Pinggu Agricultural Innovation Campus

Master plan and design report

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Pinggu Agricultural Innovation Campus
Master plan and design report

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Wageningen Environmental Research

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Beijing Municipal Government has developed an initiative to stimulate agricultural innovation in cooperation with Wageningen University & Research. One of the first results of this cooperative effort is the design of the Agricultural Innovation Campus (AIC) at Yukou Town in Pinggu District on the north-eastern border of Beijing. A master plan has been designed for the AIC that synthesizes regional and local characteristics (landscape, land use, cultural heritage) with existing planning policies and regulations. Chinese planning tradition has been combined with a typical Dutch landscape approach and theory to take the best of these 'two worlds'. State-of-the-art knowledge and innovations are introduced in the design process where relevant and possible.

The key aim of the master plan is the design of an interconnected blue/green framework (the Green Dragon) that envelops three building zones for the development of agricultural institutes, laboratories and other companies. The Green Dragon will connect the AIC with surrounding recreational, ecological and agricultural areas. The Green Dragon will also form an important landscape element that provides several ecosystem services for Yukou Town. These ecosystem services include recreational facilities and opportunities to collect and store water. The master plan includes a set of rules for the development of buildings within the AIC (the Quality Book). The master plan also contains detailed designs for roads and road verges and designs for several pocket parks (the Gardens of Life). Recommendations for the organization and management of the AIC complete the project.

Keywords: agricultural innovation, campus development, green network, landscape design

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Wageningen Environmental Research (WENR) greatly values the quality of its end products. A review of its reports' scientific quality forms a standard part of its quality policy.

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Summary

China is facing a serious challenge to provide its population with sufficient and safe food and other agricultural products. It is also striving to decrease its dependency on imported agricultural products. And, although China's enormous – predominantly industrial – economic growth has increased wealth, it has also resulted in an outflow of agricultural workers. These developments are even more pronounced in Beijing. As a result, Beijing's municipal government aims to stimulate agricultural innovation. To achieve this, it is cooperating with Wageningen University & Research. The aim is to combine, apply and reinforce Chinese and Dutch knowledge on agricultural development in a sustainable way.

One of the first projects resulting from this Chinese-Dutch cooperation is the design of the Agricultural Innovation Campus (AIC) at Yukou Town in Pinggu District on the north-eastern border of Beijing. The AIC is meant to be the first in a series of centres that will further agricultural development in Beijing. This campus will host a number of institutes, laboratories and other companies and facilities, stimulating innovative and state-of-the-art knowledge and applications for sustainable agricultural production.

This report describes the design of a master plan for the Pinggu AIC from a regional to a local perspective. The master plan comprises a detailed design of the 'backbone' of the AIC, planning and design regulations for the development of the built-up areas of the AIC, and a set of recommendations for the project.

The report starts with a thorough landscape analysis of the study area at various scales. Although an analysis of local characteristics was not possible during the first phase of the project, the analysis provides a basic understanding of the functioning of the fundamental landscape processes (abiotic and anthropogenic) necessary to be able to initiate the sustainable development of the area and the AIC. In this respect, coping with climate change and responding to and restoring hydrological processes proved to be key points. Included in the analysis is a characterization of important cultural heritage elements and structures. Interpreting these cultural phenomena helped to understand former hydrological conditions. At the same time, an extensive inventory of national, regional and local planning policies and regulations was made. All of these elements were summarized in a comprehensive set of planning and design principles.

The master plan may be described as a synthesis of regional and local landscape characteristics with existing planning polices and regulations. Current Chinese planning policies are thus combined with a typical Dutch landscape approach, taking the best of these 'two worlds'. A key part of the master plan is the design

of an interconnected green framework (the Green Dragon) that envelops three different building zones for the development of agricultural institutes, laboratories and companies. To develop this Green Dragon, a combination is made of all the green areas that are required under the planning regulations: this includes the zones designated as 'park', but also the prescribed verges along the different types of roads. The core of the green framework is an open area with paths for cycling and walking and scattered trees in a matrix of flowering fields and meadows (the Honey Bikeway). The Green Dragon therefore connects the AIC with the surrounding recreational, ecological and agricultural areas. The master plan also provides detailed designs for roads and road verges.

The green area will also form an important landscape element, providing several ecosystem services for the further development of Yukou Town. These services include recreational facilities and opportunities to collect and store water. A system of interconnected swales (wadis) will be created to cope with peak rainstorms, moving water from built-up areas to basins for infiltration in the Green Dragon. Furthermore, a set of four small 'parks within the park' – symbolizing the life cycle of the peach tree – will give local people and workers the opportunity to enjoy the fresh air, the pleasant scenery and locally produced healthy foods and beverages. The master plan contains sketch designs for these 'Gardens of Life'.

The area enveloped by the Green Dragon offers ample space for hosting new innovative agricultural industries and institutions. Included in the master plan is a set of rules for the development of buildings within the AIC (the Quality Book). Ecological building principles, such as harvesting and recycling water and energy, form part of these rules. State-of-the-art knowledge and innovations are also included in the design process where relevant and possible. Recommendations for the organization and management of the AIC complete the project.

中文概述

自2019年以来，北京市和荷兰瓦赫宁根大学与研究中心合作，提出创建农业科技创新示范区的倡议。此次合作的第一个成果是在北京东北部平谷区峪口镇的农科创核心区的总体规划。该园区规划符合北京市规划规范，并融合当地景观风土和文化特色，结合了中国传统规划和典型的荷兰景观设计手法。同时，筛选世界领先的园区规划创新技术，依据国内实际情况加以应用和转化。

农科创核心区总体规划的重点，是一个互通的绿色景观体系，它犹如一条'绿龙'，把科创园和周边的山水连成一体，同时提供多种生态系统服务功能。其中，包括雨水收集和回收利用的功能。这个规划不仅仅停留在图纸规划层面，它也包含了指导开发建设的质量手册以及建成后的组织管理建议。

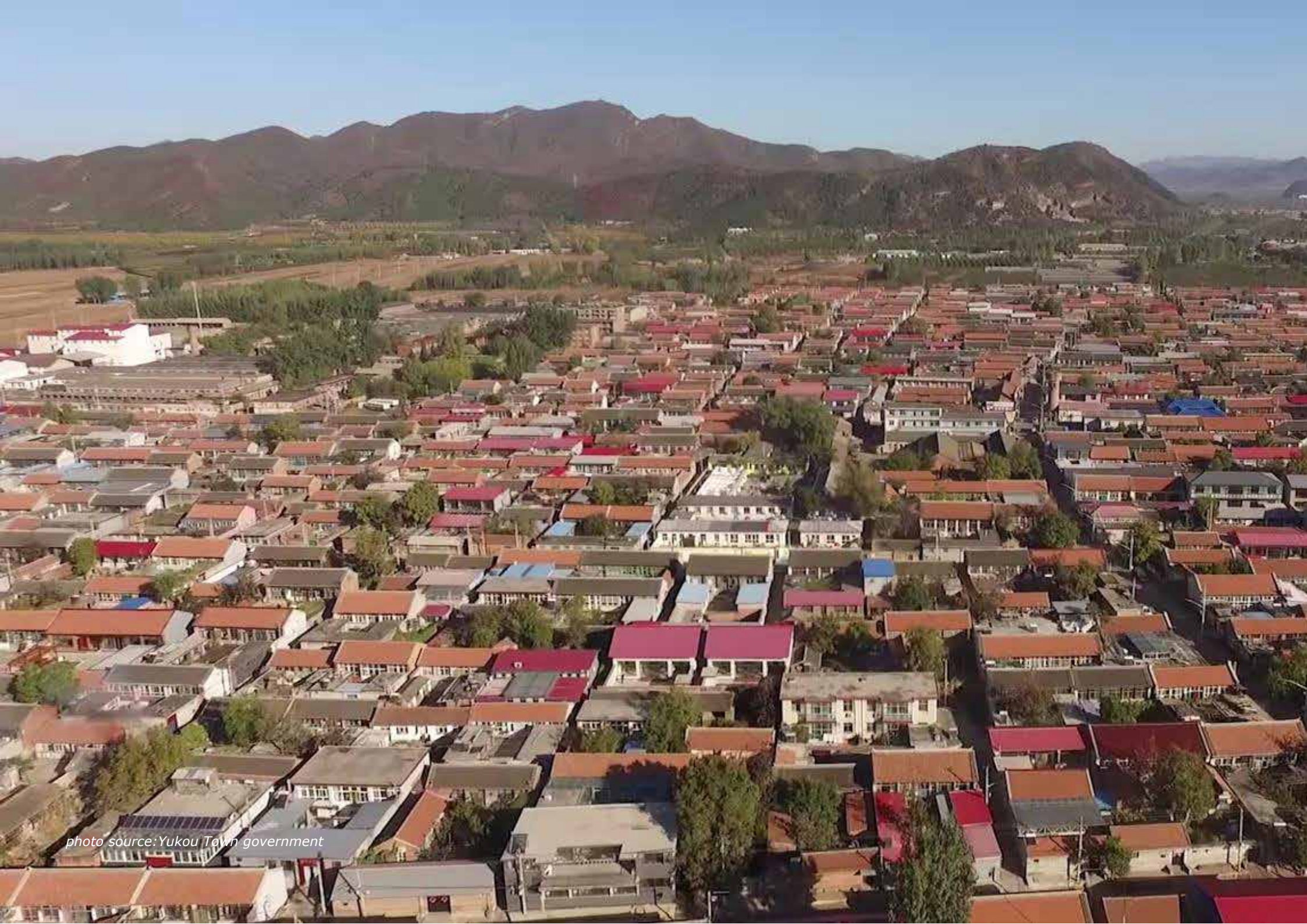


photo source:Yukou Town government

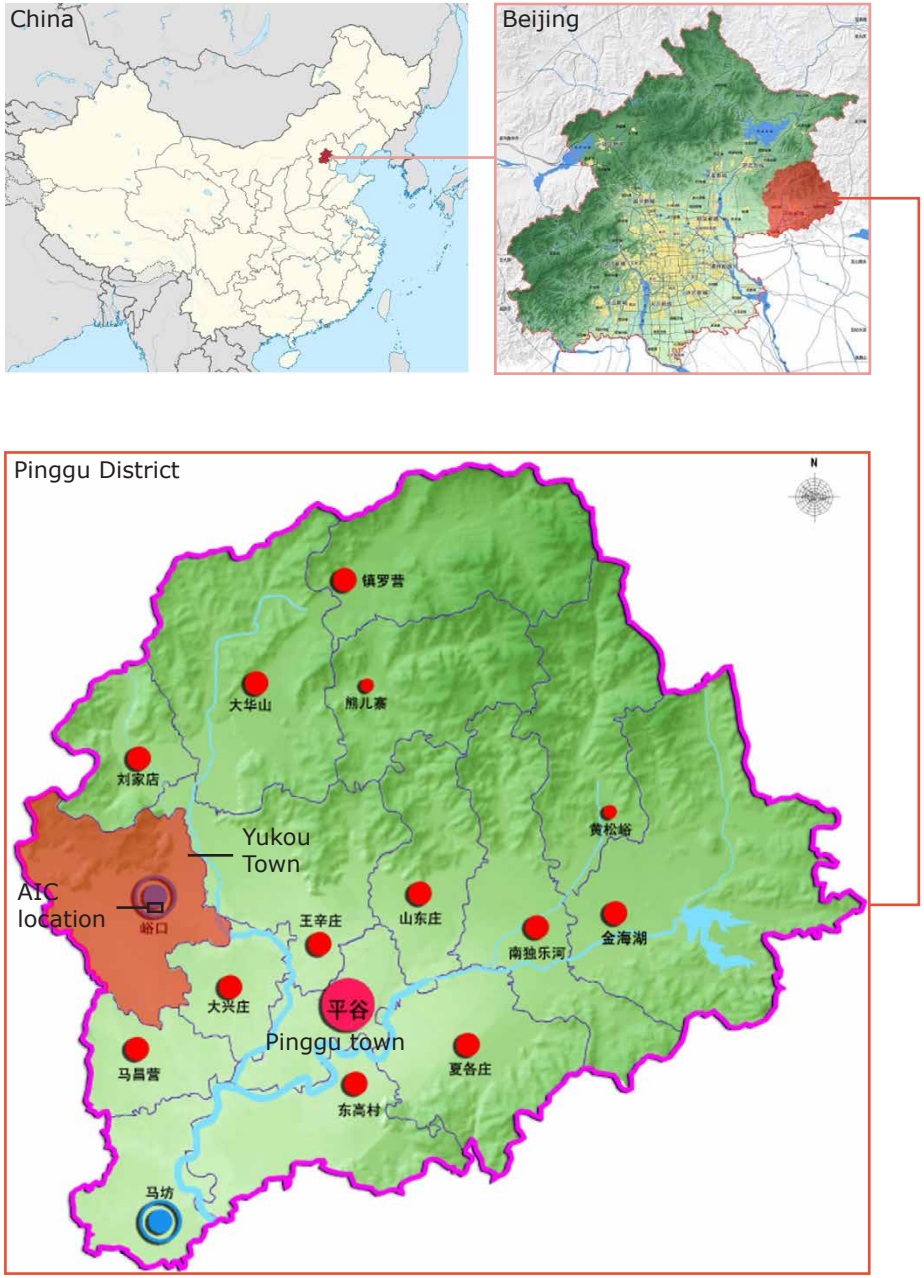


Figure 1. The locations of Yukou Town, Pinggu District and Beijing in China. Source: Baidu map (above), Yukou Town government (below).

1 Introduction

1.1 The Agricultural Innovation Campus in Yukou Town, Pinggu District, Beijing, China

Beijing Municipal Government has developed a plan for one of the first Beijing Agri-Tech Innovation and Demonstration Zones, or Agricultural Innovation Campus (AIC), to be located in Pinggu District, bordering Yukou Town. With a focus on six major industries, including the modern seed industry, smart agriculture, intelligent agro-machinery, biotechnology, nutrition & health, and food safety, this demonstration zone, or Beijing's 'Agricultural Zhongguancun' (innovation centre, known as 'China's Silicon Valley') will be a pioneer in agri-tech coordinated development and innovation-driven development. The AIC will reflect local characteristics of Beijing, serve the core functions of the capital, play a leading role domestically, and exert an influence globally. In this report, the Yukou Town innovation zone is referred to as the AIC. Its location is shown in Figure 1.

The aim is therefore to establish an area with room for innovation-driven development that incorporates sustainable and rural revitalization strategies. To stimulate technological innovation and green development, WENR will establish a 'golden triangle' cooperation mechanism, which incorporates governments, enterprises and scientific research institutions. WENR will also help to build a cluster of agricultural high-tech enterprises and agricultural research and development (R&D) institutions to pool the resources of scientists and engineers and better lead Pinggu District's surrounding areas in the commercialization of research findings.

1.2 Planning policy at the regional level

The relevant planning documents of Pinggu District issue the following general statements and prerequisites for the development of the AIC in Yukou Town:

1. The area must attain a pastoral ecological outlook:
- focus on protecting the farmland fabric and preserving the rural scenery of ecological towns;

2. The AIC will develop the following industries:
- modern seed industry, smart agriculture, intelligent agro-machinery, biotechnology, nutrition & health, and food safety;

3. The AIC will focus on establishing:
- integrated innovation, agricultural science & technology, international cooperation, agricultural financial services, agricultural information services, agricultural logistics, and agricultural talent education and training.

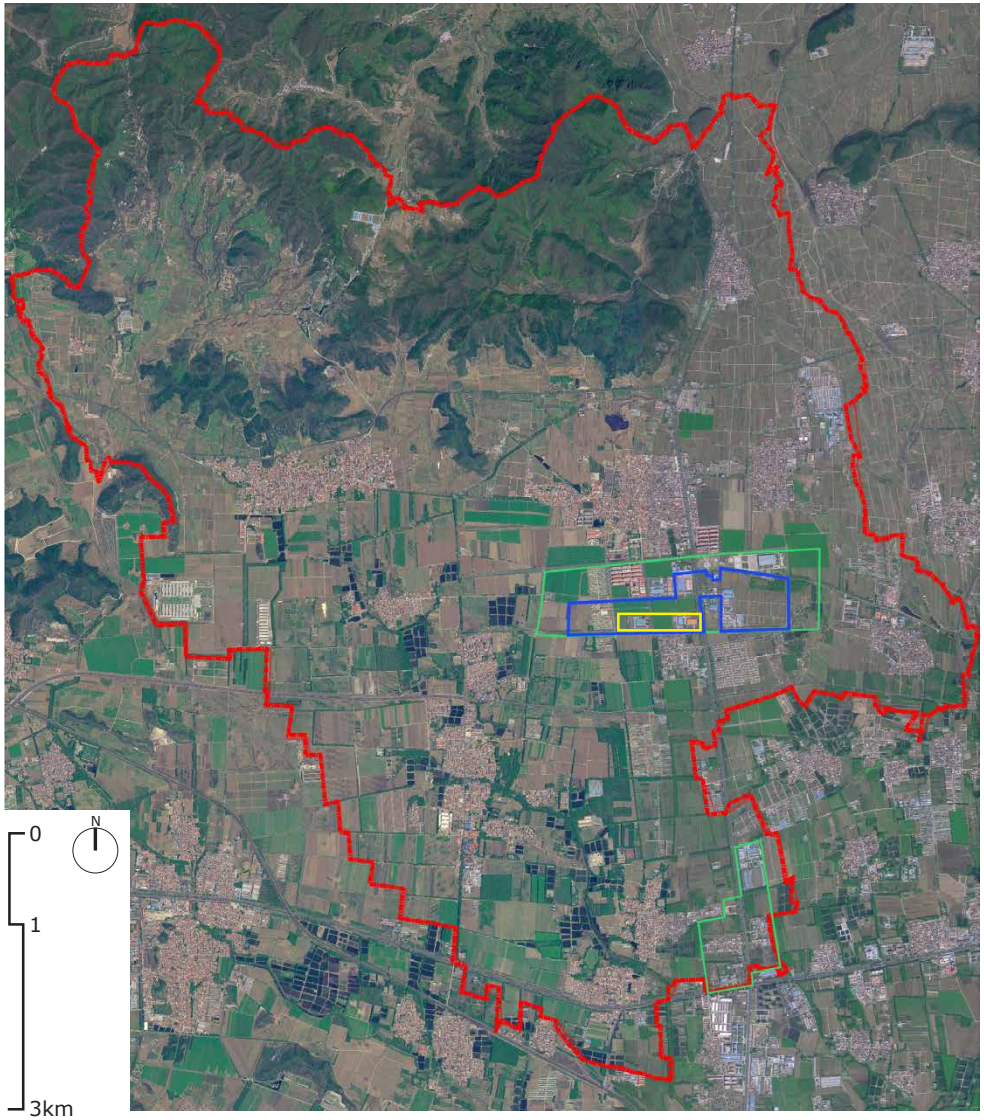


Figure 2-A. The areas for the three planning phases: the start-up area for phase 0 (yellow), the core area (phase I, blue) and the extended area for phase II (green). Source: Yukou Town government.

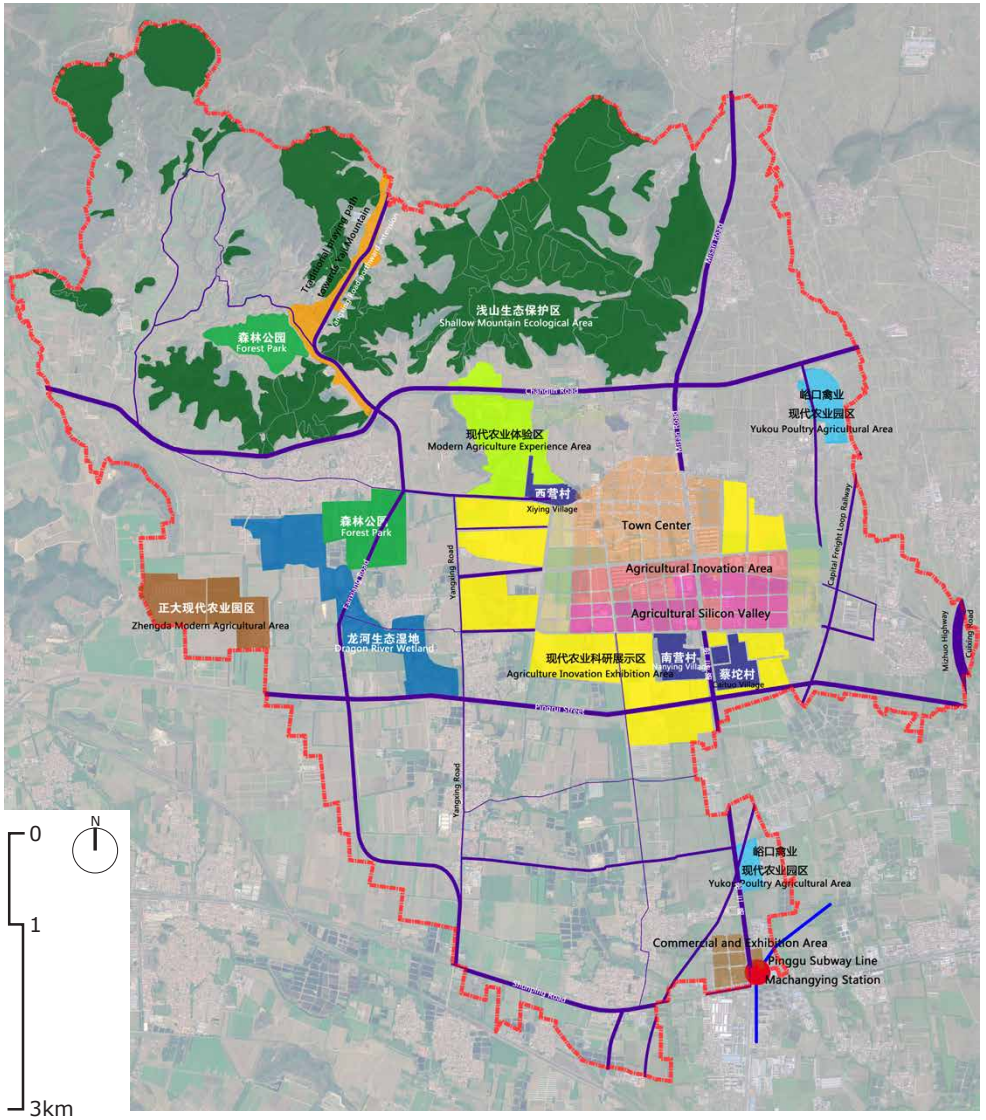


Figure 2-B. The planning scheme for Yukou Town. Source: Yukou Town government.

Allocation of planned functions:

Construction area:	*857 ha.*
Township area:	*369 ha.*
TOD area:	*22 ha.*
Village:	*466 ha.*
Agriculture:	*3,077 ha.*
AIC:	*109 ha.*

1.3 Planning policy at the local level

Yukou Town provided preliminary planning guidelines outlining the aims and ambitions for the AIC. These guidelines can be summarized as follows:

1. Develop a green 'ecological' park
Yukou Town aims to develop a green environment for the AIC that enhances the development of ecological functions (greenways, ecological infrastructure) and that provides a clean and healthy open-air recreation park for local people and workers.

2. Incorporate shared office and activity space in buildings in the AIC
The integration of different functions in the area should be stimulated. This will result in the more efficient use of space and prevent the development of monofunctional and uninteresting public spaces.

3. Create a smart campus
The latest, most sustainable techniques and solutions must be applied. The cyclic reuse of rain and sewage water, energy conservation and nature-based solutions must be standard in the AIC.

Based on the overall assignment provided by the commissioners of this project, three phases for developing the AIC were distinguished (Figure 2):

- Phase 0 (yellow outline)
In this first phase, an 11 ha start-up area will be developed. Construction in this area was planned to begin in early 2020. An initial detailed sketch for this zone – showing the master plan for the AIC – is presented in Chapter 4 (Figure 22).

- Phase I (blue outline)
The second phase spans a total acreage of 93 ha. This is the core area for the design and development of the master plan in this report and will be referred to as the 'Yukou Town Agricultural Innovation Campus' (AIC).

- Phase II (green outlines)
The last planning phase aims to enlarge the area in phase 1 in two further stages. An 80 ha logistic development area in the southern part of Yukou Town will be developed in this last phase.

This report focuses on the design of a master plan for phase I, including detailed suggestions for the start-up area (phase 0) and recommendations for the further development of the areas in phase II.

Figure 3-A. The locations of Yukou Town, Pinggu District and Beijing in China.
Source: Baidu map

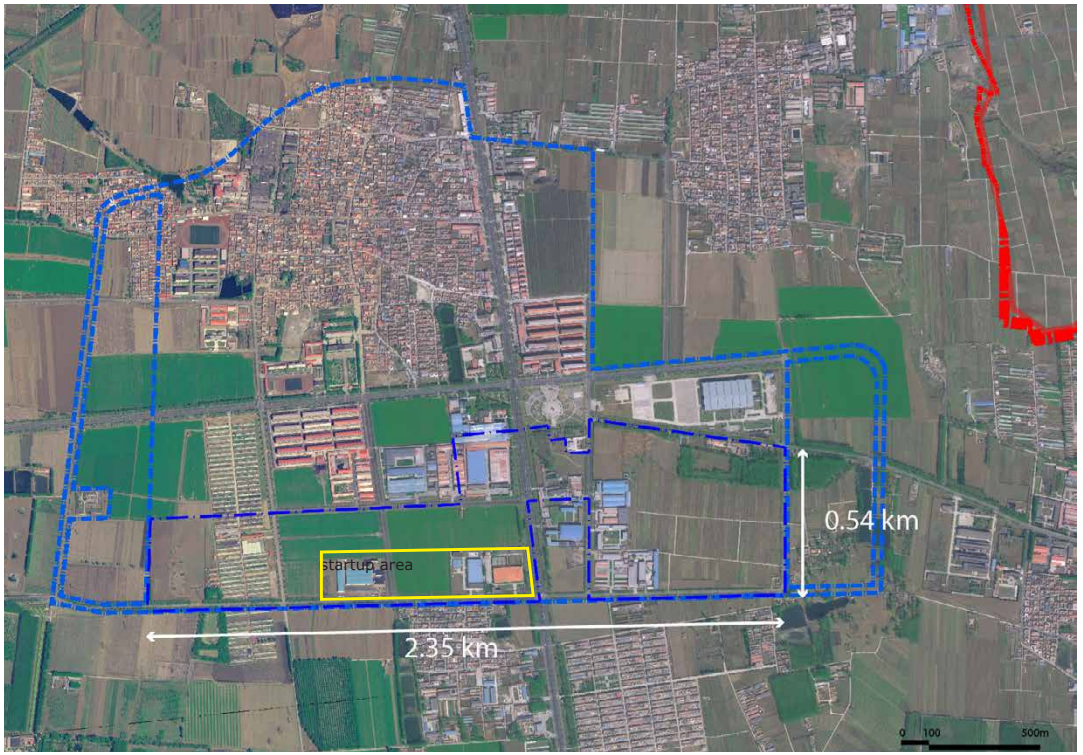


Figure 3-B. The site of the AIC.
Source: Yukou Town government

Figure 3-C. Yukou Town centre
Source: WENR

1.4 Location and site

The location of the AIC

The project site for the AIC is located near the small town of Yukou Town. As Figure 3-A shows, Yukou Town is part of the Pinggu District, one of the most eastern parts of Beijing. The distance between Yukou Town and Beijing city centre is about 73 km. Beijing is located in the north-eastern part of China. The distance from the demonstration zone to Beijing International Airport is about 53 km. The campus is therefore well-located for receiving visitors from other parts of China and the rest of the world.

