A duet practice of low carbon city from Holland to China: Comparative research between City of the Sun, Heerhugowaard in Holland and its counterpart in China: Wuhan Sixin Area

1. Introduction

The global warming has raised a world environmental warning on both developed and developing countries. The challenge is the same but their solutions reveal both similarities and differences.

The “City of the Sun” (Stad van de Zon) is a sustainable waterside living area in Heerhugowaard in Holland, which has been designed to be a CO_2 emissions neutral area, totally covers an area of about 300 hectares composed of 123 hectares urban area including 3,000 housing units and 170 hectares recreation area including 90 hectares water buffer. It was planned by KuiperCompagnons. With the use of a large number of the world's newest concepts of sustainable development and eco-technologies, planning and design of City of the Sun has become a model of higher education in Holland.

Sixin area is a new developing zone in Wuhan City in China, which is a core of the Wuhan New District between Han River and Wuhan Economic and Technological Development Zone, an area of 1374 hectares. It is a similar polder as Heerhugowaard. Its ambition is to be promoting new functions – productive service center and waterfront living city, and inject the new vigor into Wuhan New District with new image, new features and new functions.

Since 2006 KuiperCompagnons have worked together with Wuhan Planning and Design Institute (WPDI) to conduct “conceptive master plan and core area urban design” for Sixin area. This master plan has introduced the experiences of low carbon city from Heerhugowaard to Sixin. It has promoted a few advanced means of sustainable planning. In addition, it has highlighted the water features of Sixin as a "Water City" and planed Sixin Boulevard as "urban spine".

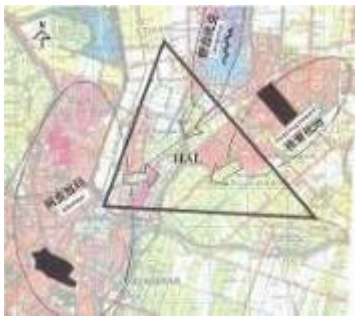
Co-operative Workshop of KuiperCompagnons and WPDI

This paper firstly give profiles of both “City of the Sun” and Sixin project in terms of low carbon design and those means of sustainable planning. It then make a comparison between these two cases to examine what planning means or sustainable technologies have been or not been used in these two cases. It further explores some reasons why these means or technologies are used or not used. Finally it has drawn some conclusion for planning low carbon city in introducing experiences or technologies from developed world to the developing world.

1. Polar City in Holland: City of the Sun

Mater Plan

In 1992, the area between the North-Holland municipalities of Heerhugowaard, Alkmaar and Langedijk, abbreviated HAL-location, was identified as a future urban development for 12,500 houses. The well-known planner Ashok Bhalotra from KuiperCompagnons was invited by the city of Heerhugowaard to make a "structural sketch" for the HAL-location. It has largely applied passive solar techniques. City of the Sun is the center of this HAL-location, and is located within the territory of Heerhugowaard. The main concept of City of the Sun is balance of red (transportation), green (open space) and blue (water) to achieve a sustainable area.



HAL-location *sketch of City of the Sun by Ashok Bhalotra, 1992*

From a single concept, KuiperCompagnons has succeeded in transforming an initially “vacant interconnecting area” in Heerhugowaard, into an area with a new and strong identity. In an impoldering in which the original natural culture-historical value was already susceptible to erosion, a new landscape has designed by using a “turntable”. The center of which is the City of the Sun. By turning the orthogonal parcelization of the impoldering to an optimum positioning towards the sun, it achieved many objectives in one fell swoop. In this way, City of the Sun has become a suburb with a neutral output of greenhouse gases.

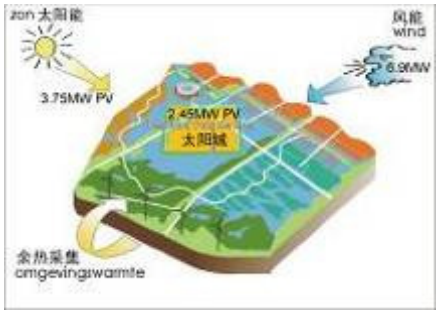
Master Plan of City of the Sun

PV System

Both the province and the three municipalities involved in the HAL-location have high ambitions with regard to quality of building, quality of living and above all energy and CO_2 reductions. The ideas for the solar city were further developed in 1997, when the schedule of requirements for City of the Sun was defined. Furthermore, national policy was becoming

more and more focused on reduction of CO_2 emissions and the government was providing financial support for initiatives in this field. When the development of the HAL-location started, the application of PV (photovoltaic abbreviated) was strongly supported by a national research program on solar energy, financed by the Ministry of Economic Affairs and coordinated by the national energy agency Novem. With strong support for PV available, it was obvious that a low carbon city should focus on PV, combined with low energy demand, passive solar energy and solar thermal energy.

