



Coastal urbanisation and creating Eco-Cities

Challenges and innovative, holistic solutions in the Chinese coastal zone

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Summary

China's rapid coastal urban development causes enormous pressure on its coastal zone. Sustainable strategies for future urban development are necessary. China with partners are developing plans for the expansion of old and the construction of new cities in harmony with their surrounding landscape, solving user conflicts and providing enough water resources. Examples of planned coastal Eco-cities are the Tianjin Binhai New Urban Area and the Caofeidian Coastal Port city in the north-eastern part of China and Dongtan Eco-city near Shanghai. The results of these pilot projects will determine whether the concept of Eco-cities is viable and can be implemented on a large scale in China and beyond.



Project rendering of the Caofeidian coastal masterplan. (source: DHV)



1. Introduction

China faces large-scale urbanisation in its coastal zone. A few hundreds of million people will move from the rural areas to the coast in the next few decades. This wave of coastal urbanisation will not only result in a massive expansion of the current cities, but also hundreds of new cities will have to be built in order to accommodate this mass migration. The scale of coastal urbanisation is unprecedented in the world.

China's rapid coastal urban development is leading towards spatial and ecological conflicts, negatively affecting the economic use of the coastal zone. Existing rivers are drying up because water is extracted by upstream cities and industries. Ground water is exploited for agricultural use, and many water systems are polluted due to rapid development and inefficient waste treatment.

Furthermore, the low-lying coastal areas are vulnerable to impacts of climate change such as sea level rise.

New approach

There is a growing recognition in China that long-term economic and social vitality depends upon a more efficient, effective use of the natural resources, coupled with improved human and environmental health. In light of that recognition, the Shanghai Industrial Investment Corporation (SIIC) has chosen to be among those leading China toward a more sustainable future.

Global climate change, environmental issues, water shortages and the need for the use of cleaner and renewable energy applications are all driving forces in the creation of a new approach to urban development.

With this background the Dutch engineering consultancy DHV with its Chinese partners, developed two coastal urban master plans for areas along the Bohai Sea (Figure 1), Tianjin Binhai area (#1) and Caofeidian (#2), in harmony with the dynamic character of the delta and the coast. The plans are based on a new integrated approach combining urban planning with water management. There is a focus on avoiding water conflicts, by creating urban environments in harmony with

their surroundings.

Between 2005 and 2006, Arup, the global firm of engineers, planners and consultants, was contracted to produce a master plan for the construction of an "Eco-city" on Chongming - a large island in the mouth of Yangtze River, near Shanghai (#3 in Figure 1).



Figure 1: The East China Sea & the locations of three planned coastal Eco-cities:

- #1 Tianjin Binhai area,
- #2 Caofeidian and
- #3 Dongtan - near Shanghai.

(source: ©2011 Google-Kaartgegevens ©2011Geocentre Consulting, Mapabc, SK M&C, Zenrin)

This chapter provides information about these innovative plans for sustainable urban development in three coastal regions, which have become the most dynamic and competitive economies serving as an example for the entire nation. The new approach integrates urban planning with water and coastal management.

2. Tianjin Binhai New Urban Area - Bohai Sea

Situation

Tianjin is a city with 10 million inhabitants, located approximately 120 km SE from Beijing and 40 km from the coastline of the Bohai Sea. The land where Tianjin lies today was formed in historical times by sedimentation of various rivers entering the sea at Bohai Gulf, including the Yellow River, which once entered the sea in this area (Figure 2).

Tianjin is one of China's most important commercial ports. It ranks on the six place of the world ports in 2006 (see CCC-I-2-2). The nominal GDP for Tianjin was 635.4 billion yuan (US\$ 90 billion) in 2008, with very strong growth a year-on-year of 16%.

Figure 2: The Bohai Sea with the locations of two planned coastal Eco-cities:

#1 Tianjin Binhai area and

#2 Caofeidian.

*(source: ©2011 Google-Kaartgegevens
©2011Mapabc)*



One of the constraints to the socio-economic development in this part of China is the limited availability of fresh water.

In the Hai River basin (Figure 3), where Beijing and Tianjin are located, only 1.5 percent of China's water resources are available to support 10 percent of the total population and 11 percent of the total arable land (WB, 2009).

The envisaged impacts of climate change may further exacerbate this water shortage in the coastal zone through rising sea level, increased frequency of storm surges and flooding leading to increased salt water intrusion. This in case no effective adaptive measure are taken.