The site of the AIC

The AIC will be developed to the south of Yukou Town (Figure 3-B). Yukou Town has approximately 34,000 inhabitants, and its name refers to its location near one of the most important river valleys leading up into the hills on the northern side of the Pinggu District: 'the gate to the river'. The town developed from an old town centre founded during the Ming dynasty (Figure 3-C).

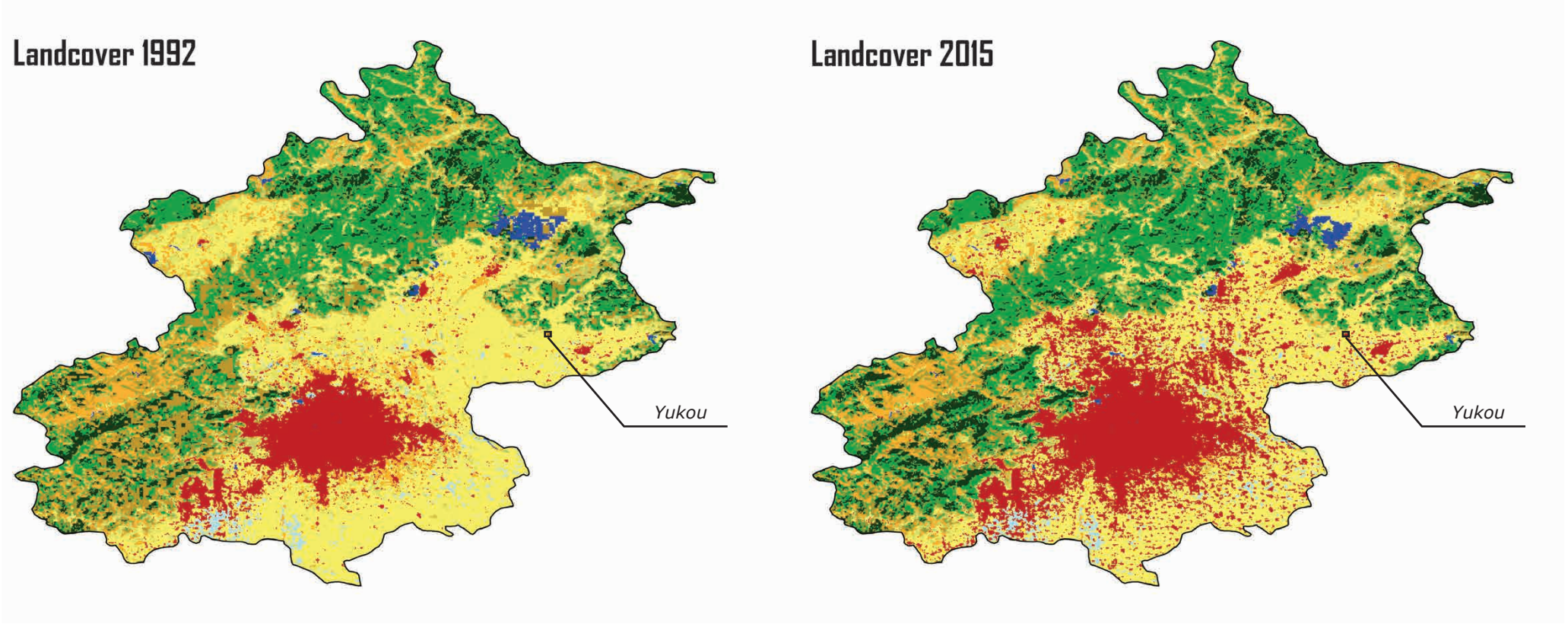


Figure 4. Urban expansion in Beijing in the period 1992 to 2015, illustrating the fast development of towns and villages.
Source: WENR.

1.5 Problem statement and assignment

The rapid and substantial urban and economic development of Beijing (Figure 4) has created great socio-economic improvements for its inhabitants. However, new issues have also arisen. For example, the extensive urbanization has created a large decline in agricultural and other non-built-up areas. Also, there are profound environmental problems, such as a reduction in the groundwater table, the deterioration of air and surface water quality and the loss of nature areas and wildlife (Beijing Municipal Ecology and Environment Bureau, 2018). These structural and serious issues must be taken into consideration in the planning and design of the AIC, due to the manifold processes and relations with different spatial and time dimensions that will determine the successful development and functioning of the AIC.

Contributing to solving the environmental problems in the area while also meeting the strict planning regulations and high ambitions for the AIC as stated by the regional and local authorities is a complicated assignment. It requires a thorough multi-scale analysis of the involved landscapes, their environmental characteristics and intertwined processes. Chapter 2 of this report contains a summary of this landscape analysis.

In Chapter 3, the analysis is followed by an integrated planning and design approach, starting at a regional scale and ending in a master plan design, at a scale of 1:5,000, for the site bordering Yukou Town. The master plan contains several detailed designs for the roads and their verges, for a series of 'pockets parks' within the AIC containing ecological and recreational functions, and for swales to help manage surpluses and shortages of surface water.

An important part of the AIC master plan is a set of planning and design rules and suggestions for the development plots in the AIC: the areas to be jointly realized by organizations and authorities. These plots will host the facilities and buildings that are necessary to develop the six main industries. These rules are described in the 'Quality Book', summarized in Chapter 4.

The last chapter of this report describes a number of recommendations for the further development, realization and management of the Yukou AIC. In the last part of the closing chapter, some conclusions on the Chino-Dutch cooperation are discussed to stimulate further exchange.

References

Beijing Municipal Ecology and Environment Bureau (2018). Beijing Ecology and Environment Statement 2018, pp. 7-8. Available from: http://sthjj.beijing.gov.cn/

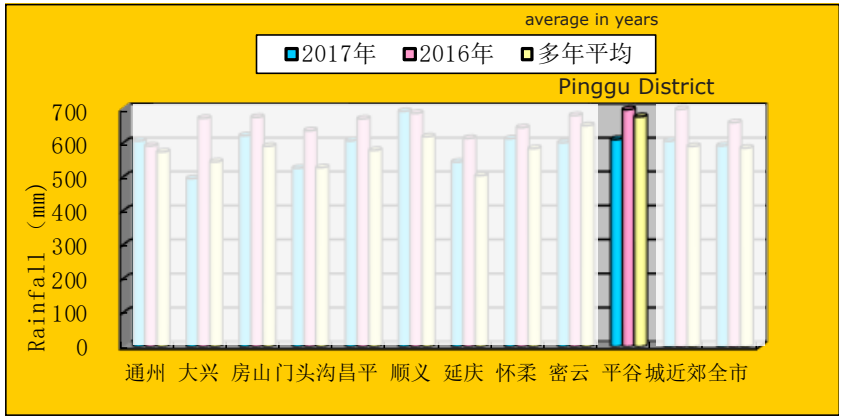
Source:Yukou Town government

2. THE LANDSCAPE OF YUKOU TOWN AND SURROUNDINGS

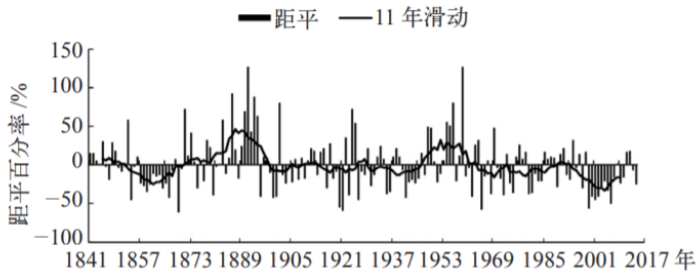
2.1 Introduction: The Wageningen Landscape Approach

The first stage in designing the master plan is an analysis of the current landscape. The goal is to understand the landscape processes in the planning area and its surrounding regions. To achieve this, a 'layer approach' is followed, based on methods described by Kerkstra et al. (1974) that involve identifying abiotic, biotic and anthropogenic processes and phenomena at different scales. Exploring the cultural heritage of the area is also an important element of the landscape analysis.

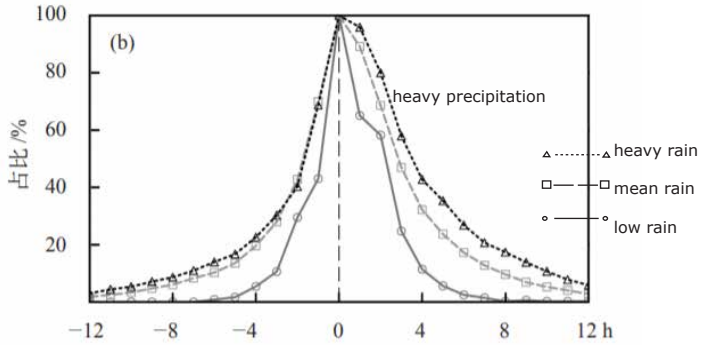
The results of the landscape analysis are summarized in this chapter. We first focus on the regional level of Beijing and Pinggu District (Section 2.2), followed by the study area south of Yukou Town in Section 2.3. The analysis was hindered by the low availability of data, especially at a more detailed level, as the commissioners of this project were not allowed to share detailed maps and other information. Consequently, general open source data were gathered and interpreted. The resulting insights were tested and discussed with relevant stakeholders during site visits and several field trips in the study area.



Precipitation in Pinggu District in 2016,2017 and yearly average



Annual precipitation in Beijing between 1841 and 2017



Synthesis of classified precipitation events (relative to peak precipitation) between 1977 and 2003 for suburban Beijing. The graph shows that heavy rainstorms prevail over mean or low-density events.

Figure 5. Changes in precipitation reflect the development of more extreme weather conditions.
Source: Open data from water authority, 2017; data.cma.cn; weather.com.cn.

Figure 6. The occurrence of cold sandstorms, predominately from a northerly direction in Pinggu District.
Source: www.weather.com.cn.

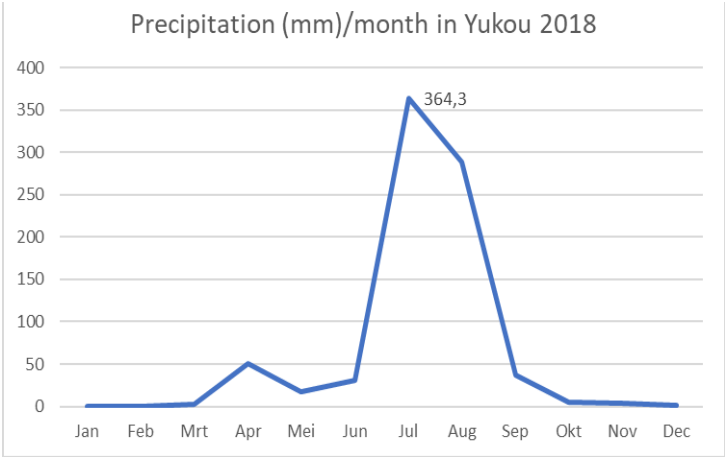


Figure 7. The distribution of precipitation in Yukou in 2018. The most severe rainstorms appear in the summer period (June-August).
Source: Yukou Town government.

2.2 Climate, climate hazards and climate changes

The climate is changing worldwide, also in Beijing, Pinggu District and Yukou Town. Data are presented in Figure 5 that express these changes. As a consequence, the area is confronted with four types of climate-related environmental problems and hazards (Figure 6): drought (October-February), smog (November-December), sandstorms (December-April) and flooding (June-September). These issues reflect the general development towards more extreme weather: hotter, drier and, in specific periods, more heavy rainstorms and wind. The precipitation in Yukou Town is depicted in Figure 7, which shows that the most severe rainstorms take place in the summer months. In built-up areas in particular, these heavy rainstorms can lead to flooding in otherwise dry periods. In many cases, the existing network of streams and ditches does not have the capacity to drain these intense rain periods.

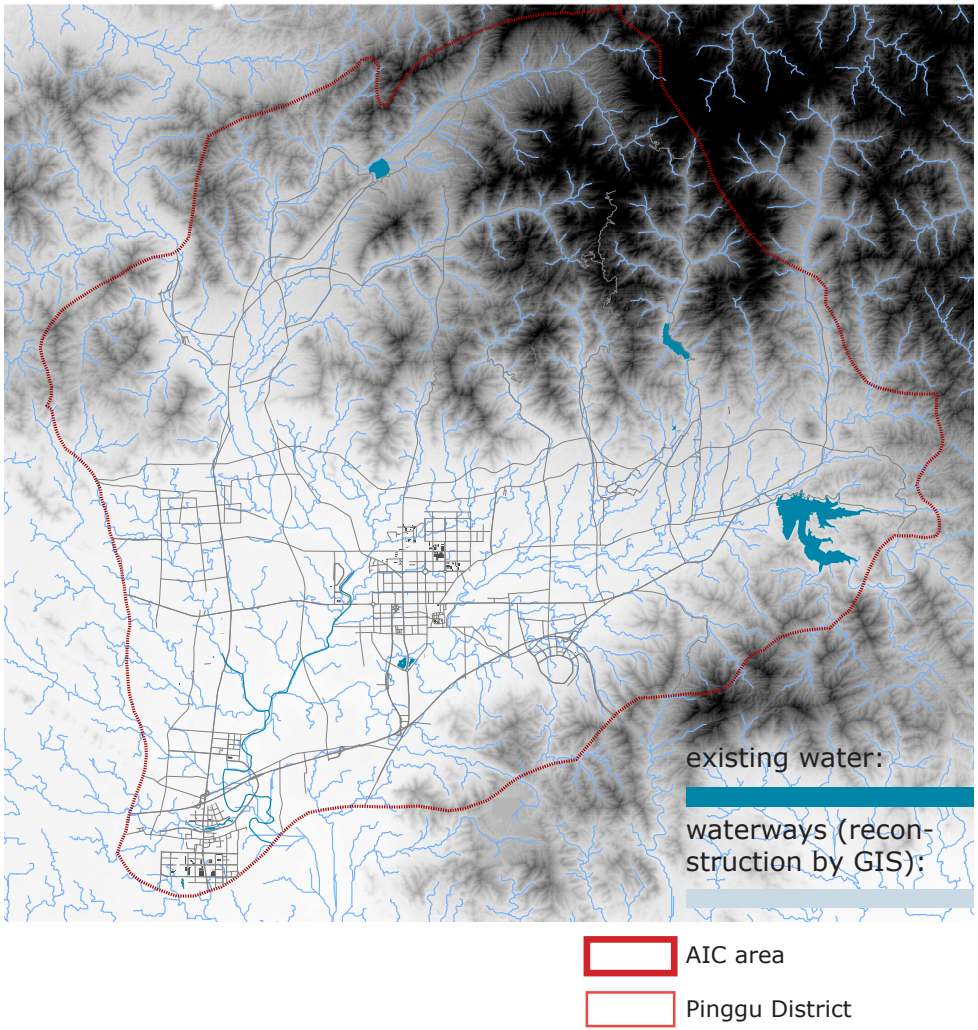


Figure 8-A. The reconstruction of current and former waters-heds and waterways in Pinggu District.
Source: Open data from water authority, 2002.

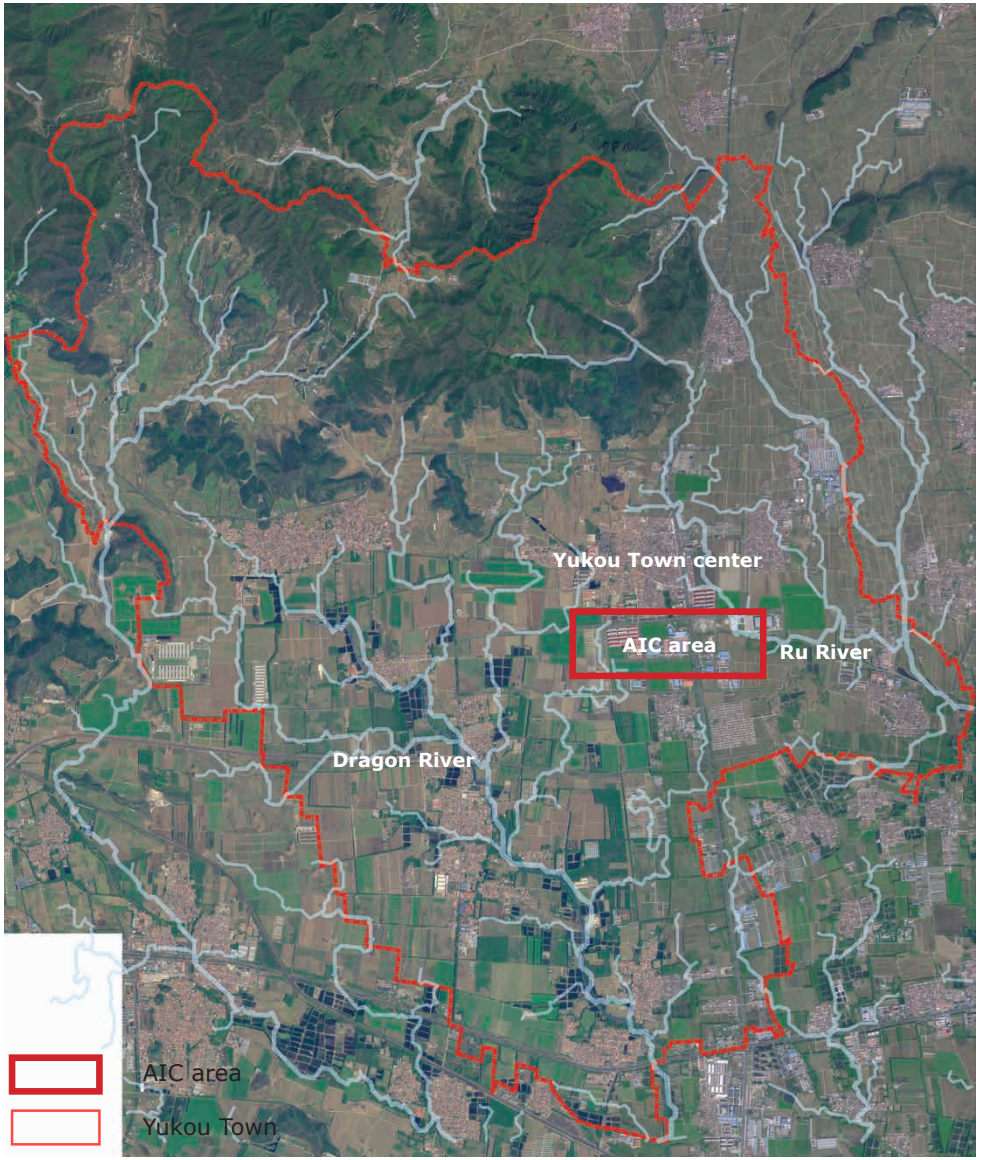
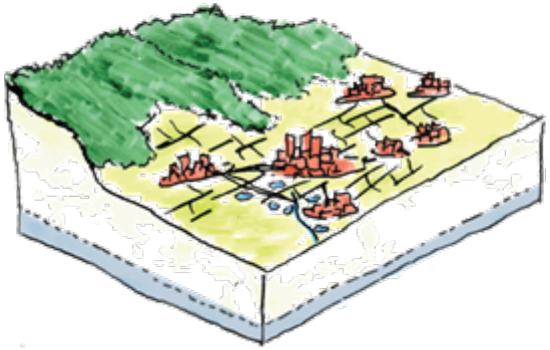


Figure 8-B. The main ecological features of Yukou Town: the gradient from the hills to the river plain with many streams that have fallen dry in the last decades of the 20th century. The drawing reflects the historic conditions with villages in the foothills and meandering streams (and roads).
Source: WENR.



Yukou Town with low ground water level

Dragon River wetland in Dongzhuang

Ru River in Zhongqiao

Figure 8-C. Sketch and photos of hydrological conditions. Source: WENR (left), Yukou Town government (right, photos).

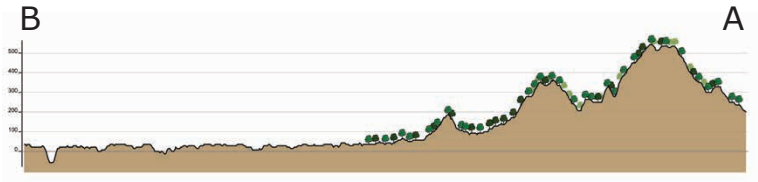
Hydrology

The lack of water in certain periods is an urgent issue, and affects agricultural use, ecological development and outdoor recreational potential. Although detailed information on the hydrology of the area was not available, a reconstruction of the Pinggu District watersheds was made based on open source data. This provided fundamental insights into the hydrological landscape structure (compare Van Buuren, 1997 and its changes in recent decades (Figure 8-A; Boone et al., 2019).

The map in Figure 8-B shows former watersheds and waterways (streams, small rivers) in Pinggu District. This situation corresponds to old maps of the area and stories told by local people. In the current landscape, only the lower courses of the bigger rivers still contain water year-round. Some of the middle and upper reaches of the streams only contain water from sewage treatment plants, while the other streams have generally fallen completely dry. This situation is caused by the overuse of aquifers for the production of drinking water for the growing population in Beijing. Groundwater levels in Pinggu District have decreased dramatically (from 20-30 metres deep to 200-300 metres deep; source: Beijing Water Affairs Bureau, 2017).

Yukou Town is located at a strategic position overlooking the Ru River (east) and Long River (west), which both cross the hills in the north and enter the floodplain north of Pinggu District. As the reconstruction of the river network shows, Yukou Town used to be connected with smaller streams that connected with these two river valleys.
Yukou and the study site are located along the boundary of two watersheds. Water from these areas flows in a westerly direction to the Long River or in an easterly direction to the Ru River.

The reconstruction of watersheds and waterways shows clearly where wetlands and/or streams and rivers may be reconstructed. or where water retention areas may be developed to prevent flooding during heavy rainstorms. These insights are important, as is the fact that groundwater extraction for drinking water recently ended.



