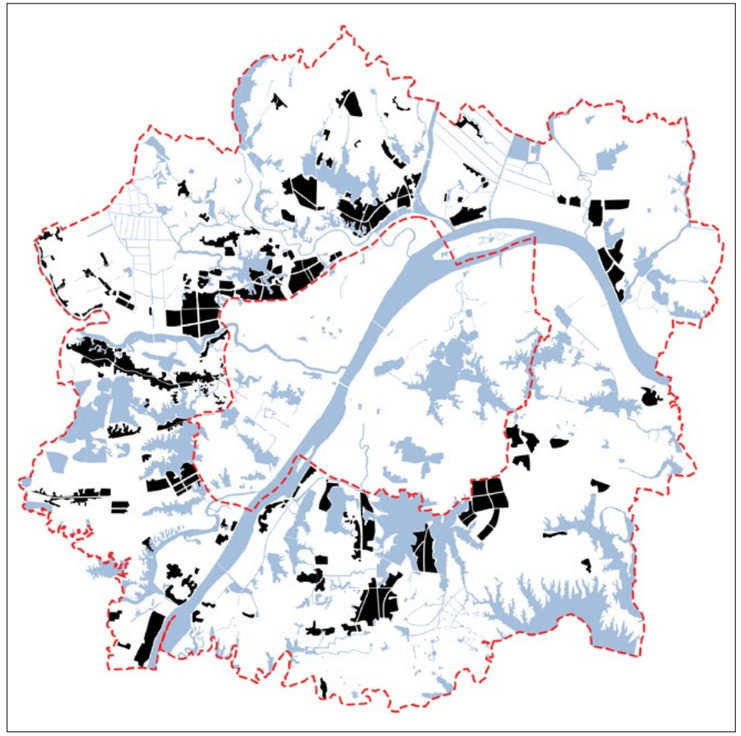


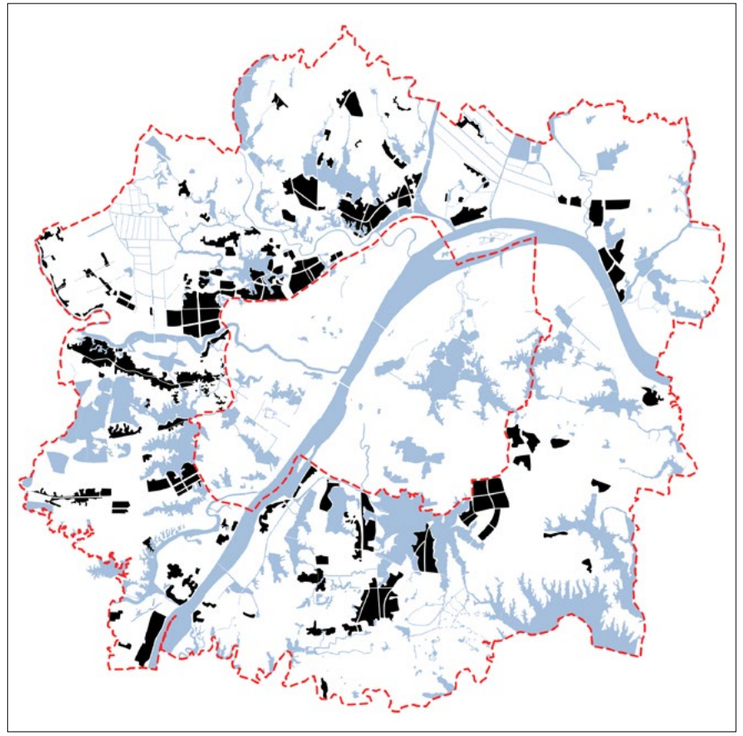
Figure 6.3
Metropolitan Area homogeneous areas in 2006 (Bekkering, CAI, Kuijper)

Metropolitan Area homogeneous areas, 2006 ▸ 2013

The pattern of urban growth continues, further strengthening the outward linear developments. In many cases, this results in larger areas with a grid-like structure.

1870

1910



1950

1970

1990

2000

2006
2013

2016

2019

Figure 6.4
Metropolitan Area homogeneous areas, 2006
(Bekkering, Cai, Kuijper)

1870

1910

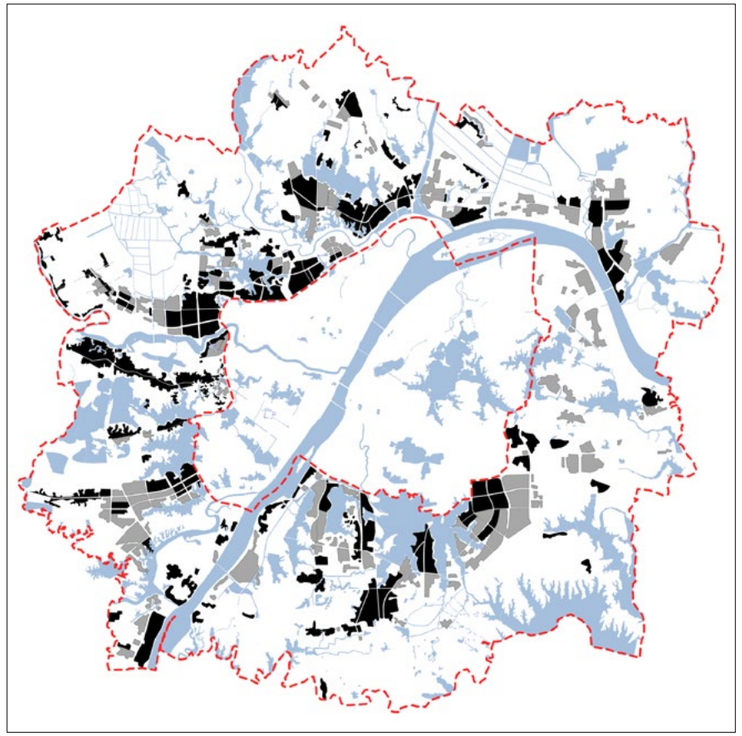


Figure 6.5
Metropolitan Area homogeneous areas, 2006 ▸ 2013
(Bekkering, CAI, Kuijper)

1950

1970

1990

2000

2006
2013

2016

2019

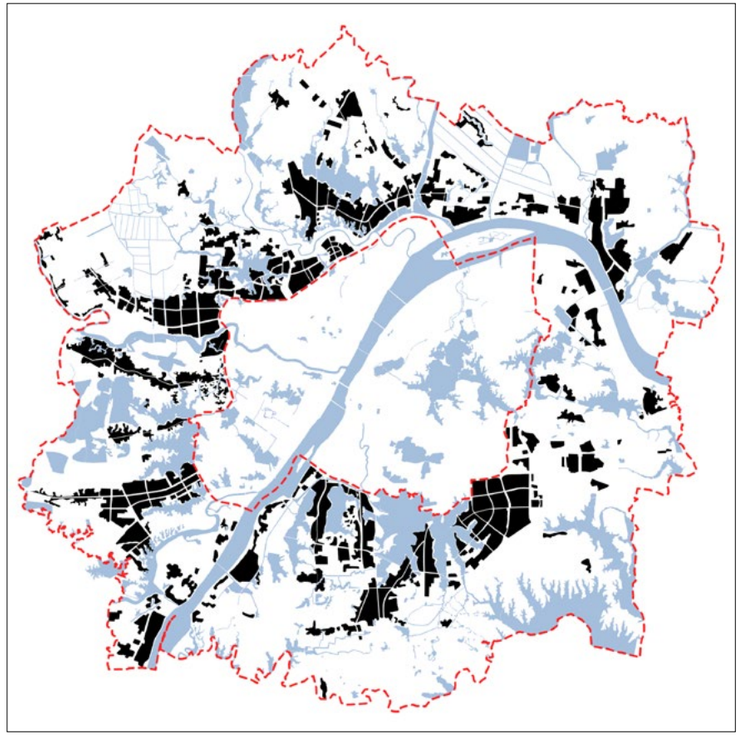


Figure 6.6
Metropolitan Area homogeneous areas, 2013
(Bekkering, CAI, Kuijper)

Metropolitan Area homogeneous areas, 2013 ▸ 2016

Most of the growth of the Metropolitan Area is in the form of continuations of the earlier, more or less linear extensions out into the landscape.

1870

1910

1950

1970

1990

2000

2006

2013 | 2016

2019

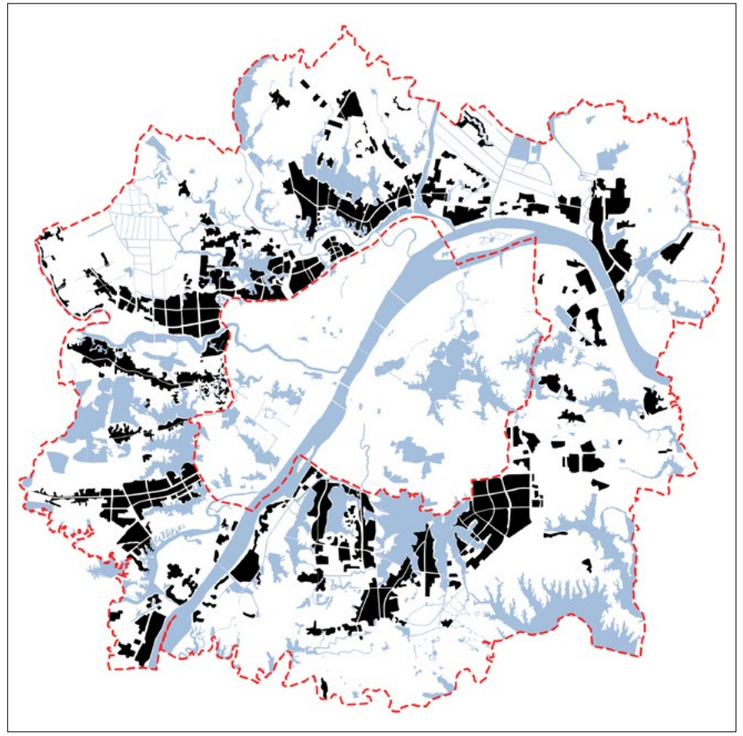


Figure 6.7
Metropolitan Area homogeneous areas, 2013 (Bekkering, CAI, Kuijper)

1870

1910

1950

1970

1990

2000

2006

2013 | 2016

2019

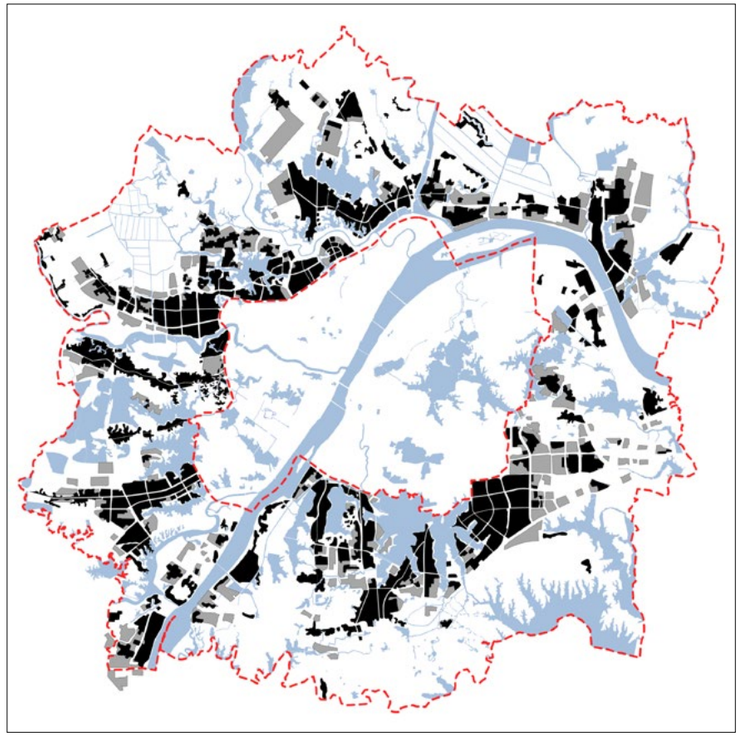


Figure 6.8
Metropolitan Area homogeneous areas, 2013 ▸ 2016 (Bekkering, CAI, Kuijper)

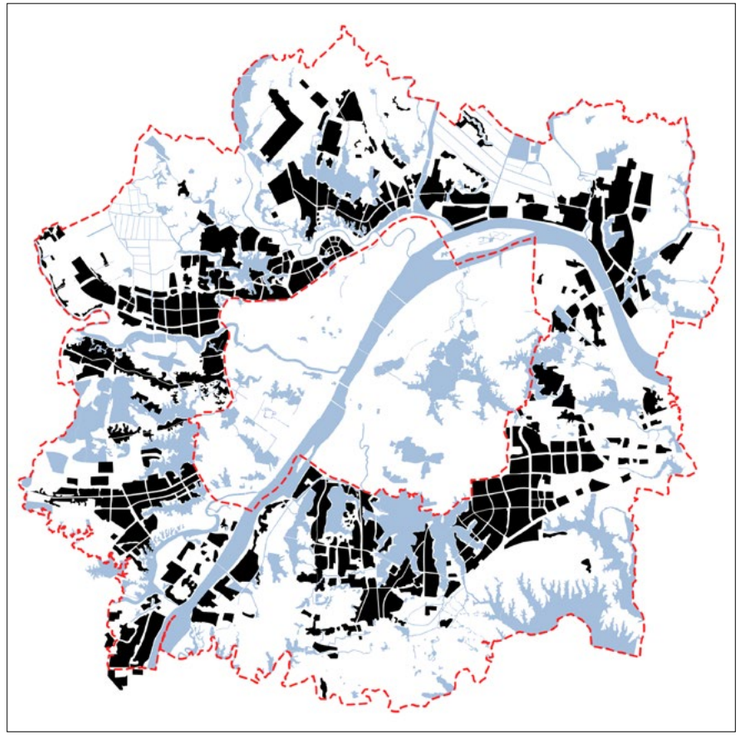


Figure 6.9
Metropolitan Area homogeneous areas, 2016 (Bekkering, Cai, Kuijper)

Metropolitan Area homogeneous areas, 2016 ▸ 2019

Existing extensions are strengthened. In eastern direction the growth goes beyond the administrative border of the Metropolitan Area.

1870

1910

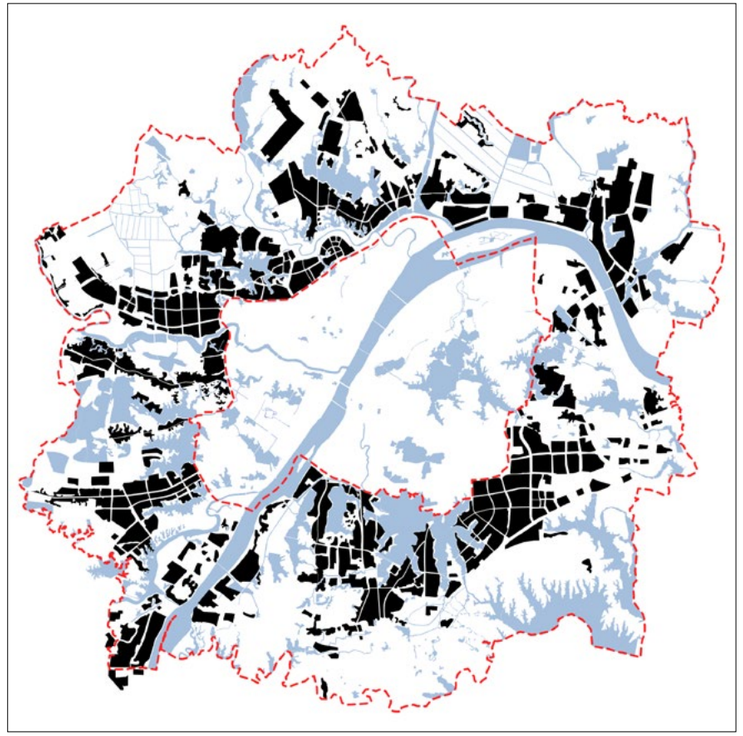


Figure 6.10
Metropolitan Area homogeneous areas, 2016 (Bekkering, CAI, Kuijper)

1950

1970

1990

2000

2006

2013

2016
I
2019

1870

1910

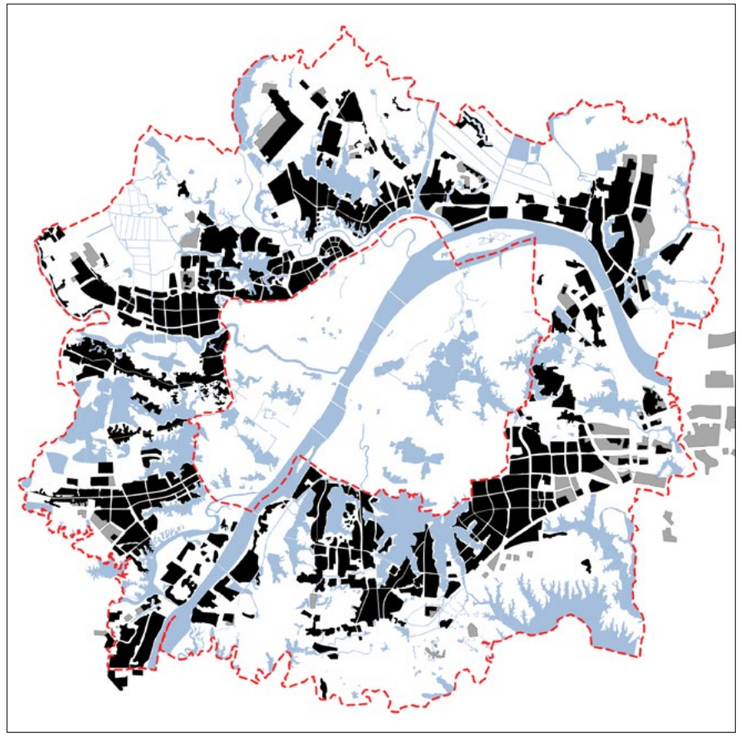


Figure 6.11
Metropolitan Area homogeneous areas, 2016 ▸ 2019 (Bekkering, CAI, Kuijper)

1950

1970

1990

2000

2006

2013

2016
I
2019

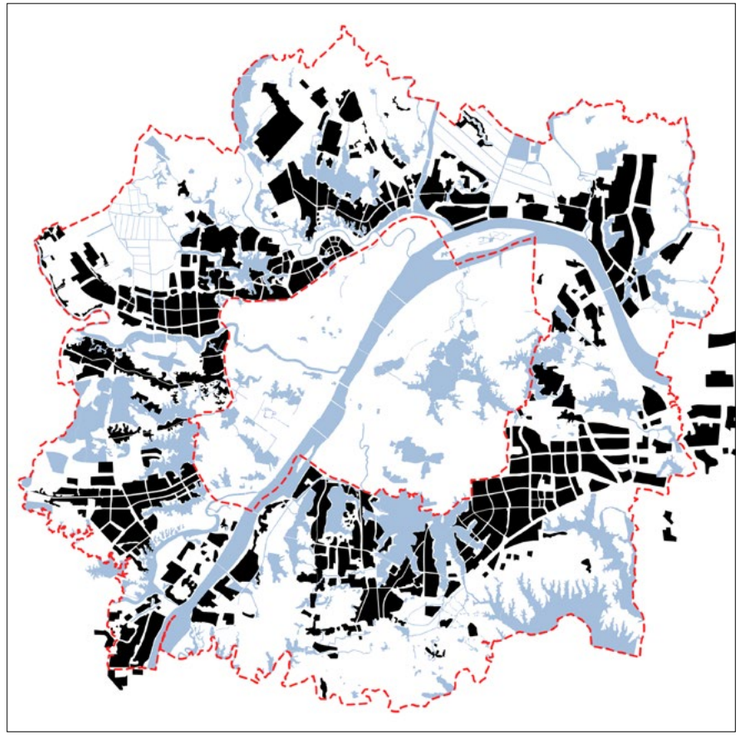


Figure 6.12
Metropolitan Area homogeneous areas, 2019 (Bekkering, CAI, Kuijper)

Overview of Metropolitan Area including Inner City homogeneous areas, 2000 ▸ 2019

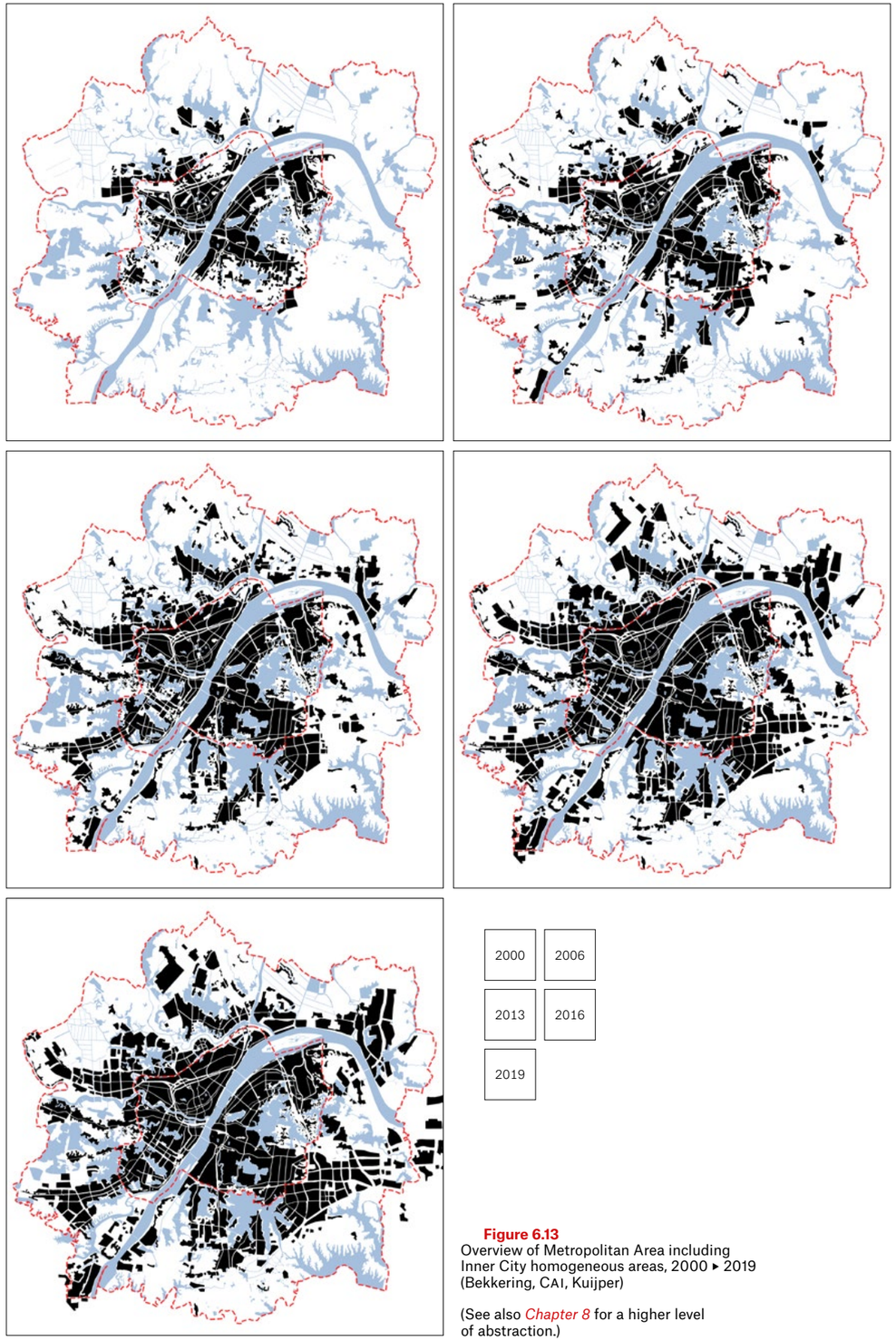


Figure 6.13
Overview of Metropolitan Area including Inner City homogeneous areas, 2000 ▸ 2019 (Bekkering, CAI, Kuijper)

(See also *Chapter 8* for a higher level of abstraction.)