Bird view of City of the Sun, 2006



Energy demand of City of the Sun

The core of the City of the Sun is the residential area in Heerhugowaard, which has been designed to be a net zero CO_2 emissions area. This would be achieved by installing 3,75MW of PV systems, 80 hectares of forest and three wind turbines of 2,3 MW each, Surrounding warmth is used for thermal pumps with 8 satellite houses. Together with PV-projects in Alkmaar and Langedijk the project was aimed to have a total installed peak power of 5MW, which is one of the biggest PV-project on buildings in the world. The houses with PV in Langedijk and Alkmaar are ready now. In Heerhugowaard, the residential area has been built up since 2002 and the development will be completed in 2008/09.

The total cost for PV-System in City of the Sun approximate €20 minllion. There are three major subsidizing bodies: the Dutch government, the province of North Holland, and the European Commission. Part funding for 5MWp of PV in the HAL location was obtained from the European Commission under the Sun Cities project; with matching funding from the national government. The council of North Holland contributed € 4.5 million for the 5-MegaWatt project. The Utility Nuon pays an amount per Wp and take off the electricity. In addition, residents contribute by 'woonlastenneutraliteit' (own contribution for the cost of PV-System will be recovered in 6.5–10 years).

Urban quality and Social quality

Sustainability is the key in the City of the Sun. Not only sustainability of the environment, but also social, cultural and economic sustainability have been successful in fitting in the various sustainability aspects on a large scale. There are about 3,000 houses and amenities like schools, nurseries, shops, medical centre and community centre will be built in 123 hectares urban area. The houses are various in types and prices, which run both social program and market program. The social program includes 180 rental houses, 231 rental apartments for seniors, 102 rental apartments for youngsters, 264 social sale houses (< € 136,000), the total is 777 houses (27%). The market program includes 80 apartments (€ 130,000-150,000), 376

houses in row (€ 175,000-220,000), 252 apartments (±€ 180,000), 1042 houses in row + 2/1 roof (€ 240,000-325,000), 377 single houses (>€ 400.000), all together about 2,127 houses(73%).

Under the guidance of the Mater Plan, the construction is divided into four phases The first is the different shapes of the living island, which provide over 800 houses, two schools and sports facilities with installation of 0.5 MW PV panels. Most houses situated near water and car parking in the central areas. The second is net zero CO_2 emission neighborhood square sized 720m by 720m, which providing over 1,400 houses and amenities like schools, churches, shops, medical centre and community centre with installation of 2.5 MW PV panels. Car parking is mostly in private areas and public walking path near open water. The third and fourth phases are recreation areas, not only in addition to the beach, forest, green space, but also to retain some of the ecological field. In each phase, the residential, infrastructure and public facilities are simultaneously.

City of the Sun pays much attention to create opportunities for exchange through the planning and guidance of public facilities and public space. For example, kindergarten, primary school and community center are in a same building where lobby becomes the common place of adults and children. All public facilities are in walking distance of residence. A 170 hectares recreational area which is abundant in water for rowing and swimming, beach, forest, walking-, cycling- and skating paths, and other recreational amenities, has been realized. Hence an attractive living environment has been created: a sustainable city in the water.

Recreational area

Natural water circulation

As Holland planners believe, “water for land and land for water”. At areas where water used to be, but that now is claimed by land, land will be given back to water. A large amount of water storage has been realized in City of the Sun by means of closed ground balance. It can remove the upper layer of the ground out of the water system; the sand excavated is piled where need filling. There are many benefits of this: keeping the water of this area and does not reduce the storage capacity and reduce flood risk; adjusting in micro environment; saving infrastructure investment; richen in water and leisure activities to improve the quality of the life; and providing a growth environment for diversification of aquatic plants and animals.