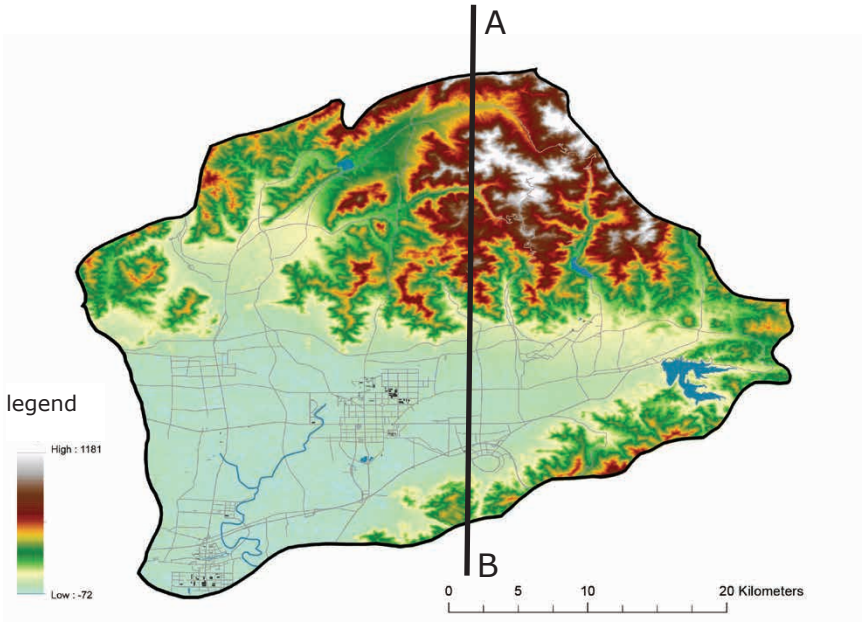
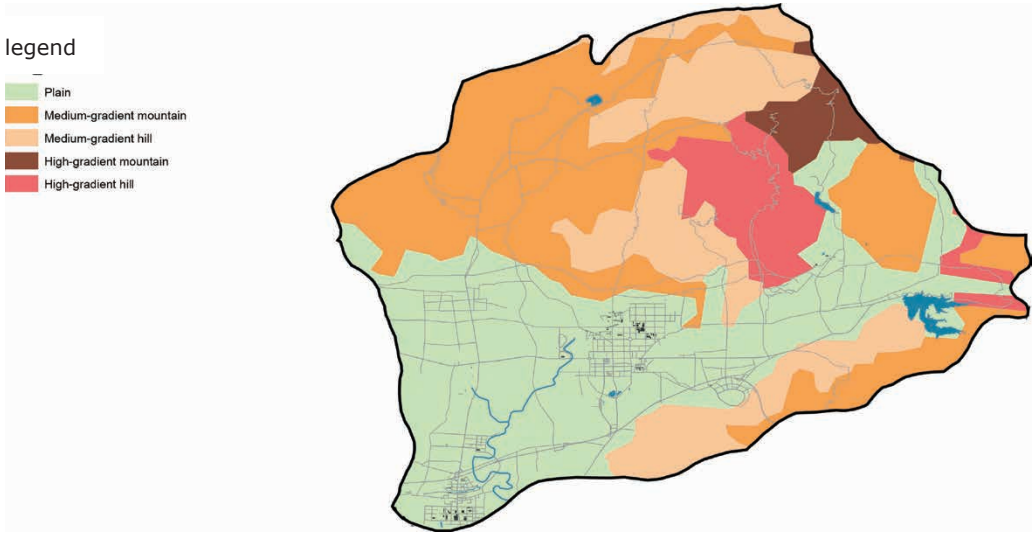


Figure 9-A. The elevation map of Pinggu District: a clear gradient from the hills to the river plain.
Source: WENR



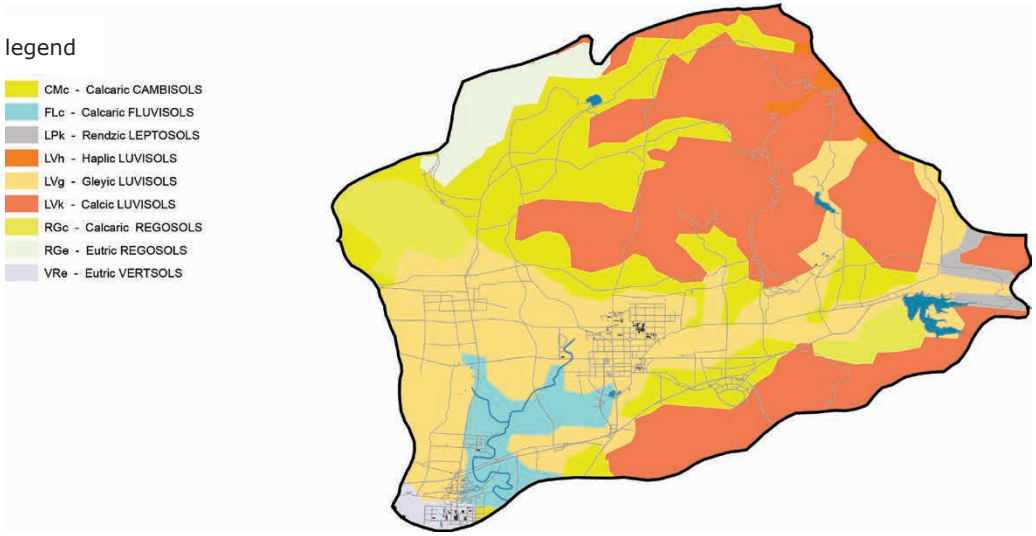


Figure 9-B. Typology of the hills (above) and soil map (below).
Source: WENR

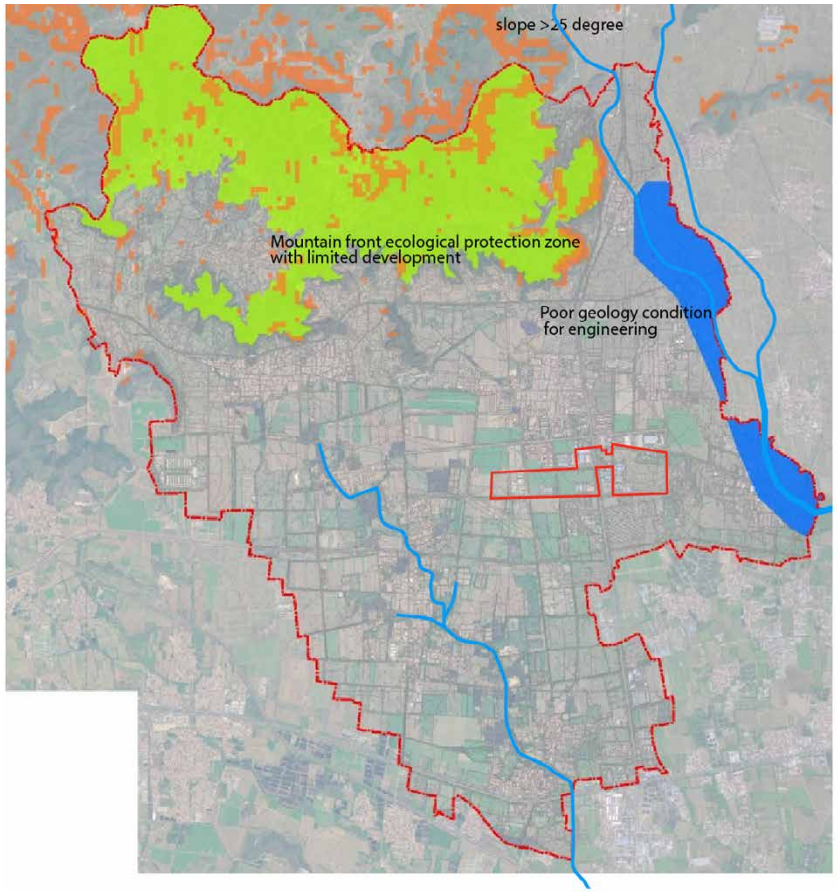


Figure 9-C. Limiting factors for development, related to abiotic and biotic characteristics of the Yukou area.
Source: WENR, Yukou Town government

Droughts and Floods

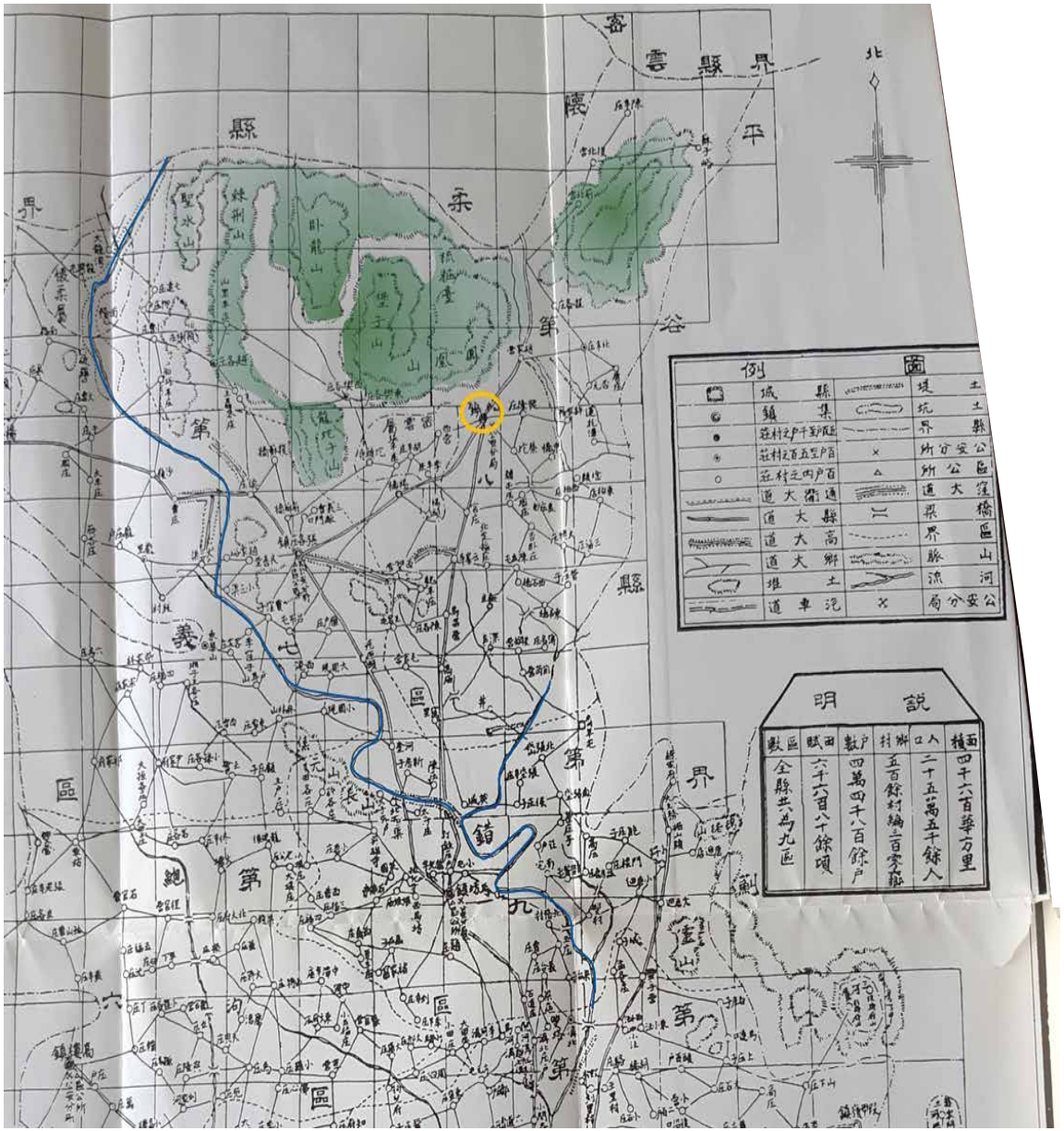
Although the large-scale pumping of groundwater for Beijing has come to an end, the replenishing of the aquifers will take a long time. At the same time, more extreme weather conditions will cause more frequent droughts (winter and spring) and, sometimes, greater flood risks (summer). Planning strategies that incorporate adaptive water management are therefore necessary at all scales. This requires creating more 'room' for rivers and streams for infiltrating, retaining and reusing rainwater.

Elevation and soils

The elevation map of Pinggu District shows the gradient from the hills in the north and east to the river plain in the south and west (Figure 9-A). The soils in the river plain are predominantly fluvisols, suitable for a wide range of agricultural uses. The hilly parts of the area contain very weakly developed mineral soils in unconsolidated materials (regosols). Most of these areas are covered with forests, and some parts are important for wildlife and recreation. The flat floodplain, with more fertile fluvisols, offer good perspectives for agriculture. The areas at the foot of the hills and in the river valleys (cambisols and fluvisols respectively) are less productive.

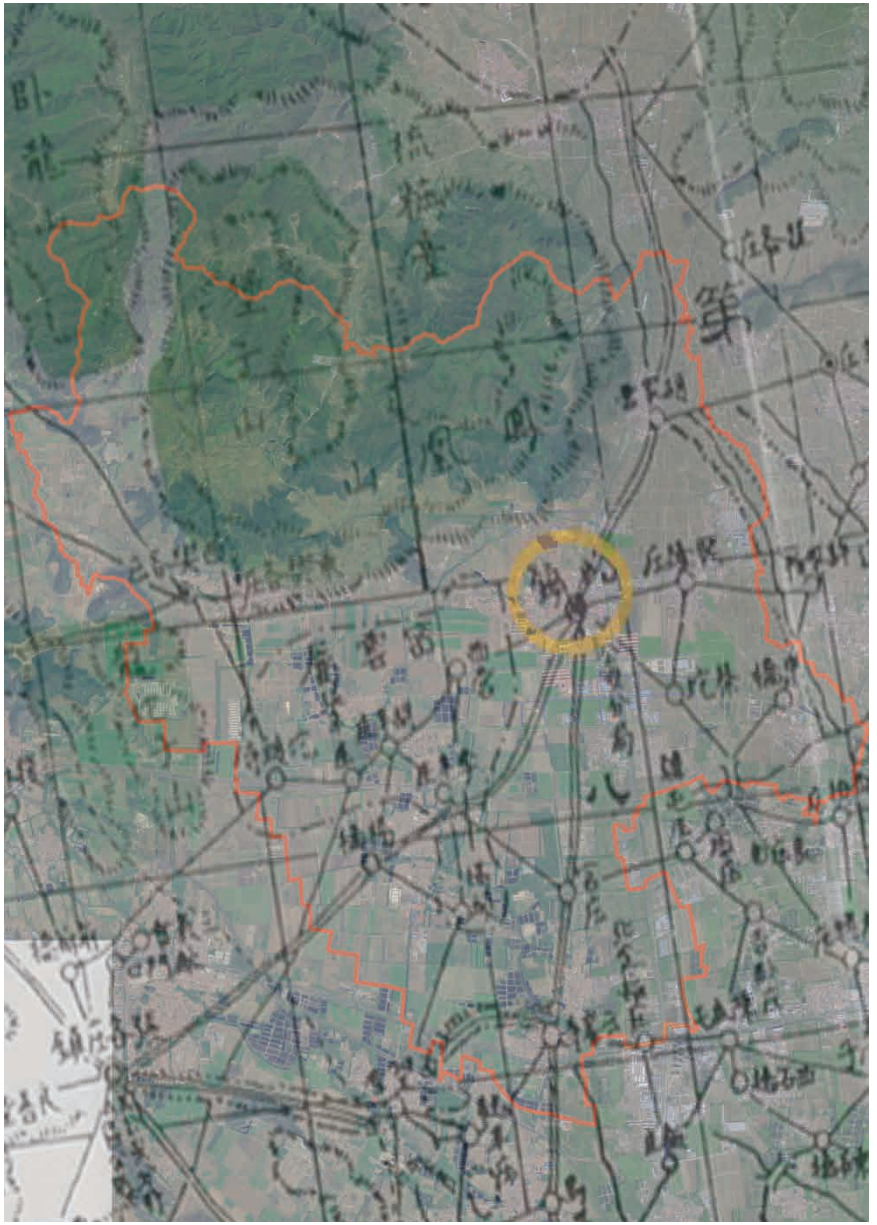
Limiting factors

As a result of the physical characteristics of the area, the planning authorities have issued several restrictions to further development, as shown in Figure 9-C. These restrictions may be due to environmental, ecological, hydrological, geological or scenic values and conditions.



Old Yukou Town centre

Figure 10-A. Map of Pinggu District from 1935. Yukou Town centre is located in the yellow circle. Source: WENR; Yukou Town government.



Old Yukou Town centre Yukou Town

Figure 10-B. Part of the historic map from Figure 10-A, projected on the aerial photograph of Yukou Town. Source: WENR

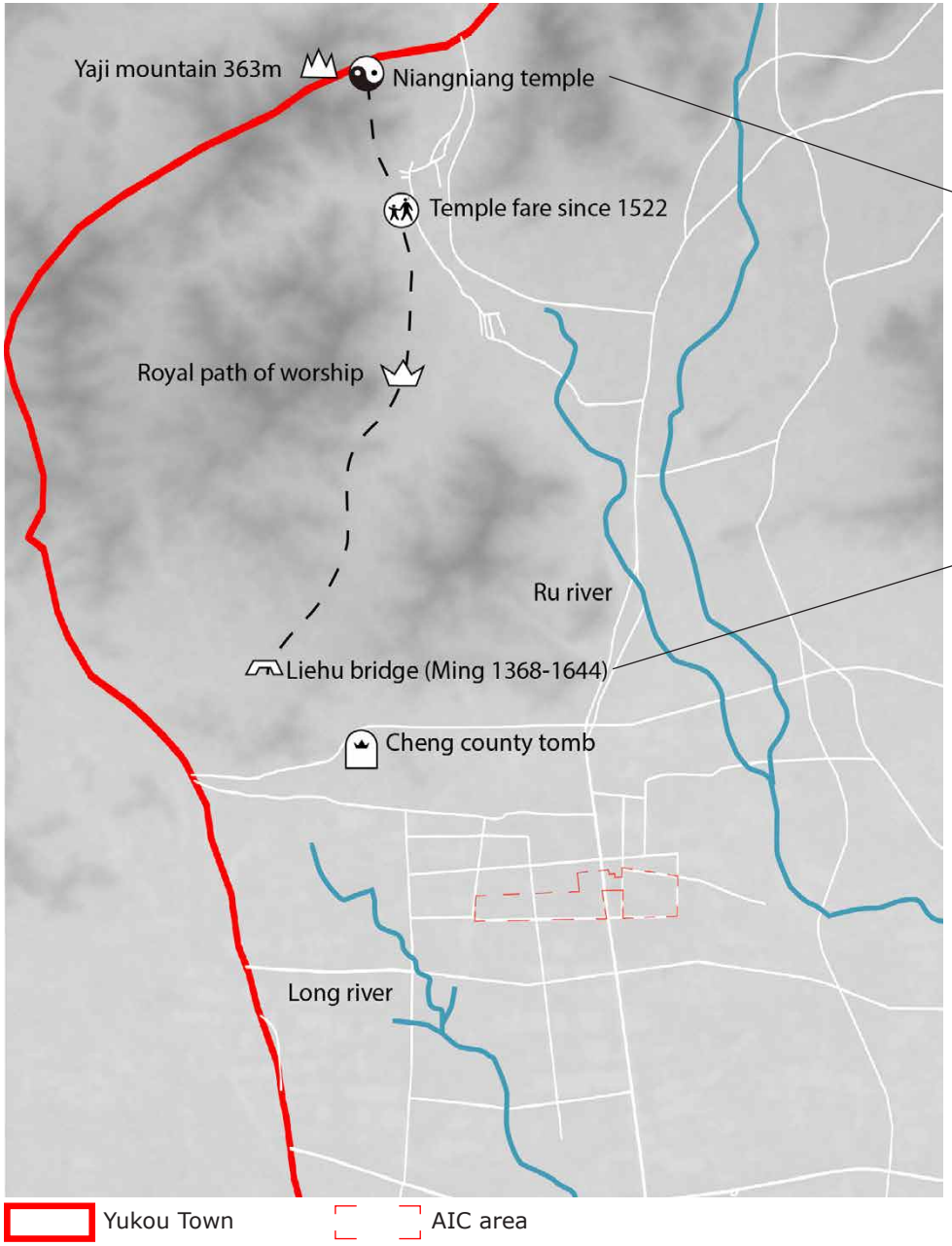


Figure 11. Cultural heritage: landscape elements that can still be found in and around Yukou Town. Source: WENR

2.3 Cultural history and heritage

Old maps and books referring to the cultural history of the area reveal some interesting phenomena. Figure 10 depicts some of the most important geographic elements in Pinggu District in the year 1935. Towns and villages were scattered over the area, and were interconnected by a variety of more or less winding, and smaller or bigger roads. The network was dense in the floodplain and predominantly restricted to the valleys in the hilly area. Some of the towns and villages formed clear nodes in the network, where a number of roads converged in market places. The road network was crossed by meandering rivers and streams at various places. Important cultural heritage elements can still be found in the current landscape (Figure 11). From the foothills just north-west of Yukou Town, the 'royal path of worship' runs into the hills, leading to one of the last remaining temples: the Niangniang temple that was built in AD 632. The yearly 'temple fair' is held at the foot of the hill on which the temple is located. Other important cultural heritage elements along the path are the Liehu Bridge and several stone monuments. Apart from the tangible landscape elements, different cultural festivals and festivities are organized in the Yukou area. The fair at Niangniang temple stems from the first half of the 16th century, and other important activities are the Yukou Market, the Peach Festival and the Toon Festival.

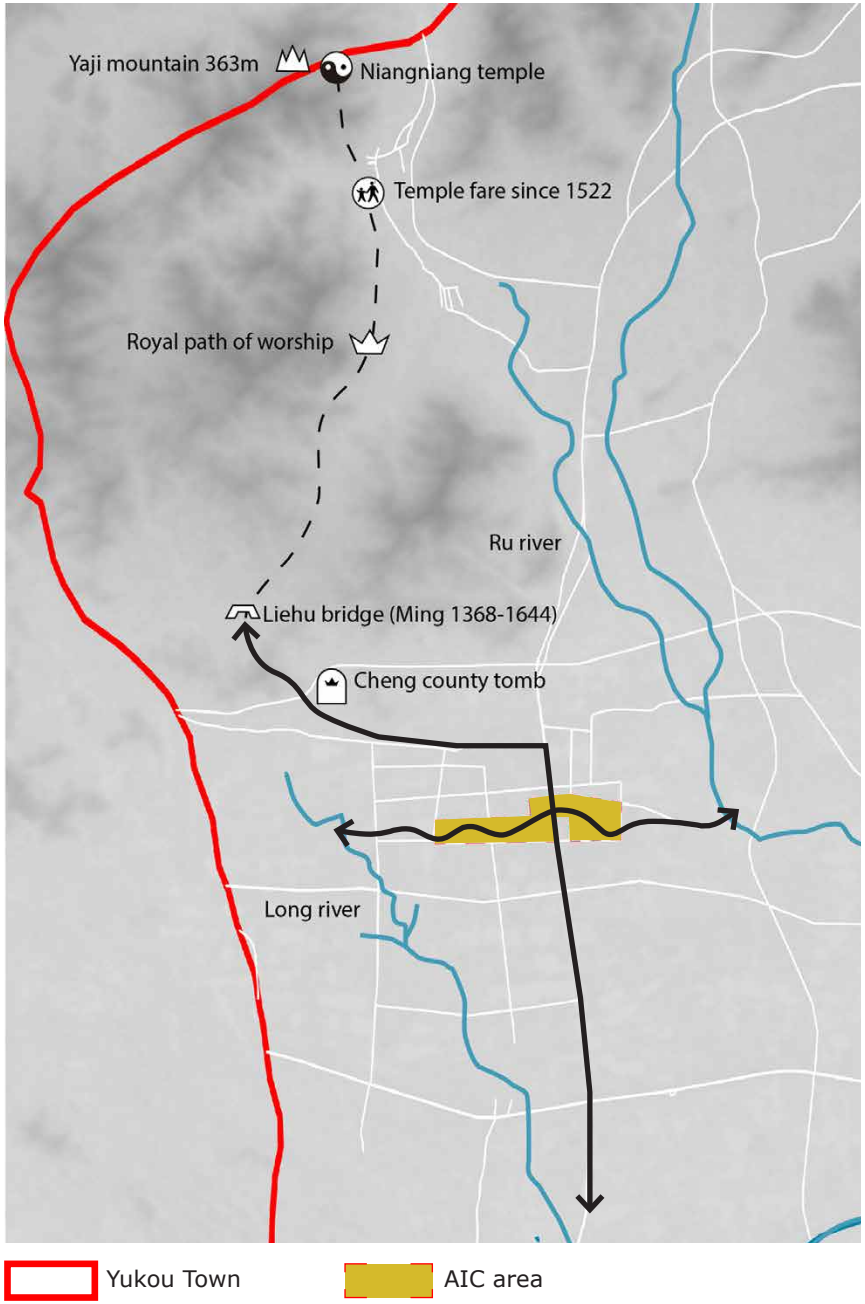


Figure 12. Yukou Town: the 'nodes' in the cultural heritage network. Source: WENR

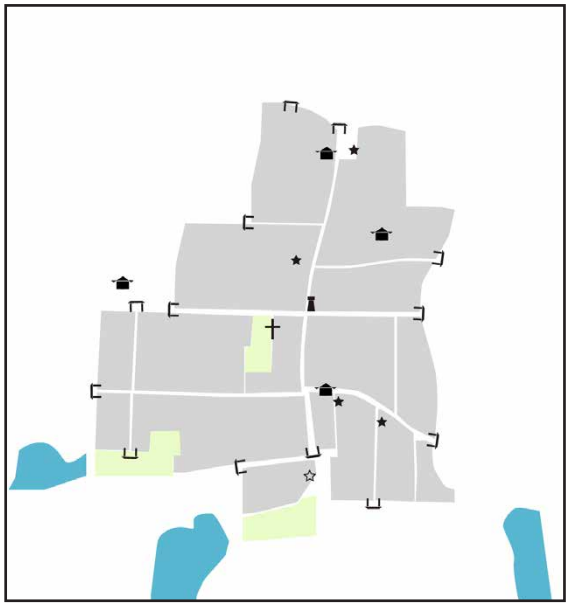


Figure 13. Reconstruction of the old Yukou Town centre
Source: WENR, Yukou Town government

Figure 14. Existing landmarks and modern development of Yukou Town centre.
Source: WENR.

Yukou Town

One of the nodes in the cultural heritage network is Yukou Town (Figure 12), which is strategically located in the Ru River valley as the entrance – or gate – to the mountains. Or, seen in the opposite direction, as the opening up from the river to the floodplain. The name 'Yukou' refers to 'valley entrance', while 'Rukou' means 'gate to the water'. Yukou Town (and its surroundings) had several war horse farms and the location of a historical battleground underlines its historical importance (Chai, 2014).

The current centre of Yukou Town sits in the same location as the historical centre (Figure 13). There used to be four temples in the north, south, east and west parts of the old town centre, each of which had one or two trees in front. The houses in the town centre, with their small courtyards and arches, are still located closely together. Some courtyards contain trees, giving this close-built part of the town centre a green appearance. The roads, which converge in the market place, used to have arches that marked the town centre's entrances. However, only one of these arches is still present.

Modern developments

Although the above-mentioned elements are still intact and are important tangible objects that connect local people to the past, old patterns, structures and elements in the landscape have changed extensively over the last decades. The number of remaining landscape elements must, consequently, be considered a poor representation of the richness of cultural traditions and developments. The overall landscape structure is now dominated by a rectangular system of roads, mostly heavily planted and with wide verges. Not temples and arches, but other landmarks (a water tower, monuments and statues) dominate Yukou, and the old town centre recently expanded to form a new town centre with many four- to five-storied apartment blocks enveloping the historical centre (Figure 14).

A scheme for reforestation has been started in rural areas, both in the hilly areas and in the river valleys. From the originally close-grained agricultural structure, a rich combination of different types of production has evolved: from greenhouses and orchards to arable lands and grassland. Pinggu District and Yukou are famous all over China for their peach orchards. However, most cropping relies on pumping up groundwater. Scattered in the area are 'industrial' agricultural activities (e.g. pig and chicken breeding). There are also many fishponds in the stream and river valleys, most of which are artificial.

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Source: Yukou Town government

3. THE NEED FOR A GREEN FRAMEWORK

3.1 Introduction

The design for the AIC has to meet the planning rules in China that are set at national, district and local government levels. Combining these strict planning policies with the 'environmental' ambitions of the commissioning authorities in the assignment for this project – the reason for hiring WENR – proved to be a difficult task, and not only because of the unavailability of relevant and detailed data as described in Chapter 2. The monofunctionality in the formal spatial planning requirements (Figure 15-A) creates a handicap for a sound, environmentally-friendly planning and design, as the actual physical space to integrate measures to meet climate adaptation or mitigation standards is rather limited. For instance, the space to be occupied by different individual functions and uses is strictly prescribed; the number, hierarchy and character of roads and their verges leaves hardly any room for deviation or further elaboration; the area for parks may not be changed; and so on. Furthermore, the formal, principally monofunctional, planning rules tend to exclude functions or land-use types that are not mentioned in the planning documents. As a result, merging rules and environmental ambitions in the master plan needed extra interpretation and discussion with the authorities at different government levels.

In the final design for the AIC, the Chinese planning rules were balanced with insights on environmental design. The most important elements of this approach are described in the following section, which introduces a set of planning rules that were agreed upon during intensive discussions with the authorities in the study area. The most crucial element of the master plan is the development of a clear 'green framework' based on fundamental physical landscape structures in the area: the 'Green Dragon' (compare Van Buuren, 1991; Van Buuren and Kerkstra, 1993; Vroom et al., 1994; Ahern, 2002).

3.2 Planning rules and environmental design principles

An overview of the most important formal planning rules is provided in Figure 15-B. Many decisions for the AIC at a detailed level were already decided on before planning and design of the master plan started. This applies not only to the 'overall programme' but also for instance to the exact spatial distribution of land uses, the roads and their cross-sections and the floor area and heights of different uses. The pie chart diagram reflects the overall prescribed land uses and their acreage.