Metropolitan Area: georeferencing and working backwards in time

As for the Inner City, in this section are shown on each spread: the historical map of the beginning of the period; that map georeferenced on the map with the homogeneous areas of the later period; and the resulting changes in the urban form in the period in between.

1870

Metropolitan Area homogeneous areas, 2019 ▸ 2016

The composite aerial photograph is taken from Google. It is surprisingly complete and did not need georeferencing. The only conversion applied is to the QGIS project's Coordinate Reference System (CRS).

1910

1950

1970

1990

2000

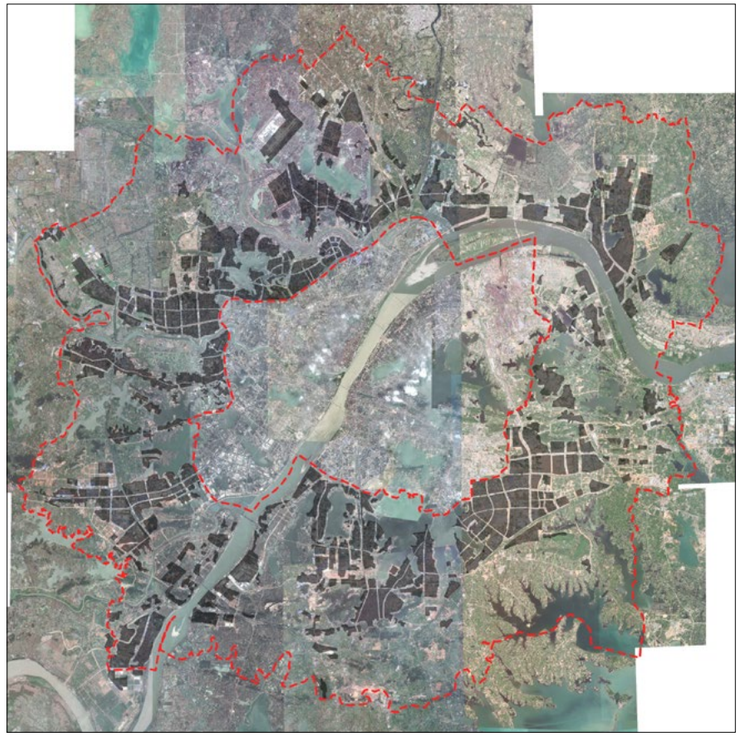
2006

2013

2016
I
2019

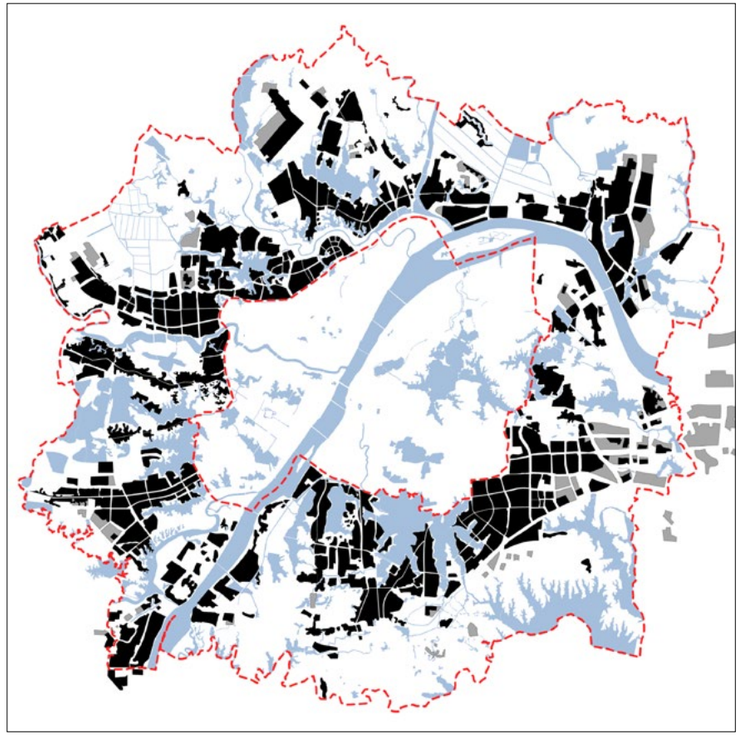
Figure 6.14
Metropolitan Area, aerial photograph, 2019 (Google Maps Satellite)

1870



1910

Figure 6.15
Metropolitan Area georeferencing the relevant area of the 2019 map on the homogeneous areas in 2016 (Bekkering, CAI, Kuijper)



1950

1970

1990

2000

2006

2013

2016
I
2019

Figure 6.16
Metropolitan Area homogeneous areas, 2019 ▸ 2016 (Bekkering, CAI, Kuijper)

Metropolitan Area homogeneous areas, 2016 ▸ 2013

The map of urban land use in the *2016 Wuhan Master Plan* has a high level of abstraction, that is corrected by checking the aerial photograph of the same year for the forms of the homogeneous areas.

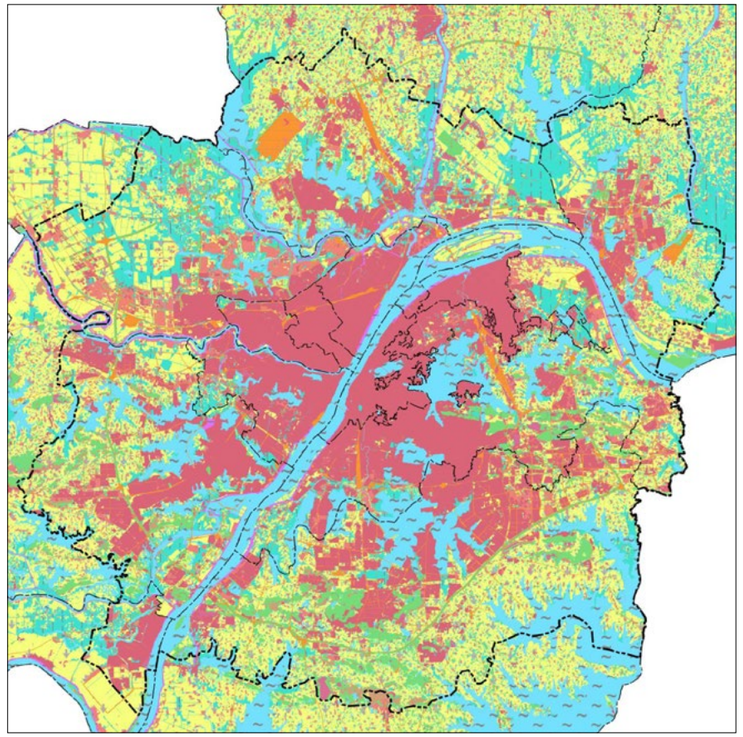


Figure 6.17
Excerpt of Metropolitan Area urban land use, 2016 (2016 Wuhan Master Plan; Wuhan Planning & Design Institute)

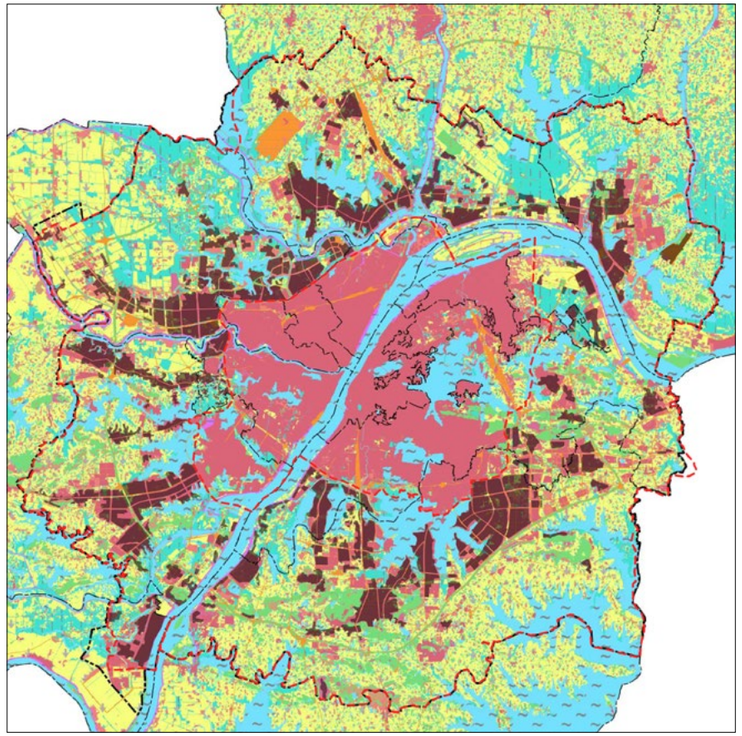


Figure 6.18
Metropolitan Area georeferencing the relevant area of the 2016 map on the homogeneous areas in 2013 (Bekkering, CAI, Kuijper)

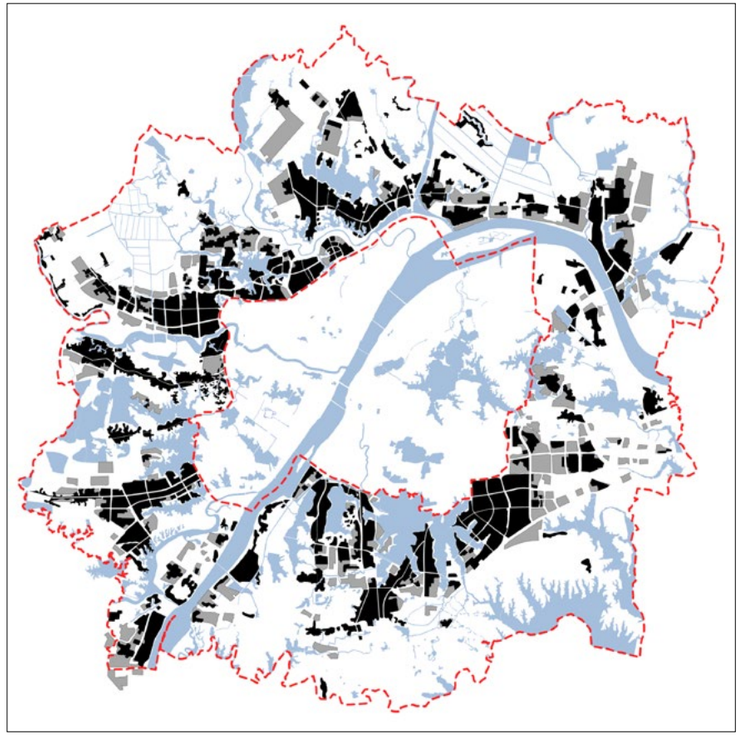


Figure 6.19
Metropolitan Area homogeneous areas, 2016 ▸ 2013 (Bekkering, CAI, Kuijper)

Metropolitan Area homogeneous areas, 2013 ▸ 2006

The map with the urban land use situation in the Metropolitan Area in 2006 is from the *2006 Wuhan Master Plan*. The map data in this map is strongly reduced, but on the level of the macro scale homogeneous areas, this is sufficient, in combination with close comparison to the 2013 analytical map on top of which it is georeferenced.

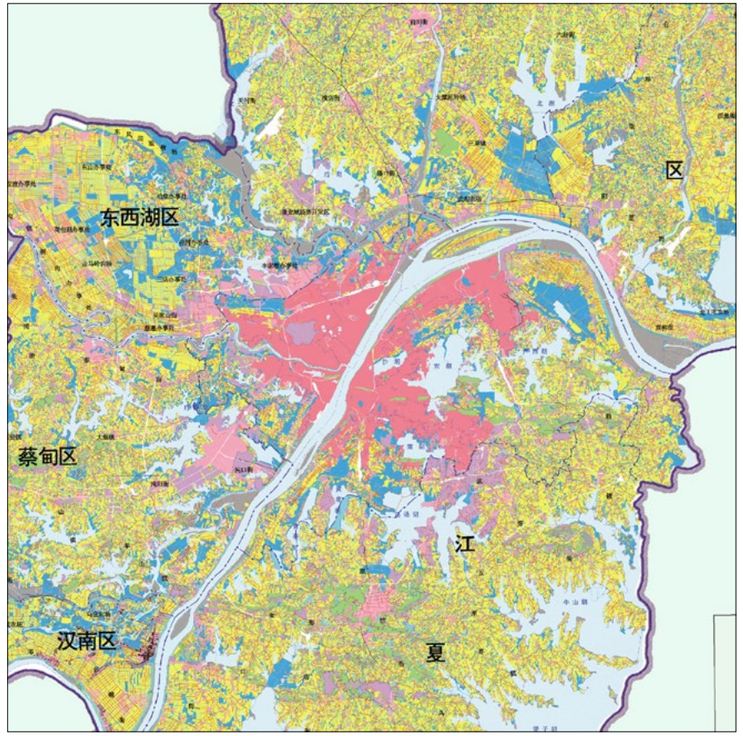


Figure 6.20
Excerpt of Metropolitan Area urban land use, 2006 (2006–2020 Wuhan Master Plan; Wuhan Planning & Design Institute)

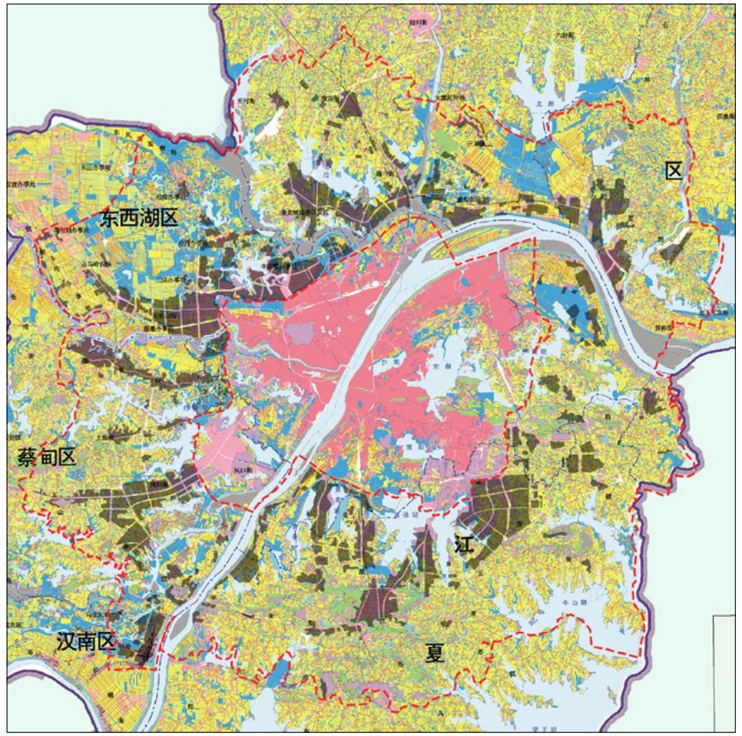


Figure 6.21
Metropolitan Area georeferencing the relevant area of the 2006 map on the homogeneous areas in 2013 (Bekkering, CAI, Kuijper)

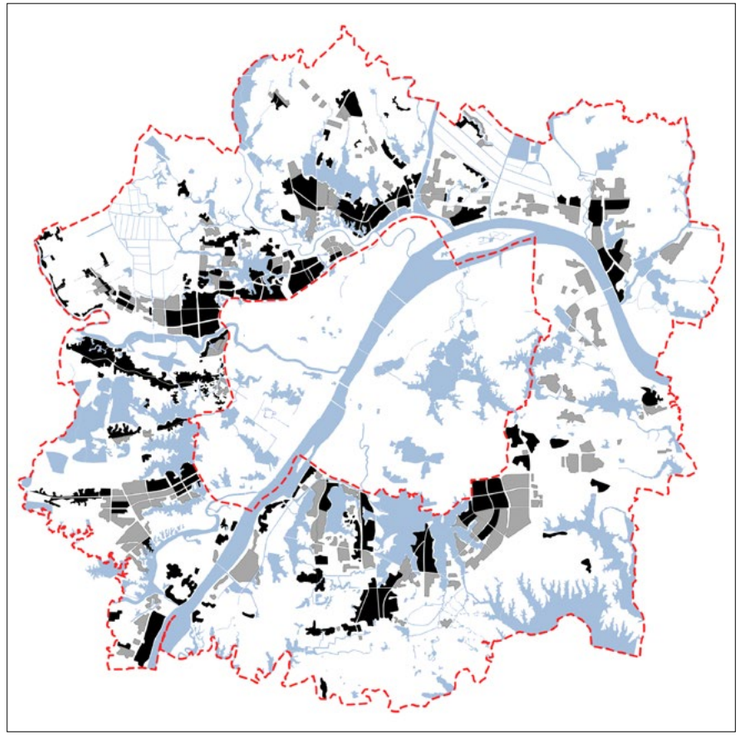


Figure 6.22
Metropolitan Area homogeneous areas, 2013 ▸ 2006 (Bekkering, CAI, Kuijper)

Metropolitan Area homogeneous areas, 2006 ▸ 2000

Again, a map is used with strongly reduced data. This map is taken from a series showing the urban growth of Wuhan by the Wuhan Planning & Design Institute.

Maps on these pages have different scales

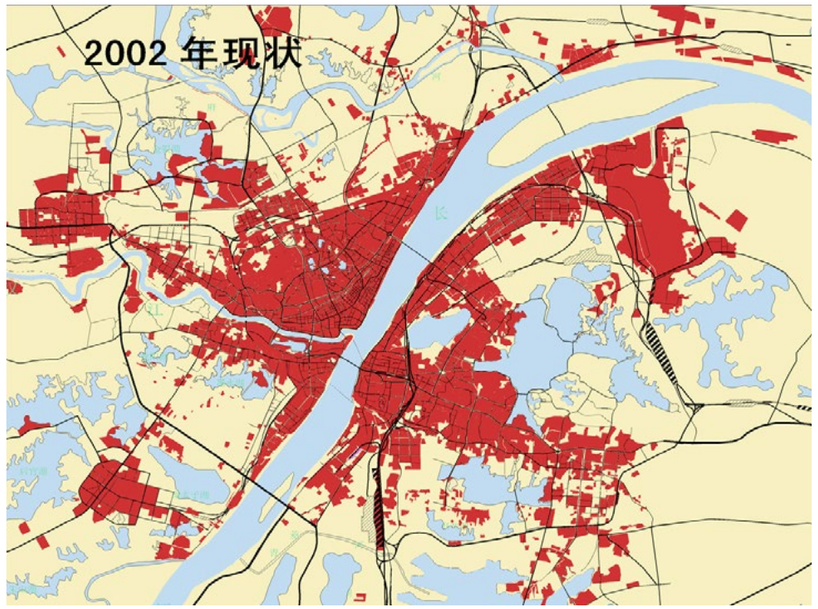


Figure 6.23
Metropolitan Area urban land use, 2002 (Wuhan Planning & Design Institute)

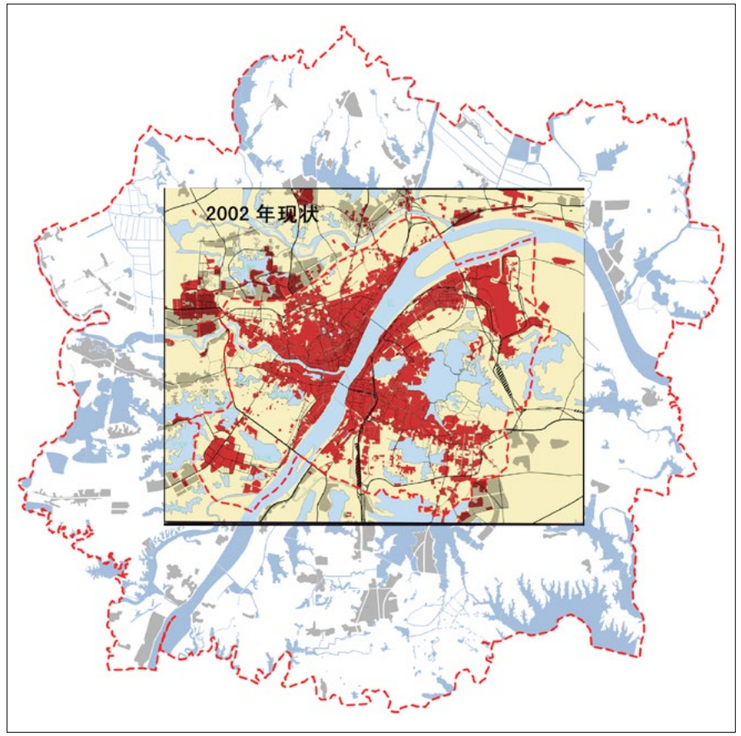


Figure 6.24
Metropolitan Area georeferencing the 2002 map on the homogeneous areas in 2006 (Bekkering, CAI, Kuijper)

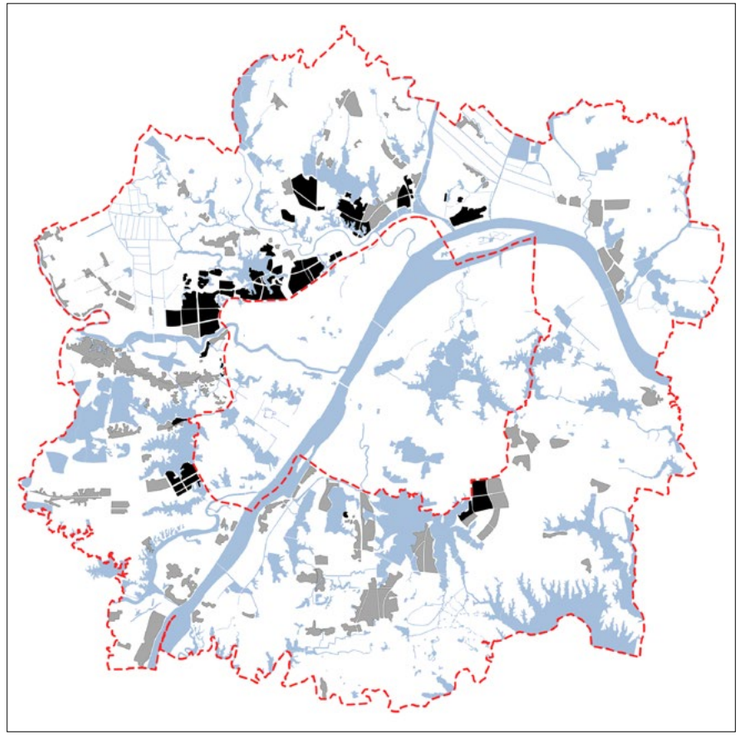


Figure 6.25
Metropolitan Area homogeneous areas, 2006 ▸ 2000 (Bekkering, CAI, Kuijper)

Chapter 7
Hankou Riverside: micro scale

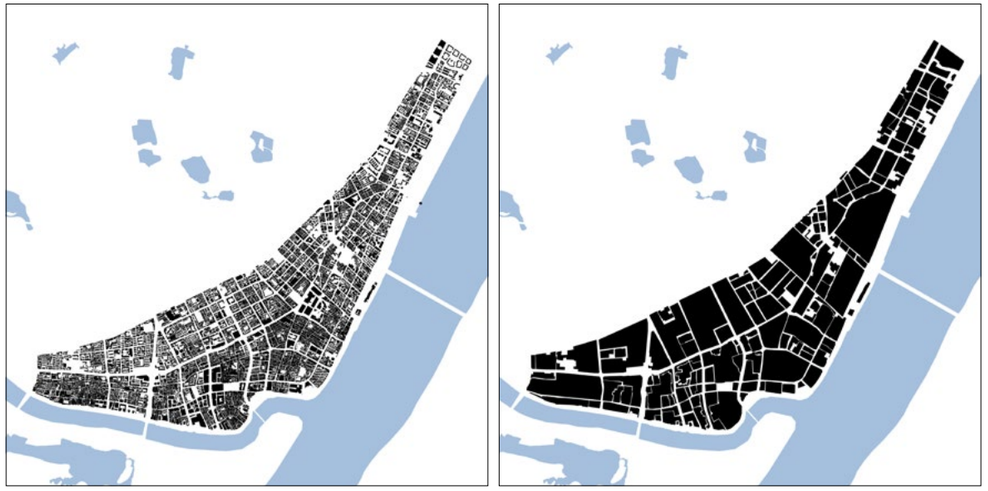
As mentioned in the section on research method (see Chapter 4), on the micro scale of the urban district Hankou Riverside for most of the maps the base material is the building footprint. (See Figure 7.1a and b, next pages.) This data is more detailed and smaller in scale than the urban land use data that is used for the analysis of the macro and meso scales: the Inner City and the Metropolitan Area. All offer spatial information.