During the design of new land development and the planning of coastal Eco-Cities in north east of China, water management is therefore one of the leading principles.

Figure 3: The Hai River Basin (source: Wikipedia - <http://commons.wikimedia.org/wiki/File:HaibeBasinEn.png>)

Masterplan for the Expansion of Tianjin

Around the port, the Tianjin Economic Development Area (TEDA) is built. TEDA has approximately 200,000 inhabitants and it is expected to grow to over 300,000 inhabitants in the next 10 years. The GDP (gross domestic product) of TEDA makes up half of Tianjin's region GDP. This is caused by the explosive growth of the port in the last decades. The focus for urban expansion lies just north of the commercial port, where the Hai river forms a delta in the Bohai sea. Today it is a heavily polluted, with a very salty and shallow sea. The tidal difference can reach 4.5 m per tidal cycle and the supply of fresh water from the rivers or rainfall is limited.

DHV provided a master plan for the expansion of Tianjin. This aimed to develop a high quality seaside resort as a mixed urban, maritime, green and ecological wetland area with high value waterfronts and coastal leisure facilities. It also included a dedicated study to investigate the requirements for the water system within the so-called Delta Diamond areas and the relation between fresh and salt water, water quality and water quantity issues, and the lock systems (Figure 4).

The master plan was based on a holistic Delta concept. This mixed socio-economic and natural delta elements such as water flows, rivers, lakes, islands with waterfronts (either urban or natural), to reach an integrated delta wide programme. The total amount of waterfront area will be increased from 2,8 to 12,6 km² by creating islands upon which to build expensive waterfront properties.

Sea defence enclosure dam

Hydraulic and hydrological expertise is used to design the 'aquatic part' of the master plan. Because of the difficult local hydraulic conditions, it is important to control the water, before creating the land. This does not only imply the protection against waves and high water, but also the prevention of drainage from the land at low tide. Therefore, the proposal is based on the construction of an enclosure dam forming a sea defence around the area to separate a sheltered saltwater bay from the sea. Sluices will be constructed in the dam to allow in- and outflow of water to maintain the water level and water quality at all times.



Figure 4: *Tianjin, the Delta Diamond, Birdseye of Master plan of the harbour and city. (source DHV)*

Water management

For the area to be sustainable, the management of both the scarce fresh water and the salt water is of great importance in this project. For this reason it is necessary to make the reclaimed land high enough above the salt water (ground) table to allow development of a semi-natural fresh water lenses in the sandy soil in the central parts of the islands.

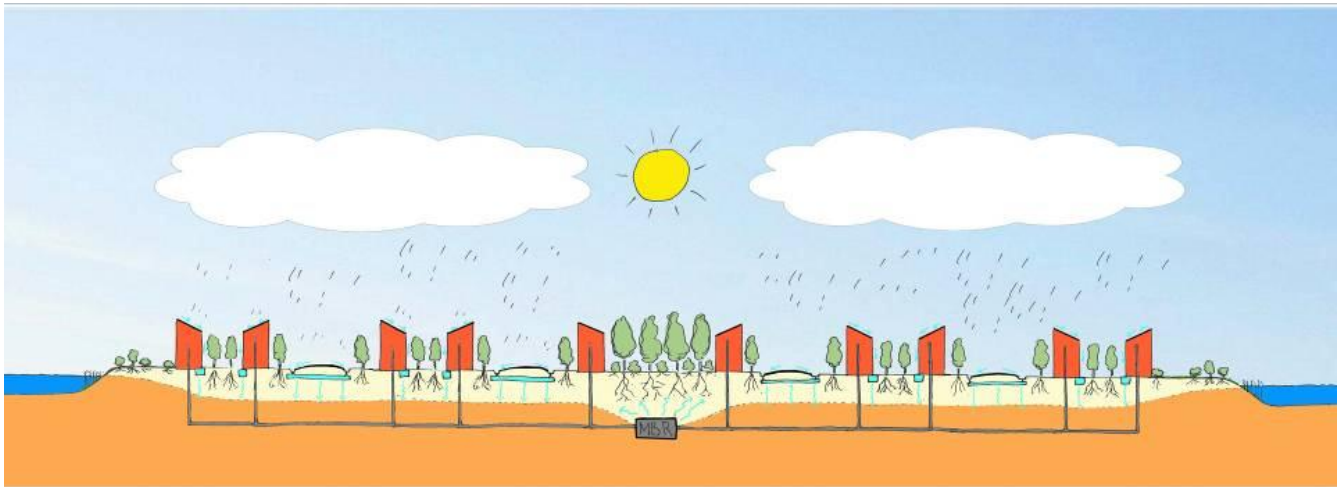


Figure 5: **Fresh water lens** on top of the saltwater in the sandy sediments of the reclaimed land. (source: DHV)

A proven infiltration system can transport rain underground quickly. Furthermore the effluent from municipal and industrial wastewater can be treated and provide an additional source of fresh water. The island concept is a flexible solution that provides possibilities for reclamation as required. Once the ring – dike is built, islands can be created one at a time. This creates flexibility in time and place.