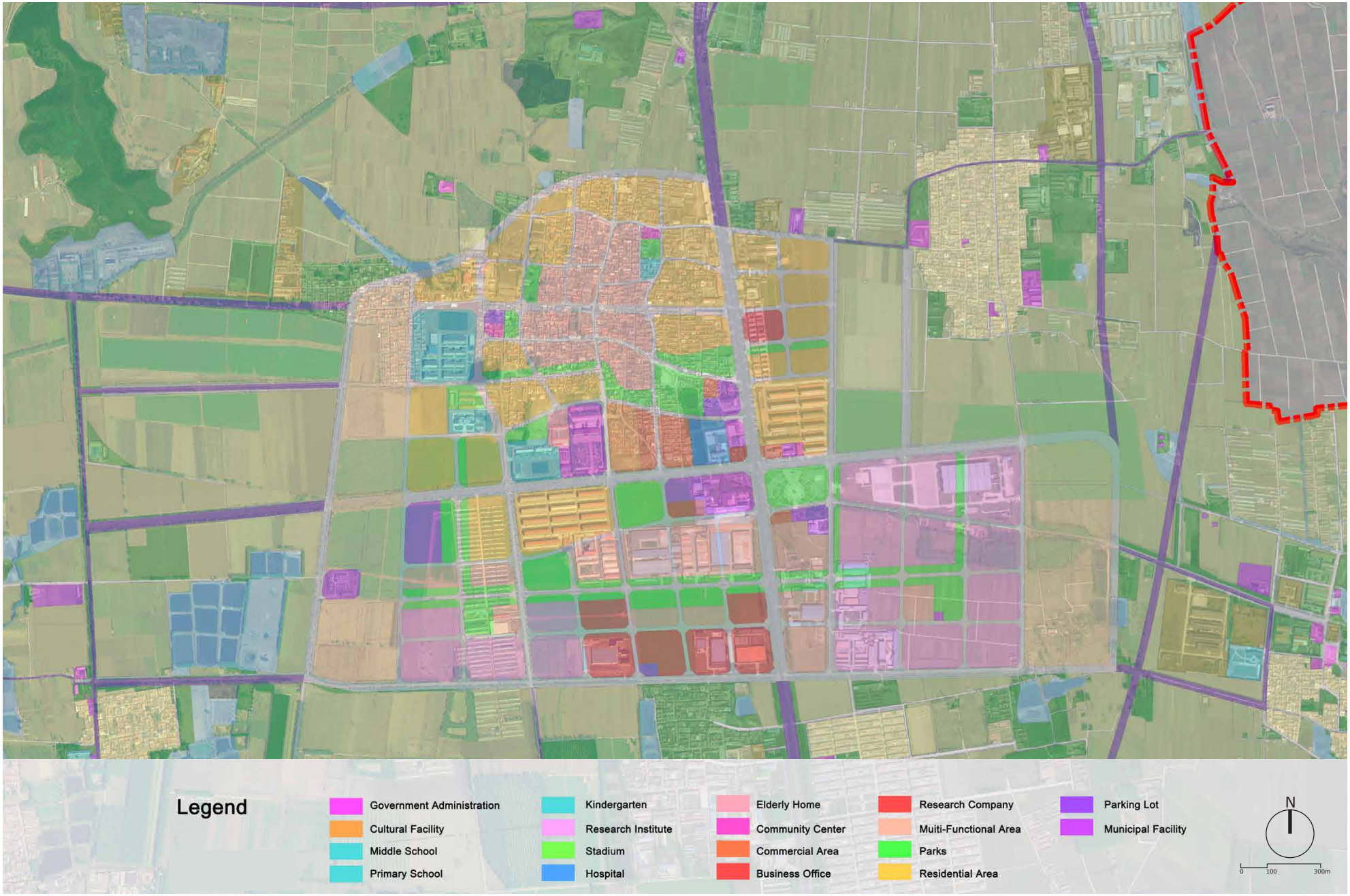
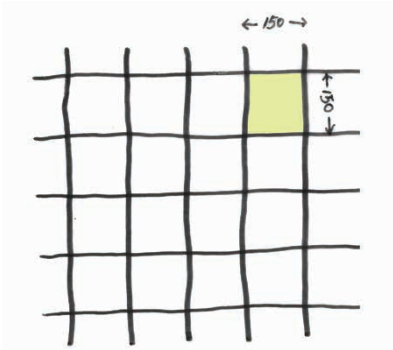


Figure 15-A. The former land-use planning for the AIC. The new land-use planning is shown in Figure 20 on p.40.
Source: Yukou Town government.

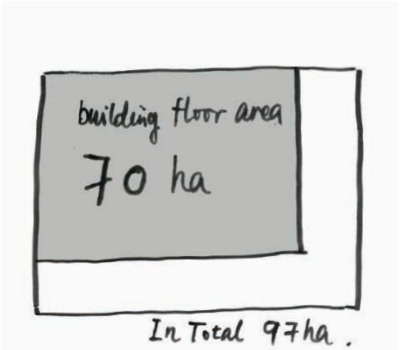
Rule 1

Road density ≥ 8% of area (97 ha)
Plot side lenghth ≤ 150 m



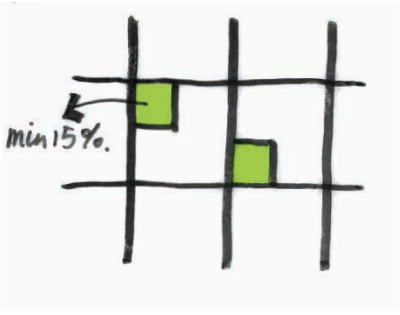
Rule 2

Building floor area = 70 ha



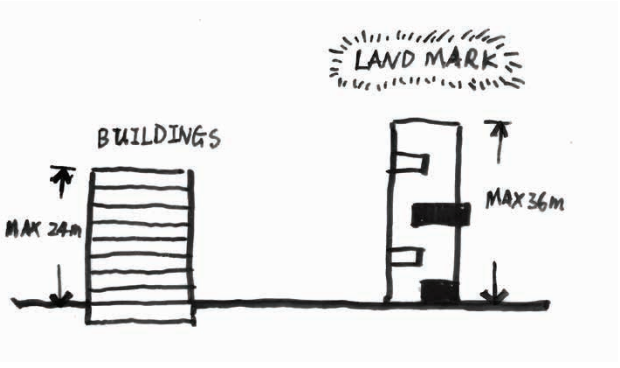
Rule 3

Green area ≥ 15% of each plot



Rule 4

Building height ≤ 24 m
Landmark height ≤ 36 m



Rule 5

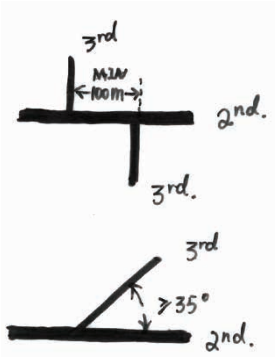
Land use

✓ Industry, non-polluting
Business office Multifunctional area Green
Traffic functions
Restaurant/Cafe

✗ Residential area Hospital/ Care/Treatment
Big public service buildings
B & B

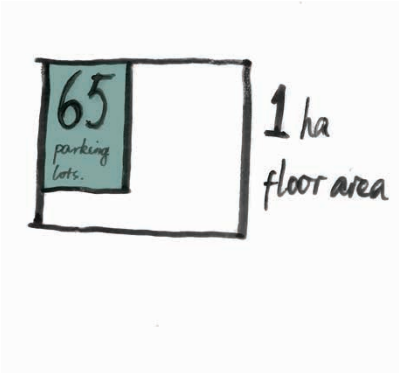
Rule 6

Ranking angle and split distance



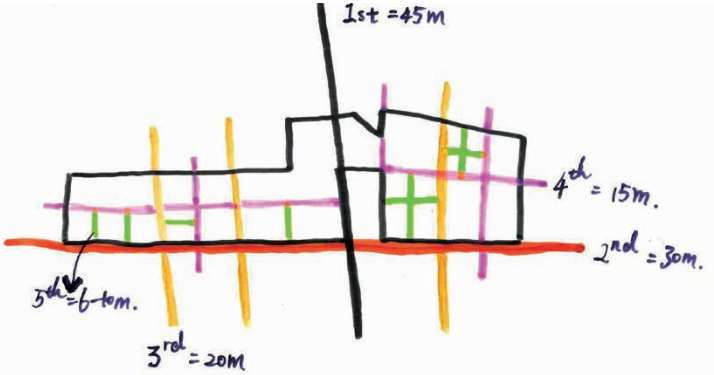
Rule 7

Parking ratio
65 parking spaces / 1ha. floor area



Rule 8

Ranking roads



Rule9

No bridge over first level road

Rule 10

Plot ratio max. 1.5

$$\frac{\text{Floor area building}}{\text{whole area surface}} \leq 1.5$$

Figure 15-B. Graphical representation of the general planning rules from Chinese authorities to be met in the master plan.
Source: WENR.

Sponge villages

Introducing summer breezes
Blocking winter winds

Figure 16. Schematic representations of some of the 'design rules' that were derived in this project.
Source: WENR

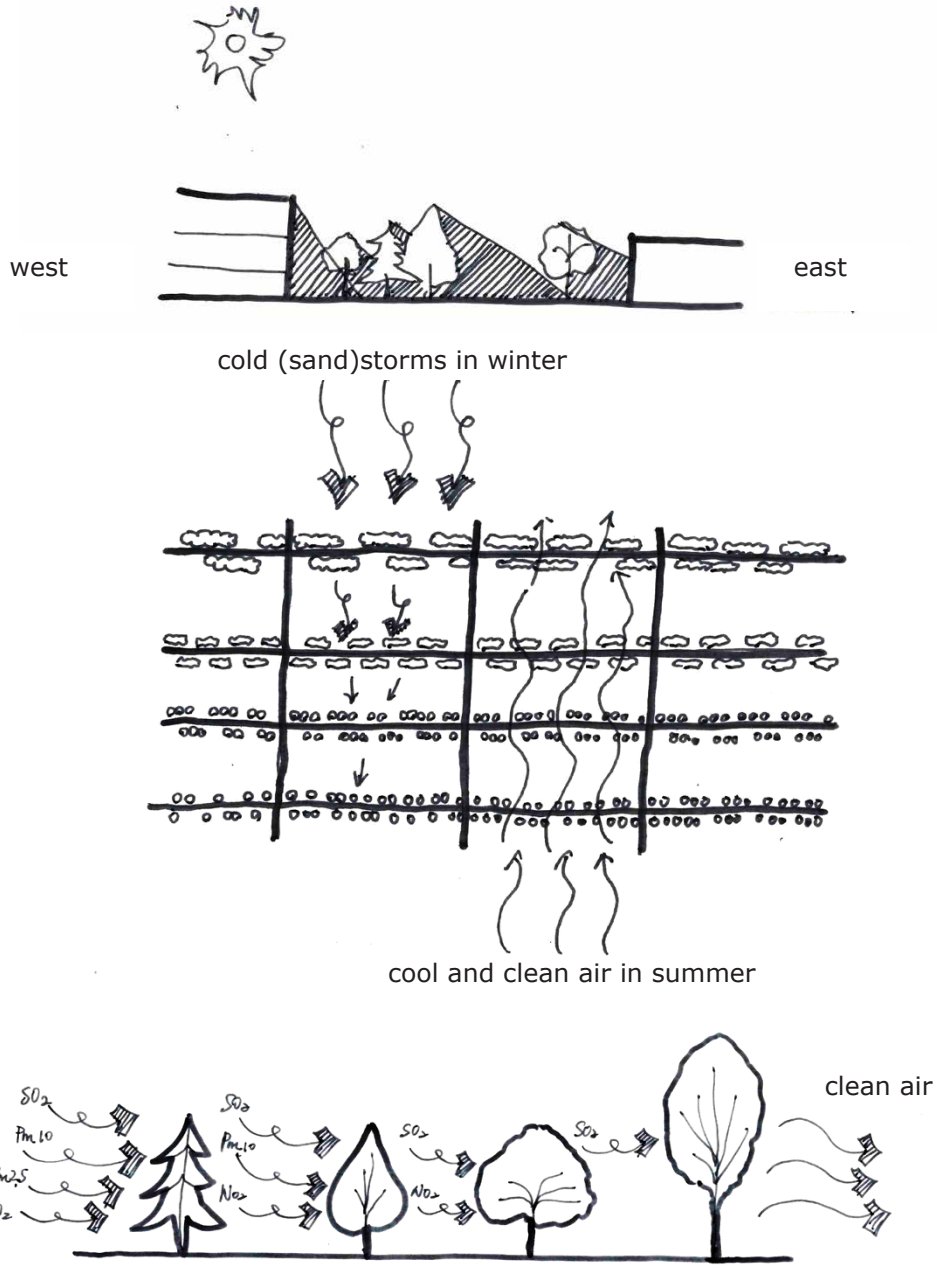


Figure 17. Representation of the design rules for directing winds and air quality by strategic planting schemes in the study area.
Source: WENR

figure 18-A. Design rules at a local level: catching, storing and reusing rainwater.
Source: www.tuinbranche.nl.

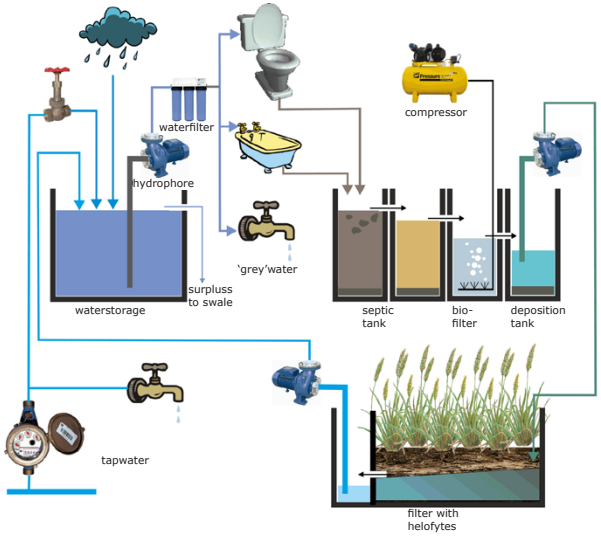


figure 18-B. Innovative systems using helophytes treat used water for reuse.
Source: rubenvanwijngaarden.nl.

To harmonize the formal planning rules with the high-level environmental and landscape architectural ambitions, a series of design workshops were organized. Many environmental and sociocultural aspects were discussed with local and regional authorities and their representatives. Finally, in addition to the formal planning rules, further starting points, directives and guidelines were agreed upon, here referred to as 'design principles'. The outcome of the landscape analysis was then interpreted and elaborated based on these design principles. The design principles focused on (Figure 16):

- Wind and air quality
- Water and hydrology
- Cultural heritage

After deriving these design principles, they were further discussed with groups of experts from Wageningen University and Research (Appendix 7.1), resulting in the principles described in this chapter.

The main idea behind these three types of design rules is to restore a landscape in which fundamental systems – either abiotical or biotical – and the use of the landscape by inhabitants and users are in balance again. By doing this, a sustainable and adaptive master plan for the Yukou AIC was the result. This will allow new challenges that arise due to climate change and socio-economic developments to be met.

Wind and air quality

One of the outcomes of the landscape analysis was the awareness that wind and air quality are important factors in the planning and design of the study area. The basic idea (Figure 17) is to block the harsh winter winds from the north by planting trees, hedges and other vegetation. To accommodate the refreshing and clean air from the south in summer, open areas and lines of trees allow winds from this direction to enter the area. Consequently, the strategic planting of rows of trees and other vegetation helps to create an agreeable microclimate in the newly developed area that may stimulate land uses and functionality even under more extreme weather conditions.

Water and Hydrology

The analysis of climate-related data and the hydrological situation in the study area shows that water is very scarce and, due to climate change, will be more so in the near future. To counter this problem, the idea is to develop the AIC in such a way that Yukou Town becomes a 'sponge city' (Figure 18-A). To achieve this hydrological design, principles on different scales were derived. The main design principle, both regional and local, is the development of a water management system based on: 1. catching water, 2. storing water, 3. controlled use. This applies to river catchments in the region, the entire AIC site and individual building blocks. In newly developed buildings, rainwater from the roofs will be 'harvested'; in other words, caught and subsequently collected in the AIC in swales (or wadi systems) and/or in underground basins beneath buildings in the plots. This means that roof run-off water is not connected to the sewer system. The collected water from the roofs can be used to water gardens or, via irrigation systems, in park and garden areas connected to the AIC. These water systems may be improved even further through monitoring and evaluation. Several projects are ongoing incorporating not only rainwater, but also new ways of treating and using or reusing sewage water (Figure 18-B).

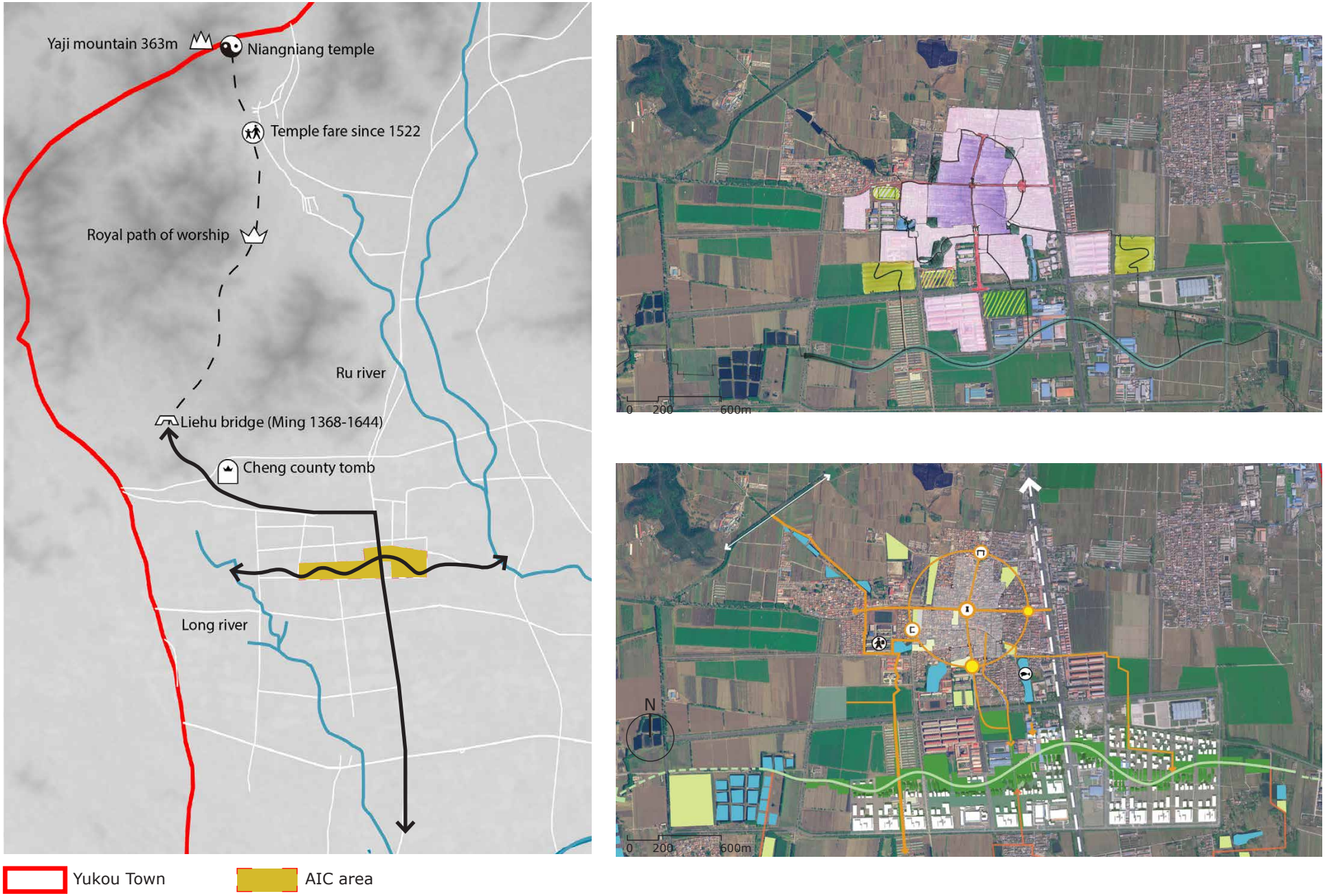


Figure 19-A. Representation of the development of the AIC as a 'crossroads' system, connecting historic routes (left).
Sketches of possible connections between the AIC and the surrounding parts of Yukou Town, using both traditional and modern developments (right).
Source: WENR.

Cultural heritage

Yukou Town is considered to be ‘the gate to the river’. From a cultural historical perspective, therefore, the town should be reconnected with the rivers to the west and east of the AIC that originate in the surrounding hills. Traditionally, the north-south road (S204) has been the major transport axis connecting the river plain to the green hills. From this road – the category 1 road in our planning area – the hills can be seen almost constantly driving north. The new AIC can therefore be developed as the connecting ‘crossroads’ with the ancient directions (Figures 19-A & 19-B), adding a new chapter to the history book of Pinggu District.

The local municipality strives to redevelop and protect the old town centre of Yukou Town while also creating new neighbourhoods around the existing town. The AIC will become part of this new development, not only in a physical-spatial way but also in a social, cultural and economic way (employment, recreation, tourism, residential housing, retail). To realize this, the town, the campus and the surroundings need to be interconnected in a recreational network that is mainly for cyclists and pedestrians (distances are small). At the same time, the idea is to expand the town itself and to install or reintroduce connections between old parts of the town and new neighbourhoods, using small green places, public functions and cultural remainders such as porches, trees and landmarks. Original architecture can still be found in the old town, and we suggest restoring these buildings and giving them a new public function. The business case for this comes from the expected spin-off from the campus, as the demand for public services will grow from tourism, business and leisure. This combination seems feasible.

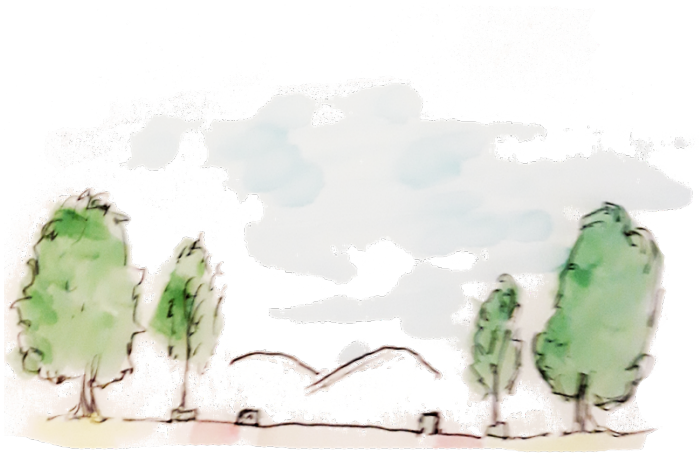


Figure 19-B. The view towards the hills from the S204.
Source: WENR.

3.3 The Green Dragon: a framework for development

The principles presented in this chapter will enable the resilient and environmentally well-established development of the Yukou AIC. Based on these principles, while also meeting the formal planning rules set by local and regional authorities, a master plan was designed that focuses on the creation of a continuous green framework of designated park areas, road verges and other public spaces. This interrelated system of 'green spaces' is referred to as the 'Green Dragon'. Following concepts such as the 'framework concept' (e.g. Van Buuren and Kerkstra, 1993), 'greenways' (e.g. Ahern, 2002), 'Green Cities' (e.g. Kahn, 2006) and 'designing urban climate' (e.g. Lenzhölzer, 2015), the master plan proposes the development of a green framework that envelops the further development of this new agricultural business area. This choice will enable the development of a new landscape for the area with a strong identity, with enough 'volume' or 'space' for the cultural and functional identities of the location in and near Yukou Town. This core element of the master plan is presented in the next chapter.