Building footprint and street pattern

The building footprint allows for 'true' figure-ground drawings on the scale of the individual buildings in their relation to open space—building footprint in black and open space in white—while the land use data does not indicate open space. Rather, it shows publicly administered space; the space outside the lots with urban land use. This difference shows very clearly when the homogeneous areas on the two scales are compared. (See *Figure 7.3*.)

Regrettably, the building footprint data is only available for the years in the timeline after 1970. From 1970 backwards in time these maps either do not exist or are not available. The maps we used for these earlier periods are of street patterns and building blocks, rather than building footprint. Therefore, the series of maps for Hankou Riverside is based on two different map formats. The homogeneous areas on the more recent maps are based on maps of the building footprint at the time, reduced to 'true' figure-ground drawings—building footprint in black, and open space in white. The 1950, 1910, and 1870 maps are based on historical maps of street patterns and building blocks, depicting the composition and hierarchy of the streets. Working backwards in time, this information too can be reduced to homogeneous areas with the same characteristics as when reduced from the building footprint. Figure-ground drawings and street pattern maps offer different types of information with different levels of abstraction. The information provided by figure ground maps is more detailed and concrete than that offered by street pattern maps. This difference disappears, however, when the data is abstracted into homogeneous areas.

Figure 7.1a
Hankou Riverside, 2013: (left) Building footprint; (right) Homogeneous areas. (Bekkering, CAI, Kuijper)



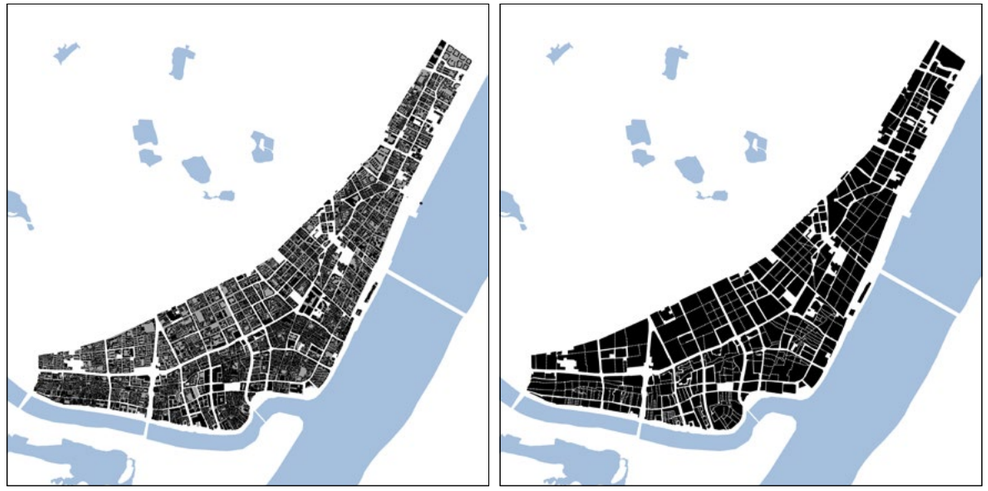
Working backwards in time and in historical order

The maps series on the micro scale of Hankou Riverside does not only show the growth of the built-up areas in more detail than the maps on the macro and meso scales, but also the internal changes and transformations. To uncover this, a working process is required that combines working backwards in time and working in historical order. Consistent with the technique used for the macro and meso scale analytical maps, the micro scale maps of Hankou Riverside also start from the contemporary one: in this case the 2013 base map in AutoCAD format with the building footprint in black. (See *Figure 7.1a left*.)

In the year 2006, one step earlier in the timeline, enormous transformations were going on. Areas that were under construction in 2006, while they were built up in 2013, are subtracted from the 2013 map. Similarly, areas that were still part of the older tissue in 2006, while in 2013 they were under construction or rebuilt with a completely new urban pattern, are reconstructed to their earlier state for the 2006 map. The relevant homogeneous areas are adjusted, mostly enlarged. The same working process is employed for the maps of 2000 and 1990. While working backwards in time, the homogeneous areas generally become larger as compared to their later state, indicating the originally larger continuity of the urban tissue.

The maps after 1990 mainly show internal transformations within the boundaries of Hankou Riverside, rather than growth, as the area was fully developed before. This means that the maps of the earlier stages in the timeline cannot be made by simply eliminating parts from the maps of the later period. Each map is based on the corresponding historical map, while at the same time comparing it to the earlier and later maps in the timeline. This is more so than in the case of working backwards in time for the analytical maps on the macro scales of the Inner City and the Metropolitan Area, because of the—relatively larger—size and intensity of the transformations that have taken place in Hankou Riverside.

Figure 7.1b
Hankou Riverside, 2013: (left) Building footprint and homogeneous areas; (right) Homogeneous areas and secondary connections. (Bekkering, CAI, Kuijper)



1870

The 1870, 1910, 1950, and 1970 maps mainly show the growth within the boundaries. Some changes happened in the urban fabric through the opening up of roads perpendicular to the Yangtze River. This series of maps was also drawn checking both forward and backwards in time. It is started from the 1910 map, because that offers the most complete and reliable representation of the original urban tissue and specifically the alley system. The second map drawn was that of 1870. (See also the description of the reconstruction of the map of the three constituting towns in the beginning of *Chapter 5*.) The as yet unbuilt areas and alleys were eliminated from the 1910 map. The third one to draw was the 1950 map. The growth occurred mainly outside the built-up areas, thus these are added as individual homogeneous areas. Some open spaces are subtracted from earlier built-up areas.

The changes in the alley system, depicted as secondary connections, were also drawn working forwards and backwards in time. This too began from the 1910 map, based on which secondary connections are eliminated in the other maps. (See *Figure 7.3*.)

1910

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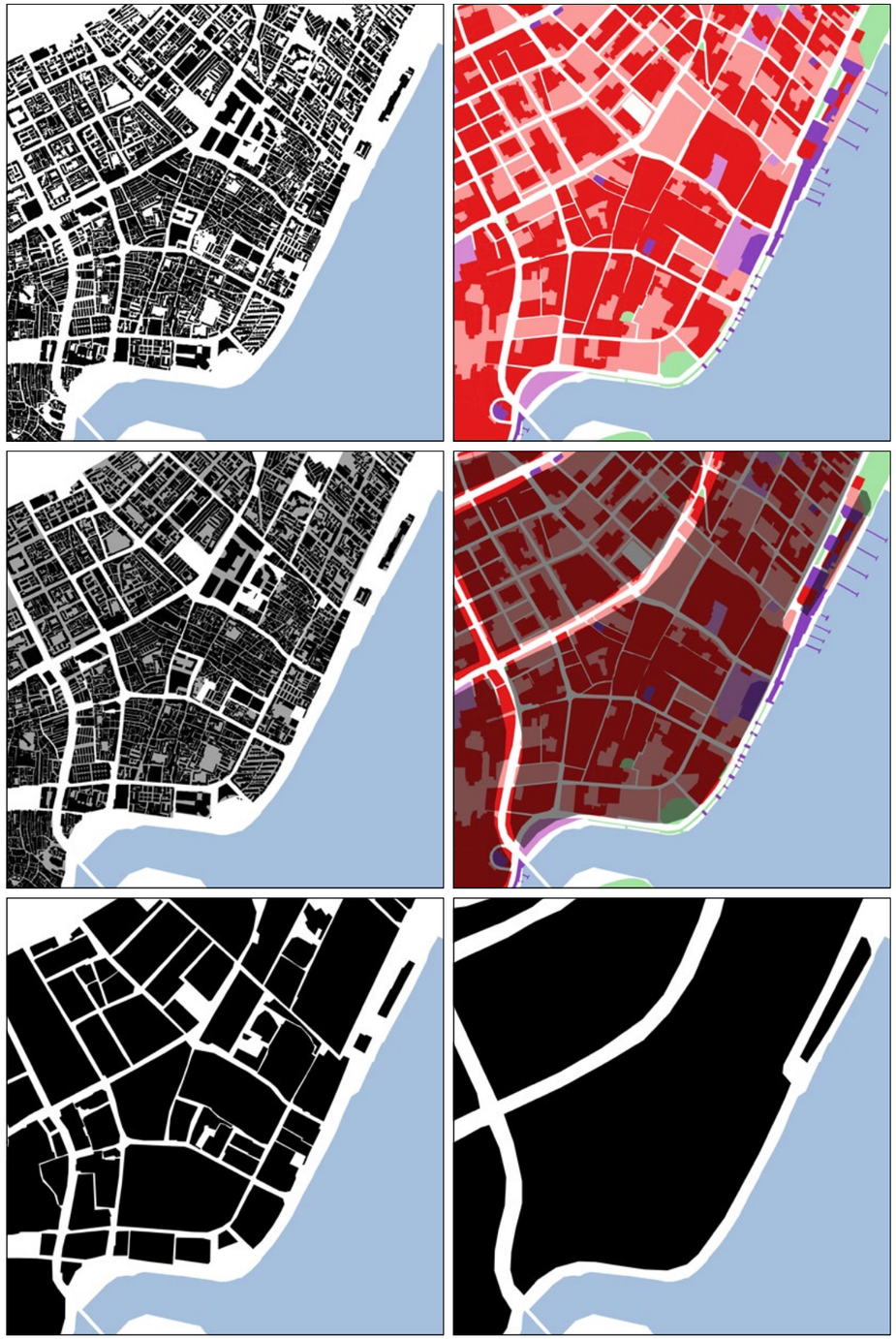

Figure 7.2
Hankou Riverside, 2013: (left) Building footprint on micro scale;
(right) Urban land use on macro scale (Bekkering, CAI, Kuijper)

1910

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Figure 7.3
Hankou Riverside homogeneous areas, 2013: (left) Based on building footprint on micro scale;
(right) Based on urban land use on macro scale (Bekkering, CAI, Kuijper)

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Hankou Riverside in historical order

The explanations with the maps in this section are longer than those on the macro and meso scale, as this micro scale shows more detail.

Hankou Riverside homogeneous areas and secondary connections, 1870 ▸ 1910

The period from 1870 to 1910 for Hankou Riverside can be characterized as the establishment period for the dual settlement, consisting of the much older Chinese and the new western part; the Foreign Concessions.

Hankou was originally a sailors' village for trade, for safety reasons situated not on the main river, the Yangtze River, but on its tributary, the Han River, similar to the location of many other water towns in China and elsewhere in the world. The area was cut off from Hanyang between 1465 and 1487 by the diversion of the Han River from its riverbed south of Hanyang to the north side of the town. Since the middle of the sixteenth century traders from the Shandong, Jiangsu, Anhui, and Sichuan provinces came to Hankou for trade, resulting in a culturally diverse port town.

In 1870 the Chinese settlement was contained between the rivers and the town wall. It had what is called a fish bone structure with long streets more or less parallel to the riverbanks, and alleys perpendicular to the streets connecting to the rivers. The lengths of the alleys varied from 130 to 150 m (427 to 492 ft), the distances between them from 15 to 20 m (49 to 66 ft), allowing for two plots back to back.

The British were the first to obtain a concession in 1861, situated adjacent to the Chinese town on the Yangtze River, toward the northeast. The new streets were laid out in a regular grid in a western colonial manner.

By 1910, the model of growth for the Chinese town was densification rather than extension, because of its clear confining boundaries of the rivers and the wall. A large number of new alleys was developed based on the existing alley structure, intensifying the fish bone structure. In 1910 the alley system was at its most complete and complex.

By that time an extensive growth had happened next to the Chinese town. From 1861 on, the official British, Russian, French, German, and Japanese Concessions (from south to north) were gradually built up, with a small, not officially approved Belgian settlement at the northern end. Different from other concession areas in China, such as in Shanghai and Tianjin—where the Concessions were built outside the city wall—in Hankou the town wall was extended to include the British, Russian and French Concessions. The land leasing model was also different. Each concession in Hankou was leased to the respective country all at once. This required planning and resulted in a clear and tidy urban structure that has been well preserved up to now. In general, the concession areas were planned with a grid system consisting of streets more or less parallel and perpendicular to the Yangtze River.

The course of a part of the town wall in the French Concession generated some radial roads and triangular plots. Each concession shows a distinctive urban form as well as architectural typology, the last often reminiscing that of the home country:

- British Concession: regular grid system,
- Russian Concession: grid system with some triangular plots,
- French Concession: grid system with radial roads and triangular plots,
- German Concession: regular grid system with larger plots,
- Japanese Concession: regular grid system with smaller plots.

Figure 7.4
Hankou Riverside homogeneous areas and secondary connections, 1870 (Bekkering, CAI, Kuijper)

Figure 7.5
Hankou Riverside homogeneous areas and secondary connections, 1910 (Bekkering, CAI, Kuijper)

1870

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Hankou Riverside homogeneous areas and secondary connections, 1910 ▸ 1950

The period from 1910 to 1950 can be characterized as the development period in which the available area between the rivers and the town wall was gradually filled up.

The town wall itself was demolished in 1907 to allow for the city's development inland. The Jinghan Railway was inserted following the course of the demolished town wall. It remained functional till 1991. This forms the northwestern boundary of Hankou Riverside in this research. The Chinese town extended somewhat beyond the line of the former town wall. Hospitals, schools, factories, and other public services were built, as well as residential areas with a clear grid system, evidencing the influence of the western way of planning of the Foreign Concessions. In the western part, the British Concession filled the space up to the railway. On the edge of the Japanese Concession, the establishments of some industrial facilities changed the original urban structure.

The operation of the railway and the increasing volumes of trade on the Yangtze and Han Rivers created a demand for links between the rivers and the inland, as well as between the Chinese town and the Foreign Concessions. New roads perpendicular to the Yangtze River, and new open spaces were inserted in the original tissue. This broke up the large homogeneous areas into smaller pieces. In addition, River Street (Yanjiang Road) that was built immediately along the bank of the Yangtze River cut the original alley system off from the river. Dragon Temple Park was constructed on the hill at the confluence of the two rivers.

The spatial structure of the Concession areas remained largely intact.

Hankou Riverside homogeneous areas and secondary connections, 1950 ▸ 1970

Between 1950 and 1970, the area of Hankou Riverside filled up completely. Most of the development of the new industries based on the national First and Second Five Years Plans took place in other parts of Wuhan. In Hankou Riverside the leftover space at the northwestern end was filled up with some small factories and their corresponding residential areas, *danwei*. Qiaokou Park was realized in the western part.

The opening up of the Jianghan Bridge across the Han River in 1956, its connecting road, and two other new roads perpendicular to the river, broke up the originally large homogeneous areas in this part of Hankou. Along the original town wall, the urban tissues of both the fish bone street-and-alley structure and the grid structure are distinctively present, creating local identity and orientation. Even though the newly introduced roads diminished the sizes of the homogeneous areas, the area as a whole kept its main characteristics of long streets following the course of the rivers at a distance, and smaller streets perpendicular to the rivers, though on an increased scale.

The opening of the Yangtze River Bridge in 1957 provided a much more efficient and effective alternative for transportation by ferries across the river. At the time, this was one of the reasons why the role of Hankou as a port city declined. In addition, due to the newly introduced Plan Economy since the establishment of the Peoples' Republic of China in 1949, traditional small scale commerce and manufacturing gradually disappeared. Also, under the national and very strict household registration system (*hukou*), only officially registered local residents were and are allowed to live here, which put an end to the cultural integration with immigrants from all over China that characterized the local community. (LONG 2006) Though the physical urban form mainly remained the same, the traditional socially, economically and culturally diverse city gradually disappeared.

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Figure 7.6
Hankou Riverside homogeneous areas and secondary connections, 1950 (Bekkering, CAI, Kuijper)

Figure 7.7
Hankou Riverside homogeneous areas and secondary connections, 1970 (Bekkering, CAI, Kuijper)

1870

Hankou Riverside homogeneous areas and secondary connections, 1970 ▸ 1990

Between 1970 and 1990, the area did not change much. Small cracks appeared in the edges of the large homogeneous areas along Zhongshan Road that runs through all of the length of the central area of Hankou. The Cultural Revolution from 1966 to 1976 suspended development for the area, similar to the rest of China. However, since the end of the 1970s, local policy encouraged self-employed and private businesses, and stimulated market-oriented development. This break from the Plan Economy stimulated the Chinese settlement of Hanzheng Jie to become a nationally known small business and wholesale market area, specialized in textiles of all kinds, which at a later time led to its transformation, setting in with ever larger commercial and residential building complexes. (CHEN 2009)

1910

Hankou Riverside homogeneous areas and secondary connections, 1990 ▸ 2000

1950

The period after 1990 is characterized by intensive transformation and regeneration, in the beginning government initiated; later more and more market driven. The old urban tissue with its large homogeneous areas began to fall apart.

Many transformations were caused by the construction of new large-scale infrastructure. Big changes occurred between 1990 and 2000 as consequences of the building of three new bridges: one over the Yangtze River, the Second Yangtze River Bridge in 1995, and two over the Han River, Yuehu or Moon Lake Bridge in 1998, and Qingchuan Bridge in 2000, plus two newly built roads to handle the bridge traffic. In addition, the construction of overpasses, as part of the Yangtze River Road upgrading project, eroded parts of the urban tissue.

1970

1990

2000

The growing awareness of the high efficiency of modern architecture, the application of new building construction methods and materials, such as steel reinforced concrete, and the transformation of the business model from trade on the streets to shopping in wholesale complexes and department stores, together led to the construction of a large number of enormous, out of scale complexes in the original Chinese settlement. The Wuhan Pageant Place, for example, with a height of 251.44 m (825 ft), was the tallest building in Wuhan at that time.

In the former German, Japanese and French Concessions, some *danwei* belonging to government offices with their related residential high-rise buildings, inserted in the 1950s and 60s, were under reconstruction.

By 2000, complete urban blocks were demolished and transformed into new urban tissue. These transformations more or less retained the existing formal structure, with an increased scale.

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Figure 7.8
Hankou Riverside homogeneous areas and secondary connections, 1990 (Bekkering, CAI, Kuijper)

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Figure 7.9
Hankou Riverside homogeneous areas and secondary connections, 2000 (Bekkering, CAI, Kuijper)

1870

Hankou Riverside homogeneous areas and secondary connections, 2000 ▸ 2006

2006 is the year with the most intensive transformation in Hankou Riverside. New wide roads between the inland and the Yangtze River were inserted with a number of big commercial building complexes on both sides, and an underground civil air raid shelter.

Another breakthrough between the inland areas and the river was constructed to connect to the Qingchuan Bridge. These transformations destroyed considerable parts of the urban tissue. Empty plots appeared everywhere in the area and were often combined for large-scale new developments, most with high-rise buildings of more than 30 floors. As many secondary connections were eliminated, the spatial system lost its coherence and recognizability for the area as a whole.

1910

Hankou Riverside homogeneous areas and secondary connections, 2006 ▸ 2013

From 2006 to 2013, more and larger scale transformations took place, filling many of the empty plots and further destroying original urban structure. Large parts of the former British Concession were taken out for the construction of the Yangtze River Tunnel and replaced by new urban blocks and a park.

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Figure 7.10
Hankou Riverside homogeneous areas and secondary connections, 2006 (Bekkering, CAI, Kuijper)

1910

Figure 7.11
Hankou Riverside homogeneous areas and secondary connections, 2013 (Bekkering, CAI, Kuijper)

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Hankou Riverside homogeneous areas and secondary connections, 2013 ▸ 2016

Wuhan starts up the 'Three Old Transformations' program, i.e. the urban regeneration program for shanty towns, old factories, and old villages. The Hanzheng Street area is prioritized and is now in the implementation phase. The areas around the intersection of Zhongshan Road and Duofu Road, and the areas along Youyi Road are the key areas. (See the new large white areas in *Figure 7.12*.) All of the existing buildings are demolished, and the traditional urban tissue disappears. In other parts large scale redevelopment continues.

1910

Hankou Riverside homogeneous areas and secondary connections, 2016 ▸ 2019

Wuhan has entered the advanced stage of 'Three Old Transformations' in this period. More integrated urban regeneration approaches are applied. For instance, the government regenerates the old neighborhood through urban infrastructure renewal and public facilities supply. The areas around Minquan Road are completely demolished resulting in empty plots and changes in urban structure. (See the new large white area in *Figure 7.13*.)