City of the Sun is surrounded by water circulation which internal and external water channel

connected with each other, but the controlled water level is difference. The internal water system is a closed circulation. Grey water coming from residential zone is naturally purified with the man-made wetland system named “Moon Park” at the south side. There is a major improvement in the water quality, even reaching the quality of swimming water. Water buffer are a peak reception 700 million gallons (700 liters/m^2, highest rainfall per day in the Netherlands so far 200 liter/m^2).

Water cycle system

Simplified scheme closed water system

2. Water City in China: Wuhan Sixin Area

Specific Position

The Hanjiang, a large river, joins China’s great Yangtze in Hubei Province creating a river-crossed fertile land known as Jianghan Plain. Situated on the Plain, Wuhan, the capital city of Hubei Province, is the biggest hub city in Central China. Divided by the Yangtze and Hanjiang, Wuhan has come to be known as the “Three Towns of Wuhan” with Hankou and Hanyang on the west bank, and Wuchang on the east. But, Hanyang is the less developed town of Wuhan. Water is the biggest struggle for development in Wuhan as well as the greatest quality for new development.

The Sixin new area is located in the Hanyang town, between the 2nd and 3rd ring road of Wuhan city. Part of the area is located directly at the Yangtze River. More inland the watery area of the polder facing south is the lowest land in the city. The area is surrounded by three main lakes. The north lake has a level of 19.65m, the west lake and the south lake both have levels of 18.65m. In the polder the land is the lowest (approximately 17.0m). The Yangtze dyke is 30m high. The average land in the new situation will be 21m, slightly going up towards the Yangtze to 23m. Some roads are now under construction or already finished. The existing site consists of large wetlands and a system of canals containing rich flora and fauna.

Satellite map of Wuhan

Main Strategies of Conceptive Master Plan

Toward a sustainable development and a low carbon city, four main strategies are guiding the Wuhan Sixin Area Conceptive Master Plan and Core Area Urban Design.

- **Give space to water:** Water is essential for the environment and resources of cities, industries and transport. To give the Sixin area a sustainable basis for the future, the green and watery corridors in this area should be respected, improved and extended, and whenever possible integrated in the urban planning visions. “City at Water” may be the new image for Sixin. Water in the city is crucial to prevent flooding; to establish capacity to absorb the water in the raining season (average rainfall 1300mm/year in Wuhan).
- **The concept of mix, clustering and segmentation:** A sustainable city is vital, not just because of its carefulness to nature, but also to the human beings. The city is a place to meet others. Mix, clustering of urban functions, urban areas and industrial units will raise efficiency of land-use, energy, resources and infrastructure. Besides the strategy of clustering, segmentation of different industrial processes and products is also important for the urban planning of industrial zones.
- **Respect the existing environment:** Respect the existing geomorphologic, social, cultural, historical and environmental situation and adopt these in the new urban planning. In this way it even can improve the existing structure. Also respect the already made investments in terms of constructed roads, leveled up land and planned or proposed plans in the wider region such as pipelines, railways, bridges, tunnels, cannels, etc.
- **concentration of public service:** The strategically located main center in the“spine”of the project for the whole area, and community facility centers on walking distance of no more than 600 meters encourage slow traffic means such as bicycle and walking. The Spine offers comfort for all forms of transportation including pedestrians, bicyclists and wheelchairs and is also flexible for future transportation systems, combined with metro or light railway.

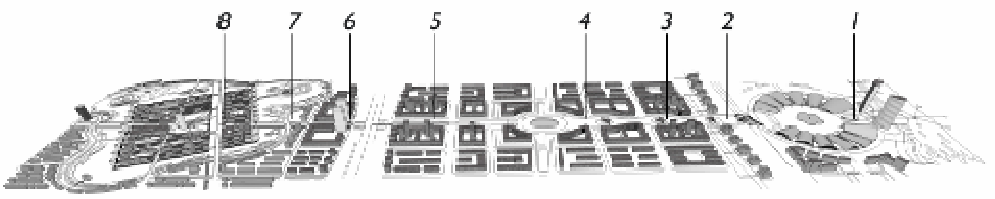
Conceptive Mater Plan of Wuhan Sixin Area

Land Use

Land is a basic resource for all kinds of development. Based on Dutch experiences there is should aim for 1/3 urban development, 1/3 water, and 1/3 green space for the total master plan. Land use of Sixin shows 40% plots to be developed, 20% water and wetlands and 40% green, roads and squares. There are two kinds mixed landuse in Sixin area. One is based on residential zone along canals. It is to form mixed-use corridor combine residence, small business, green space and traffic. Another kind of mixed – use land is based on public facilities which along Sixin Boulevard. Furthermore, building underground parking in community parks, parking fees can be used to subsidize community park management and maintenance costs.