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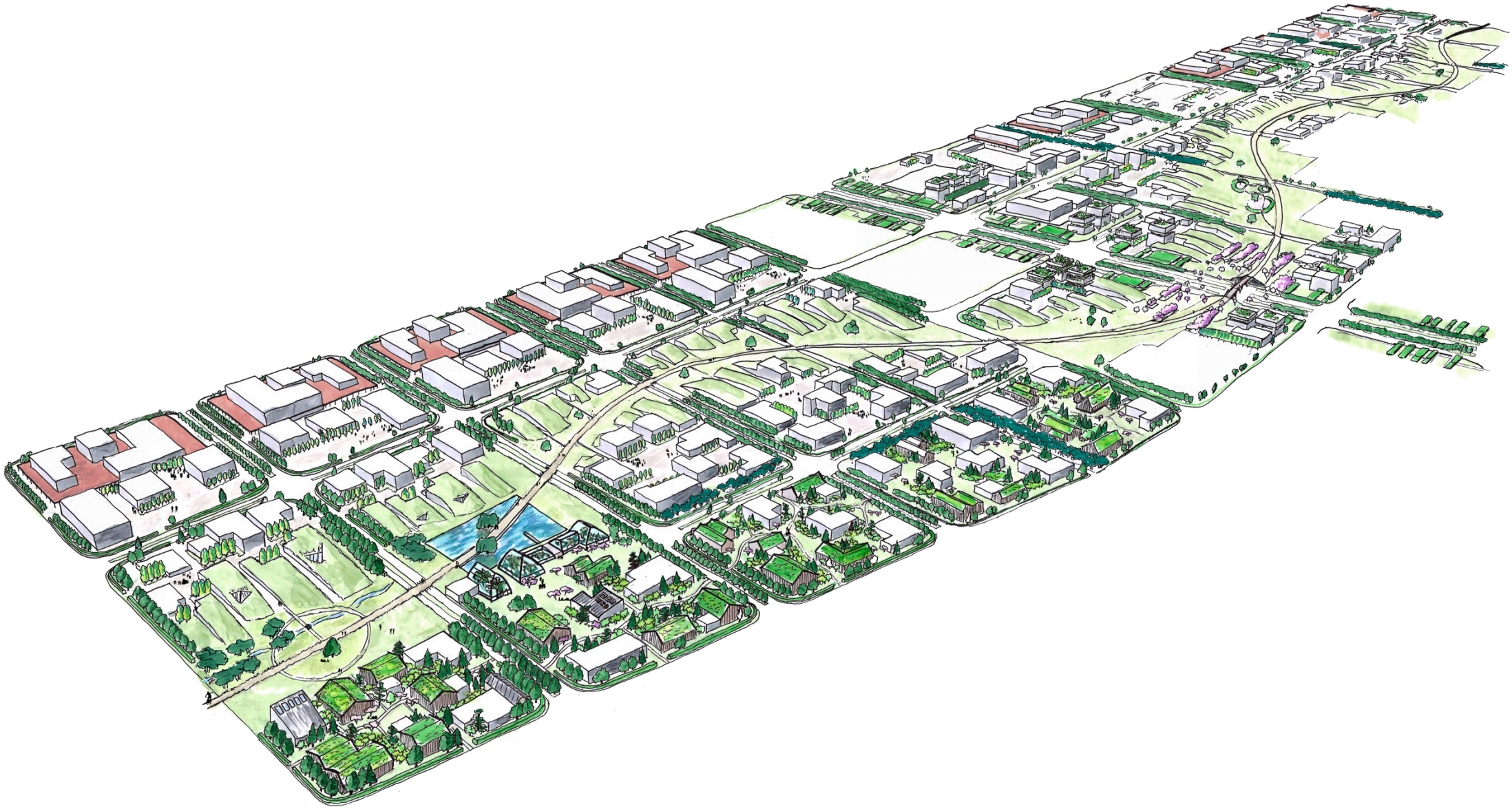


Source: WENR

4 THE GREEN DRAGON

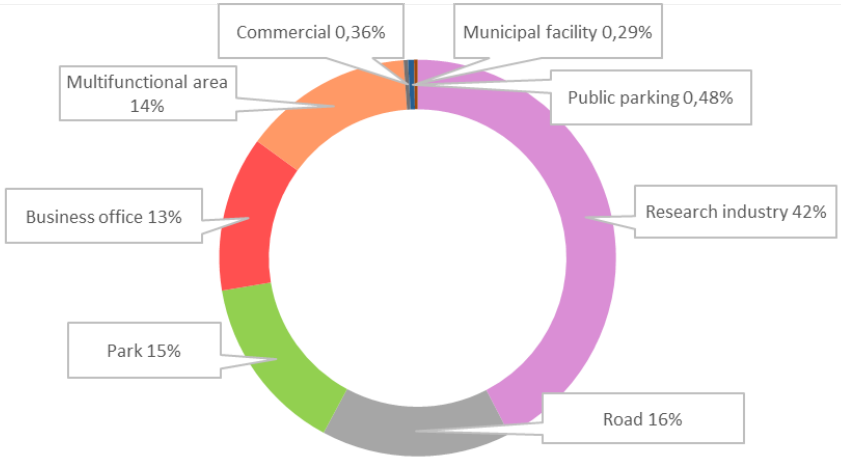
4.1 Introduction

The key component of the Yukou AIC master plan is the development of a green framework of public spaces, referred to as the Green Dragon. This encompasses all public spaces, roads and verges, parks and other 'green' areas. A final, 'controlled' design is presented for this framework. Designing the Green Dragon required achieving a balance between formal planning rules and environmental ambitions. After intensive discussion with the relevant authorities, the adapted planning scheme presented in Figure 20 was agreed upon and approved by the Pinggu District planning bureau. While the overall acreages of the prescribed land uses are still in line with the original planning rules, their distribution over the area has been changed, providing space for the design of a green framework. This chapter describes the Green Dragon and the controlled, detailed design.

The second part of the Yukou AIC master plan is the 'Quality Book', a set of planning and design rules and restrictions for the further development of the business plots enveloped by the Green Dragon. The Quality Book is described further in Chapter 5.

4.2 The 'Green Dragon' master plan

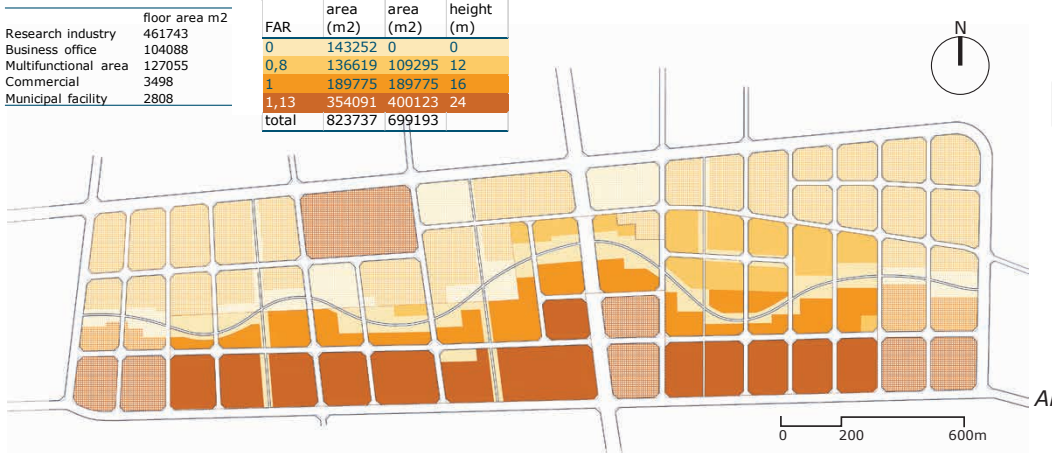
As can be seen in Figures 20-21, the Green Dragon covers 15% of the total project area. The biggest part consists of the original 12% area for green public spaces (compare Figure 15-A in Chapter 3). Road verges and other necessary public spaces add an extra 3% to this amount and are an integral part of the green network as a whole. The Green Dragon will be realized and managed as a public asset, thus facilitating infrastructure for both private and public transport, and ensuring the safe use of recreational traffic and space for leisure, informal meeting and natural development. The Green Dragon also provides the necessary sustainable environment for development of the business plots. To be able to fulfil these functions from the very start, it is important to realize the Green Dragon as the first stage of developing the AIC. This ensures that the very first users and business developers can profit from the green image and ecosystem services offered by the Green Dragon. This applies to the start-up area, but also to both phases of the AIC development, as depicted in Figure 2. This strategy of early development of a green framework before developing the buildings has proven to be very successful in the Netherlands, for example in the planning and development of the new town of Almere (Nawijn et al, 1979; Rijksdienst voor de IJsselmeerpolders,1984; Thorsdottir, 2010).

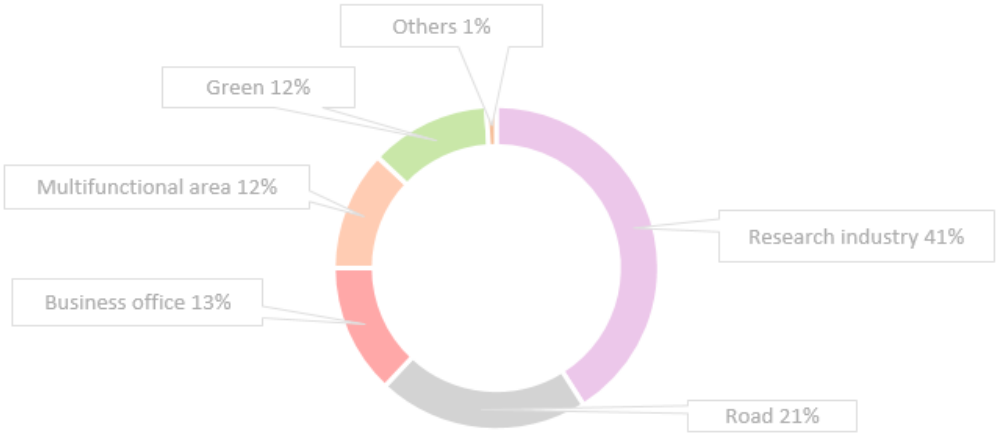


Allocation of land uses in the master plan

	floor area m2
Research industry	461743
Business office	104088
Multifunctional area	127055
Commercial	3498
Municipal facility	2808

FAR	land area (m2)	floor area (m2)	Max. height (m)
0	143252	0	0
0,8	136619	109295	12
1	189775	189775	16
1,13	354091	400123	24
total	823737	699193	



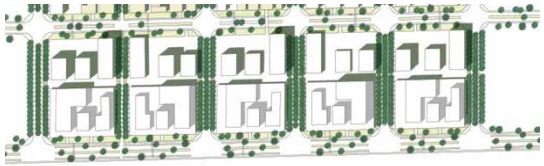


Allocation of land uses in formal planning policy

Figure 20. The masterplan meets the landuse planning rules.
Source: WENR

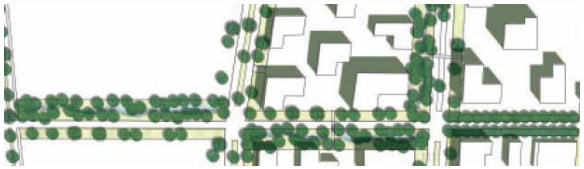
Figure 21. The Green Dragon, a continuous green structure in the heart of the AIC that expresses its unique identity.
Source: WENR.

One of the key points in the master plan design is the combination of all 'green spaces' (the designated park area, the green parts included in the road verges and profiles, etc.) into one, continuous green framework that we name the Green Dragon (Figure 21). In this way, an integrated, interconnected and efficient public space will become the core of the new development, exceeding the 15% 'park area' in the land-use planning scheme. This choice will enable the development of a new landscape for the area with a strong identity, with enough 'volume' or 'space' for the cultural and functional identities of the location in and near Yukou Town.



- The roads

- The 'Honey Bikeway'



- Swales (or wadis) combined with roads

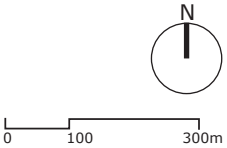
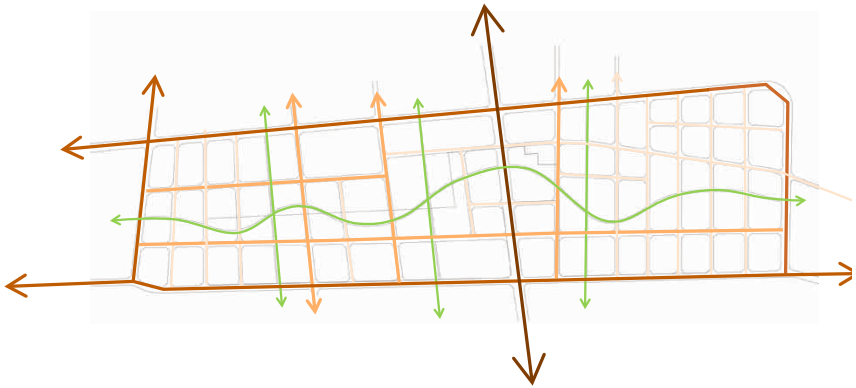


Figure 22. The master plan for the AIC at Yukou Town. The buildings here are fictitious.
Source: WENR.



Category 1 road: 50 m
Category 2 road: 30-40 m
Category 3 road: 20 m
Category 4 road: 15 m
Category 5 road: 6-10 m

16% for roads
Category 1-3 roads = 8 km/km²

Bus line planning

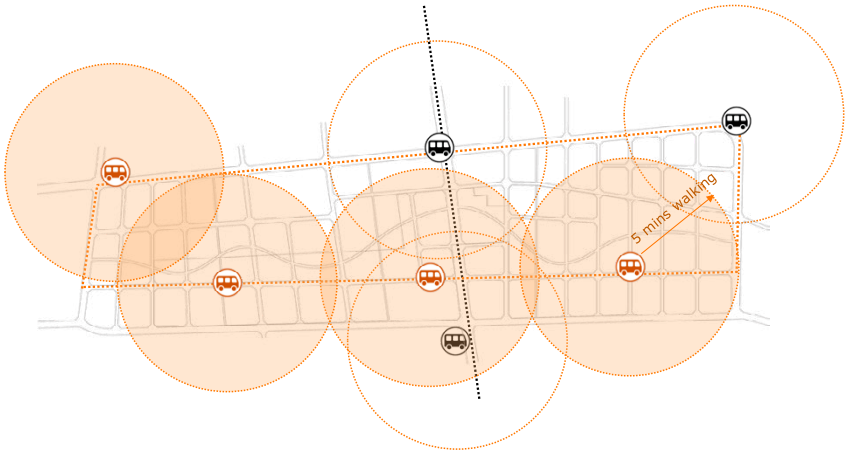


Figure 23. The road hierarchy (above) and the bus connectivity (below) from the master plan. Source: WENR.

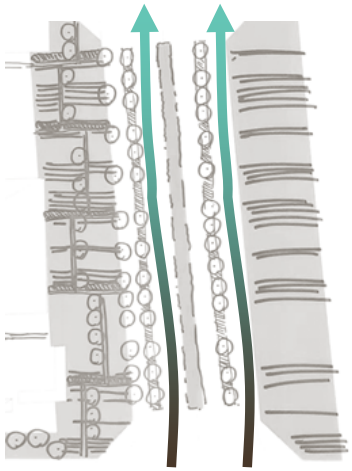
The master plan for the Green Dragon is presented in Figure 22. It consists of three different types of public spaces:

- the roads
- the Honey Bikeway, which connects a series of pocket parks
- the swales (or wadis)

The roads

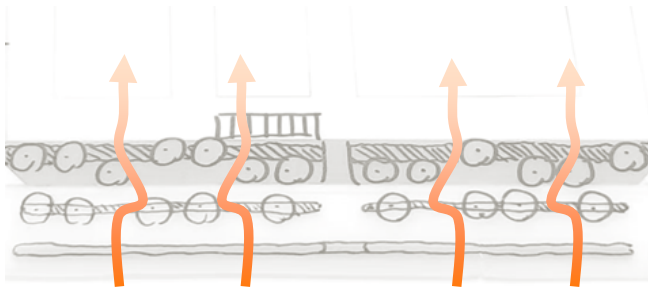
As Figure 23 shows, the original hierarchy of the roads in the formal planning documents was adapted to connect the AIC with Yukou Town and other surrounding areas for various means of transport. The central 'meandering' road is a cycling path, also accessible for emergency traffic. The cycling path enables local residents and workers to use the bicycle as a sustainable means of transport. The area is well served by public transport (buses), stimulating another sustainable means of transport. An important element of the master plan is the design of a series of road and verge cross-sections that comply with the planning policy standards set by the authorities (dimensions, functions). The cross-sections in Figure 24 show the layout of the different road categories and the selection of planting, paving, lighting, street furniture, and so on. These more detailed elements will also determine the quality, atmosphere and appearance of the area.

As previously explained, one of the most important issues in creating the right microclimate and other ecological services (e.g. biodiversity, recreational values) is the strategical use of planting. Trees are selected for each road category depending on their size, with large trees planted along the high-category roads and small trees planted along low-category roads. North-south directed roads are planted with mono-species, while west-east roads are planted with a mixture of trees to increase their air purification capacity.



Guide the wind to purify the air

Figure 24-A. Category 1 road section



Open to summer breezes

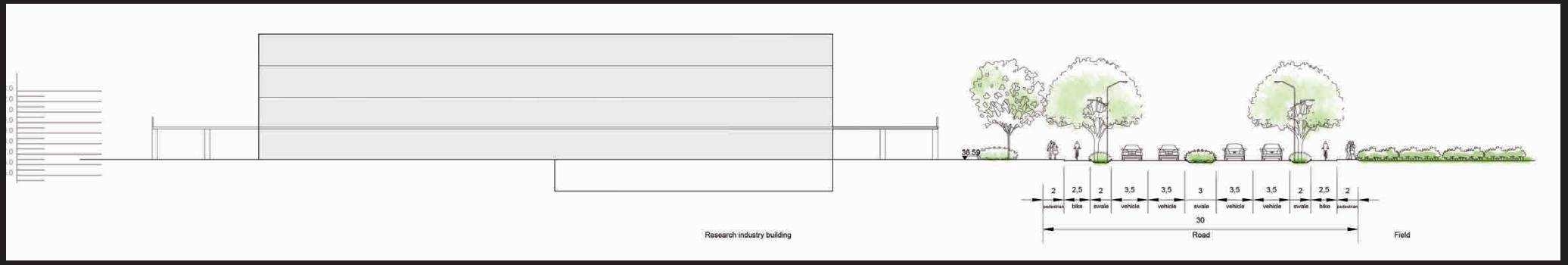


Figure 24-B. Category 2 road section

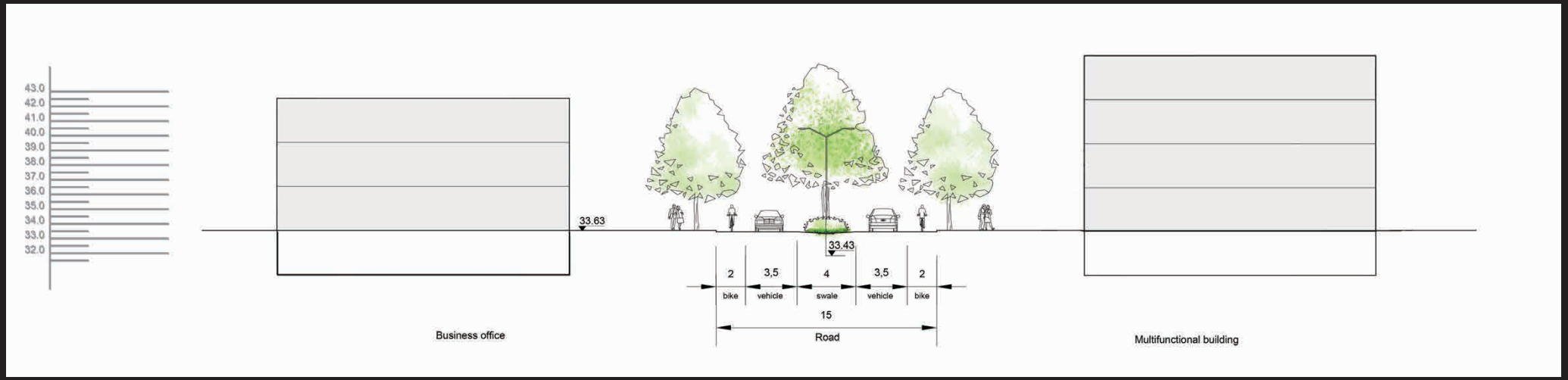


Figure 24-C. Category 3 road section

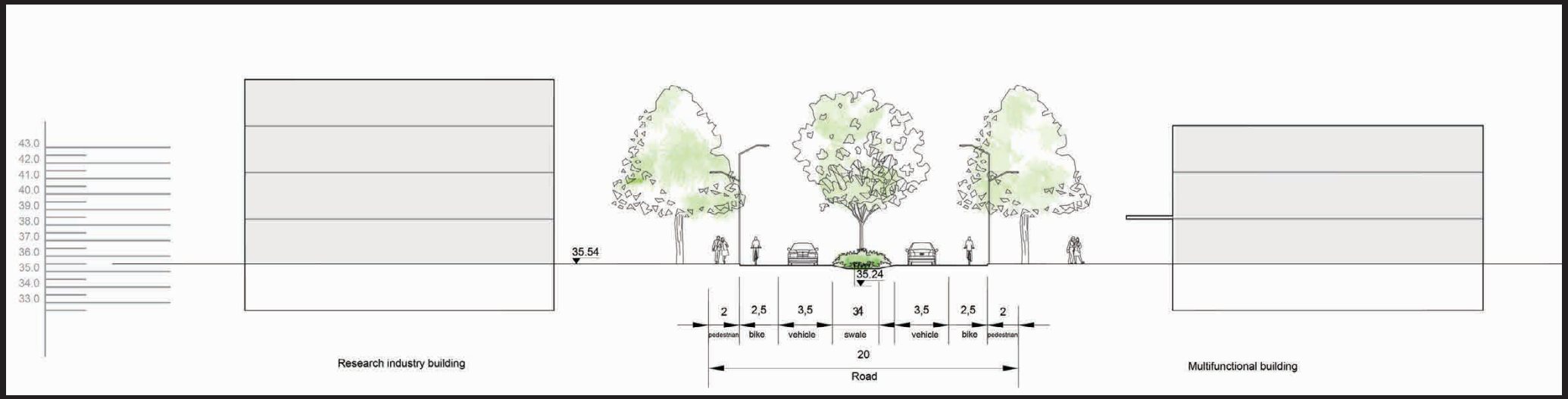
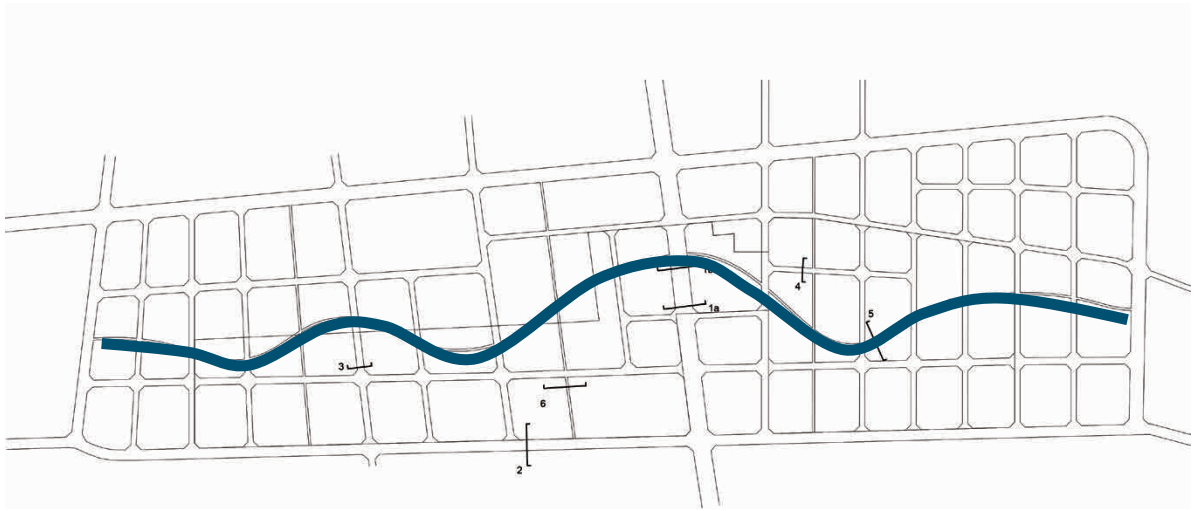
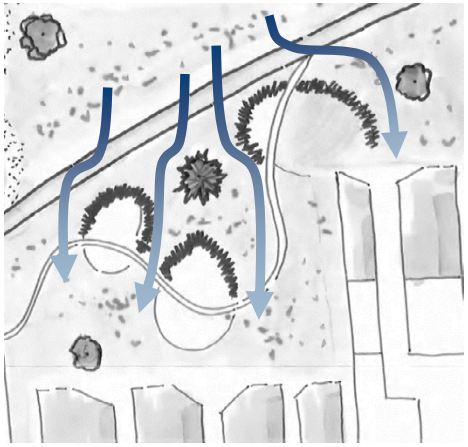


Figure 24-D. Category 4 road section



Bicycle highway section



Open to summer breezes Mitigates winter winds

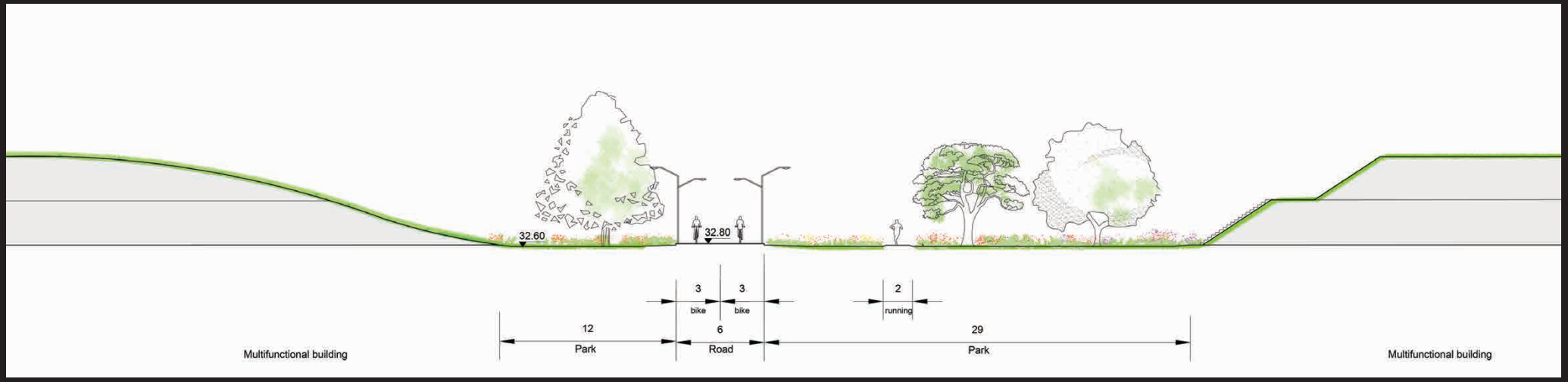
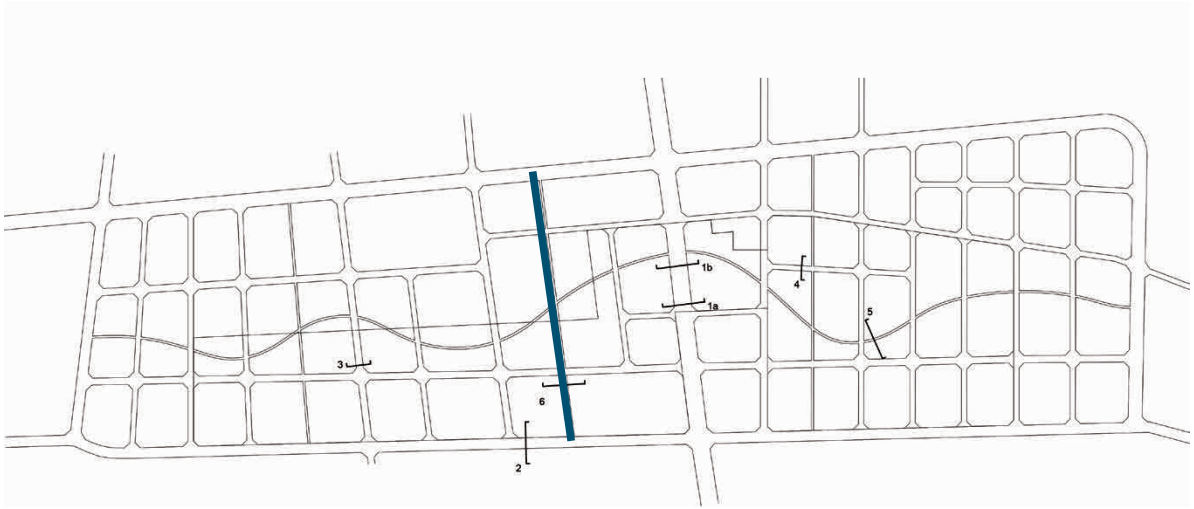