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2019

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Figure 7.12
Hankou Riverside homogeneous areas and secondary connections, 2016 (Bekkering, CAI, Kuijper)

1910

Figure 7.13
Hankou Riverside homogeneous areas and secondary connections, 2019 (Bekkering, CAI, Kuijper)

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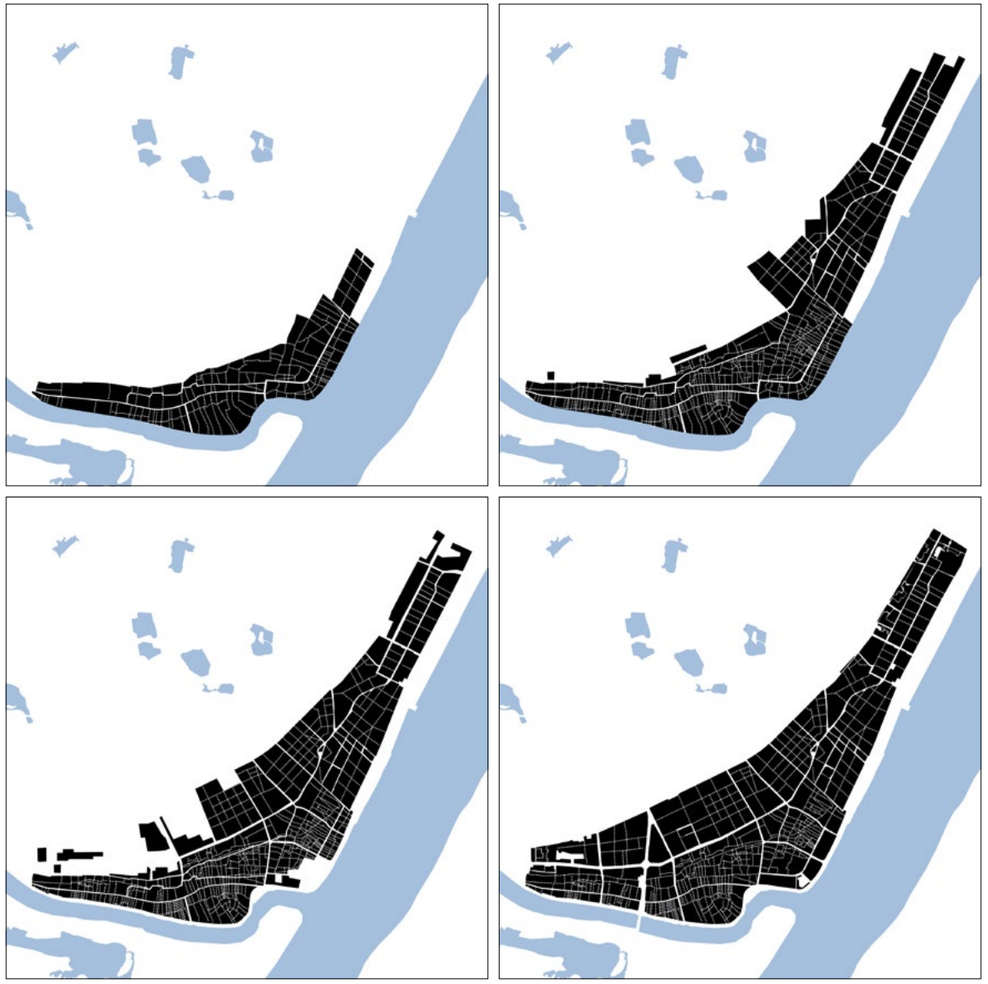
2019

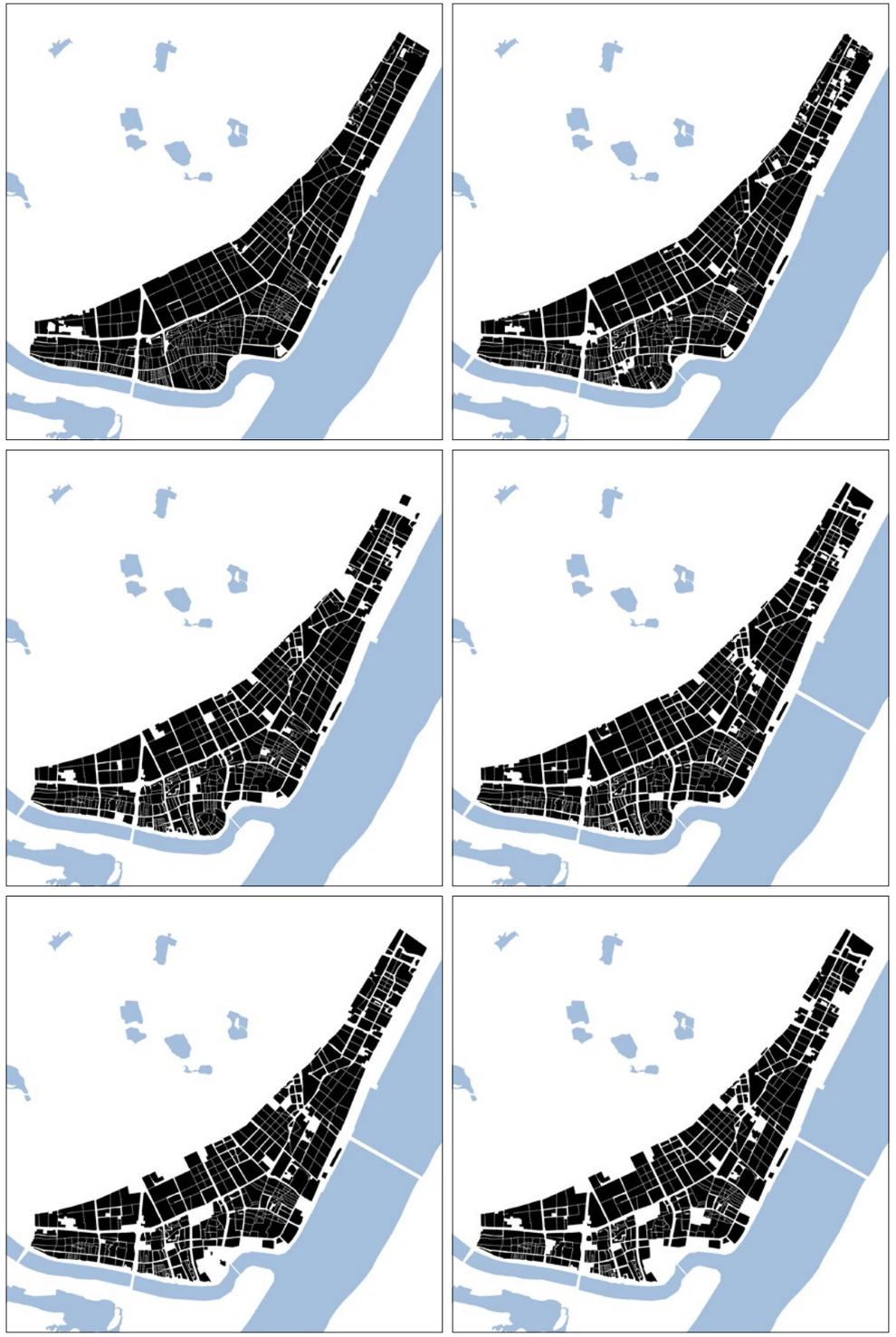
Overview of Hankou Riverside homogeneous areas, 1870 ▸ 2019

Figure 7.14b [right page ▸]
Overview of Hankou Riverside homogeneous areas and secondary connections from 1990 ▸ 2019
(Bekkering, CAI, Kuijper)

Figure 7.14a
Inner City homogeneous areas from 1870 ▸ 1970
(Bekkering, CAI, Kuijper)

		1990	2000
1870	1910	2006	2013
1950	1970	2016	2019





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Conclusions

Chapter 8
Urban Spatial Structure in Historical Order

Chapter 8 is the first of this section of the book, presenting the CONCLUSIONS of the analyses coming out of the maps series: the structural elements on the macro, meso and micro scales respectively (Chapters 8 through 11). These indicate the methods in which the insights derived from the historical-morphological analyses can be applied in the practice of the decision making on, and the design of urban regeneration, transformation and extension. A further explanation of the application of homogeneous areas and secondary connections in practice is given in Chapter 12. The relevance of this research for the future of the city and recommendations for further research conclude this part.

The series of sketches in this chapter are interpretations of the overall urban form. They are abstractions on the highest level of scale of the urban transformations and extensions: finding the overall Urban Spatial Structure of Wuhan.

1870

1910

Urban Spatial Structure in historical order

The series of sketches in this chapter are interpretations of the overall urban form. They are abstractions on the highest level of scale of the urban transformations and extensions: finding the overall Urban Spatial Structure of Wuhan.

Urban Spatial Structure, 1870

In 1870 three towns are situated where the Han River, the most important tributary of the Yangtze River, flows into the main stream; each across the two rivers from the others. Hanyang in the west and Wuchang in the east are towns protected by and contained within their walls and moats; the first relatively small, the last much larger. Hankou in the northwest is a partially walled port town with a linear structure along the banks of the two rivers and open to them, but protected by a wall toward the countryside in the north and west. The three towns develop independently of each other.

Urban Spatial Structure, 1910

In 1910 Hanyang has spread to the river bank in the north with the establishment of the Hanyang Ironworks. Wuchang is still contained within its wall with considerable open spaces inside. Hankou has developed further linear growth downstream along the Yangtze River to the north.

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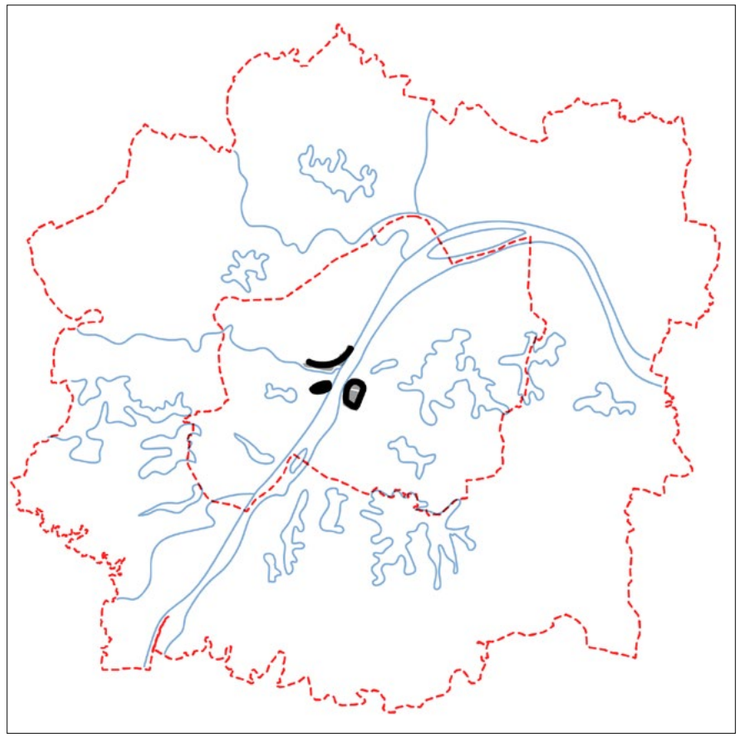

Figure 8.1
Urban Spatial Structure, 1870
(Bekkering, CAI, Kuijper)

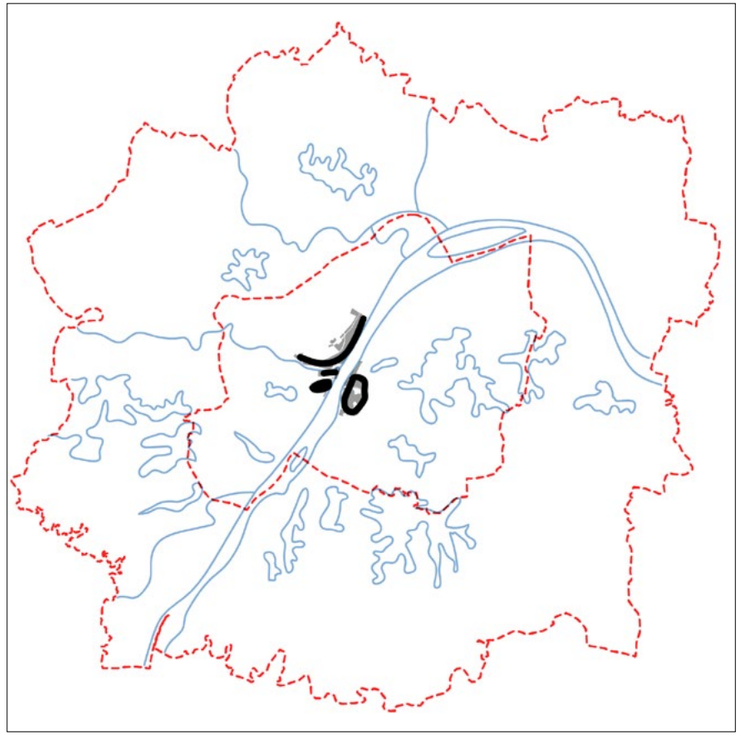

Figure 8.2
Urban Spatial Structure, 1910
(Bekkering, CAI, Kuijper)

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Urban Spatial Structure, 1950

In 1950 the situation in Hanyang shows little change. Wuchang has expanded to the north, downstream along the Yangtze River. In Hankou, the center shifts to the north with the redevelopment of the Foreign Concessions.

1910

Urban Spatial Structure, 1970

In 1970 the center of the three towns has moved further north, downstream along the Yangtze River, with linear growth on both banks. Hankou has also expanded westward along the Han River. New industrial locations are established around all three towns. A large steel factory, Wuhan Iron and Steel, is located in the far northeast. Wuchang has grown a long extension toward the north along the bank of the Yangtze River.

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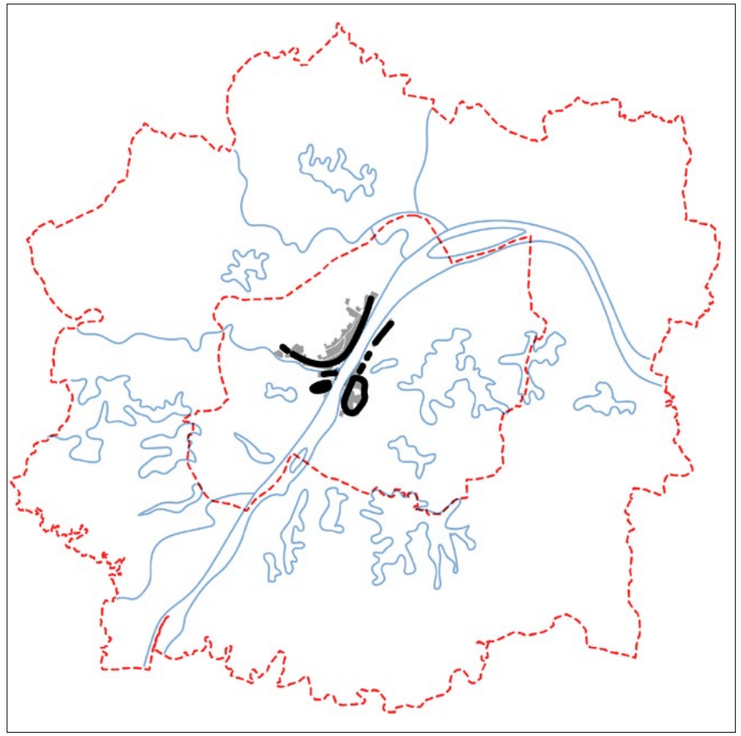

Figure 8.3
Urban Spatial Structure, 1950
(Bekkering, CAI, Kuijper)

1910

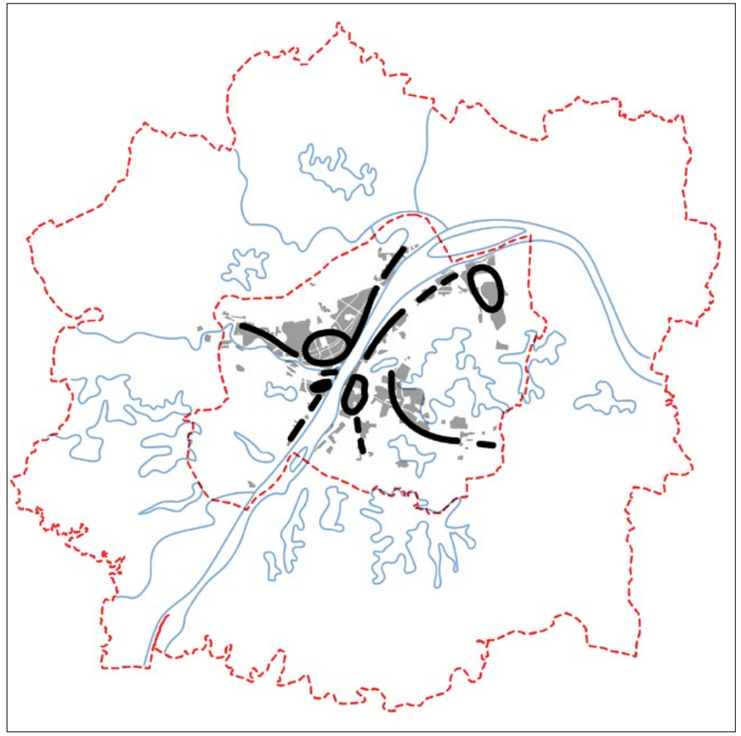

Figure 8.4
Urban Spatial Structure, 1970
(Bekkering, CAI, Kuijper)

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Urban Spatial Structure, 1990

In 1990 Hanyang lags behind in development. The Wuchang side has developed into a large-scale horseshoe shaped spatial structure bent between the local topography of lakes and mountains. Hankou has developed into a compact city contained within its boundaries of the two rivers and the dike protecting against flooding from the northwest, though with linear extensions reaching into the countryside across the dike.

1910

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Urban Spatial Structure, 2000

In 2000 the surroundings of Hanyang have become like an extension of Hankou after the new Yuehe Bridge over the Han River is built in 1998. The horseshoe structure of the Wuchang side is strengthened.

The commercial center or central business district of Hankou becomes the most powerful of the CBS's in the city's three parts. Development also grows along the anti-flooding dike in the north.

1870

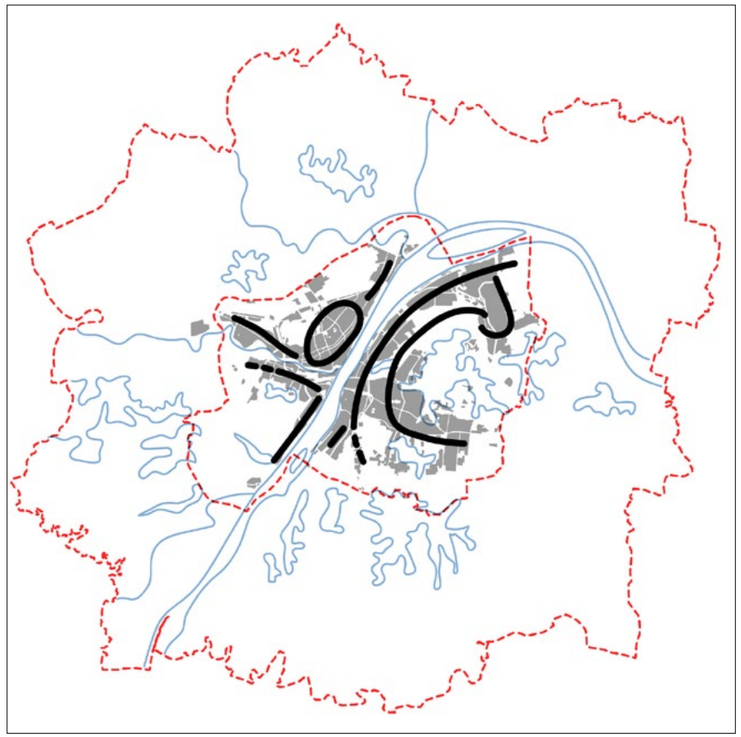

Figure 8.5
Urban Spatial Structure, 1990
(Bekkering, CAI, Kuijper)

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2019

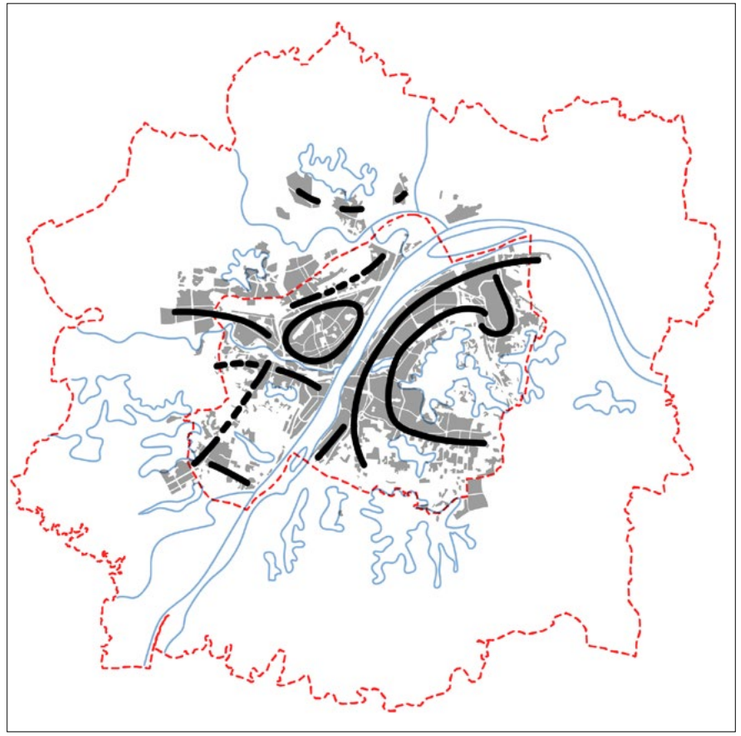

Figure 8.6
Urban Spatial Structure, 2000
(Bekkering, CAI, Kuijper)

1870

Urban Spatial Structure, 2006

In 2006 Wuchang and Hankou together form the core of the city. Hanyang has continued its linear development toward the south and west as an extension of Hankou. Wuchang has developed linear elements far from its center, in addition to the horseshoe structure. The compact core of Hankou has crossed over the dike to the north, with new development emerging across the Fuhe River to the north as well.

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Urban Spatial Structure, 2013

In 2013 the dual core is strengthened by increasing density. Urban extensions have been built on the outskirts of the Metropolitan Area, including linear developments on the northern side of the Yangtze and Fuhe Rivers.

1870

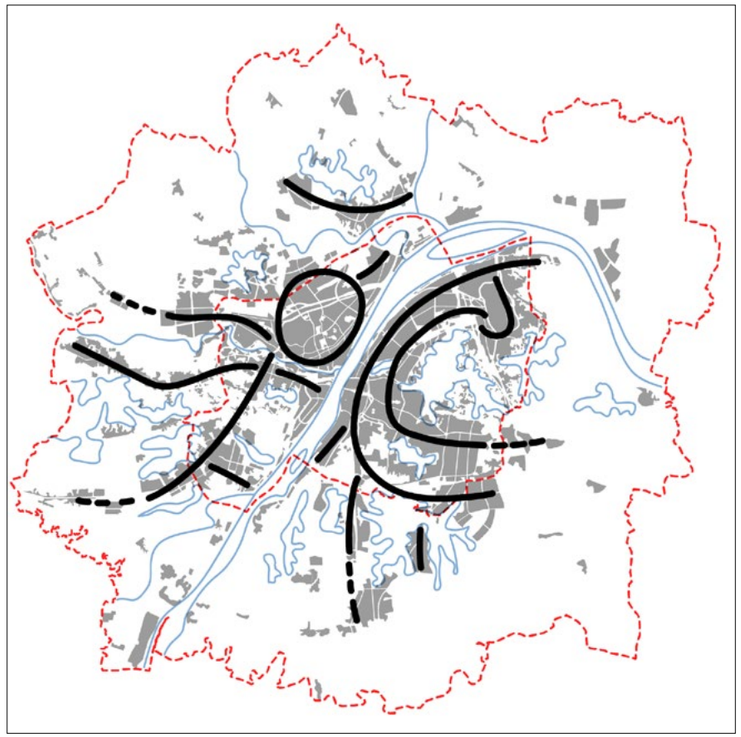

Figure 8.7
Urban Spatial Structure, 2006
(Bekkering, CAI, Kuijper)

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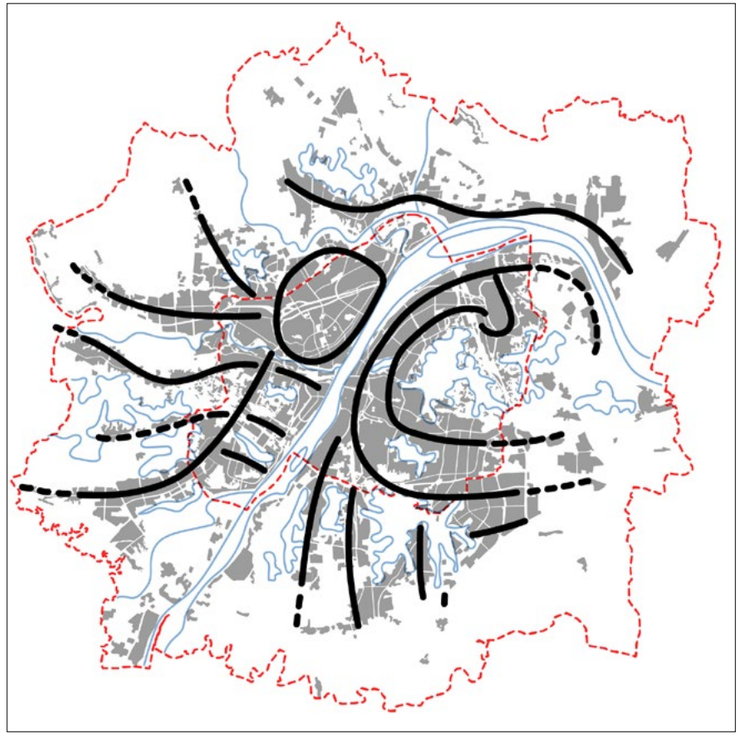

Figure 8.8
Urban Spatial Structure, 2013
(Bekkering, CAI, Kuijper)

Urban Spatial Structure, 2016

Though the urban area shows considerable growth, the structure does hardly change, except in the northeastern corner where the development starts to deviate from the course of the Yangtze River.

Urban Spatial Structure, 2019

Changes in structure only occur in the east. There is development beyond the border of the Metropolitan Area, though it seems scattered. Its true structure may become clear in the future, on a larger scale.

In the end, it is striking that the areas of and around the original three towns still have distinctly different spatial structures, though not the same they had originally.

The Hanyang side displays a finger city of linear developments stretching towards the west and southwest. The Wuchang side forms a horseshoe around the lakes with far-reaching linear developments towards the south. The Hankou side is a compact city between rivers with linear developments extending into the landscape towards the west, north and east.