3. Caofeidian Coastal Port and Eco-city (see for location: #2 in Figure 2)

Situation

Caofeidian is an industrial zone, located along the Bohai delta area about 130 km east of Tianjin. The Chinese government wants to develop a large-scale deepwater port, as an industrial transportation hub between the urban industrialised region and the international shipping networks. Apart from its strategic location, the area is famous for its local natural resources. Here a new coastal city will be built. DHV has been commissioned, together with the Chinese Urban Planning Department of the Qinghua University and Arup consultancy from the UK, to carry out this urban development project. The coastal Eco-City has to become one of the models for China and the rest of the world.

The overall development and construction of Caofeidian will be carried out in two phases, the industrial harbour phase to receive up to 300,000 ton vessels (see CCC-II-2-3) and the construction of the Caofeidian Eco-city. This development is transforming the existing natural coastline into a future coastal port city. This new city will probably become one of international importance. This has happened before with other cities located along the coast of China. Shenzhen, near Hong Kong, is an example where a deep-sea port transformed a village into a city of 12 million within only a few decades.

Island structure

The concept of the coastal and urban development plan includes an island and lagoon structure, which reminds one of the Dutch Wadden Sea. The coastal city will be built on an area of 150 km² on islands in the lagoon and will soon provide space for one million inhabitants.

The islands will be raised several meters above the salt water level, by drawing sand from the lagoon. At high tide, the outer islands off the coast form a sea defence wall that offers flood protection for the lagoon, which is located behind. At low tide, a vast intertidal area separates the main land from the outer island ring.

The lagoon design will restore part of the original tidal mud-flat coast as it was before the salt water industrial cultivation. The existing coastline will be transformed into a green eco-dike with inlets and outlets for water, creating a safe environment for the city in the lagoon.

The principle of the design is not to create land from the sea, but rather to reintegrate the land with the sea in a controlled manner. The water of the lagoon will be managed as a coastal waterfront for nature and ecology. The principle: Building with Nature (see CCC-III-3-3-3), is often applied in Holland and exported abroad. The city is designed to create harmony with the port, using different types of port, urban and ecological infrastructure.



Figure 6: *Caofeidian - Fresh and tidal water systems, connecting new and old land.* (source: DHV)

Fresh water

One of the major challenges in the master plan of Caofeidian is to control the development in a coastal area where fresh water is lacking. The increasing need for fresh water in urban development and effects of climate change on salt water intrusion, demand an increasing role for water in future spatial planning, which is in harmony with landscape and environment. The new coastal Eco-city is located in an area where salt water is used for a flourishing shrimp and salt production industry. Because of the limited rainfall in the north of China, there is little fresh water available for the future inhabitants and for a fresh water landscape.

For this reason, the Eco-City master plan is based on strategies to capture and recycle fresh water in as sustainable a manner as possible. The concept allows for the creation of fresh ground water for use in the city's green spaces. Furthermore, the Eco-City master plan will combine coastal development, renewable energy, water, and transport in an attractive urban design, with a high degree of sustainability.

4. Dongtan: an Eco-City plan near Shanghai

In 2005, Arup was commissioned by the Shanghai Industrial Investment Corporation (SIIC) to produce a master plan for a 500,000 person Eco-City on the eastern part of a large island in the Yangtze River mouth. This island, Chongming (Figure 7), lies near the dynamic metropolis of Shanghai, the centre of China's global ambitions.

The Eco-City, called Dongtan, was intended to be one of nine new towns planned by the city of Shanghai to relieve overcrowding in a city of more than 20 million people. SIIC initially aimed to have the first phase of the development complete by 2010, in time for the Shanghai World Expo – however, the development has not progressed as planned.