Figure 24-E. Category 3 road section



Swale section, shadow from planting improves water quality

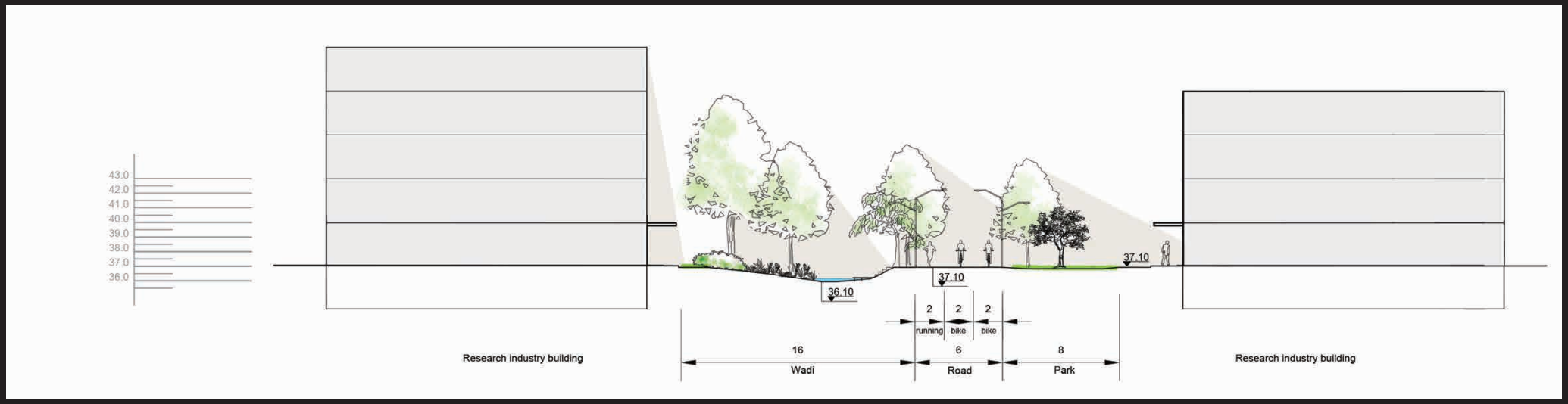
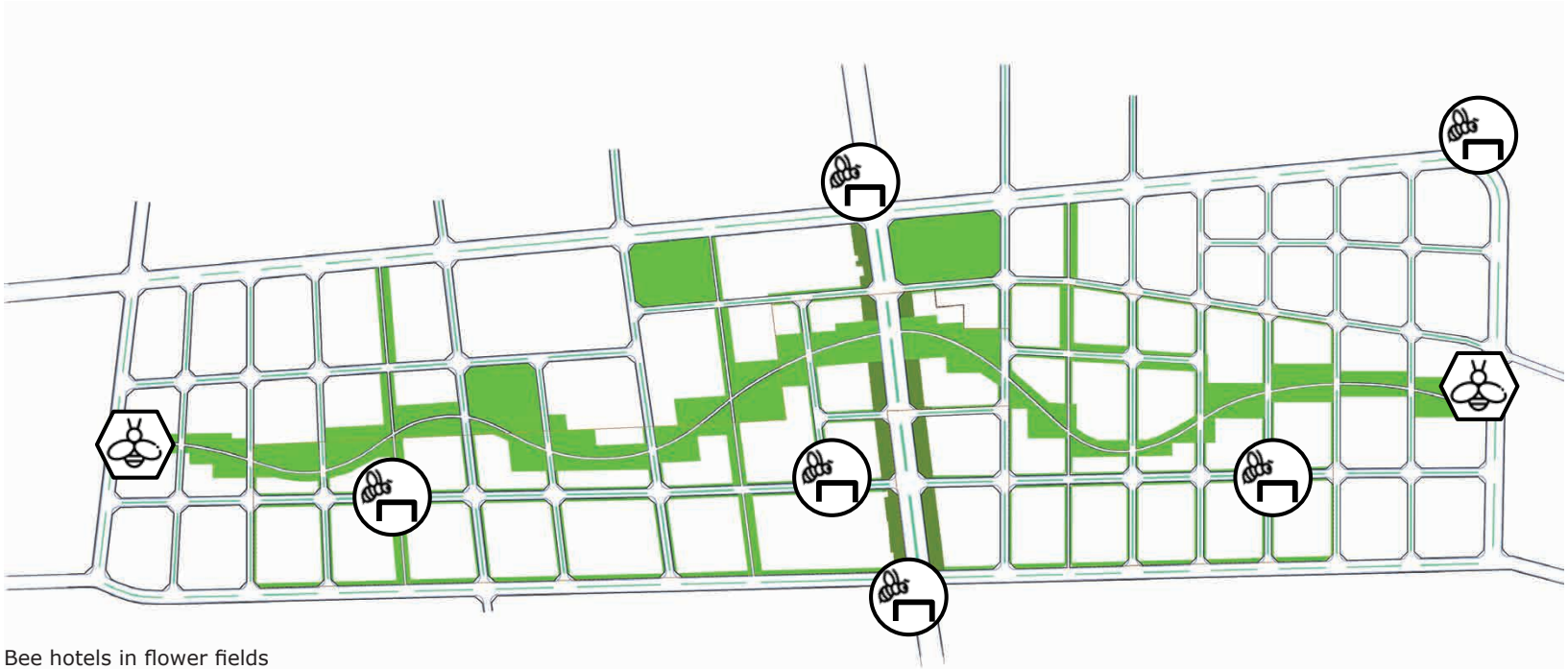


Figure 24-F. Category 4 road section



Bee hotels in flower fields
Bus stop = Bee stop

Bus stop = Bee stop online

Figure 25-A. Flower fields and measures to enhance pollination.
Source: WENR (above), www.ivn.nl (below left), Dreiseitl (below centre), ruiz891.wordpress.com (below right).

Figure 25-B. The Honey Bikeway, an artist's impression.
Source: Yukou Town government.

The Honey Bikeway: bicycle highway and flower fields

The landscape of the Honey Bikeway can be best characterized as a two-kilometre flowering carpet with a main cycling path and other paths leading to the business plots (Figure 25-A & B).

The major cycling path, to be developed as a 'bicycle highway', is the main route connecting the constituent parts of the AIC and with its surrounding areas, towns and villages. The path enables people who work in the AIC and live in the neighbourhood to commute between home and the office by bicycle – a healthy and sustainable means of transport. It also makes it possible for other residents of Yukou Town to visit the AIC and nearby recreational facilities, while it connects the town with the surrounding river valleys and the hilly areas. The bicycle highway provides an agreeable entrance to all the individual plots of the AIC, while the construction and dimensions of the central cycling path allow emergency vehicles to use the path when necessary. Accompanying the cycling path is a set of footpaths, so that workers and visitors can stroll outside during breaks or at other times.

For most of the year, the field of flowers will produce colours, scent and pollen. Natural vegetation is lacking in the present agricultural landscapes of Pinggu District, similarly to the situation in agricultural landscapes in the Netherlands (e.g. Reemer, 2018). In these intensively used agricultural fields with their monocultures of food crops, biodiversity is very low, creating many environmental problems. It was only recently acknowledged that the presence of wild flowers, and with them insects and other animals, is essential (e.g. Hung et al., 2018; Smitley et al., 2019; Wilk et al., 2019). These contribute to a sound and sustainable agricultural production, for example by preventing plagues, invasive species and other problems. At the same time, flowers are essential for pollinating insects, and therefore for fruit orchards and vegetable farming. For this reason, the flower fields are introduced to contribute to a local chain of natural plants that host insects and that attract birds and other useful species.

Some trees will be planted in the flower fields, to create solitary standing trees in a pastoral setting. Solitary trees, as individual objects, have a monumental silhouette and require special maintenance. The trees in the flower fields can grow in their natural shape, branching from the lowest parts of the trunk.

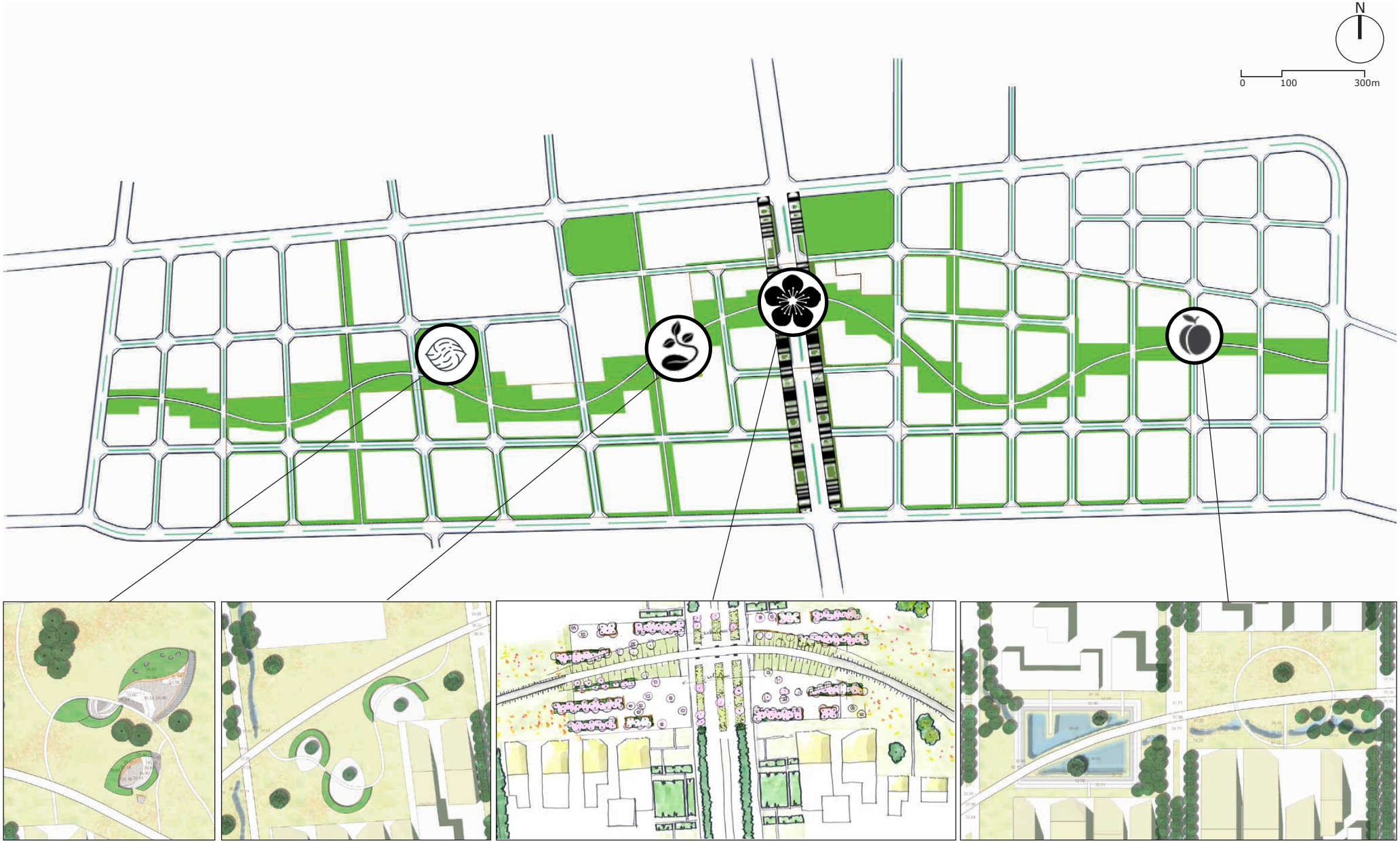


Figure 26-A. Small 'pocket parks' are part of the Green Dragon.
Source: WENR

Pocket parks

The Honey Bikeway connects a series of four small intimate ‘parks within the park’. These ‘pocket parks’ are meant for public use and recreation for local workers and visitors in the AIC. These parks may also be a suitable location for communal vegetable gardens, producing products to be sold or used in local restaurants or markets. The Green Dragon offers space for these facilities, but the actual development depends on the initiatives of local people, workers or the companies and industries that settle in the AIC. Many such ‘urban agriculture’ projects are being developed in urban and suburban areas (Mougeot, 2006; Nordahl, 2009; Roggema, 2016).
The pockets parks are called ‘Gardens of Life’, as they symbolize the successive phases of plant life – in this case the peach, the speciality of Pinggu District. From west to east, the four parks are (Figure 26):

- Garden of Seeds: differences in elevation create small open-air theatres that may be used by both local people and workers;
- Garden of Shoots: intimate spaces are created for people to relax or spend time in between working or cycling along the Bicycle Highway;
- Garden of Flowers: a special place with peach trees that will create a cloud of pink blossoms surrounding a small marketplace for farmers to sell local produce;
- Garden of Fruit: mainly an area where water will be gathered flowing from one of the swales, with a place for lunch or dinner.

A final addition to the Gardens of Life is ‘DNA Alley’ along the main road in the centre of the AIC, road S204. The DNA pattern (Hollender et al., 2018) of the peach tree is used to design a series of gardens that can be used to demonstrate new crops and other prototypes, showcasing new developments by the companies in the AIC.

Figure 26-B. The Garden of Seeds. The pit lays under the ground, the seed breaks through. The beginning of life, learning for the future. Source: WENR.

Figure 26-C. The Garden of Shoots. The seed germinates and the first leaves are protected, sheltered, grow. Source: WENR.

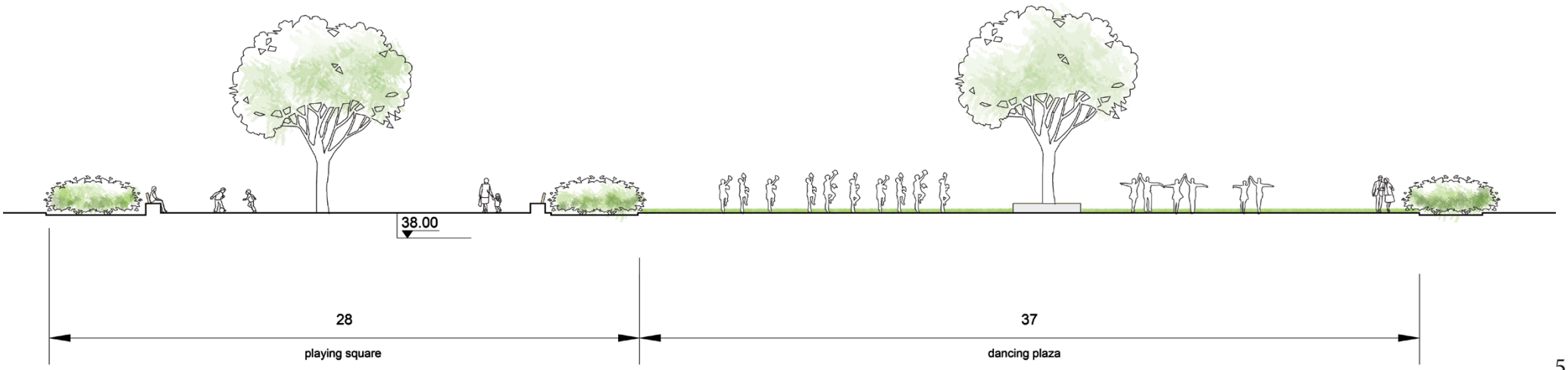
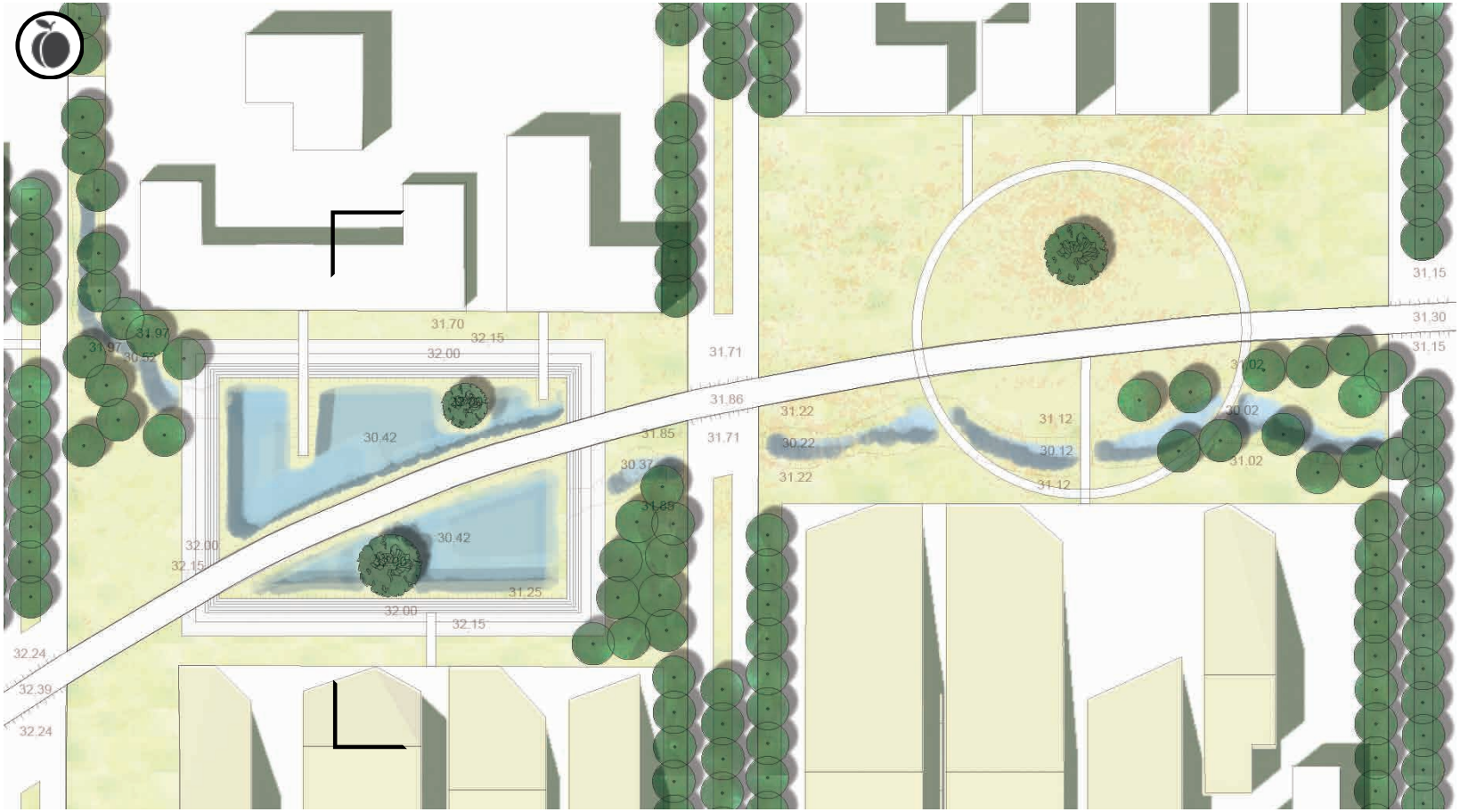


Figure 26-D. The Garden of Flowers. When in bloom, the peach trees invite people using the main road to visit. The area itself is a place for markets and other activities. Its design is based on the DNA structure of the peach tree. Source: WENR.

Figure 26-E. Views from the bridge, an artist's impression.
Source: Yukou Town government.



Four season fruits, harvesting, sharing

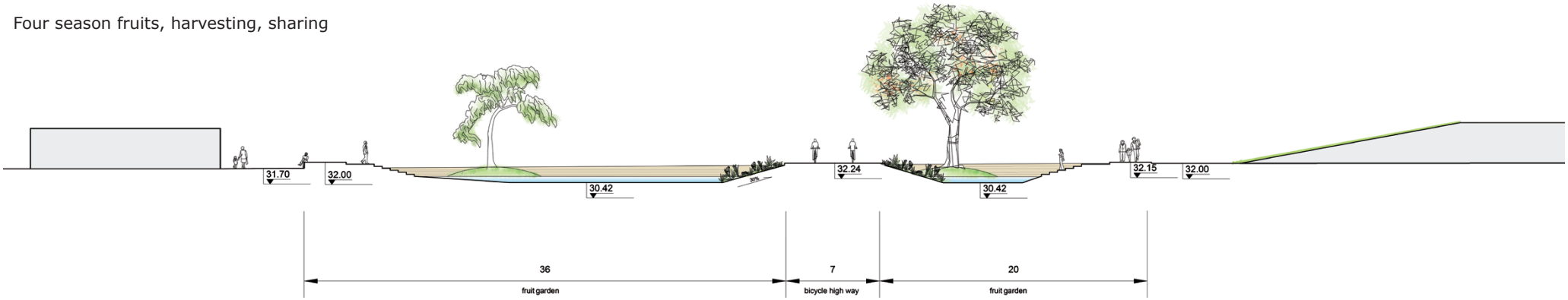
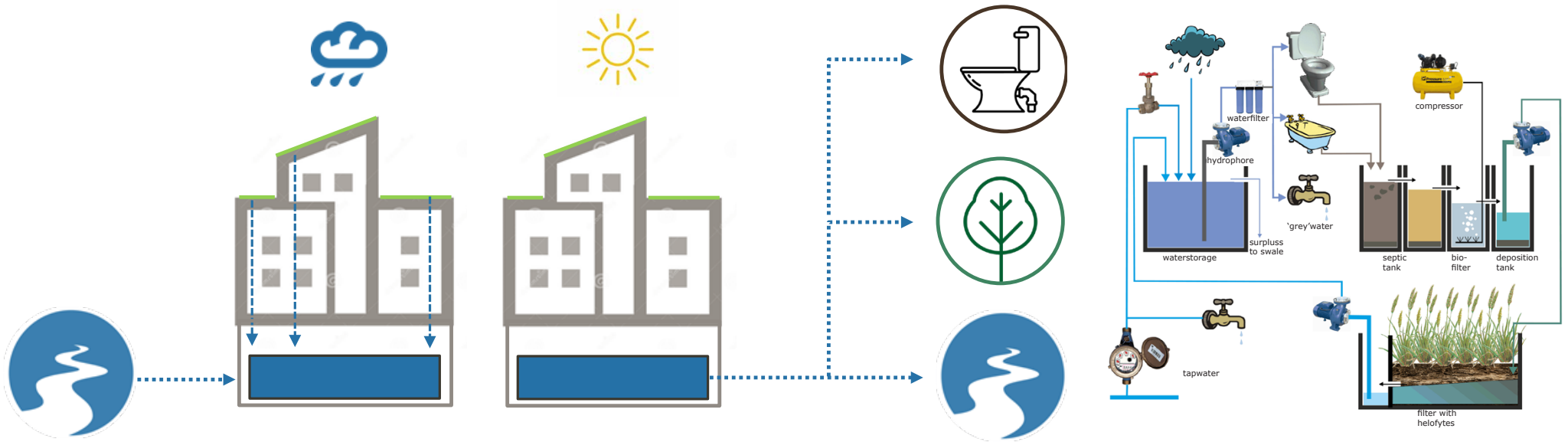


Figure 26-F. The Garden of Fruit: a place for visitors to taste the produce of local farmers in all seasons. The garden offers a place for a restaurant in a greenhouse. The garden is also meant to temporarily store excess rainwater, discharged from the swales that connect the Green Dragon to Yukou Town. Source: WENR.

Figure 26-G. The Garden of Fruit: an artist's impression.
Source: Yukou Town government.

Figure 27-A. A swale in the AIC, an artist's impression.
Source: Yukou Town government.



http://www.tjalfbloem.nl/tjalfbloem.nl/index.php/nl/

Figure 27-B. Schematic representation of rainwater harvesting, collecting and storing in the buildings for different uses (toilets, vegetation, swales). Innovative systems using helophytes treat the used water for reuse, thus closing the cycle as much as possible.
Source: WENR (left), rubenvanwijngaarden.nl (right).

Sustainable water strategy: buildings and swales

Water is essential to nature as well as to human life. We therefore cannot be careful enough when it comes to its use. As the assignment was to design a sustainable agricultural campus, a responsible and sustainable strategy for water use is a key element, both at a regional level and at the local scale of the AIC.

The wise use and recycling of water is considered a key point for dealing with the more extreme weather conditions that will occur in the area. An overall strategy and ambition for all developments is therefore to catch, collect, store and reuse water (Figure 27-B). Applying this strategy will help to replenish groundwater levels in the regional aquifer; a necessary measure that should be applied in the whole of the area of Beijing. The basis for adapting the sustainable water strategy is the local water balance. As our analyses show, there is a high level of water run-off during heavy rainstorms, which can be harvested, stored and used. The hard surfaces of buildings and pavements, necessary for developing the AIC, will produce even more rainwater run-off. Apart from harvesting water, local water treatment must make use of innovative techniques, such as helophyte filters.

At the scale of the AIC, the most important measures focus on the sustainable use and handling of rainwater. Rainwater from roofs will be collected, stored and reused in the buildings. Collection can take place in the basement of buildings or in the open air; however, the storage of water in closed basins is best to prevent evaporation.

Figure 28. The system of harvesting, recycling and discharging (surplus) rainwater. The different areas of the Green Dragon absorb the drainage water from nearby plots (light blue) to replenish groundwater. The plots with the circular symbol harvest and reuse the rainwater within the plots and the buildings.

Swales (or 'wadi's')

Water can also be transported to the public, green areas in the rainy season, when there is a precipitation surplus. To make this possible, three swale systems are incorporated in the master plan (Figure 28). These can absorb the surplus rainwater during heavy rainstorms, preventing flooding.
Water from roofs, buildings, paving and other hard surfaces is gathered and discharged, infiltrating the subsoil and thus replenishing groundwater. Any excess water is discharged to agricultural plots around the campus or to areas outside the AIC (the wetlands along the rivers). The location of the three swale systems are based on local elevation data and the reconstruction of the stream network. The rainwater from buildings is discharged to the swales through small pipes from the roofs. The swales will not carry water permanently, but only when there is a precipitation surplus. To prevent unsustainable measures, groundwater is not pumped up to create permanent visible water in the swale systems. The design, using rocks and planting, ensures that the swales look pleasant at all times, even in dry conditions.