Central Spine

The main concept is based on the central landscape spine, connecting the waterfront along the Yangtze River to the inland. In order to get the maximum hydrophilicity, Sixin road establishes an elevated platform which directly extending to the waterfront, hereby the problem that the city is separated with the Yangtze River is resolved; major public service facilities and infrastructure is arranged surround Sixin in an intensive way. This Spine is formed by a several steppingstones or nodes; a space diversity of living, recreation, administration, business, and Expo center is created from west to east. The end of the spine is marked by the remarkable residential island in a huge lake. From this central axis the density to both ring roads will decrease, finally ending in the residential islands embedded into water and green.

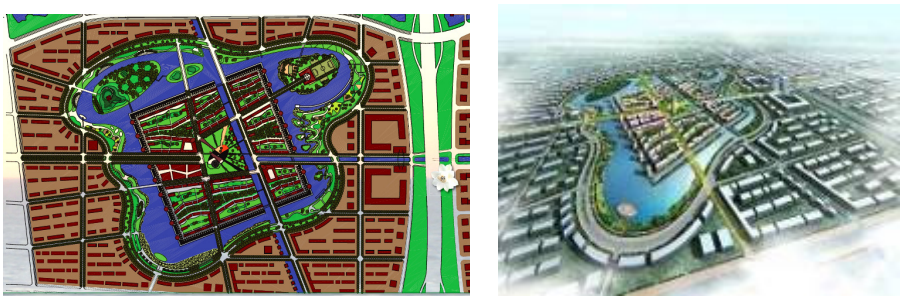


Nodes in central spine

Square Island

Centrally located in the plan, close to the Sixin New Town Centre, there will be a characteristic residential area abounding in water and wetland, transformed from the existing lowland situation and textur. “Square Island” is situated in this area and is in the centre of the “lowland lake”. The islands are not only surrounded by water but also by wetlands, resulting in an

ecologically rich and recreationally interesting area. Ecology, sustainability and diversity are key characters which should be reflected in the urban and landscape design of “Square Island”, 668m by 668m, which is exactly facing the south to obtain the best orientation of residences. The unique water and wetland surrounding will provide high quality for the relaxed island Living, as well as good views for the surrounding residential communities. The “Square Island” consists of three functional areas each with its own character: 7 residential areas, urban centre area and a 2 big community service centres with local commercial services. The borders of the island, all of which are park areas, are different features on all four sides.



Urban design of “Square Island

Water System

There has been a new water system plan in Hanyang by reconstructing 8 existing canals, and constructing 8 new canals, to link six lakes with Yangtze River and Han river, and improve self-purification ability of lakes and water quality of lakes. So far, Moshui Lake wetland, Qinduankou Creek wetlands have been built.

In the planning of the Sixin Area, the handling with water is a main issue. The development of Sixin faces the problem of securing the land from frustrating water level and reserve clean surface water. This situation is quite similar to that of the City of the Sun, where agricultural, industrial and urban development is related with broad hydrological aspects. There should be at least 10% of surface water in the developed area. Controlling water for a secure and sustainable land is integrated in the urban and landscape planning. Here in Sixin new area, 17.4% open water area and 4.7% wetland area are provided.

The new water system works undependably from the other surrounding areas with a maximum water level difference of 30cm. The average water level in the whole area will be 18.65m, with a high level of 18.95m. This means that all the water coming from the higher part of the Hanyang town will be collected in the Moshui Lake. If the level of the Moshui Lake exceeds the 19.65m water level, the pumps must start pumping water back into the Yangtze, and not in the Sixin area. Rainwater falling on the less intensive used roads and other pavement can be drained to open water. Basically it could say that the Sixin area is a controlled “polder” area.