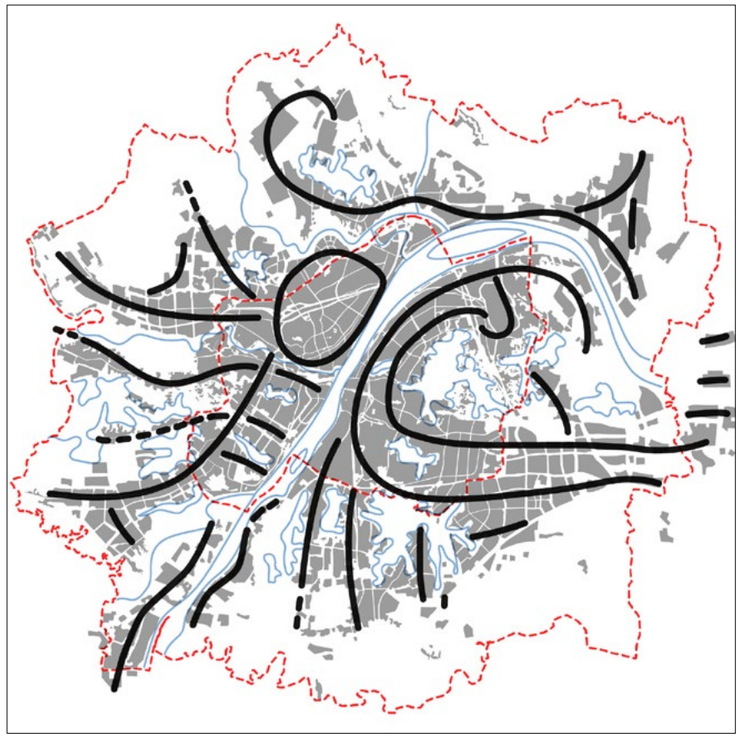

Figure 8.9
Urban Spatial Structure, 2016
(Bekkering, CAI, Kuijper)

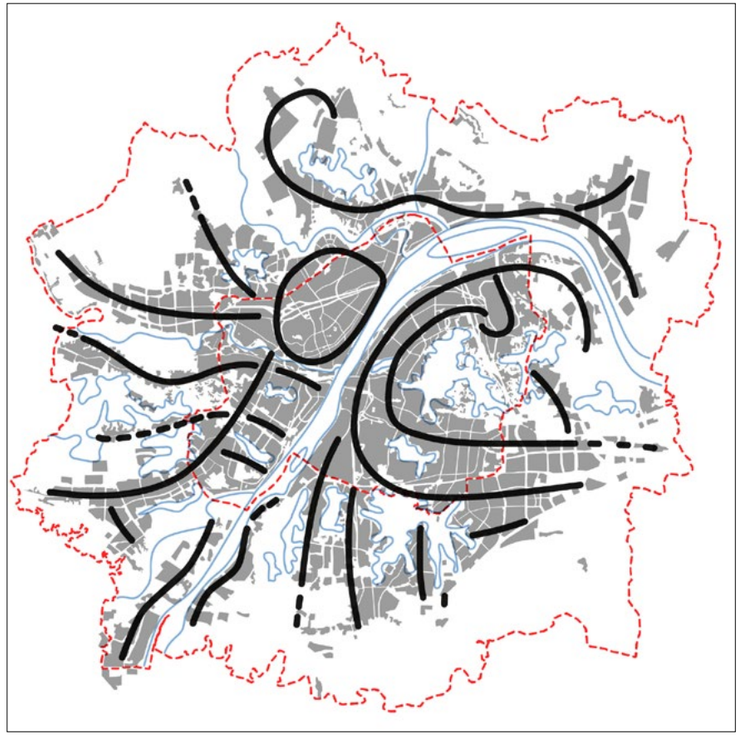

Figure 8.10
Urban Spatial Structure, 2019
(Bekkering, CAI, Kuijper)

Overview of the Urban Spatial Structure, 1870 ▸ 2019

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2019

Figure 8.11a
Urban Spatial Structure overview, 1870 ▸ 1970
(Bekkering, CAI, Kuijper)

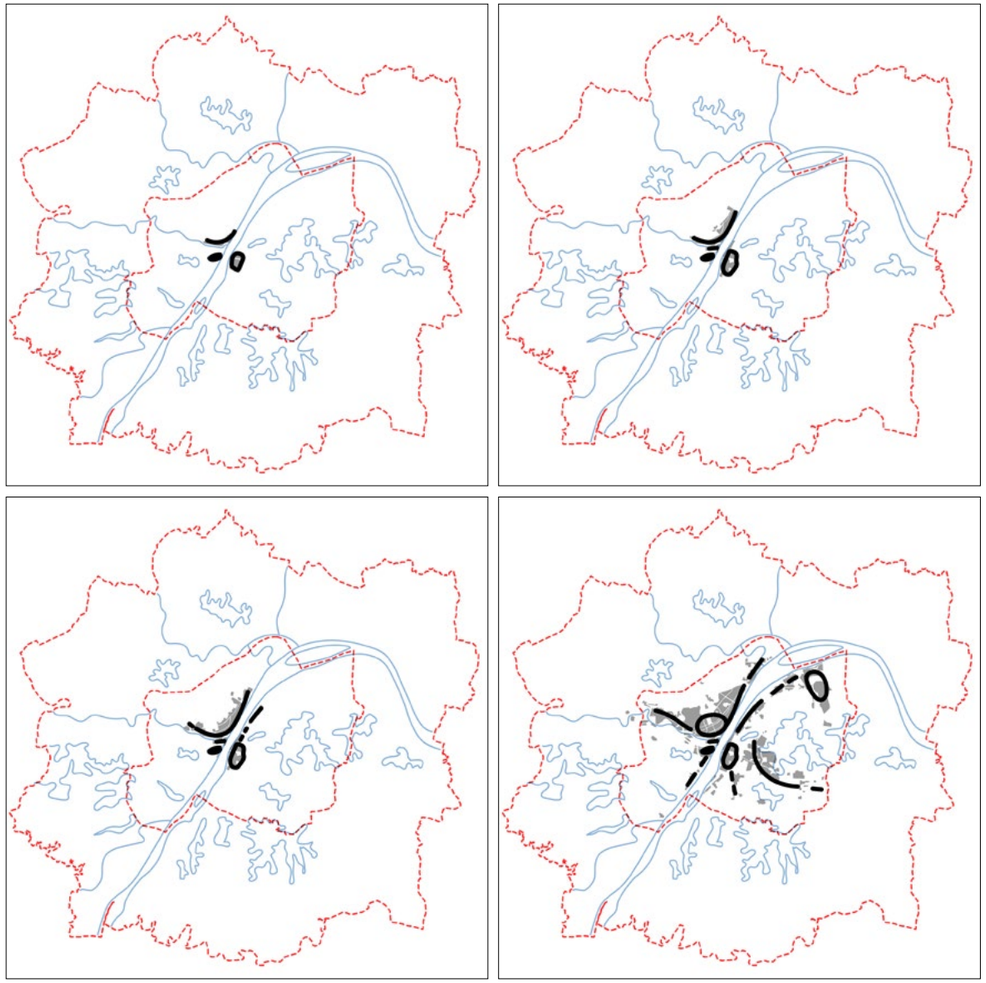
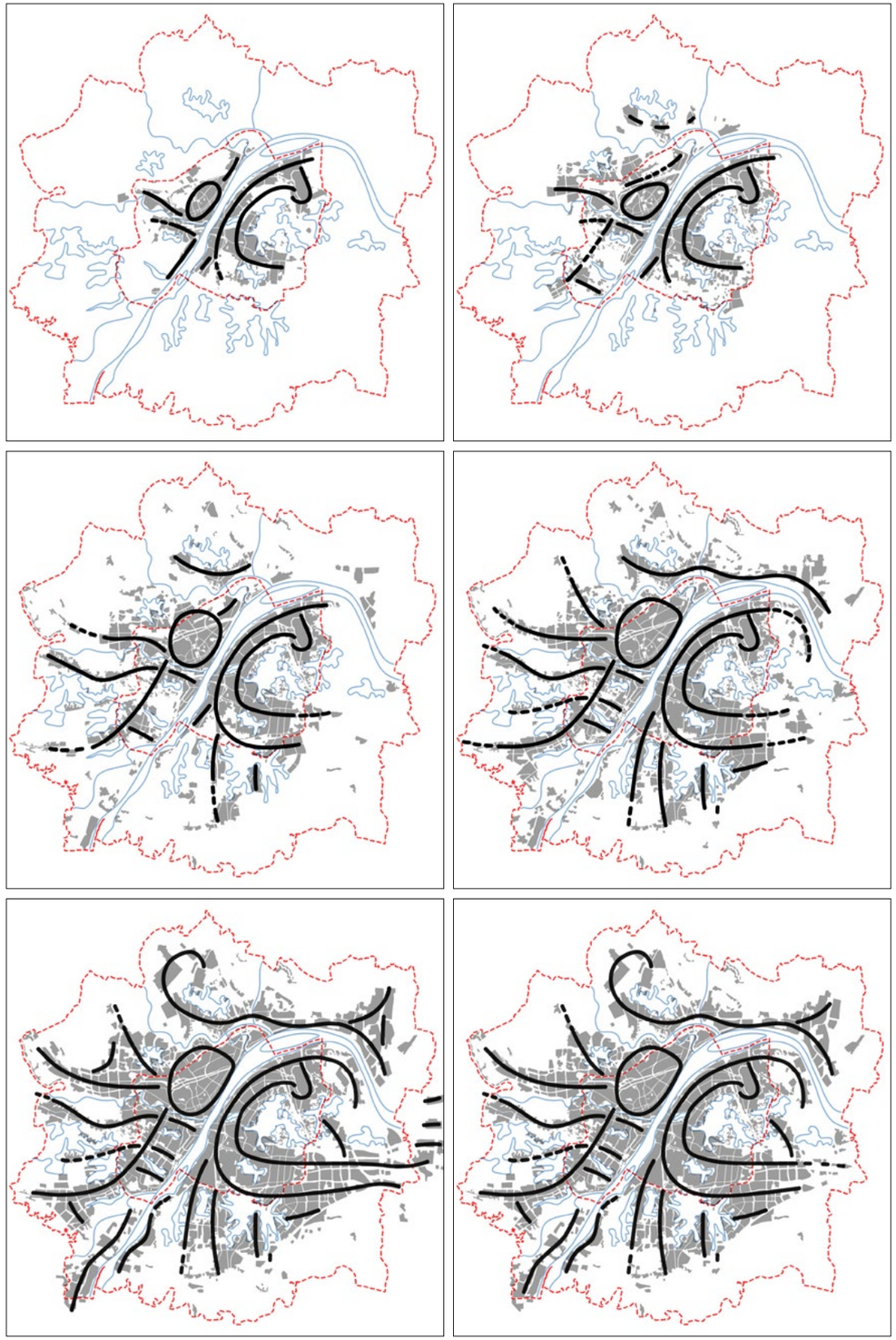


Figure 8.11b (right page ▸)
Urban Spatial Structure overview, 1990 ▸ 2019
(Bekkering, CAI, Kuijper)



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Chapter 9
Macro Scale Structural Elements

The chapter deals with a succession of macro scale structural elements: the landscape of the city, the large scale infrastructure, the homogeneous areas and their types, and the secondary connections.

Landscape

The fundamental structural element of the city of Wuhan is the landscape, particularly the abundantly present rivers and lakes, and the mountains or hills. Though these natural elements have sometimes been slightly changed by men, they have been relatively stable and constant.

In the maps' series they are kept the same all through the timeline, even though the banks and borders of the water will have changed in time, both by natural forces and by human intervention. This is done for two reasons. First, reliable data for the changes were not made available for the research. These are considered security sensitive and thus belong to the national government. And second: it helps to easily compare the maps to one another.

The landscape elements on the macro scale form the basis of the urban morphology. This shows clearly in the series of sketches of the overall Urban Spatial Structure through time. (See *Chapter 8*.) Though the natural green elements form a strong system in themselves, on all scales they are hardly integrated with the urban green areas. The city has the tendency to turn its back on its landscape.

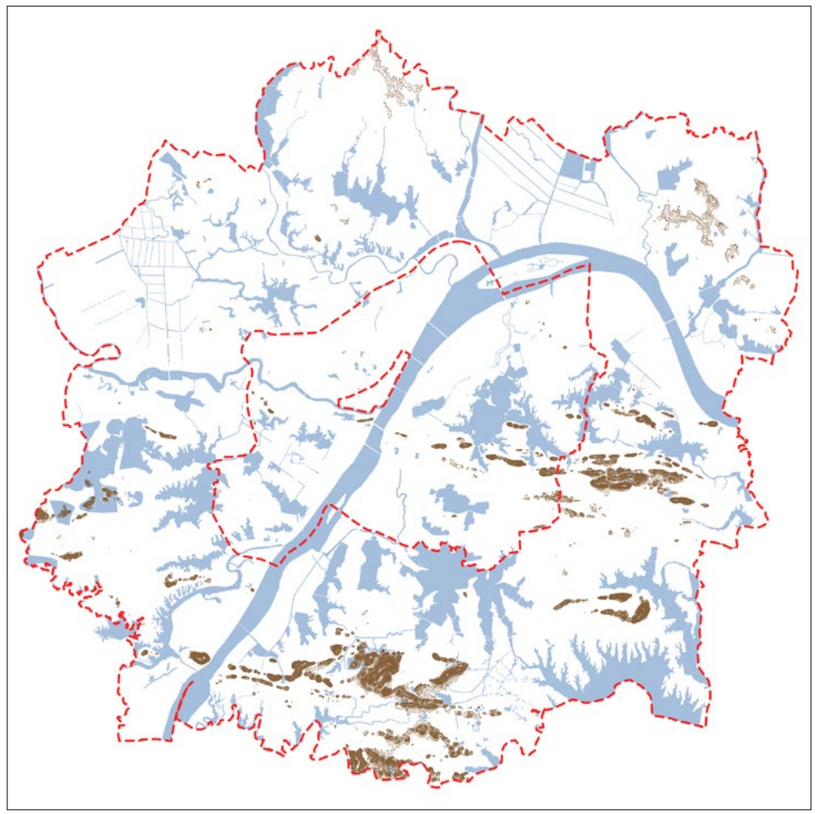


Figure 9.1
Landscape: water and mountains
(Bekkering, CAI, Kuijper)

Infrastructure

The ring roads, highways, and the railroads and metro lines constitute the main infrastructure in the city. Their conflicting characteristics, as with all large scale infrastructure, are on the one hand allowing the necessary urban flows and connect the different parts of the city, while on the other hand creating strong barriers in the urban fabric. They are the second type of determining spatial elements of the city on the macro scale. Together they cause the considerable fragmentation of the urban body.

Figure 9.2
Infrastructure on top of the landscape, 2013
(Bekkering, CAI, Kuijper)

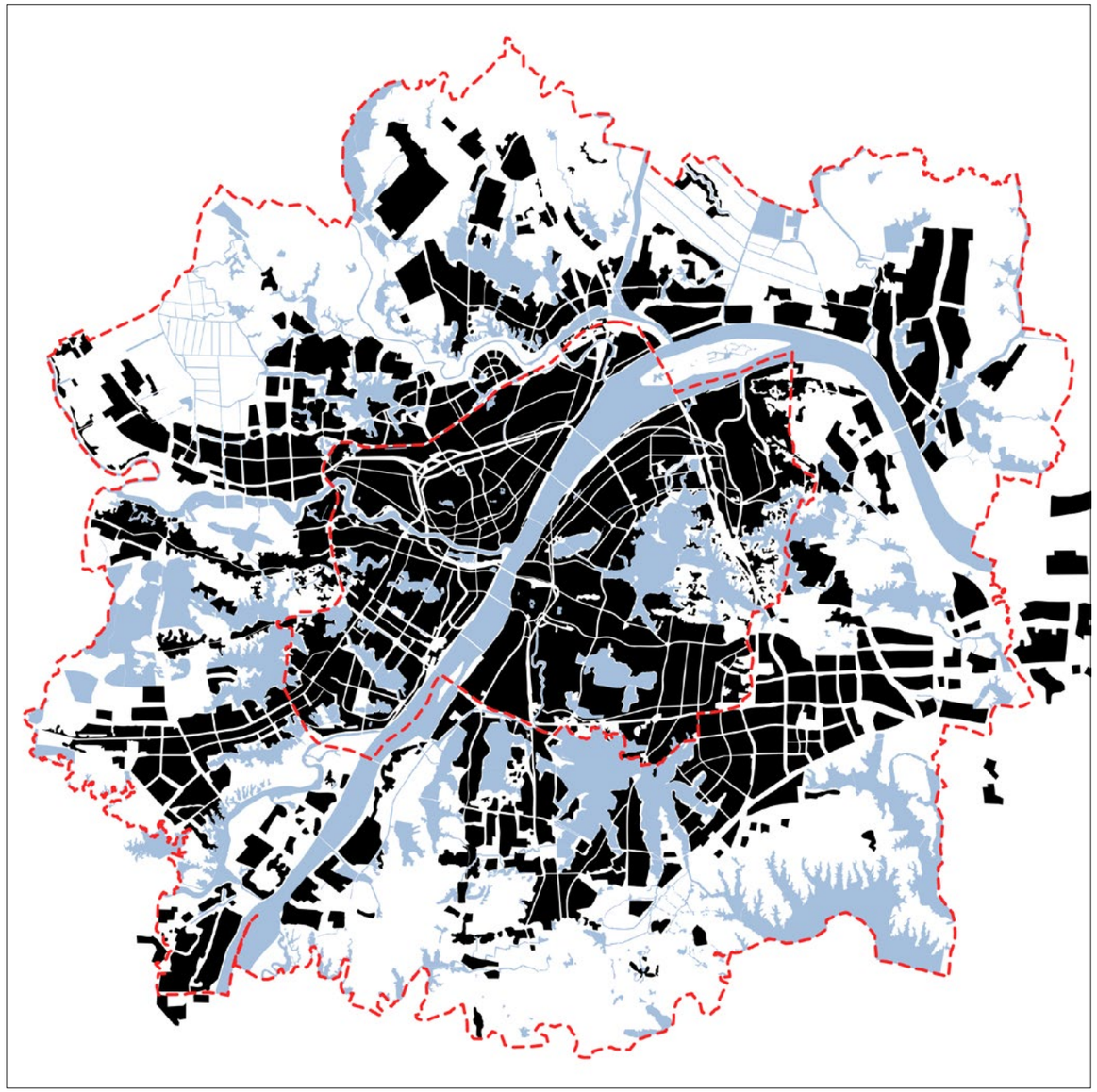
Homogeneous areas

The homogeneous areas together visualize the spatial structure: the morphology of the city on the macro level of scale. (See *Figure 9.5*.) They display the 'skeleton' of the city, but also its deep structure, in the relationships between the different homogeneous areas. (See *Figure 9.3* and *4*.) In the maps, the homogeneous areas are black, and the elements separating them from each other are white. (The third color in the maps, blue, indicates water.) When black and white are reversed, this shows the equal importance of both legend units, and their reciprocity: the one is meaningless without the other. The spatial structure of the city is represented in the black and the white together.

Figure 9.3
Reading of the homogeneous areas
(top) Different homogeneous areas;
(middle) Spatial structure;
(bottom) 'Skeleton' of the city
(Bekkering, CAI, Kuijper, ZHANG)

Figure 9.4
Wuchang and Hongshan Square
(top) Land use data and homogeneous areas;
(bottom) Homogeneous areas.
(Bekkering, CAI, Kuijper, ZHANG)

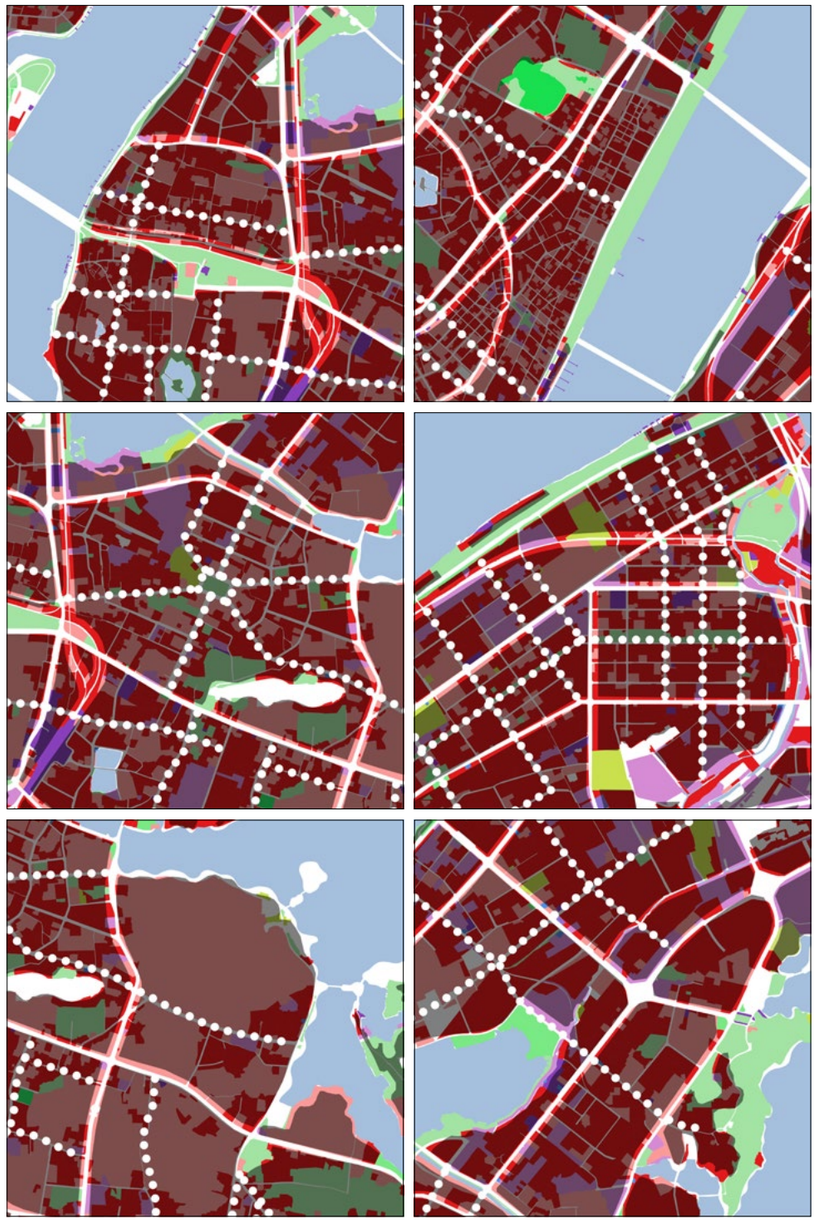
Figure 9.5
Metropolitan Area homogeneous areas, 2019
(Bekkering, CAI, Kuijper)



Three basic types of homogeneous areas on the macro and meso scale

When studying the analytical maps on the macro level of scale, a conclusion is that Wuhan basically consists of three types of homogeneous areas:

1. areas with a compact urban tissue without a dominant internal formal structure; often historical environments established before 1950,
2. areas with a strong internal spatial consistency; often following an overall design, as is the case in most newly developed areas after 1950,
3. areas crossed from one end to the other by one or two more or less straight crossroads.



1 Compact tissue

2 Strong internal consistency

3 Crossroad

Figure 9.6
Three basic types of homogeneous areas on the macro scale
(Bekkering, CAI, Kuijper, ZHANG)

Categorization of the homogeneous areas for all of Wuhan on the macro scale, including both the Metropolitan Area and the Inner City, shows how the different types are spread over the city. (See *Figure 9.7*.)

The first type, 'compact tissue', occurs in old parts of the city that have kept their spatial characteristics more or less as they were at the beginning of the twentieth century, though often dating from earlier periods. This is the case in Hanyang and Wuchang and some adjacent areas, and in towns, villages and some industrial projects that were once situated at a distance from the city before they became incorporated in it. These areas are important elements in the identity of the city.