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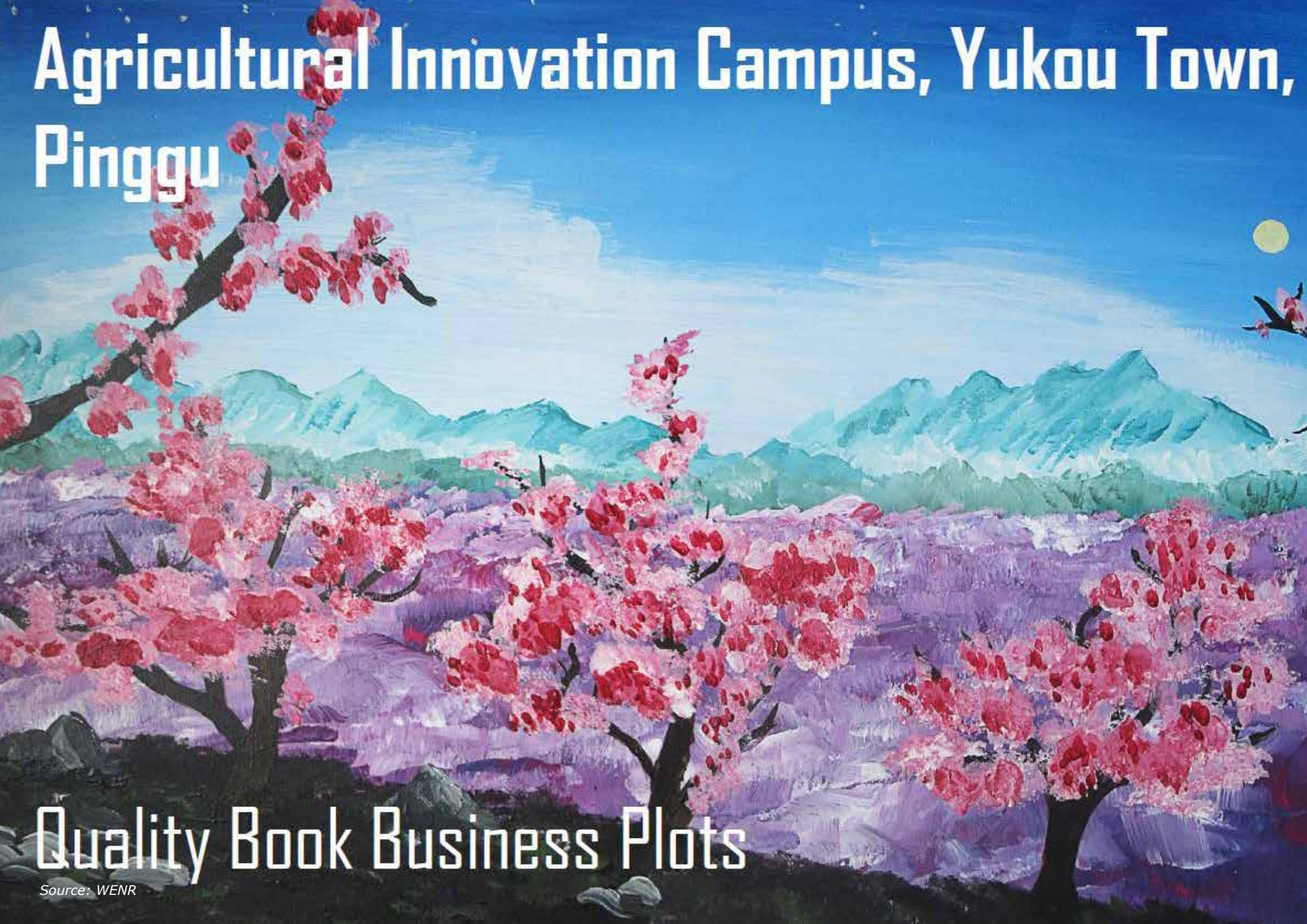


Quality Book Business Plots

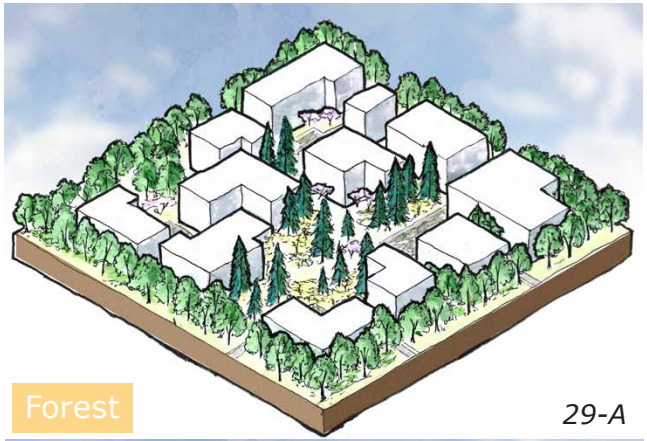
Source: WENR

5. QUALITY RULES AT PLOT LEVEL

5.1 Introduction

The commercial area, which covers 85% of the total area, is where the new built-up areas will be developed. This part of the AIC is framed by the public spaces and roads that divide the development into plots of different sizes and character.
These plots may be purchased by companies, industries and other organizations that want to settle in the Yukou AIC.

At this point, the numbers, dimensions and designs of the future buildings that will be developed in the plots are not yet clear and are subject to further elaboration. Nevertheless, a 'Quality Book' has been made with guidelines and rules for plot development. This book contains the programme of requirements for future partners who want to invest in this area by buying one or more plots. The Quality Book determines the spatial and functional requisites of the plots, such as the floor area ratio (FAR), the number of parking spaces, the building height, and planting and other necessary elements for development. The book has been published as an independent report.
In this chapter, we summarize the main elements of the Quality Book and present a sketch design for the start-up area. This design is a first visualization of the rules and ambitions as described in the Quality Book.

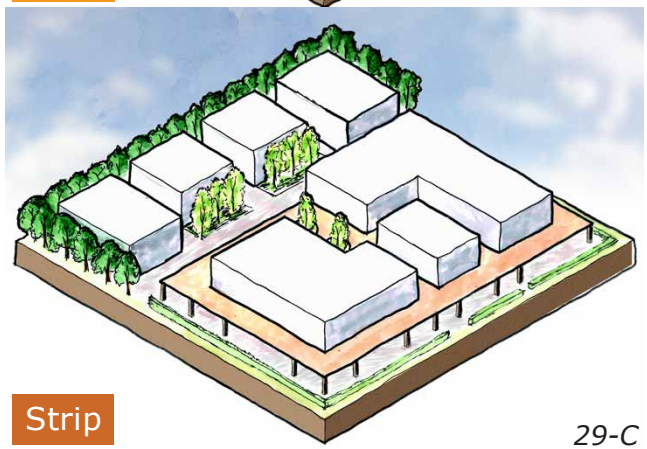


Forest

29-A

Park

29-B



Strip

29-C

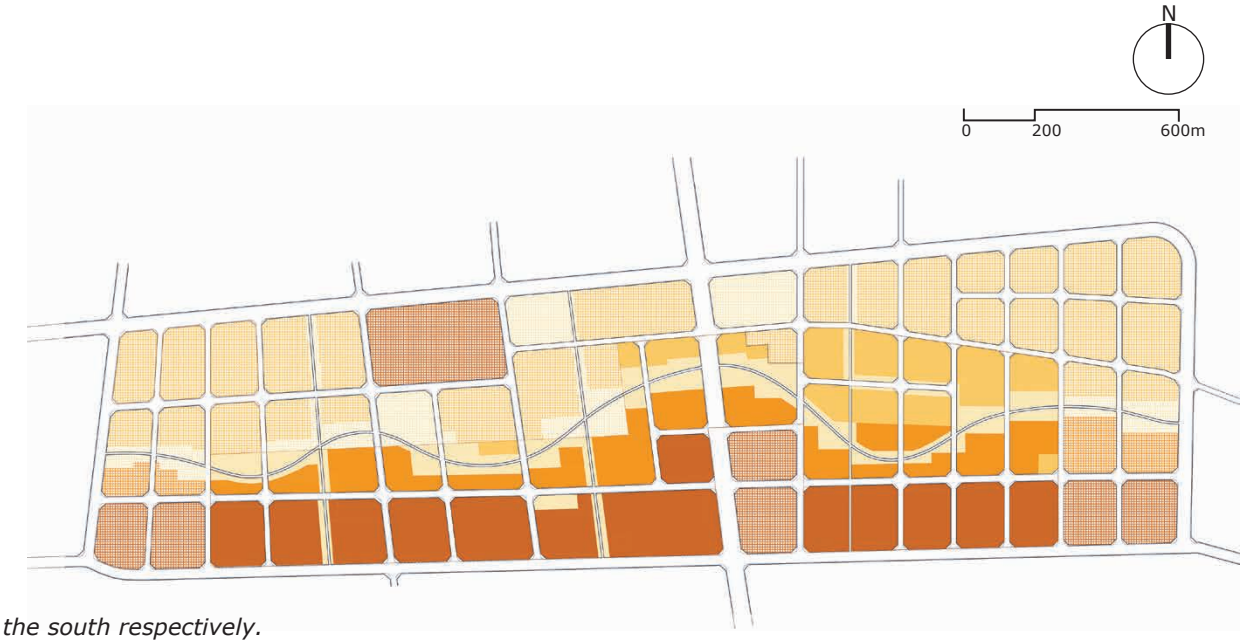


Figure 29. The three types of plots in the north, the middle and the south respectively.
Source: WENR

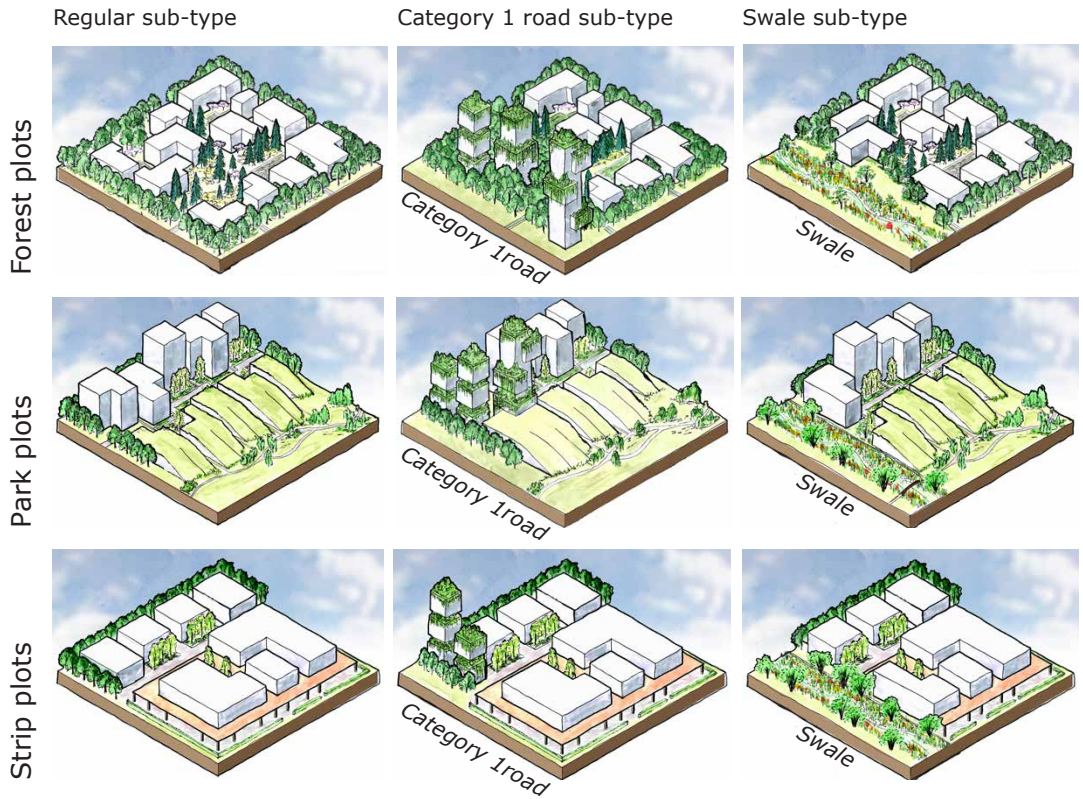


Figure 30. Sub-types of plots
Source: WENR

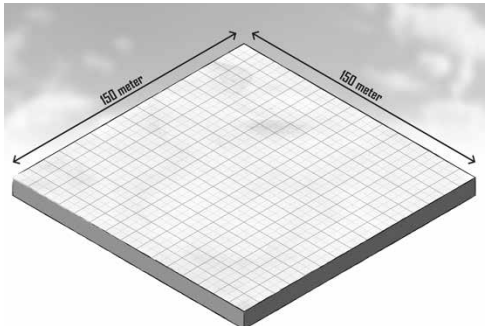
5.2 Three types of plots

Three plot development zones are determined in the Quality Book (Figure 29), each for specific types of plots and plot development:

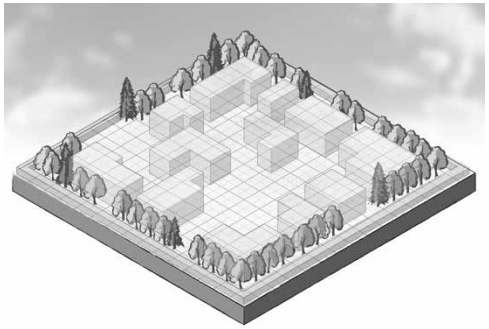
- The forest plots in the north part of the AIC;
- The park plots in the middle, enveloping the Green Dragon;
- The strip plots in the southern part.

The division in these three zones is based on the actual characteristics of the area in combination with the planting principles, to enable the development of agreeable microclimates, increased biodiversity and good recreational and other functions. The forest plots (Figure 29-A) will enhance the connection with the existing Yukou Town and protect the campus from the harsh northerly winds in the winter. In the park plots (Figure 29-B) along the Green Dragon, all the buildings will have sustainable, sloping 'green roofs', creating a gentle gradient with the Honey Bikeway. This will ensure that the architecture of the buildings in these plots complements the qualities and functions of the meandering green structure in the central part of the AIC. The strip plots (Figure 29-C) in the south of the area have the biggest potential for relatively large buildings and industries and can be easily connected to the system of main roads and the surrounding agricultural areas. Moreover, by choosing this southern location, these large buildings will not negatively interfere with the existing Yukou Town.

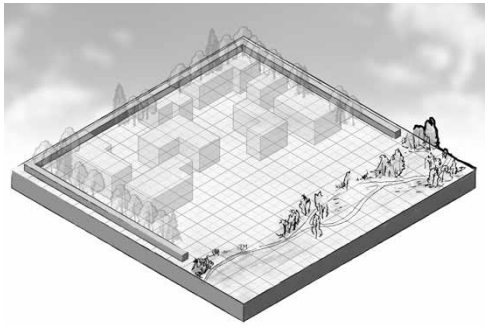
The spatial and functional requirements are different for each zone. There are also sub-plots in each zone, depending on whether they are placed along framework structures such as a category 1 road, the Green Dragon or the swales (Figure 30).



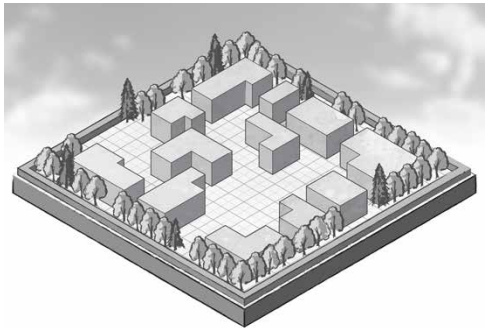
Chinese planning rules



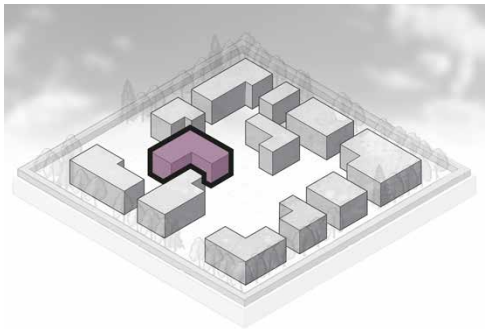
Sporadic tree placement



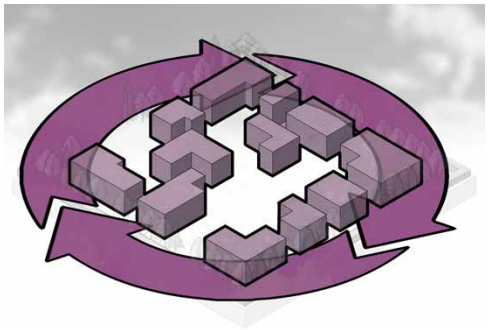
Open to the swales



Specific to zone



Building guidelines



Circular systems

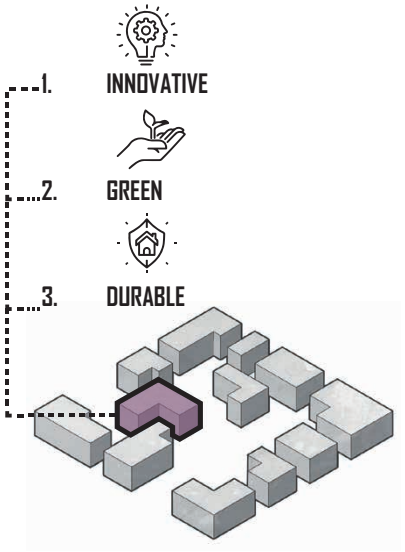


Figure 31. Private plot design principles
Source: WENR

Economy principles	Collect garbage for waste separation (>90%) Make water chain: collect-store-reuse Flush toilets with 'grey' water Install convertor to transform food and other organic waste into compost Separate collection of coffee cups Recycle shredded paper into paper towels and toilet paper for campus bathrooms Reduce fossil fuel use by 50% compared to industry average in China Build a circular campus greenhouse
Energy principles	100% green electricity, 100% green gas 85% of thermal energy storage used Install movement sensors that automatically switch off lights and heating when rooms are not used Install solar panels on all roofs of all campus buildings Create green roofs as much as possible Limit energy demand in buildings by maximizing natural light Install charging stations on campus for electric cars Free bicycles for use on campus
Environment principles	Green Design & Surroundings Biodiversity: -Place insect hotels and beehives on campus grounds -Manage grasslands with grazing sheep instead of lawn mowers -Parking garage with nesting wall for breeding swallows Create green buildings
Connectivity principles	Stimulate start-ups and create workplaces for them Community engagement (inhabitants, farmers) Organize events Attract students and scholars Create jobs for people who are distanced from the employment market Stimulate open innovation (more than commercial market) Install campus site management
Healthy workplace principles	Use vegetable gardens, greenhouses or test plots belonging to the actual industries that produce food for local uses Make gardens/greenhouses with farmers, local people and companies All products in multi-tenant buildings should be Fair Trade Use employee satisfaction score Wellness Centre and sports facilities on-campus

Table 1. Design principles for the start-up area as an example of overall and Quality Book rules. Source: WENR.

5.3 Design principles

The private plot buildings need to abide by the following design principles (Figure 31):

1. Local planning rules: A standard plot is 150 by 150 metres and surrounded by roads
of possibly different categories (CPC Central Committee, 2016).

2. Specific tree placement: Various 15-metre trees are to be planted irregularly around the perimeter of the plot. This mitigates the tunnelling effect of wind caused by rows of trees along nearby roads. It is suggested to plant a mix of local species in each plot to stimulate biodiversity (Müller et al., 2010).

3. Planting hedges as boundary/open to swales: Hedges are to be placed around the plot to create quiet inner green spaces. The hedges also mark the transition between public and private areas. These hedges are to be placed in front of the trees at the external boundary of the plots. There is no hedge next to the park strip, the north-south axis and the swales, to stimulate the functional and visual relations of the plots with these parts of the Green Dragon. At strategic locations, entrances to and from the plots are to be made that lead different types of traffic through the hedgerows.

4. Building guidelines: In order to reduce the environmental impact, the buildings in the AIC are to be built with durable innovative sustainable technologies. The roofs of all buildings should be green, with solar panels or combined. When possible, green walls may be built to overcome heat stress in and around the buildings.

5. Circular systems: All organic waste and water on the campus is to be integrated in circular systems. Water harvesting, cleaning and circulation systems within and around the buildings on the plots may help the functioning of the sustainable water strategy, as explained for the Green Dragon in Chapter 4. Organic waste is to be treated within the building complex, creating organic fertilizers to be used in the AIC and its plots and gardens.

6. Specific to each zone: Each plot has specific rules to follow as a result of the typology of Figure 30 and specific characteristics of the location (e.g. distance to Yukou Town, land use in surrounding areas, connection to different parts of the Green Dragon and/or one of the pocket parks). Buildings adhere to the FAR and maximum building heights as established by the authorities (Figure 20). At the same time, a certain amount of open space is necessary in all plots for recreation, such as taking a stroll or enjoying the green spaces during work breaks. As a rule, the necessary parking facilities must be realized subterranean, mainly by incorporating these into the architecture of the buildings.

A set of more detailed principles and suggestions is provided in Table 1. As discussed previously, the early development of the Green Dragon is an essential prerequisite for the start and further development of the Yukou AIC. With this in mind, an extensive scheme for tree and plant species to be applied in the area is presented in Figure 32 (and further elaborated in Appendix 7.2).

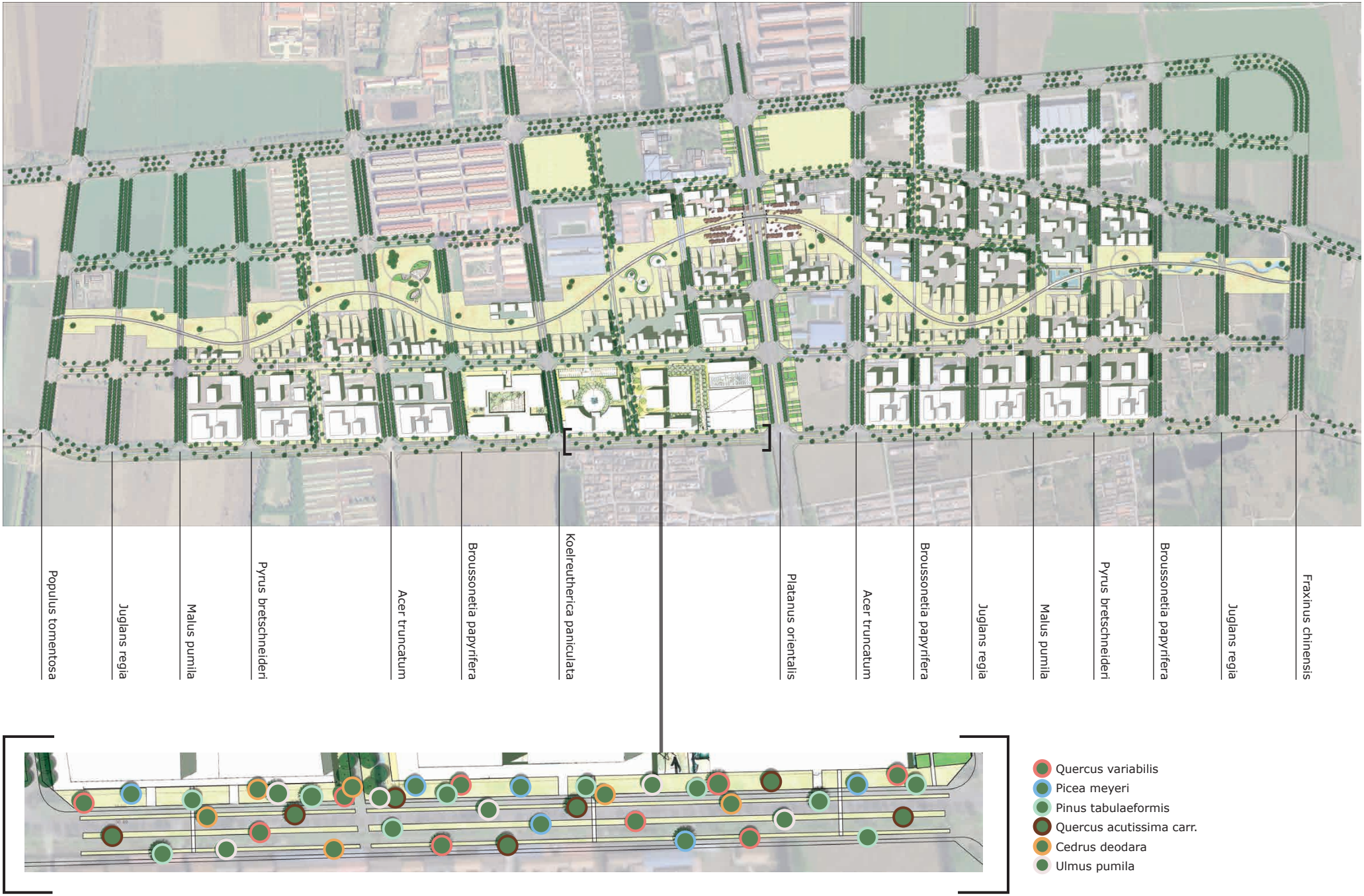
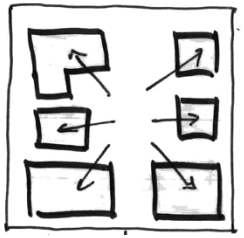
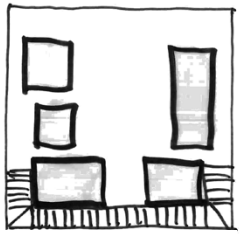


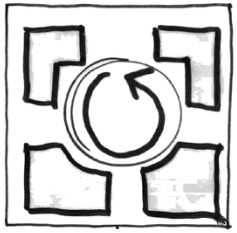
Figure 32. The planting plan for trees along the north-south roads. Source: WENR



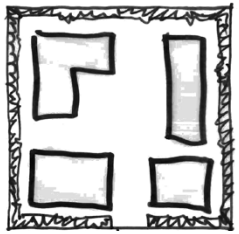
1. Buildings to the sides of the plot



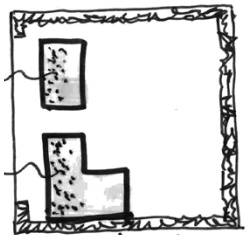
2. Arcade along the major east-west road



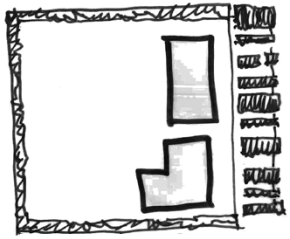
3. Create a strong inner space as a garden



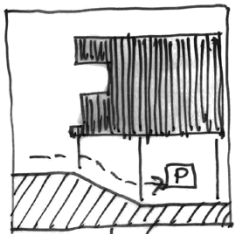
4. Hedge around the plot



5a. Along the swale: roof drains to the swale, no hedge



5b. Along DNA Alley: open plot; no hedge



6. Parking under the buidlings

fFigure 33. Design principles for the start-up area based on overall and Quality Book rules.
Source: WENR.