Six Lakes Connection Plan

Water system in Sixin Area

Vehicles, pedestrian and bicycle

In this relatively dense urban area, the compatible land uses are mixed to minimize trip lengths. High activity nodes, public spaces, sport centers are connected by large green spaces with direct cycling to provide for underground garages directly connected with the buildings as planned in this master plan. The traffic flow from roads and to the express way, runs through two, in stead of one main road. The main “spine” is the backbone of Sixin, but not the main road. These two main roads, running from east to west, are the main dividers. From there the traffic will be guided into the residential area, or to the dense spine.

Many pedestrians and bicycles paths go crossing the island. These paths are a link to neighboring areas. The paths alongside the edges are for pedestrians and bicycles. Occasionally, they go through the bridges over the canals and wooden pedestrian platforms in the reeds. Within the neighborhoods there are pedestrian areas in routes between the residences and alongside the edges and the axis, as well as informal pedestrian paths in the courtyards.

3. Similarities or Differences of two Cases

To make it clear we here illustrate similarities and differences of Sixin project and City of the Sun project in a comparisons beneath.

- **Topography:** Both their lowland is used for agriculture before, with rich water networks, and land characteristics of farmland, canal and path interphase. However, there is no height difference existed in the original terrain of City of the Sun, while the terrain of Sixin is more complex, not only with large number of fishponds and lotus ponds but also scattered rural settlements; it is separated with the Yantze River by flood control dyke and rail barriers, the topographic height difference is nearly 5m. Therefore, its hydrophilic is weaker as not closely connected with water although near the river, and the overall terrain here is of low-lying with serous water pollution and seeper.

- **Function:** Both are with living, recreation and natural ecological complex functions. City of the Sun is a large residential area at waterfront, while Sixin has more powerful functions, not only representing a new residential district with Wuhan waterside features and nice ecological conditions, but also one of the future three comprehensive vice centers of Wuhan city. Wuhan International Expo Center under construction alongside the Yangtze River is the largest

convention and exhibition center of central China region.

- **Planning objective:** To create a sustainable development new area with low-carbon emissions is common objective of two cities. City of the Sun's objective is more ambitious that is to achieve neutral CO_2 emissions through the realization of a free trial of various new technologies and bold visions. While Sixin plans to become a high qualified, humane, livable and pioneering convenient new sustainable development area.

- **Design Concept:** The site status quo is an important clue and basis for concept design. "Water Surrounding City" and "Island Life" are the common city scene of them both. In order to get the best direction, the planner of City of the Sun breaks the original inclined texture, converting the largest island in the middle into an exact north-south direction. While In order to parallel with the external road networks, Sixin a shift the original exact north-south texture into tilted direction, while the "Square Island" in the middle is still in north-south direction, reserving the original characteristics of land.

- **Land Use:** Both give priority to public service facility space and living space, run through large areas of water, green parks and green area for environmental protection, to build a nice urban landscape. City of the Sun totally recreation area accounting for about 57% of the total land. While the Sixin area has an even larger scale, and calls for mix land use better. Its total area is 1,374 hectares, where the building area covers nearly 130 hectares, water area covers 75 hectares, and green recreational space covers 95 hectares, accounting for about 57% of the total land.

- **Density**: Both promote compact and appropriate high-density development so as to economize the use of land and maximize the natural space. The building density of the City of the Sun is equally, while Sixin area creates different density grades according to the purposes of the function: High-density business and commercial buildings (FAR>1.5), relative high-density office and public buildings (1.2-1.5), medium-density housing (0.8-1.2), and low-density residences (0.4-0.8) are arranged at both sides in sequence, the building density gradually reduce from the middle axis to the outer ring on both sides. Well due to huge population in China, the buildings in Sixin area give priority in multi-storey and high-rise dwelling houses.

- **Sustainable energy:** Renewable energy, especially solar energy will be alternatives to conventional energy sources in more fields. Most energy of City of the Sun is from solar energy, which may provide 3.75MW solar energy. It has achieved the integrated design of solar panels and the overall design of construction. In addition, City of the Sun also uses ambient heat collecting systems and wind power systems, with an objective to satisfy the energy demand of the total 3,000 house units. Due to technical and cost restrictions, Sixin area has a larger gap in aspects of sustainable energy.