The second type, homogeneous areas with a 'strong internal consistency', are neighborhoods that have been built according to a clearly recognizable design and have retained these characteristics. The earliest examples date from the 1950s, when the first of the *Wuhan Master Plans* under Russian influence regulated the urban development. They include also areas that have been largely or completely transformed and areas that have been incrementally transformed according to new designs in the processes of modernization and regeneration of the city. Similarly, in this category are areas that are relatively new and as such have not—yet—been transformed or modernized. These areas usually have a clear design, often with large scale grids, and are also important for the identity of the city, whether they are older or recent.

The third type is a mixed category. It consists of different type environments that have one overriding characteristic in that they are crossed by one or two more or less straight roads, 'crossroads'—that may be avenues or boulevards. This type covers by far the largest portion of the urban area. These areas can have relatively strong identities, although not always. The crossroads play the role of connecting to adjacent areas, either built-up or natural and/or agricultural, and in this research they are part of the secondary connections.

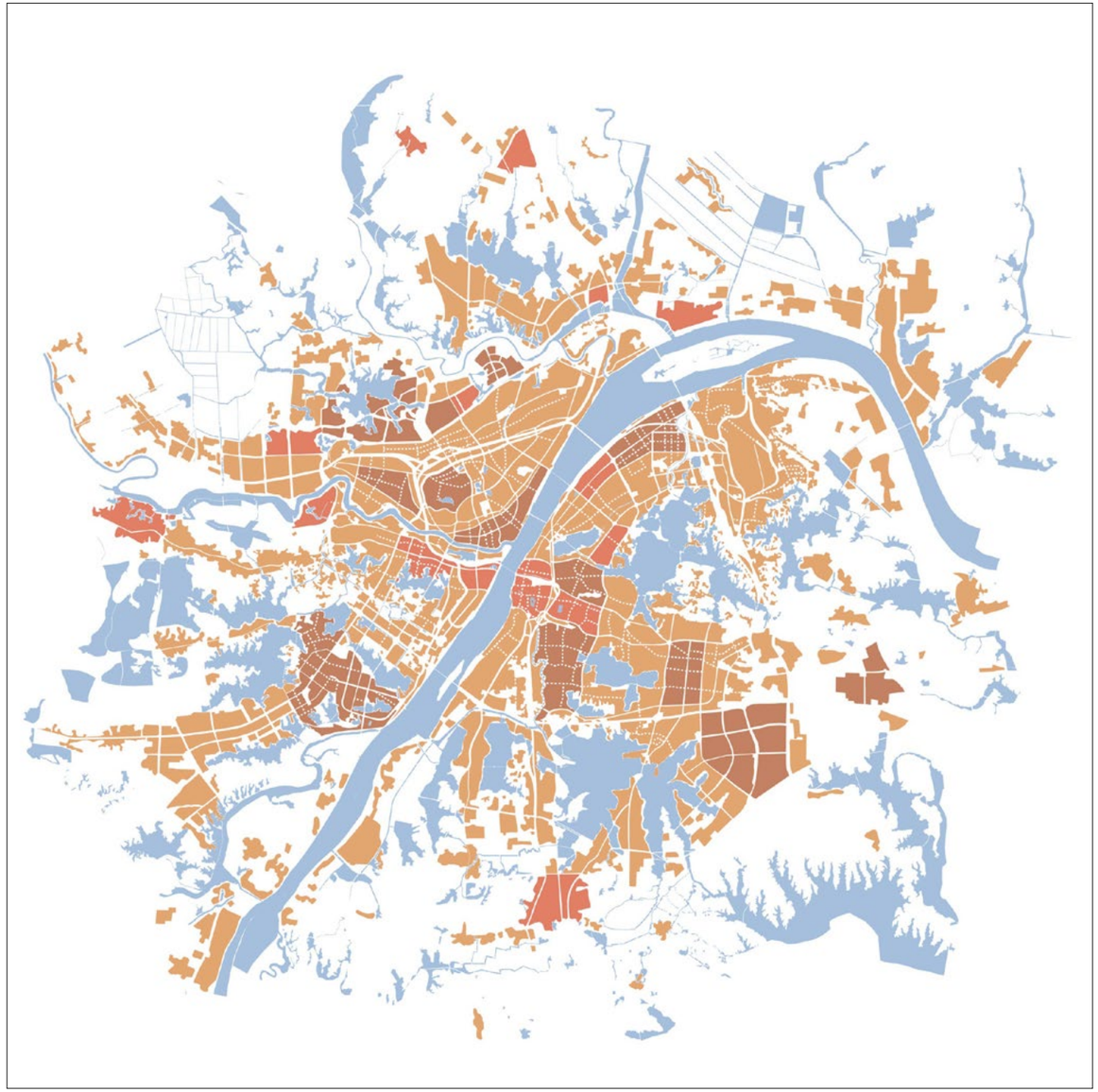


Figure 9.7
Macro scale/Metropolitan Area and meso scale/Inner City: three types of homogeneous areas, 2013
(Bekkering, CAI, Kuijper, ZHANG)

Chapter 10
Meso Scale Structural Elements

The maps of the homogeneous areas in the Inner City do not show the distinction between the three types, nor the connections between adjacent areas. A better distinction can be made when the secondary connections are added to the maps. (See Chapter 5 and Figures 10.1 and 3, next pages.) As mentioned before, these can be seen as representing the middle scale that is lacking in Wuhan, as in many Chinese cities. They are important for local orientation and identity.

Homogeneous areas and secondary connections

In case of urban regeneration, there are reasons to add secondary connections, first when the internal structure of a homogeneous area is hard to recognize or there is none, and second when there are none, or only a few connections to neighboring areas.

Often open spaces separating homogeneous areas from each other at the same time form meaningful connections on a higher level of scale, as is for instance the case between the Yangtze River and the East Lake. (See *Figure 10.2*.) Keeping these linear spaces open allows for the large scale elements to contribute to the identity of the adjacent areas as well.

Figure 10.1
Inner City homogeneous areas, 2019
(Bekkering, CAI, Kuijper)

Figure 10.2
Area north of Wuchang: land use data, homogeneous areas, and secondary connections, 2019
(Bekkering, CAI, Kuijper, ZHANG)

Figure 10.3
Inner City homogeneous areas and secondary connections, 2019
(Bekkering, CAI, Kuijper, ZHANG)

Isolated secondary connections

When isolated, the systems of secondary connections seem disconnected. (See *Figure 10.4*.) Even though they in reality work together with the open spaces between homogeneous areas, in many cases the urban structure can be improved by adding more secondary connections, strengthening the spatial structure of the city on the middle scale and making it less vulnerable for local transformations. On this level of scale, in some areas the secondary connections form networks in themselves, while in other areas individual secondary connections seem to be floating in space. This is an indication for the need for more detailed research on a lower level of scale, where new connections could be made. (See also *Chapter 12*.)

Each homogeneous area can be considered as a basic morphological unit. All the homogeneous areas together make up the spatial structure of the city on the macro scale and at the same time, each homogeneous area consists of streets and block systems on the micro scale. In this way they form a link between the macro and micro scales.

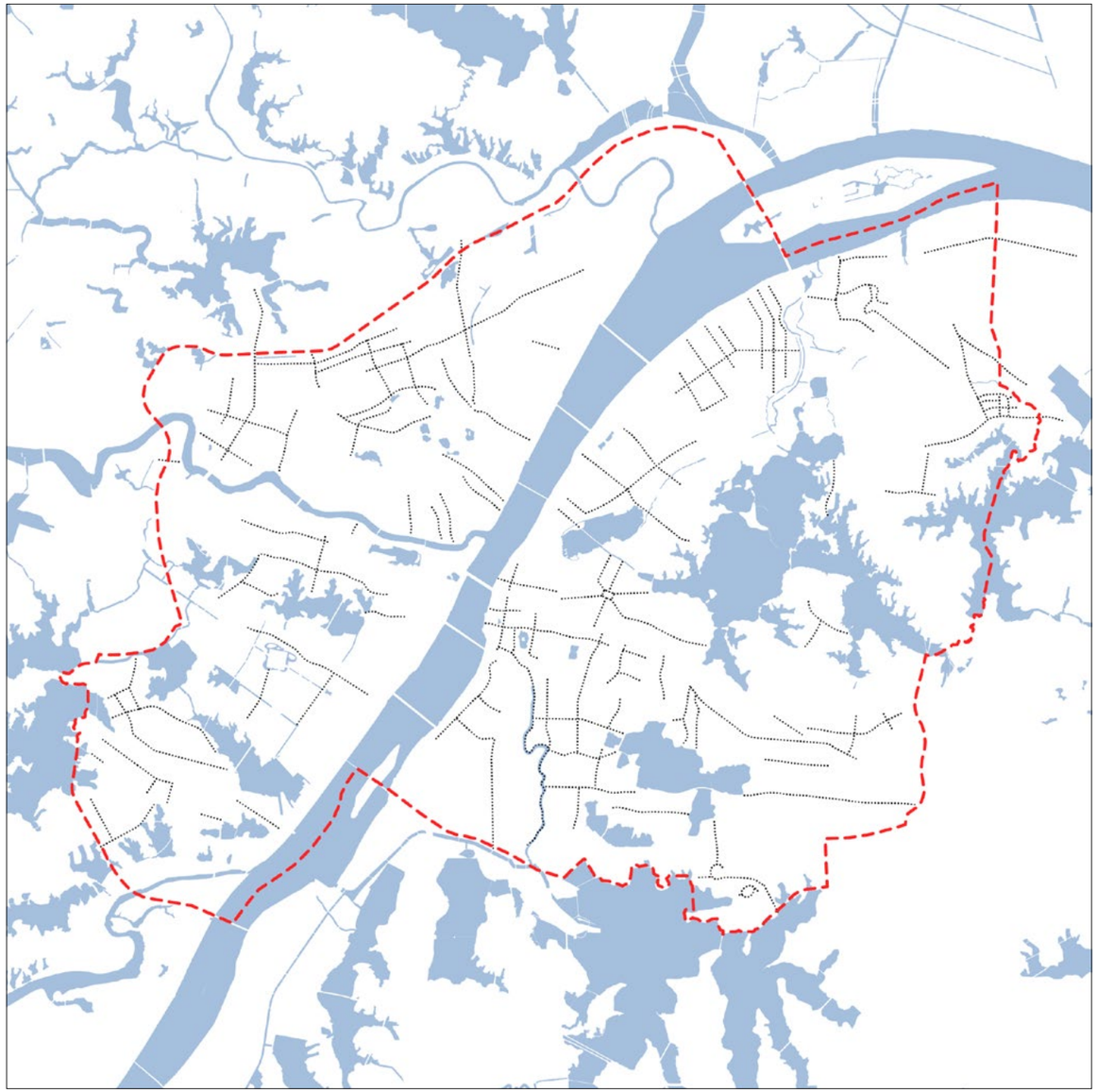


Figure 10.4
Secondary connections isolated, 2019
(Bekkering, CAI, Kuijper, ZHANG)

Chapter 11
Micro Scale Structural Elements

On the micro scale of the urban district Hankou Riverside the structural elements are obviously more detailed than on the macro and meso scales.

Eight micro scale structural elements

Rivers

Similar to most port cities in the world, Hankou Riverside owes its present urban structure largely to the courses and banks of the Yangtze and the Han River. (See *Figure 11.1*.) The rivers were and still are important, not only technically as infrastructure for water regulation, fishing, shipping, and trade, but also in a social sense: as an open and free territory connecting to the rest of China, the most recognizable feature in the identity of the city.

Anti-flooding wall

The anti-flooding wall along the banks of the Yangtze and Han Rivers, constructed after the serious flooding of 1954, forms a rather harsh and absolute boundary between the waterfront and the hinterland. (See *Figure 11.2*.) The lack of physical and visual accessibility of the rivers leaves unused their great potential for the identity of the city, and for the orientation of people, as well as for the formation of a meaningful public domain. In recent years, parks with public spaces have been constructed along the rivers across the walls. Though well used, these are relatively hard to reach and still cut off from the body of the city.

City wall

The city wall is traced on our maps based on historical maps as well as interpretation from literature. (See *Figure 11.3*.) The trace of the wall is still visible in the contemporary urban fabric, though the wall was taken down in 1907. Together with the railroad next to it, it was later transformed into one of the most important modern roads in Wuhan, Jinghan Road—both in the technical and the social sense. The course of the road, and the clear difference in urban tissues on both sides, are reminders of this history.

Railway

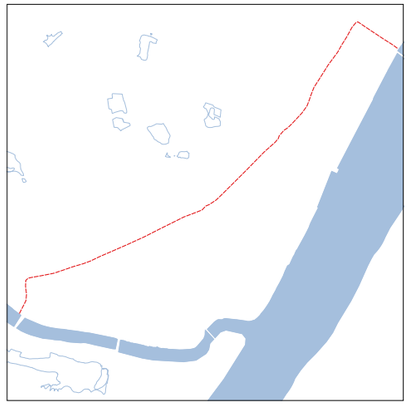
The historical Jinghan Railway, gradually built after the decision to do so in 1889 in the late Qing Dynasty just next to the city wall, with the first trains running in 1905, ceased functioning in 1991. (See *Figure 11.4*.) Replaced by Jinghan Road, its course still forms a clear boundary on the north-west.

Modern roads

The many recently constructed roads broke up the old urban fabric and now form the new urban structure on an increased scale. (See *Figure 11.5*.)

Green structure

The map shows the surprising amount of urban green areas in Hankou Riverside. (See *Figure 11.6*.) In the Concession grids, the green corresponds mainly to the pattern of streets. In the Chinese settlements, to the contrary, the green has the character of inserted and dispersed open spaces. Neither forms an integrated urban green system.



Figures 11.1 (left)
Hankou Riverside: rivers
(Bekkering, CAI, Kuijper)

Figures 11.2 (right)
Hankou Riverside:
anti-flooding wall
(Bekkering, CAI, Kuijper)

Figures 11.3 (left)
Hankou Riverside: city wall
(Bekkering, CAI, Kuijper)

Figures 11.4 (right)
Hankou Riverside: railway
(Bekkering, CAI, Kuijper)

Figures 11.5 (left)
Hankou Riverside:
modern roads, 2013
(Bekkering, CAI, Kuijper)

Figures 11.6 (right)
Hankou Riverside:
green structure, 2013
(Bekkering, CAI, Kuijper)

Fish bone structure in 1910 and 2013

The evermore diminishing part of the fish bone structure in the Chinese settlement constitutes the basic characteristic of that area. Overlapping the 1910—most complete—and the contemporary situation shows how much of the old tissue had disappeared by 2013. (See *Figure 11.8*.)

Concession Grid and Later Grid structure in 1970 and 2013

The Concession Grid and the Later Grid systems together form the second prominent urban structure in the area. Overlapping the grid system in 1970—the period when the grid system was fully developed and preserved—and the contemporary situation shows that the grid system is more resilient than the fish bone structure, and can absorb changes in the buildings and building types over a long period without losing its spatial characteristics. (See *Figure 11.9*.)

Figure 11.7
Hankou Riverside homogeneous areas, 2013
(Bekkering, CAI, Kuijper)

Figure 11.8
Hankou Riverside fish bone structure, 1910 (gray) and 2013 (black)
(Bekkering, CAI, Kuijper)

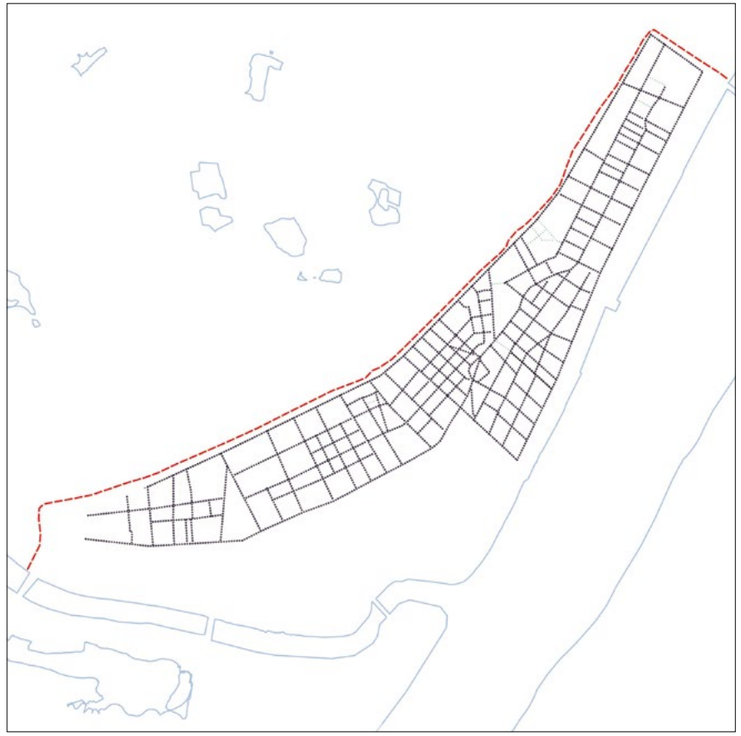


Figure 11.9
Hankou Riverside grid structure, 1970 (gray) and 2013 (black)
(Bekkering, CAI, Kuijper)

Eight types of homogeneous areas on the micro scale

On the micro scale, looking much closer at the spatial structure of Hankou Riverside, eight different types of homogeneous areas are recognized.[§]

[§] A first version of this categorization of the homogeneous areas in Hankou Riverside was developed in a workshop in the School of Architecture and Urban Planning of the Huazong University of Science and Technology/ HUST in Wuhan: *Mapping Hankou Riverside—Analysis and Design of the Urban Form*, with 21 Master students of architecture, urban planning and landscape architecture, in cooperation between Professor Henco Bekkering, CAI Jiaxiu and Joran Kuijper of TU Delft and Professor WANG Yuan, LI Shasha, and CHEN Lijing of HUST.

1 Earliest Tissue

The Earliest Tissue is what is left of the historical urban pattern of the Chinese town. (Most of the buildings are more recent.) This type of environment with dwellings in high density mixed with small scale urban facilities and services has been disappearing fast because of urban regeneration, mainly since 2000. The city has largely lost a type of urban environment that is unique to Hankou, based on the fish bone structure of long and big streets following the courses of the rivers at a distance, and narrow alleys closely spaced together leading to and from the rivers. The further away from the rivers, the bigger the blocks; the closer to the rivers the closer the alleys are spaced.

2 Concession Grid

As explained, the area of the former Foreign Concessions is largely characterized by its grid pattern laid out since the 1860s that has been withstanding changes very well. Here, many monumental historical buildings are still standing. The Concession Grid is generally composed of individual, square or skewed urban blocks of comparable scale, sometimes with a slight deviation in direction. Each block however, has a different interior configuration. There are blocks with buildings forming continuous boundaries along the streets and *Lifen* (see *type 4*) inside; with *Lifen* and various types of buildings breaking through the block; with neat linear edges and a variety of building types inside; fully filled with a variety of freestanding building types, etcetera.

3 Later Grid

The later extensions of the original concessions also have a grid pattern, but with more variation in the sizes of the urban blocks. The Later Grid consists of blocks that are sometimes four times larger, one and a half times the size of the original blocks, original size blocks, and sometimes half-sized original blocks. The largest blocks in the grid always have *Lifen* and *Danwei* inside (see *type 4* and *5*). Some intruding, morphologically unrelated elements, such as individual large building complexes or long linear buildings (slabs), have begun to destruct the blocks from the edges. In the middle of several blocks empty spaces occur, indicating ongoing transformation.

4 *Lifen*

The *Lifen* is the locally specific type of high-density low-rise housing from the first half of the twentieth century that is comparable to for instance the *Lilong* in Shanghai. Like the *Lilong*, the *Lifen* is a typological mix of Chinese and western housing located on alleys, in Wuhan within a smaller scale fish bone structure, with a main alley and smaller, secondary alleys branching off. The main alley is the widest and connects the *Lifen* with the surrounding streets. The secondary alleys can be referred to as front alleys connecting to the front courtyards and main entrances of the housing units. These are narrower, but it is where public life mainly takes place in the open, such as eating, playing *mahyong* or cards, et cetera. The third

Figure 11.10
Hankou riverside: eight types of homogeneous areas, 2013
(Bekkering, CAI, Kuijper)

level of alleys are the narrowest. These are the back alleys connecting to the back courtyards and back doors of the houses. Much of the family life or private life takes place here, such as washing clothes, cooking, etcetera. This structure can be seen as a reworking of the sequences of spaces in the traditional Chinese courtyard house, a concept called 'graduated privacy' by Nelson I. Wu, resulting in a strong sense of belonging. (Bracken 2020; Wu NI 1968)

The *Lifen* form clearly recognizable homogeneous areas with strong overall forms. Fortunately, some of the *Lifen* are still there and being renovated.

5 *Danwei*

The *Danwei* are areas where working, living and services (sometimes also small scale horticulture) are combined, directly related to a factory or institution and meant to house its workers and accommodate their daily lives. The term is most often translated as work-unit. This system follows the Russian example from the 1950s, and has become a strong element in Chinese cities as their first really rapid expansion was based on the establishment of new industries and new government institutions by the early communist regime. The physical construction of a *Danwei* consists mainly of rows of dwellings of mid-rise height, all with the same orientation according to *feng shui*. The distance between the rows is much larger than in the *Lifen* and is calculated according to the national requirement of minimum hours of direct sunlight per day in living- and bedrooms. Some of the buildings turn a corner at the end to create a more introverted courtyard supporting a sense of community. Today, the link between the factory or institution and the people living in the *Danwei* has become weaker or has been lost, but many of these environments for living have a relatively high quality of public space and life, and have kept (some of) their facilities. They are generally appreciated even though the size and quality of the housing units is limited.

6 Compound

Very different in organizational background, but similar in its urban spatial characteristics, are the housing compounds with modern housing—apartments or houses with gardens—that are widespread in Wuhan, as in all contemporary Chinese cities. These exist elsewhere in the world as well, and are often called gated communities. Contrary to the *Danwei*, these Compounds provide only housing. The physical structure is similar to that of the *Danwei*, but the scale is larger; the number of dwellings and the number of floors of the buildings are often much higher. A shared characteristic is that they have clear boundaries on the outside, and are turned inward. Though in China the housing compounds are guarded, they are normally open for visitors. They nevertheless have two main disadvantages for the urban environment. First, they are turned inward and thus contribute nothing to the public space outside their fences or walls. Second, because of the generally relatively large scale of the developments they do not connect well to the surrounding urban fabric. In terms of this research: they offer no secondary connections to adjacent homogeneous areas: the lacking middle scale of many Chinese cities.

7 Big Building

The latest urban regeneration has brought in many Big Buildings and building complexes, often replacing a complete former urban block, or even two or more. They are disruptive of the continuity in the urban environment in the scale of their footprint as well as their architectural scale, as they are often high-rises. These big buildings have hardly any spatial relationships to their surroundings, nor to each other. In most cases, the lower part has a larger block-filling footprint with one or more towers on top. Even when accommodating different functions, they generally have only a few entrances and contribute little to the adjacent public space. The map shows that this type is spreading over the area now.

8 Mixed Area

Many Areas have been or are in transition, resulting in a mix of different types next to each other. When these show reference to each other, they can result in good urban environments. Often though, the jumps in scale of the buildings and their being monofunctional does not result in any connection between them and their surroundings, and the area's internal coherence is lost. Even when this is a temporary phase in the transformation, it can be very disruptive.

The overview of the individual homogeneous areas grouped by type shows the dominance of Big Buildings and Mixed Areas with regards to their number, even though their scale often seems relatively small. (See *Figure 11.11* through *12a* and *b*.) In reality, as the term implies, the Big Buildings are not small at all. Their impact on their surroundings is strong, often overpowering.

In the northern part of Hankou Riverside, the areas with the Concession Grid are truly dominant. This is a valuable asset of Hankou. Of the other historical types, the Earliest Tissue, the *Lifen*, and the *Danwei*, there are still a number of areas in existence, though they are often threatened by demolition. Also, in many cases these areas are too small to retain the full qualities of the type.