5.4 A sketch design for the start-up area

The development of the AIC will start with three plots in the south of the study area: the start-up area. One of the existing buildings will be maintained to host the first development of the AIC. The other plots will be rebuilt and designed in accordance with the rules in the Quality Book. The design for the start-up area is based on a set of principles (Figure 33) for the overall design and the 'rules' from the Quality Book. As Figure 33 shows, there are many options for the layout and design that still take into account the described principles. Some elements (spacing of the buildings, creating an enclosed setting in the middle of the plot, the arcade and the hedges) create consistency and a recognizable continuity in all of the plots. At the same time, the detailed design offers the opportunity to create diversity and identity for each plot or company. In other words, unity and diversity in perfect harmony.

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Source: WENR

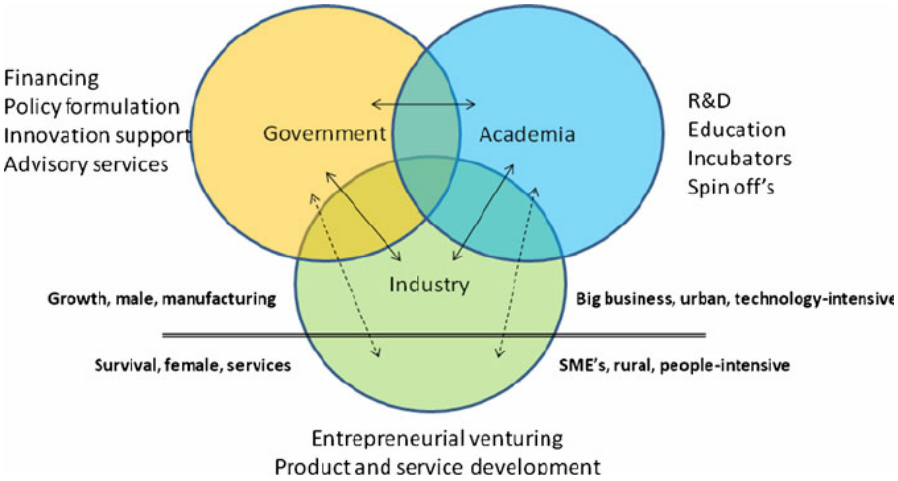


Figure 34. Schematic representation of the 'triple helix' organization model. Source: Lindberg et al., 2014.

6. RECOMMENDATIONS

6.1 Introduction

This last chapter of the report contains a number of recommendations for the further design and development of the AIC in Yukou. These recommendations are aimed at continuing the cooperation between the Chinese and Dutch partners in this project. Working jointly and exchanging knowledge and experience from both sides will help to develop the Yukou campus in the same successful way as WUR developed its own campus in Wageningen.

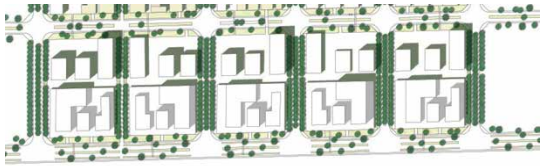
One of the major organizational factors that contributed to the success of Wageningen Campus is the 'triple helix' (often called the 'golden triangle') model (Figure 34). This model shows close cooperation between government organizations, knowledge institutes and private entrepreneurs. The triple helix model is discussed in detail in the Chino-Dutch cooperation project report for the design of the AIC master plan.

6.2 Organise local involvement

The AIC will have to 'root' in local networks, traditions and policies. It is not only an area where national and international exchange and development will take place, but it will have to connect and commit local farmers and inhabitants, as well as their corporations and companies. To achieve this, specific programming management is essential. From this perspective, a first recommendation is to appoint a local government agricultural liaison officer to establish and develop an integral programme for addressing local farmers and their organizations. Some initiatives are necessary in the very short term; others can wait and will become relevant in the longer term. It is very important that such an initiative is taken directly at the start of the campus development.

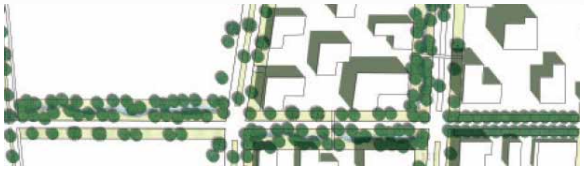
Short term

It is crucial to invite local, agricultural corporations, farmers and entrepreneurs to important meetings such as a start-up meeting from the very beginning. Information about the new development will be presented at such a meeting, and it is vital to ask these local stakeholders for their ideas and to discuss the benefits to them. For example, an action for the short term could be to organize a market in the designated start-up area. It is equally important to put in place recreational activities in the AIC for local residents and other potential workers. These could include traditional arts and crafts, agricultural and cultural heritage, exhibitions, food festivals, and so on.



- The roads;

- The 'Honey Bikeway'



- Swales (or wadis) combined with roads

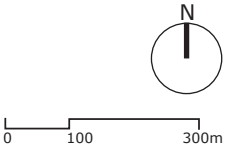


Figure 35. The master plan for the AIC at Yukou Town.
Source: WENR.

Long term

In the longer term, farmers could be invited to utilize the market garden in the Garden of Flowers as soon as this part of the framework is realized. In addition to a daily or weekly market, participation from local farmer corporations could be directed at various activities:

- Training and education programme (longer term) in modern techniques, e.g. 'model farms';
- Enhancing sustainable land use;
- Starting innovative projects;
- Setting up experimental test plots.

The AIC will provide the necessary opportunities for realizing meeting facilities and other options for knowledge dissemination and showcasing new developments.

Organizing initiatives will stimulate local involvement. Typical examples could be (Figure 35):

- Starting a local farmer's market;
- Organizing educational programmes for young and old;
- Hiring local farmers as gardeners for the daily maintenance of the AIC;
- Offering recreational activities connected to the AIC companies;
- Inviting local farmers to take part in educational programmes.

In this way, the campus will become an attractive site for local people and for newcomers who establish new companies or work in the innovation industry.

6.3 Start with realizing The Green Dragon

The campus should not become a 'middle of the road', monofunctional agro-business site where people only come to work. It should be a special place, creating an atmosphere of cultural, social, ecological and economic connection for all people involved from the very start of the project. An essential prerequisite is that the Green Dragon is realized as the first stage in the project. The earlier this green framework is in place, the better it will be able to ensure a high-quality environment for successful further development. Trees need time to adapt and thrive, although using special planting strategies and materials may speed up this process (Ruyten, 2006). Other vegetation and perennials may develop more quickly and will create abundant flowering results within a season. Appendix 7.2 contains an overview of species chosen for the Yukou AIC.

The second recommendation is therefore to start realizing the Green Dragon as the first stage in the development of the Yukou AIC. The areas that constitute the last stage of the AIC (Figure 35) must be included in this.

6.4 Park management

"We will take as our guide the implementation of innovation-driven development strategy and rural revitalization strategy. In order to make progress towards technological innovation and green development, we will further optimize the mechanism to boost agri-tech innovation via establishing and improving a 'golden triangle' cooperation mechanism that incorporates governments, enterprises and scientific research institutions and build a cluster of agricultural high-tech enterprises and agricultural R&D institutions to pool the resources of scientists and engineers and better lead Pinggu District's surrounding areas in the commercialization of research findings" (Bondt and Herceglic, 2019).

The above quote sets the ambition for the AIC. In short: it will be an innovative tripartite cooperation between government, enterprises and science institutes. In a development like this, realizing the ambition requires commercial building, exploitation and maintenance. This is referred to as 'park management' (Van Leeuwen at al., 2003), and implies strong cooperation between all parties in the development. Within the frame of this design assignment, the following aspects need to be dealt with.

The local government will start selling commercial plots to corporations and enterprises. However, according to the concept of joint park management, contracting and determining selling prices based on 'bare land values' are not enough. The quality aspects described in this master plan (and the related Quality Book) must also be met by the developers. These standards range from the use of sustainable water and energy systems (installations) to standards for architecture, gardens and parking spaces. In addition, the enterprises that will be attracted must be obliged to invest not only in their own property (plot) but also in the public spaces of the Green Dragon and its facilities. This investment yields profits from the facilities and services, for example through their use by their workers on a daily basis. The investors will also be given a say in the managing board and the organization of the AIC. This park management organization structure safeguards the corporation in the triple helix and guarantees the quality of the campus as a whole. The AIC is therefore more than the sum of its parts, and not a collection of random enterprises and buildings. In fact, this is what makes it a campus and not a business park.

This leads to the third recommendation: the tripartite cooperation must be represented in a joint park management organization that safeguards the quality of the AIC as a whole.

6.5 Appointing a park design coordinator

An external supervisor should be appointed, to safeguard the ambitions and quality during the actual development of the AIC. This person will oversee the full application of the design principles, sustainability and landscape architectural quality during realization of the master plan and the plot development. While the decision-making will be the responsibility of the local and regional authorities and the development board, the supervisor will advise on and stimulate the spatial quality, acting as a liaison officer between board, cooperating partners, architects and civil engineers. The Wageningen University & Research design team is willing to be contracted to fulfil this supervision task.

As the expansion of Yukou Town and development of the campus will take place in parallel, these major spatial developments must be taken into consideration in the process of developing the AIC. The design strategy and principles in this master plan may be fundamental to the further development of Yukou Town and its surroundings at a larger scale. The new neighbourhoods in Yukou need a strong functional and spatial relation with the larger scale of the region, as well as with the campus and all the changes that this will bring to the current community of Yukou. Again, the supervisor will have an important role in overseeing and advising on these issues.

6.6 Further research

Further research is needed, in particular to improve the understanding of and to re-establish the hydrological and ecological systems at the regional scale. As our analysis shows, restoration of these systems at the local and regional scales is necessary to ensure a truly sustainable environment in which the area and people can flourish. Restoring aquifers, water balances and watersheds may take a long time, but the sooner we start, the sooner that people can enjoy its results. Fundamental climate change issues will also have to be incorporated into the research.

We would like to reflect briefly on the differences between Chinese and Dutch planning processes. Of course, the design process and its outcome in this project is only one example, which means that the following remarks are preliminary. Nevertheless, designing the Yukou AIC made clear that Dutch and Chinese spatial planning and landscape design diverge in several ways.

As an example of the Chinese approach, the decision to develop the AIC in Yukou Town was taken at the Beijing Pinggu District level. The exact location and land-use functions were also determined at these policy levels. In the next stage of the process, a detailed zoning plan was made, in which important aspects such as road structure and hierarchy, FARs and building heights were prescribed. The zoning plan also strictly defines the acreages of individual land uses. These examples represent a primarily 'top-down' and 'monofunctional' perspective of spatial planning.

In our Dutch experience, a landscape analysis at various scales – though this tended to be difficult because of the restrictions in accessing Chinese data and information – is the normal starting point when planning and designing projects of the size and functional nature of the Yukou AIC. These analyses are necessary to achieve sustainable development that is founded on the local natural characteristics and systems. Involving local actors, such as stakeholders, non-governmental organizations and voluntary citizen groups, is strongly recommended, in addition to the relevant authorities at various levels. Both of these elements are subsequently 'translated' into tailor-made and specific planning and design principles for a project, taking into account formal and general legal criteria or prerequisites.

Looking back, the design process of the Yukou AIC can be characterized as a profitable fusion of the different planning and design traditions of China and the Netherlands. Further comparative research on Chinese and Dutch planning and design practices may reveal innovative ways of merging the strong points from both countries.

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Source: Yukou Town government

7. APPENDIX

7.1 Experts meetings

7.2 Planting design

7.1 Expert meeting reports

7.1.1 Rain harvesting

Date: 9 Sept. 2019
Participants: Koen Roest, Wouter Wolters, Tomek de Ponti, Xiaolu Hu, Gerben Hartgerink

Topic: Water management & water harvesting
How can we use green structures / green veining for water harvesting?

Note: 700-800 mm of rain falls throughout the year, comparable to the Netherlands. However, it falls in a concentrated period. Also, for large parts of the year, Pinggu District has to deal with drought and high temperatures, and therefore high evapotranspiration. Moreover, the groundwater level is very deep. Need to prevent water that falls (on buildings and in green areas) from being 'lost' and therefore no longer usable.

Sharing data: Pinggu District conceptual design and GIS hydrology analysis Conceptual design COFCO Beijing Eco-valley

Knowledge: Collect the rainwater using green roofs and green swales in the rainy season and use it in the dry season.
Roadside swales connect to underground water storage containers under buildings.
Water channel and rain pipe sizes depend on inlet water calculation. This calculation can be based on monthly precipitation data and watershed analysis.

7.1.2 Beter air quality

Date: 19 Sept .2019
Participants: Cor Jacobs, Tomek de Ponti, Xiaolu Hu, Gerben Hartgerink

Topic: How can we improve the air quality locally with green in green veining and in / on buildings? What other options do we have (green engineering, building with nature, etc.) to improve air quality locally?

a) Air quality & smog:
Pinggu District in Beijing has little wind, winter inversion layer in atmosphere, much industry and traffic, causing extreme smog problems and unhealthy low air quality.
b) More pleasant climate / cooling

Knowledge:
Mitigate smog and traffic pollution:
No continuous tree canopies Tree gaps in lined plantations
Shrubs between cars and pedestrians Diverse planting

Introduce summer cooling wind:
Enough shadow No tree clusters
Meandering wind corridors
Small-scale water body less than 1 km wide does not help Green facade

Mitigate sandstorms:
Staggered tree windscreens Movable storm infrastructure

Mitigate winter wind:
Movable windscreens, perhaps the same structure used for the green facade Evergreen trees
Land-covering plantations

Further:
When plantation planning is done, we can hold another meeting for improvements.

7.1.3 Waste water circulation

Date: 23 Sept. 2019
Participants: Weishan Chen, Tomek de Ponti, Xiaolu Hu

Topic: Sewage water reuse, waste reuse, energy and nutrition circulation Sharing data: Noorderhoek Sneek Sanitation Circulation

Knowledge:
Reduce water consumption by using vacuum toilets
Black water for biogas generation to support winter heating
Black water for fertilizer (struvite) generation as a research topic for CAU DeSah is the Dutch company for mature wastewater reuse projects
All the circulation facilities can be installed at the car park level in each building. Pipe network engineering is somewhat a problem in China, but the technologies are mature enough to apply in a single building.
There should be regulations for companies and research institutes for circulation systems, for example limiting the use of detergents.

More information needed:
Local nitrogen discharge level standards

7.1.4 Park management

Date: 26 Sept. 2019
Participants: Elike Wijnheijmer, Tomek de Ponti, Xiaolu Hu, Gerben Hartgerink, Pieter Boorne, Michael van Buuren

Topic: Wageningen Campus experiences – Management of buildings and grounds
Knowledge:
Lively campus requires collaboration of all parties in the campus Interactive dialogue centre for communication
The campus is not for WUR but for all parties in the campus Public car parks for each plot
Bicycle parking with solar panels
Branding of the campus is very important
Wind energy, solar energy, thermal storage
Companies pay for the use of public space

7.1.5 Biodiversity

Date: 24 Sept. 2019
Participants: Robert Snep, Tomek de Ponti, Xiaolu Hu, Gerben Hartgerink Topic: Biodiversity, species, crops
What possibilities are there to contribute to local biodiversity and nature? Shared projects: Heineken company terrain, high-tech Eindhoven
Knowledge:
Wild bees have higher value in terms of biological quality than honey bees. They require six-month mixed flowering fields, less wind, humidity and sunshine.
Flowering grassland combined with shrubs attracts local insects and birds but requires specific management methods.
Campus as a home for bees to pollinate the surrounding agriculture fields.
Educational programmes for children from the surrounding villages and the researchers in the campus to learn about the biological values of the campus plants and the management skills to preserve them.
The Green Dragon can be designed with a walking route with flowering lawns and enclosed green spaces for the researchers to take a lunch walk or a power nap.
Northern area in the Green Dragon can have more trees to provide shade for buildings.

Further:
Look for Pinggu District in Beijing NGO for more information about local plants and animals.

Salix babylonica

Salix matsudana

Toona sinensis

Ulmus japonica

Rhus Typhina L.

Selaginella davidii

Equisetum ramosissimum

Equisetum pratense

Athyrium pachyphlebium

Rumex crispus

Oxalis stricta

Potentilla fragarioides

Mentha haplocalyx

Ligularia intermedia

Iris tectorum

7.2 Planting design

7.2.1 Plantings along wadi's

Salix babylonica
Salix matsudana
Toona sinensis
Ulmus japonica
Rhus Typhina L.

Selaginella davidii
Equisetum ramosissimum
Equisetum pratense
Athyrium pachyphlebium
Rumex crispus
Oxalis stricta
Potentilla fragarioides
Mentha haplocalyx
Ligularia intermedia
Iris tectorum

Quercus variabilis

Prunus salicina Lindl.

Ginkgo biloba

Picea meyeri

Picea wilsonii

Cedrus deodara

Larix principis-rupprechtii

Cotinus coggygria

Festuca glauca

7.2.2 Plantings in forest plots

The planting strategy in the forest plots mimics the local natural forest planting mixed with local evergreen as well as decideous species.

Under these mixed planted trees there are many open grass fields for a summer picnic and walks in a beautiful landscape.

Selected species:

Quercus variabilis
Prunus salicina Lindl.
Ginkgo biloba
Picea meyeri
Picea wilsonii
Cedrus deodara
Larix principis-rupprechtii
Cotinus coggygria

Festuca glauca
Perennials (see list of perennials).

Robinia speudoacacia

Styphnolobium japonica

Quercus acutissima Carr.

Ailanthus altissima

Castanea mollissima

Fraxinus chinensis

Acer truncatum

7.2.3 Planting in park plots

In these park plots the large trees are selected to create modern English style landscapes.

Robinia pseudoacacia
Styphnolobium japonica
Quercus acutissima Carr.
Ailanthus altissima
Castanea mollissima
Fraxinus chinensis
Acer truncatum

Mixed flowering herbs (mixed seeds to be obtained locally)

Platanus occidentalis

Ailanthus altissima

Quercus variabilis

Cudrania trucuspidata

Crataegus pinnatifida

Malus pumila

Pennisetum alopecuroides

Populus cathayana

7.2.4 Planting in strip plots

Within the open spaces, the planting will be quite similar to the inner planting of the park plots. This increases the unity of the overall design. This formal planting also suits the more large-scale buildings found in the strip plots.

Platanus occidentalis
Ailanthus altissima
Quercus variabilis
Cudrania trucuspidata
Crataegus pinnatifida
Populus cathayana
Malus pumila

Pennisetum alopecuroides
Perennials (see list of perennials).

Castanea mollissima

Ulmus pumila

Cotinus coggygria

Morus australis

Ailanthus altissima

Quercus variabilis

Robinia pseudoacacia

Acer truncatum

Fraxinus chinensis

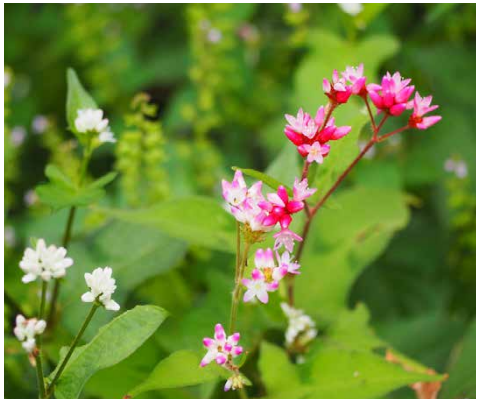
7.2.5 Planting in Green Dragon

Large, broad-leaved trees are selected for planting in the Green Dragon area.

For green roofs, the mat-forming species of Sedum, Sempervivum and moss are good choices. Common sedum species include Sedum acre, S. rupestre, and S. album. Delosperma could be tried in a sunny, frost-free area. Ferns such as Polypodium vulgare and Asplenium trichomanes could be used in dry shady conditions. Ready-grown mats of sedum grown inside geotextile pockets filled with substrate are often available from contractors who install green roofs. These are usually self-sustaining and should not require watering or weeding if the species chosen are appropriate to the climate.

To attract bees, we would suggest spreading the mixed seeds of local wild flowering plants.

Castanea mollissima
Ulmus pumila
Cotinus coggygria
Morus australis
Ailanthis altissima
Quercus variabilis
Robinia pseudoacacia
Acer truncatum
Fraxinus chinensis



Polygonum senticosum

Duchesnea indica

Gueldenstaedtia multiflora

Vicia unijuga

Oxalis stricta

Erodium stephanianum

Althaea rosea

Peucedanum terebinthaceum

Saposhnikovia divaricata

Cynanchum paniculatum

Phlomis umbrosa

Rehmannia glutinosa

Plantago depressa

Plantago asiatica

Adenophora divaricata

7.2.6 Perennials in forest and strip plots

Polygonum senticosum
Duchesnea indica
Gueldenstaedtia multiflora
Vicia unijuga
Oxalis stricta
Erodium stephanianum
Althaea rosea
Peucedanum terebinthaceum
Saposhnikovia divaricata
Cynanchum paniculatum
Phlomis umbrosa
Rehmannia glutinosa
Plantago depressa
Plantago asiatica
Adenophora divaricata

Kalimeris lautureana

Kalimeris incisa (Fisch.) DC.

Heteropappus altaicus

Erigeron kamtschaticus

Echinops latifolius

Cirsium setosum

Taraxacum mongolicum

Lactuca indica

Hemerocallis citrina

Hemerocallis minor

Phlomis umbrosa

Allium senescens

Scilla scilloides

Iris lacteal

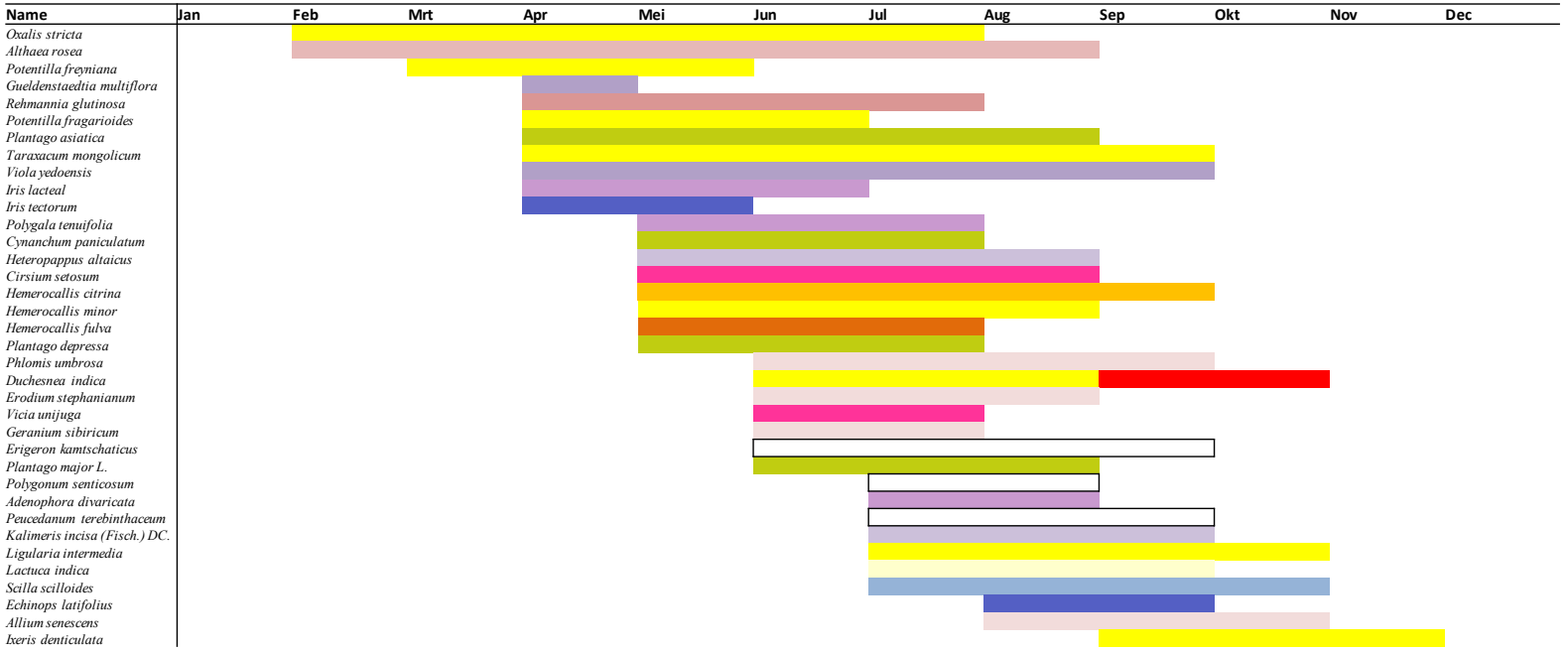


table 2. Flowering seasons for selected perennials

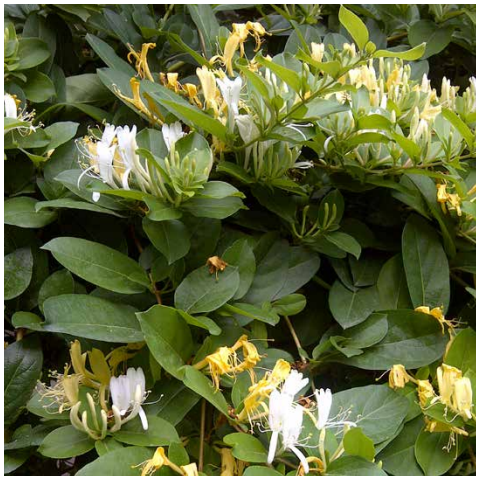
7.2.7 Long flowering perennials in forest and strip plots

Kalimeris lautureana
Kalimeris incisa (Fisch.) DC.
Heteropappus altaicus
Erigeron kamtschaticus
Echinops latifolius
Cirsium setosum
Taraxacum mongolicum
Lactuca indica
Hemerocallis citrina
Hemerocallis minor
Hemerocallis fulva
Allium senescens
Scilla scilloides
Iris lacteal

Parthenocissus tricuspidata

Metaplexis japonica

Wisteria sinensis (Sims)Sweet



Lonicera japonica

Humulus scandens

Orostachys fimbriatus

Sedum

7.2.8 Climbers

Parthenocissus tricuspidata
Metaplexis japonica
Wisteria sinensis (Sims)Sweet
Lonicera japonica
Humulus scandens

7.2.9 Roof plants

Orostachys fimbriatus
Sedum

Morus alba

Crataegus pinnatifida var. Major

Diospyros kaki

Lonicera japonica

Juglans mandshurica

Orostachys fimbriatus

Amygdalus davidiana

7.2.10 Garden of fruits

Morus alba
Crataegus pinnatifida var. Major
Diospyros kaki
Diospyros lotus
Juglans mandshurica
Juglans regia

7.2.11 Garden of flowers

Amygdalus davidiana

Source: Yukou Town government

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Source: WENR