Figure 7: The location of the planned Eco-city Dongtan (#3): on the Chongming Island connected with Shanghai by the 25 km long Shanghai Yangtze River Tunnel and Bridge, all in the mouth of the Yangtze River. (source: ©2011 Google-Kaartgegevens ©2011 Mapabc, SK M&C)

Sustainability

In 2008, a Memorandum of Understanding was signed between China and the UK (HSBC, Arup and Sustainable Development Capital LLP – SDCL were all signatories) to establish a long-term strategic partnership to develop the funding for Eco-Cities. One facet of this partnership was the founding of a research network to share and develop the concepts of Arup’s work on Dongtan. A joint programme is now underway between China’s Tongji University and the Thames Gateway Institute for Sustainability. These and other planned centres will become world centres of excellence for examining the connection between the environment and economic performance. The original master plan included priority projects such as the process of capturing and purifying water in the countryside to support city needs, community waste management recycling to generate clean energy, and reducing landfill that damages the environment.



Figure 8: Artist’s impression of Dongtan. (source: Arup)

Dongtan's primary source of renewable energy supplies would be a combined heat and power plant running on biomass in the form of rice husks - these are the waste product of local rice mills. Dongtan's buildings were designed to reduce energy use, making more efficient use of energy sources and generating energy from renewable sources. The link between Chongming Island and Shanghai opened in 2009 and is an 18-mile long bridge-tunnel, which also spans two smaller islands.



Figure 9: *Artist's impression of Dongtan.* (source: Arup)

The masterplan for the area intended that Dongtan would also produce energy from wind, the sun and recycled city waste. Clean technologies such as hydrogen fuel cells would power public transport. The planned network of cycle and footpaths was designed to help the city achieve close to zero vehicle emissions. Farmland was included within the Dongtan site, using organic farming methods to grow food. Cars with zero tail pipe emissions were to be allowed into the city area, with conventional transport being kept on the perimeter.

When the project began, SIIC was committed to achieving a zero-carbon development, and Arup's design for Dongtan would have reduced energy demand by 66%, and the ecological footprint of the city by 60%.

Bringing such an integrated, comprehensive plan to fruition would be a great challenge, requiring the alignment of political will and technical expertise, and is a challenge involving many Chinese and international partners.

While Arup's integrated urban development plan for Dongtan has not progressed so far, if developed, it will create China's first sustainable and ecologically friendly city. Either way, the project has inspired a legacy of research and new initiatives, which are being applied across the world.

5. Conclusions

China faces enormous pressure on its coastal zone from massive coastal urbanisation now and into the future. To address this pressure, China is developing holistic, integrated and sustainable strategies for urban development. These strategies must contribute to a better environment for people and nature as well as creating opportunities for local and regional economies.

Within this context master plans for three coastal Eco-Cities have been formulated in the deltas in the Bohai Bay and of the Yangtze river. The results of these projects will determine whether it is possible to pursue large-scale development of new Eco-Cities along its entire coast.

The short and long term benefits of coastal Eco-City design in an economic and environmental sense, are the development in harmony with the coastal landscape, solving user conflicts and providing enough water resource to sustain the future urban development and protecting it from the potential impacts of global climate change.

The enthusiasm of Chinese society for the concept of Eco-Cities is high. Planning ambitious urban development in coastal areas based on water management perspectives could well prove to be the template for improved sustainability in city planning – not only in China, but also elsewhere in the world. Implementation of the Chinese Eco-City plans involves careful preparations dealing with ecological, civil and financial engineering.

6. PDF reports and Websites

PDF reports:

- **BBC- China's eco-city information:**
<http://news.bbc.co.uk/2/hi/business/6756289.stm>
- **DHV – brochure on Tianjin Binhai land reclamation:**
http://water.dhv.com/EN/Coastal_development/Documents/CHN-A0290_Tianjin_land_reclamation.pdf
- **Dongtan Eco-City information:**
http://www.worldarchitecturenews.com/index.php?fuseaction=wanappln.projectview&upload_id=2137
- **Map of Hai River basin:**
<http://en.wikipedia.org/wiki/File:HaiheBasinEn.png>
- **SIIC - Shanghai Industrial Investment Corporation:**
www.siicsh.com.cn

Websites

- **Arup – UK : global design and business consulting firm:**
www.arup.com
- **Chinese Urban Planning Department of the Qinghua University:**
<http://www.tsinghua.edu.cn/eng/index.jsp>
- **DHV – Consulting and Engineering**
www.dhv.com
- **SIIC - Shanghai Industrial Investment Corporation:**
www.siicsh.com.cn