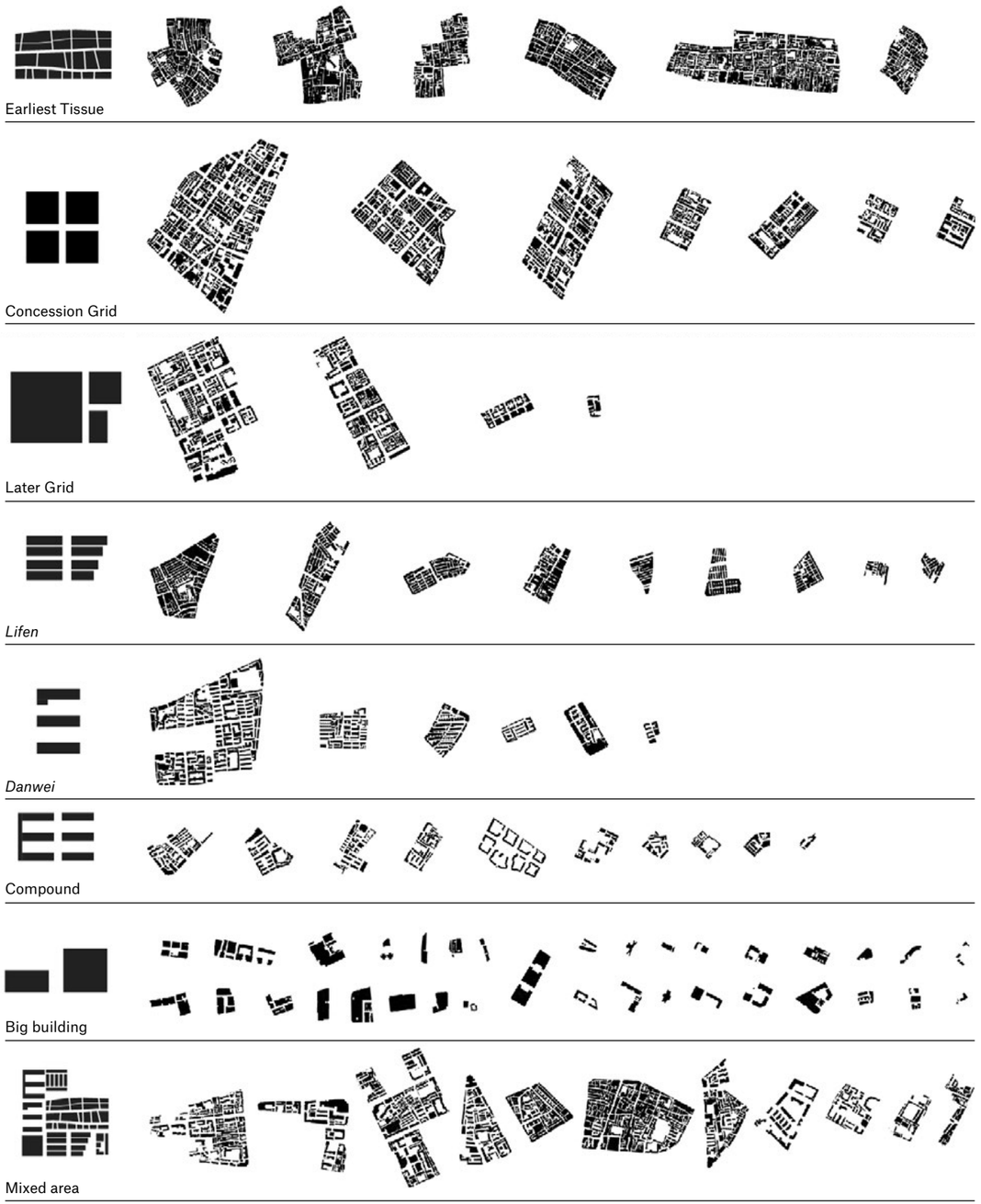
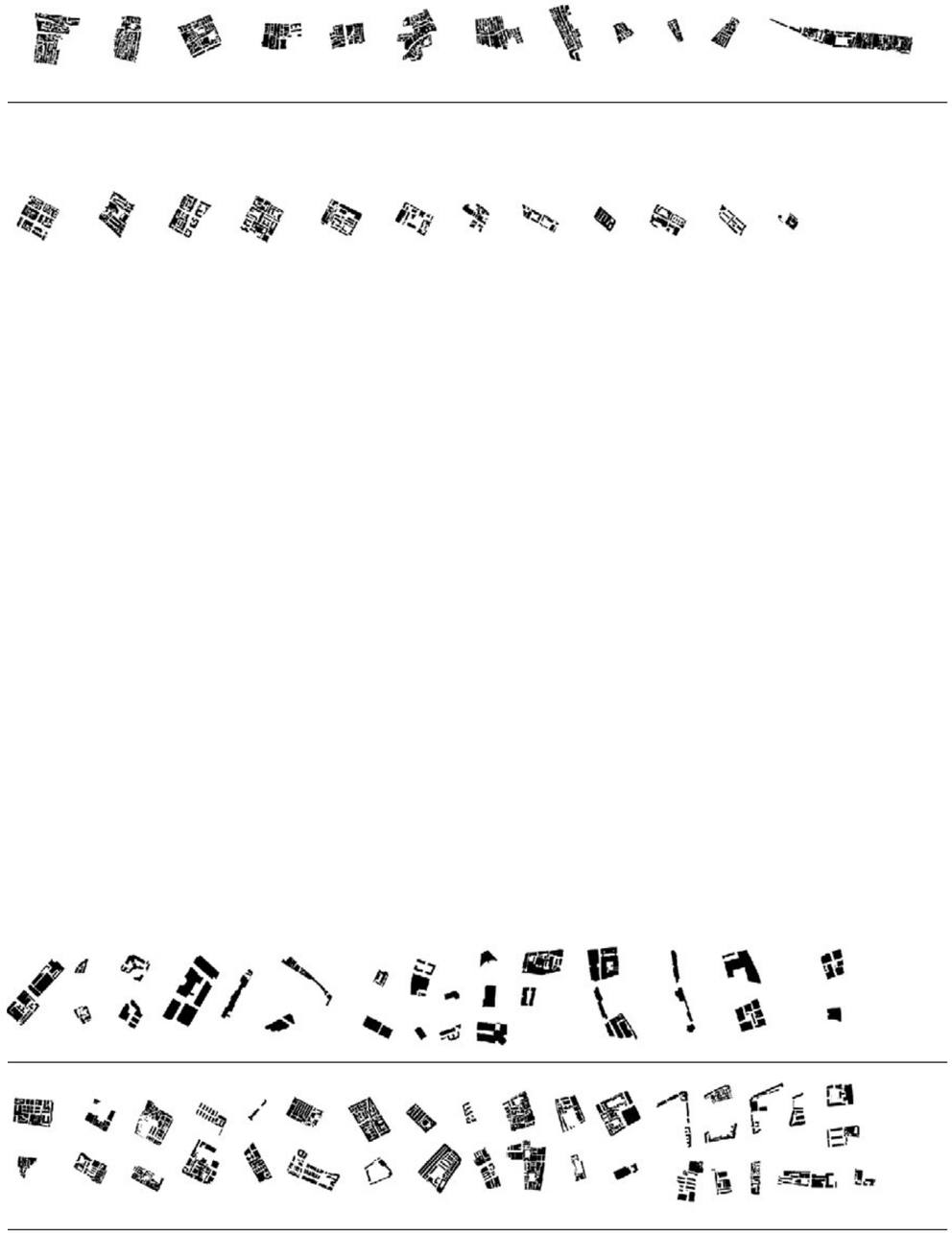


Figure 11.11
Hankou Riverside: overview of eight types of homogeneous areas grouped by type, 2013
(Bekkering, CAI, Kuijper)

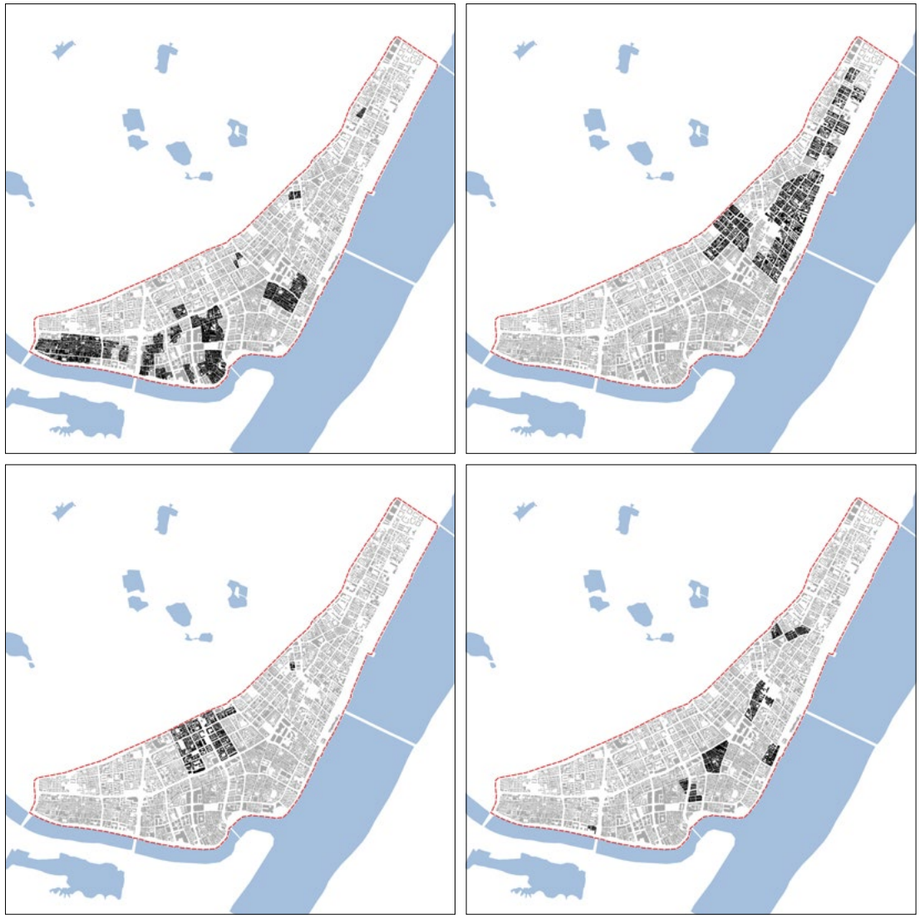


The maps of the different types of homogeneous areas isolated from each other show their spread over Hankou Riverside. This indicates that the remaining historical types are disappearing, and consequently losing their context more and more. The new types are taking over.

Fragmentation

The fragmentation in Hankou Riverside is mainly manifested by:

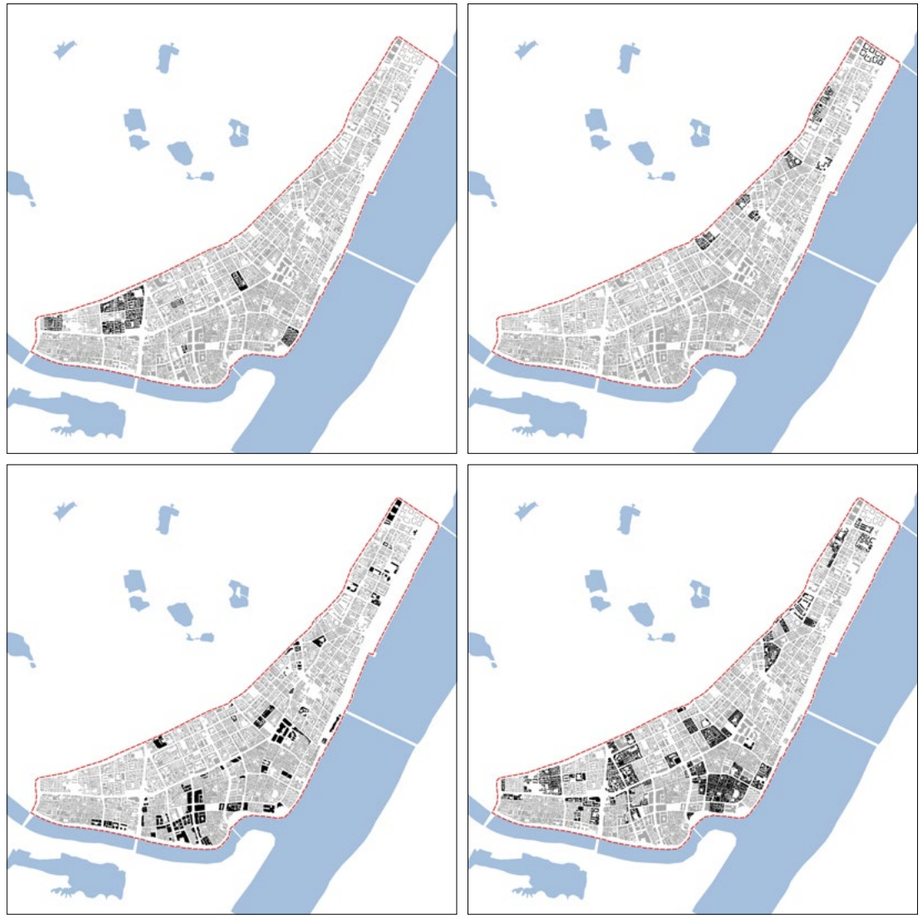
- the segregation between the waterfronts and the hinterland, resulting from the anti-flooding wall and the heavy traffic along the banks of the rivers,
- the modern road system perpendicular to the rivers,
- the big buildings and out of scale regeneration projects.



(left) Earliest tissue
(right) Concession grid

(left) Later grid (left)
(right) *Lifen*

Figure 11.12a
Hankou Riverside: separate locations of eight types of homogeneous areas, 2013.
(Bekkering, CAI, Kuijper)



(left) *Danwei*
(right) Compound

(left) Big building
(right) Mixed area

Figure 11.12b
Hankou Riverside: separate locations of eight types of homogeneous areas, 2013
(Bekkering, CAI, Kuijper)

Chapter 12
Relevance

The relevance of this research for the study of urban morphology is in: (1) the insights in the growth pattern of a mid-size Chinese city over a period of a century and a half; and (2) the addition of the secondary connections to the method of the Delft School; together with the homogeneous areas, these allow for the incorporation of a middle level of scale in the analyses.

Application of homogeneous areas and secondary connections in practice

The analyses in this research are on the scale of the city as a whole and a relatively large urban district. (Potential) qualities and problems within the homogeneous areas do not show as much as those between them on the level of the secondary connections: the—often missing—middle scale of the city. Only in the analyses of Hankou Riverside has this research touched on the level of scale of the buildings and the public or open space. Even that micro level of scale may be too high as a basis for decisions on building or rebuilding on project level in three dimensions. In such cases additional research on lower level(s) of scale is needed.

The following is an indication of the way morphological analysis applying homogeneous areas and secondary connections can be used and incorporated into the practice of urban planning and design.

1. *For any project, consider the homogeneous area it is situated in as a whole, in relation to its surrounding homogeneous areas, and including secondary connections.*

   Within a homogeneous area spatial changes should not work against the existing urban structure, unless this structure is completely changed. In most cases the surrounding spatial structure does stay unchanged, so it is necessary to understand this structure and to continue, support or strengthen it. This does not exclude change, but asks for a sensibility to enrich the spatial structure, rather than to work against it.

2. *Keep, improve, and add secondary connections to strengthen the urban structure and introduce a stronger middle scale for the city as a whole.*
   Secondary connections as defined in this research do either of two succinct things: they depict a coherent spatial structure within a homogeneous area, or they form connections between adjacent homogeneous areas. Both are categorized as middle scale elements, but they bring different type of arguments to design decisions. The first is about strengthening the existing pattern, or subordinating the design to the existing spatial pattern; the second and third are about improving existing connections and/or adding new connections, thus strengthening the middle scale of the city.
3. *Research and analyze the morphological structure on a lower level of scale, relevant for the project at hand. The example in this research is the urban district Hankou Riverside, but depending on the scale of the project lower scale analysis may be needed.*
   Urban renewal does not only affect the spatial coherence on a larger scale beyond the project, up to the homogeneous area it is part of, it also affects the higher scale of the surrounding homogeneous areas.
4. *Replacing a building block within a homogeneous area generally will not change the Urban Spatial Structure of the city as a whole—depending on (changes in) density and scale.*
   It may, however, change the inner consistency of the homogeneous area itself, which should be considered on the lower level of scale. In processes of regeneration, it will occasionally be possible to change the type of a homogeneous area itself. This should be judged against the pattern of surrounding homogeneous areas, their sizes relative to each other, and the existing or potential coherence between them.
5. *For the homogeneous areas, size and differences in size are not normative. Very small is not necessarily a problem, as long as there are secondary connections to the surrounding areas. Nor is very big a problem in itself, as long as there is a clear internal structure.*
   What really matters is the middle scale of the secondary connections that is so often missing and undervalued in Chinese cities nowadays, though it was definitely an integral part of the design of the traditional Chinese city, where it even had a clear meaning in organizing the city in areas for different social groups.

All of this does not imply that change is not wanted or not acceptable. Of course, new urban designs should take care of programmatic aspects of a contemporary nature and modern conditions for living, including environmental effects, while at the same time incorporating basic human needs and accommodating daily life in the city—in the great diversity that is asked for by a living and changing society. This should include attention for public space and pedestrian scale, as well as a lively mix of urban functions that sustain daily life in the city.

The above can be seen as an elementary procedure for the preparation of an urban design that takes advantage of this historical morphological research.

Fragmentation

The three elements of landscape, infrastructure and homogeneous areas together show that the urban structure of Wuhan is fragmented, as both the natural and the artificial lines are hard to cross and thus form strong borders resulting in separation between urban areas. This does not necessarily have to be interpreted as all bad; in fact, it is a characteristic of the city of Wuhan and as such part of its identity. At the same time, while in many parts of the city these elements assist in orientation, in other parts they hinder the actual movement from one part to another.

Where wanted, it is possible to integrate large scale infrastructure in the city and eliminate the barriers it causes, or prevent those. In such cases, designing and adding (public) spaces that connect both sides of the infrastructure can save or enhance the coherence in the city—for instance wide underpasses under elevated railroads and highways that also relate areas on both sides visually; pedestrian bridges over water that can be effective on lower levels of scale; or buildings and/or public spaces spanning infrastructure, preferably with a public program that attracts people from both sides of the border. Such new elements should always be connected to existing spatial structures and relate to and be integrated in the existing urban pattern. In the case of urban regeneration of existing built-up environment, it will generally not be possible to completely change the urban structure. In the case of newly designed areas (urban extensions) it is easily possible and generally necessary to create a coherent spatial structure that on the next larger level of scale should also be related and connected to existing urban structures.

Relevance for the future of the city

The insights developed in this research, the historical morphological analyses, are intended to better understand the urban form of contemporary Wuhan, and to identify the spatial structure and structuring elements of the city in relation to the urban history: the elements that contribute to the identity of the urban environment and its sense of place. The subject of study is the urban form as it changes through time: historical-morphological analysis. These insights are important for the multitude of decisions that have to be made every day on the planning and design of the future changes in and around the city. The relevance is for the urban transformations within the existing city as well as for the extensions into the metropolitan area.

As described in the previous paragraph, in the practice of planning and design it will be necessary to conduct additional morphological analyses on the relevant level(s) of scale.

Recommendations for future research

Any aspect of the city should be seen as related to its morphology, and be researched as such.

Metropolitan region

This research is on three levels of scale: Metropolitan Area, Inner City, and Hankou Riverside. There is, however, the higher level of scale of the metropolitan region with its satellite towns, but also the important aspects of agricultural production, water management, nature conservation, and ecology. This level of scale, too, should be researched as for its spatial characteristics.

City and water

The very limited relation between the public space of the city and its rivers and lakes asks for improvement. This is directly related to the problems of rainwater management and flooding that hit important parts of the city quite often, with serious direct and indirect effects. Interventions are complicated because specifically the retaining wall of—in many places—7 m (23 ft) high is the responsibility of the national government. At the moment the wall is untouchable, eventhough the level of the water has dropped 7 m (23 ft) on average as an effect of the Three Gorges Dam dimishing the flow of water in the Yangtze River downstream. Paradoxically it also creates a barrier for over-abundant rain water to flow into the rivers, resulting in flooding areas in the city even adjacent to the rivers.

Multi-Centrality

The city of Wuhan and its metropolitan area show obvious characteristics of multi-centrality. Although this is not per se a morphological category, the form of the city does relate to these centralities. As such, it would be useful to map the development of the centralities in time. For the moment, the necessary information for this is missing; further research is recommended to help the planning of the relationships between the existing centralities, possibly new ones, and the body of the city.

Density, the third dimension, and functional mix

This research is based on mapping. Consequently it is two-dimensional. The city, of course, is not. Including the third dimension requires a very heavy additional data set. It would, however, enable the inclusion of density in the research and lead to important additional insights in the city as mechanism. This would be even more the case when also urban functions would be incorporated, specifically the degrees of mix of functions.

Infrastructure

Though the morphological research does not include the development of transportation networks, clearly the development of the city is strongly correlated with this, and large above-ground infrastructure creates discontinuities in the urban form. For better understanding of movement in the contemporary city, in an additional map the metro system of public transportation is superimposed on the analytical map.

Transportation is a field in which traditionally planning and engineering are the determining forces, but the large infrastructures in the city also have important visual and spatial effects that should be studied and designed. Further research of the interdependency between transportation networks and urban form as it develops in time is recommended.

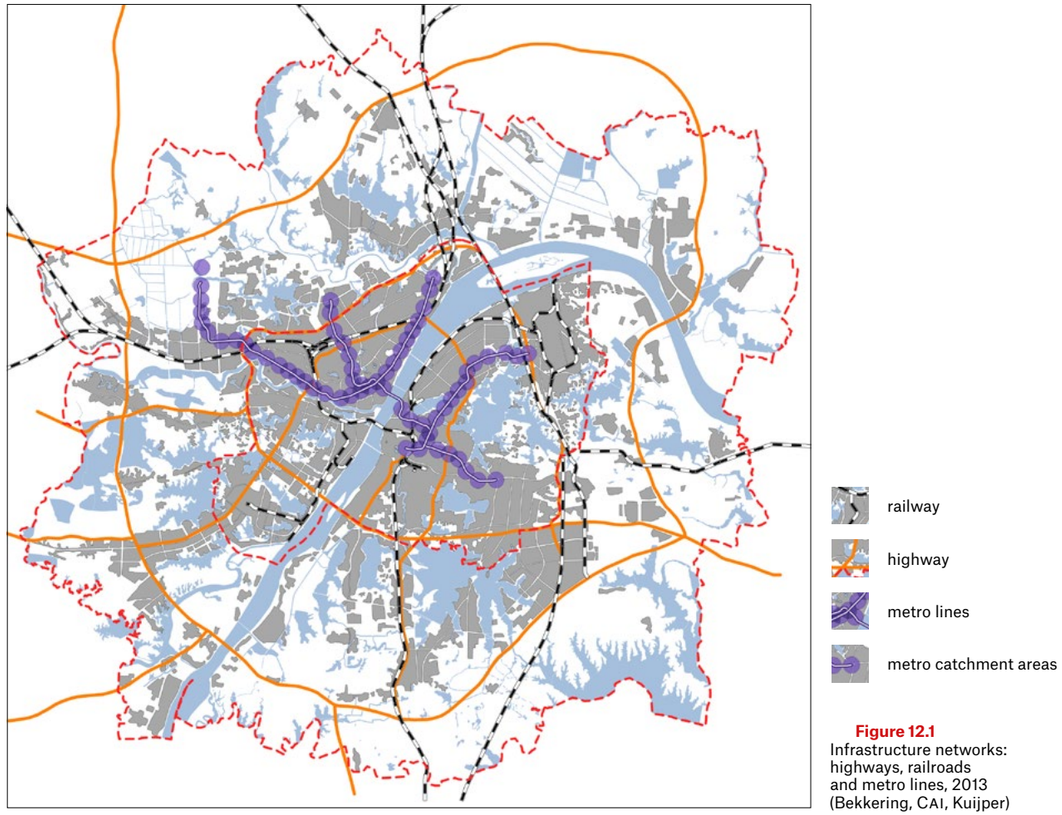


Figure 12.1
Infrastructure networks: highways, railroads and metro lines, 2013 (Bekkering, CAI, Kuijper)

Green structure

Though the GIS data does not show a clear and strong green structure in the city, Wuhan does have several big and important parks and natural areas. The most prominent natural areas are the many lakes and their shores all over the city, but also for instance the wetlands around the Fuhe River in the north, and the mountains that have generally no built-up areas on their slopes. The large parks include for instance the park on the western bank of the Yangtze River in Hankou that is 7 km (4.5 mi) long and wide enough to accommodate different kinds of recreational use and nature development, and the park jutting into the East Lake next to the Huazhong University of Science and Technology.