- **Water System:** Both common goals are to form a sustainable water system for reducing

carbon emission and rainwater discharge, and the internal water self-purifying system and circulating system are formed. The channels of original polders system of City of the Sun have been rearranged to form large-area waters surrounding the central square island and many small channels inside the residential areas. Sixin area retains two major channels, and added three planned channels which connect the six lakes system. Inside the District retains the original ground elevation of the central polders to form a water area with double functions of ecological wetlands and gardens and increase the waterlines and enhance the value of lands.

- **Transportation System:** Both adopt external express driveways to connect other areas, footpaths and bicycle paths are arranged along the waterfront space. Commuting in City of the Sun mainly adopts cars; hence many parking lots are arranged in it. While Sixin area adopts public transportation priority system and high-density road network to form an express road – main road – secondary road – feeder road grading system. The main axis of the Sixin road is a living and landscaping road, parts of which will form special pedestrian areas, the car traffic will be divided by side streets and auxiliary roads. Two underground lines and one ground bus rapid transit (BRT) and water bus route will be planned. Parking underground is always adopted for saving lands.

5. Conclusion and Future Work

Now China is in a rapid developing stage, how China shall learn from the sustainable development experience of urban cities in European countries and apply the experience to China's low-carbon urban construction under pressure of immense population growth and land requirements becomes the focus of this article. Through comparisons between cases of City of the Sun and Wuhan Sixin area, the article holds, due to great differences of actual development stages, scientific and technological levels, social and cultural backgrounds between Holland and China, the successful experience of City of the Sun can not directly applied to Wuhan and Sixin area construction completely. Instead, appropriate adjustments in function arrangements, space layout, building density, transportation system and water system shall be made in accordance with the topography, regional environment and the regulations and policies of the State.

China is a large fossil consumption country second only to America in the world, energy is the bottleneck for keeping China's economy developing rapidly in 21st century. In 2006, the Government of China has put forward Renewable Energy Law for encouraging development and utilization of solar energy with an aim that makes the clean energy produced accounts for 10% of the entire energy production by 2020----higher than 1% of the present, for encouraging organizations and individuals to install and use solar water heating systems, solar energy heating and cooling systems, as well as solar energy power generating system. City of the Sun has realized the integrated design between PV-panels and buildings, solar energy facilities become one part of building structures and ornaments that turn into a unique scenery instead of affecting its beauty. At present, China still lags far behind in utilizing and studying solar energy as compared with the Euro-American countries, solar photovoltaic technology still can not be popularized at this stage due to its high costs. The subsidy needed

for the PV-panels is very large, because PV is not yet a normal daily technique. With subsidy PV-panels will be cost-effective for more people.

The experience of water buffering on polders system explored by Holland in fighting with water for land occupation is worth borrowing. In low-laying Sixin area, only relying on blocking up or draining is not enough, but adoption of combining blocking up with draining in addition to introducing water buffering system in more practical. The relationship between ground and water is no longer incompatible, bur interdependent. Moreover, comprehensive utilization of rain water is an effective way to resolve water shortage in urban cities and improve urban environment. But as for how to transform “discharging” of rain water to “ecological circulation” and “reutilization” of rain water, City of the Sun provides its concepts of water self-purifying and recycling system, technical and management modes for reference. Sixin area is planning to build a ecological rainwater collection and discharging system composed of grass ditches, retention pond and ecological wetland for effectively controlling urban pollution and realizing ecological cycles.

Sixin area is now constructing public infrastructures of road and water system, the construction of buildings has just begun. Regulative detailed plans (one of the statutory planning systems, direct reference of land lease) are carried out after completing Conceptive Master Plan. Although land use of concept planning has been adjusted, areas of construction lands have increased, external residential area surrounded water areas are reduced and requirements for average floor area ratio has improved from 0.7 to 1.5, afterwards, the sustainable development goals, concepts and planning of the central “Square island” determined in concept planning have been implemented all along and become the guidelines for future detailed planning and designing as well as land exploitation.

Note: All the photos and plans of City of the Sun are provided by KuiperCompagnons, while the photos and plans of Wuhan Sixin area are provided by Wuhan Urban Planning and Design Institute.