The data on the green as available to the research, however, is not complete, especially as to the natural reserves outside the city without agricultural use. Also, there seem to be more structural linear green strips along important roads and other infrastructures than the data indicates. It is premature to see *Figure 12.2* as an image of the green structure of the city, but it does show how the green relates to the overall structure of the city. Further research should include ecological systems. Certainly, a higher quality of use and a higher ecological value can be attained by interconnecting the green elements.

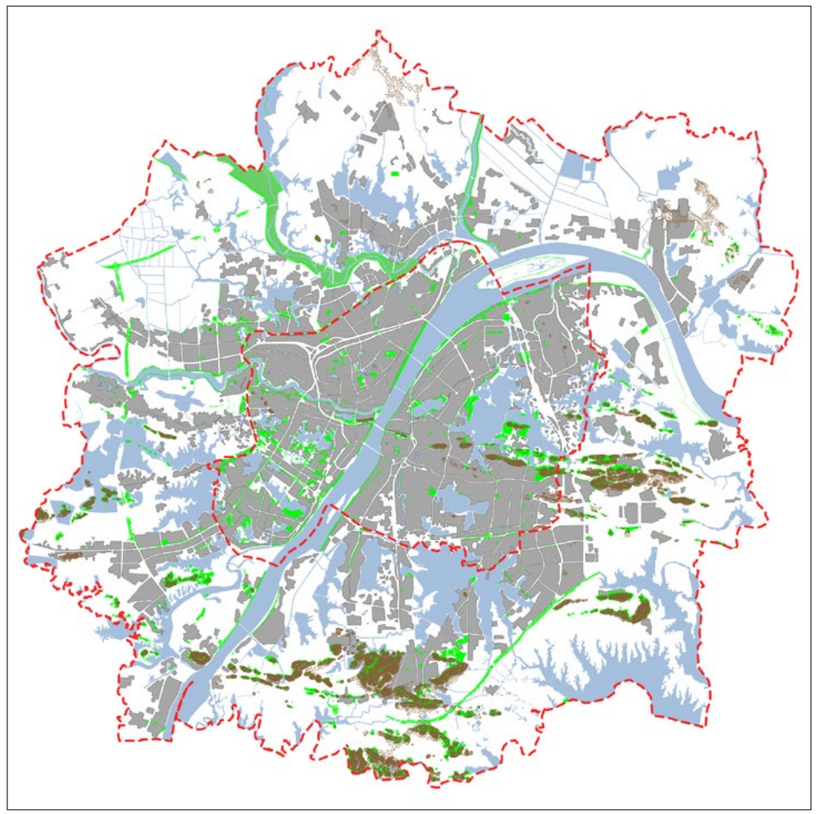


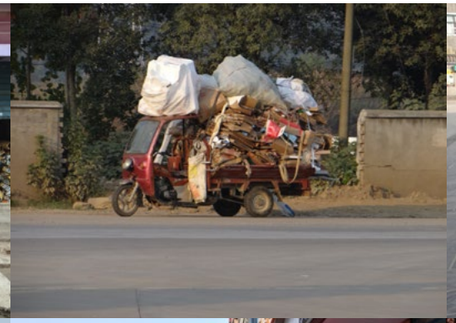
Figure 12.2
Mountains and green areas: parks and nature reserves, 2013 (Bekkering, CAI, Kuijper)

Appendices

Photocollage 6
People




















Appendix 1
Descriptions and definitions

This appendix gives descriptions and definitions of the technical terms used in the research. Where useful, each starts with the definition of the term as in the Webster's Encyclopedic Unabridged Dictionary of the English Language, edition 1994, and/or the Webster's New World College Dictionary, edition 2008.

Building footprint

The building footprint in a map displays the part of the ground that is covered by buildings.

Delft School

The unique characteristics of the Delft School of morphological analysis are:

- It is strongly design oriented.
- It was developed both in actual design projects and in education.
- Though it started as a historical research on urban transformation, intended to understand urban form through its historical development, it has a strong analytical character; it looks both backwards and forwards, studying the past to understand the present with a strong perspective on the future.
- The concerns of landscape architecture led to designing and analyzing across the scales, to the layer approach, and to the technique of reduction drawing.
- The recognition and definition of homogeneous areas leaves out detailed information in order to better understand the hierarchy in urban structures.

According to Leupen, in the method of the Delft School the following techniques are applied, separately or in combination:

> *reduction, addition, and démontage [taking apart/deconstructing] are used to extract from the plans of projects and urban areas the essential aspects which depend on the analyzed theme in order to reveal a certain logic and structure through the drawing process. [In other words:] the analytical drawing [is] a way to obtain insight in the process of designing.* (Leupen *et al.* 1997 p 207)

For the purpose of the analysis of the urban form of Wuhan, the reduction technique is especially relevant.

With its clear design orientation, the Delft School of morphological analysis has two main goals: to analyze a specific area, working towards a design or vision for that area, and to analyze a design to understand its original source.

Figure-ground drawings

Webster's Encyclopedic Dictionary: in psychology a property of perception in which a field is divisible into chiefly two reciprocally influencing parts of varying distinctness and articulation, each depending upon the focus of attention for clarity.

In the visual arts, especially in architecture and urbanism, figure-ground maps or drawings are in black-and-white. These are traditionally used in morphological analyses, and are based on building footprint, showing buildings in black and open space in white.

Georeferencing

The selected historical maps and aerial photographs in this research are positioned and overlaid on the contemporary map in the computer. This is called georeferencing. The different map projection techniques through time have resulted in historical maps not quite fitting the contemporary base map. Thus, there is a need for certain degrees of deformation. This is done with the application of a specific software: QGIS with the *Georeferencer* plugin.

Hankou Riverside

Hankou Riverside includes Hankou as one of the old constitutive parts of the city, and the former Foreign Concessions. It extends along both the Yangtze River and the Han River. The border of Hankou Riverside to the northwest is traced on its former town wall.

(Historical) morphological analysis

The method of research in (historical) morphological analysis is that of reduction drawings of maps of different moments in the history of the city, resulting in maps and descriptions that show and explain the historical development through the changes in the structure of the urban form at important moments in its history: the Delft School or method of morphological analysis. The higher the level of scale, the stronger the reduction.

Homogeneous area(s)

Webster's Encyclopedic Dictionary: 1. Composed of parts all of the same kind [–]. 2. Of the same kind or nature; essentially alike. 3. Mathematics: a. having a common property throughout. b. having all terms of the same degree. Webster's College Dictionary: 1. The same in structure [–] similar or identical. 2. Composed of similar or identical elements or parts; uniform.

The mapping of urban mass on a certain level of scale allows for creating what in the Delft School is called homogeneous areas, leaving out detailed information internal to these areas that is not structural on the scale of the analysis. Criteria for determining the homogeneous areas are three, each one sufficient in itself:

1. internal spatial consistency,
2. strong difference from neighboring areas,
3. strong borders that are often hard to cross.

The recognition and definition of homogeneous areas leaves out detailed information in order to better understand the hierarchy in urban structures: the form of the city.

Inner City

The inner city of Wuhan, within the administrative border of the municipality: an area of 678 km² (262 sq mi), measuring approximately 34 km (21 mi) east-west and 30 km (18.6 mi) north-south.

Layer analysis/approach

The layer approach in urbanism originated from landscape architecture. The influential book by the American landscape architect Ian McHarg, *Design with Nature* of 1969, presents his Ecological Inventory Approach. It was introduced in the Netherlands by Meto Vroom, Professor of Landscape Architecture in Wageningen University & Research/WUR, and developed as a strategic planning concept. (Hooimeijer and Manting 2018) The concerns of landscape architecture led to designing across scales, to the layer approach and to the technique of reduction drawing. The concept was broadened to include urbanism and planning, in the Netherlands first by Rein Geurtsen, and his students Frits Palmboom in the analy-

sis of Rotterdam (1987), and Casper van der Hoeven and Jos Louwe for Amsterdam, and in the late 1990s by Maurits de Hoog, Dirk Sijmons and Sem Verschuren. In Delft it is an important element in the urbanism education. The basic textbook *Het ontwerp van de stadsplattegrond* [The design of the plan of the city] mentions five layers: landscape, urban plan, public space, buildings, and use. (Heeling *et al.* 2002; Meyer *et al.* 2020)

Metropolitan Area

The Metropolitan Area of Wuhan, within its administrative border: an area of 3,261 km² (1,259 sq mi), measuring east-west and north-south approximately 68 km (42.3 mi).

Morphology/urban morphology

Webster's Encyclopedic Dictionary: 1. The branch of biology dealing with the form and structure of plants and animals. 2. The form and structure of an organism considered as a whole. [–] 5. The form or structure of anything. [–] 6. The study of the form or structure of anything. Webster's College Dictionary: [–] 6. Any scientific study of form or structure.

The term 'morphology' was originally introduced by the German writer and polymath Johann Wolfgang von Goethe, 1749–1832. (Marshall and Çalıskan 2011) Goethe pointed out that *morphology [is] a science dealing with the very essences of forms*. (Bullock *et al.* 1988)
The objects of morphological research are actual physical form and its structure. (Duan and Qiu 2008) As firstly applied in biology, morphology was developed in different other domains later, for instance in geography and landscape architecture in reference to the form of a landscape and its transformation. In linguistics it was developed in reference to the elements and structure of language. The use of morphology in the context of the built environment starts in the early nineteenth century. (*ibid.*) This is called 'urban morphology', and can be considered as the science of urban form and structure.

Reduction drawings

Morphological reduction is a means of uncovering and explaining the spatial structure of an object. The purpose of the reduction drawings is to visualize the spatial characteristics of a building, an area or a city. To do so, a distinction is made between built (i.e. mass) and unbuilt (space or void). [Reduction is considered to be] the most elementary way of processing a map or a drawing. Its purpose is to visualize the structure of a design. A commonly used technique in design analysis, reduction consists essentially of omitting all irrelevant data from a design drawing so that only information essential to the study remains. (Leupen *et al.* 1997 p 207)

In fact, every map is a reduction—or simplified representation—of reality. Even in the most detailed map a lot of information and objects we are able to see in reality are necessarily left out.

In this research, reduction drawings reduce the available map data to establish

so-called homogeneous areas.
On the meso and micro levels of scale, the Inner City and Hankou Riverside, secondary connections are added to the homogeneous areas. Their internal or secondary structure shows two important aspects of the homogeneous areas at the same time:

- internal spatial structure, and thus distinctions in spatial structure between areas,
- connections between (adjacent) areas.

Together these secondary connections indicate the formal coherence of the city that people use for orientation in, and understanding of their environment, in addition to the recognition of the homogeneous areas themselves. Because of this, they can remember places and attach meaning to them, which then becomes part of their identity and as such a strong social factor.

Secondary connections

Timeline

Webster's College Dictionary: 1. A chart, table, etc. of historical dates and events in chronological order [–] 2. Any chronological summary or listing of historical or planned events.

This research uses a timeline that starts in 1870, the first date for which reliable cartographic data was available. The time lapses between successive periods are diminishing, in accordance with the speeding up of urban development in time. From 1870 on, those maps are selected that as a series show the most important structural spatial changes in the city. The years are:
1870–1910–1950–1970–1990–2000–2006–2013–2016–2019

Typomorphology

Typomorphology [–] considers all scales of the built landscape, from the small room or garden to the large urbanized area. Second, it characterizes urban form as a dynamic and continuously changing entity immersed in a dialectic relationship with its producers and inhabitants. Hence, it stipulates that city form can only be understood as it is produced over time. (Vernez Moudon 1994)

Typomorphology accounts for what Italian urbanist Saverio Muratori called a:

operational history of urban form, because it is a record of actions taken by planners, designers, and builders, both lay and professional, as they mold city form. (Muratori *et al.* 1959)

Appendix 2
Schools of Urban Morphology

	Research objects and subjects	Research aims	Research characteristics	Main researchers and disciplines	Time
ITALY	– Architectural forms/lay-outs, and their types and transformations	– Provide context and references for the renovation of historical buildings and small-scale urban regeneration projects	– Origin and development of the typological study of architecture – Understanding the urban tissue and the city as architecture and a composition of different architectural types – Architectural type and typology as architectural design tool	– Saverio Muratori (1959) – Aldo Rossi (1982), etc. – Mainly architects	– Main focus on the past, i.e. before modern architecture, that is seen as a major transition
FRANCE	– Public infrastructure, street networks, land divisions, buildings – Urban transformation in relation to economic and social aspects	– Understand the mechanism of urban transformation – Develop theories and methods to analyze cities	– Focus on the actual urban form and its formation – Study of urban spatial patterns in relation to originally proposed ideas and theories of urban design	– Henri Lefebvre (1970) – Philippe Panerai and Jean Castex (1980; 1997; 2001; 2004; 2008), etc. – Geographers – Social scientists – Economists – Philosophers – Architects – Urban studies	– Focus on history and the present
ENGLAND	– Land use, town planning – Decision making in the planning process	– Understand why and how a city is built – Examine the influence of decision-making in the planning process – Setup town planning theory – Study human scale and walking experience in cities	– Focus on land use, town planning and architectural forms – Descriptive rather than analytical – Serial sketches as representation of the human experience of the city (the 'picturesque')	– M.R.G. Conzen (1958; 1960) – Gordon Cullen (1961), etc. – David Harvey (2006) – J.W.R. Whitehand (1987; 1990; 2001), etc. – Geographers – Urban planners	– Focus on history
THE NETHERLANDS	– Relation between landscape and city – Urban forms, urban spatial structures, urban transformation – Design	– Design and practice oriented study – Develop design proposals through morphological analysis of the context – Analyze and understand the underlying logic of the design	– Reduction drawings and layer approach – Design oriented urban morphology studies – Focus on relation between water and the city – Invention of cartoon-like drawing – Integration of research and design	– Henco Bekkering (2006) – Rein Geurtsen (1981; 1988; 1990; 2009) – Maurits de Hoog (2005) – Han Meyer (1999; 2002) – Willem Jan Neutelings (1988) – Frits Palmboom (1987; 2010; 2014; 2018), etc. – Urban designers – Architects – Educators	– Future oriented through understanding history
USA	– Suburbs and urban periphery – Post industrial urban morphology – People's perception of the city	– Understand the problems in and of cities	– Focus on commerce and consumerism – Environmental psychology – Focus on effects of environment on health	– Kevin Lynch (1960) – Robert Venturi and Denise Scott Brown (1966; 1972) – Anne Vernez Moudon (1994; 1997; 2003), etc. – Urban designers – Architects	– Present
CHINA	– Architecture, architectural layouts and types – Streets and street networks – Public space	– Understand the original architectural forms and their transformations – Understand urban transformations on different scales – Provide references for urban design and urban regeneration	– Focus mostly on the forms themselves, lack of attention for the transformation of types – Mostly descriptive research, not analytical – Well-developed and widely accepted method of analyzing urban form in China does not exist yet	– CHEN Fei (2013) – DUAN Jin – GU Kai – WU Liangyong, etc. – Architects – Urban designers – Urban planners – Geographers	– Focus on past, present and future – Looking for references for the future in studying the past

Table 1
Urban morphology and different schools (based on Pinzon Cortes, 2009; CHEN & Thwaites, 2019)

Appendix 3
Selected Maps

This appendix lists in historical order the most important maps that were used in the research, with their sources.

Wuchang, 1521
(Compilation Committee 1998 p 2)

Wuchang, 1521
(Compilation Committee 1998 p 2)

Hanyang, Wuchang, and Hankou, 1748
(Compilation Committee 1998 p 13)

Hankou, 1868
(Compilation Committee 1998 p 18)

Hanyang, Wuchang, and Hankou, 1876
(Compilation Committee 1998 p 22)

Hankou, 1877
(Compilation Committee 1998 pp 20–21)

Wuchang, 1877
(Compilation Committee 1998 p 23)

Wuchang, 1883
(Compilation Committee 1998 pp 24–25)

Hanyang, Wuchang, and Hankou, 1890
(Compilation Committee 1998 pp 42–43)

Reconstruction Plan of Hanyang, Wuchang, and Hankou, 1890 (Rowe 1989 p 72)

Hanyang, Wuchang, and Hankou, 1899
(Compilation Committee 1998 p 27)

Hanyang, 1900
(Heizō and Wallacker 1979 p 245)

Wuchang, 1900
(Heizō and Wallacker 1979 p 244)

Hanyang, Wuchang, and Hankou, 1900
(Wuhan Archive)

Hanyang, and Wuchang, 1904
(Compilation Committee 1998 p 28)

Wuchang, 1909
(Compilation Committee 1998 pp 30–31)

Hanyang, 1909
(Compilation Committee 1998 pp 34–35)

Hanyang, 1909
(Compilation Committee 1998 pp 36–37)

Hankou reconstruction plan, 1911, (Library, School of Oriental and African Studies, University of London, UK: reference CWM/LMS/15/14/037)

Hankou reconstruction plan, 1912
(Compilation Committee 1998 p 134)

Hanyang, Wuchang, and Hankou, 1912
(Compilation Committee 1998 p 47)

Hanyang, Wuchang, and Hankou, 1915
(Waseda University Library)

Hanyang, Wuchang, and Hankou, 1915
(Wuhan Archive)

Hankou, 1918
(Compilation Committee 1998 pp 48–49)

Hankou, 1918
(www.pmgs.kongfz.com/detail/85_204011)

Hanyang, Wuchang, and Hankou, 1922
(Compilation Committee 1998 pp 52–53)

Wuchang reconstruction plan, 1923
(Wu Z 2009 p 45)

Hanyang, Wuchang, and Hankou, 1926
(Compilation Committee 1998 pp 56–57)

Wuchang, 1929
(Compilation Committee 1998 pp 60–61)

Wuhan, 1930
(Compilation Committee 1998 pp 64–65)

Wuhan, 1930
(Wuhan Archive)

British Concession, Hankou, 1931
(Compilation Committee 1998 p 70)

Wuhan, 1931
(Compilation Committee 1998 pp 72–73)

Wuhan, 1932
(Compilation Committee 1998 p 74)

Wuhan, 1933
(Compilation Committee 1998 pp 76–77)

Hankou, 1933
(Compilation Committee 1998 pp 80–81)

Hanyang, 1934
(Compilation Committee 1998 pp 82–83)

Wuchang, 1936
(Compilation Committee 1998 p 86)

Hankou, 1938
(China cartographic publishing house)

Wuhan ("Map of Hankow"), 1945
(Wuhan Archive)

Wuhan, 1949
(Compilation Committee 1998 p 93)

Hankou, 1951
(Compilation Committee 1998 p 94)

Wuhan, 1951
(Compilation Committee 1998 pp 100–101)

Wuhan, 1952
(Compilation Committee 1998 p 97)

1954 Wuhan Master Plan

1959 Wuhan Master Plan

Wuhan, 1970
(www.meipian.cn/2cd9g2au)

Wuhan, 1973
(Wuhan Planning & Design Institute Archive)

1982 Wuhan Master Plan

1988 Wuhan Master Plan

1996–2020 Wuhan Master Plan

Inner city land use, 1996
(1996–2010 Wuhan Master Plan)

Aerial photograph, 2001
(Wuhan Geomatic Institute)

Inner city built-up area, 1989
(http://zhuanti.whjs.gov.cn/content/2009-09/17/content_178644.htm)

Metropolitan area urban land use, 2006
(2006 Wuhan Master Plan)

Inner city urban land use, 2006
(2006 Wuhan Master Plan)

Inner city urban land use, 2010
(2010 Wuhan Master Plan)

Metropolitan area urban land use in GIS format, 2013
(Wuhan Land Use and Spatial Planning Research Center)

(Wuhan Planning & Design Institute Archive)

Built-up area, Qing Dynasty ▸ 2002
(Wuhan Planning & Design Institute Archive)

Inner City urban land use, excerpt of Metropolitan land use map, 2016
(2016 Wuhan Master Plan)

Excerpt of Metropolitan Area urban land use, 2016
(2016 Wuhan Master Plan)

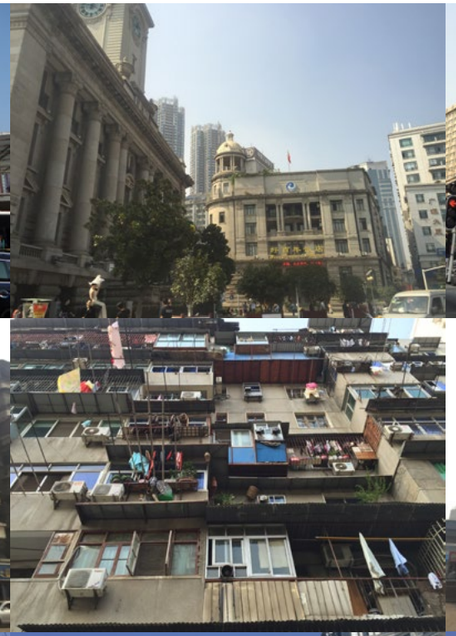
Metropolitan Area, aerial photograph, 2019
(Google Maps Satellite)

Wuhan Inner City Expansion,
Three Kingdoms period ▸ 2008
(Yu 2011 p 330)

Mapping Wuhan in Time, 1915 ▸ 2011
(Wuhan Planning & Design Institute Archive

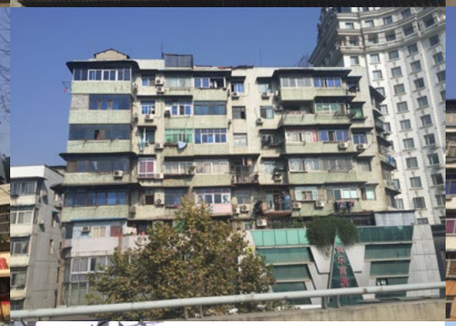
Inner city built-up area, 1966 ▸ 1978
(Wuhan Planning & Design Institute Archive)

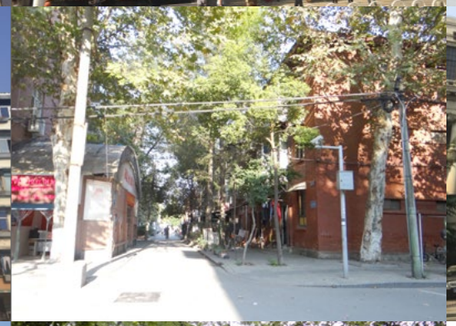
Photocollage 7
Historical buildings













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Chinese cities have been expanding since the early 1980s under trends of rapid modernization, urbanization, and globalization. Since then, they have changed dramatically, and have in the process lost many of their traditional environments and spatial characteristics.

Urban planners and designers have been and are facing unprecedented challenges in China. They not only have to learn to understand the constantly emerging new urban mechanisms, and seek balance among stakeholders, but they also need to cope with the political pressures and the changing context under often extreme time pressure.

In such circumstances, future- and design-oriented analysis based on a *designerly* way of thinking is useful—if not indispensable—for understanding the existing city and deciding on its transformations in a responsible and accountable way that is communicable among designers and with the public. This is especially so, in light of the growing awareness—also in China—of the value and importance of local urban identity, that is always—at least partially—based on history.

In this **ATLAS** the Delft method of historical morphological analysis is applied to the city of Wuhan, valuing the importance of, and finding meaning in the local urban identity of a city with a population over 11 million with a floating population of 14 million. The series of maps show the urban development, covering a century and a half.

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