Chapter 3
Three Ecological Cities, Examples of Different Approaches in Asia and Europe

Meine Pieter van Dijk

Abstract Developing countries and emerging economies have been active in creating ecological cities. An analysis of some Asian cases will be presented to show that the reasons to create a new neighbourhood or to introduce a different approach to urban planning are mainly environmental considerations. Since the 1990s a number of cities have created new neighbourhoods taking environmental factors into consideration. More recently Shanghai announced plans to build the city of the future on an island at the mouth of China's Yangtze River, in the same way Singapore has planned new ecological neighbourhoods. These examples and one from the Netherlands (Rotterdam) will be reviewed to answer three questions like what would the ecological city of the future look like and what can we learn from these experiences for the ecological city of the future? Pollution, solid waste and wastewater problems, all aggravated by climate change require a different approach to urban management to build the ecological city of the future!

3.1 Introduction

There is not one definition of ecological or for short eco-cities that is generally accepted. Different authors have very different views of what makes a city an ecological city (van Dijk 2009b). Table 3.1 provides a number of examples of terms that are used to refer to ecological cities. One can conclude that people are driven by ideals (to create heaven on Earth) or needs (to deal with climate change). Some sources express the importance of having a livable (and economically vibrant city; van Dijk 2006), others stress a more green (more trees and parks) city. Finally some sources stress the ecological and others the sustainability aspect: the initiative should carry

M.P. van Dijk (✉)
Water Services Management, UNESCO-IHE Institute for Water Education, Delft, The Netherlands; Urban Management, ISS, Erasmus University in Rotterdam, Rotterdam, The Netherlands
e-mail: m.vandijk@unesco-ihe.org

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Table 3.1 Examples of terms referring to more ecological cities

Titles for eco-city initiatives	Source
a. Eco-heaven, a model city near Shanghai	a. International Herald Tribune (24-6-2008)
b. Garden city brochure	b. Suqian city Jiangsu province China
c. Sustainable urbanization or cities	c. Van Dijk (2007b)
d. Sustainable urban development network	d. SUD-network UN Habitat Nairobi
e. Cities of the future	e. Switch project Delft, the Netherlands[a]
f. Livable and vibrant cities	f. National library Singapore
g. Sustainable living, bringing together best practices	g. Ministry of Housing, Spatial Planning & Environment in the Netherlands
h. Green urbanites	h. *Strait Times* (21-6-2008)
i. Climate resilient cities	i. World Bank primer, Washington Oct. 2008
j. Rotterdam, climate proof	j. Rotterdam municipality the Netherlands
k. Keeping cities alive	k. *Strait Times* (21-6-2008)
l. Green city philosophy, cooperation between Thailand and the Netherlands	l. Dutch Ministry of Agriculture, Nature and Food Quality
m. Eco systems and biodiversity, the role of cities	m. UNEP & United Nations Habitat brochure

[a]The Switch project (Sustainable Water Improves Tomorrow's Cities' Health) with support from the European Union (EU) is seeking a paradigm shift in urban water management. Its purpose is to make water treatment more sustainable and protect the quality of drinking water sources. In addition, it wants to reduce risks such as water related diseases, droughts and flooding. www.switchurbanwater.eu

on, because economically, environmentally and institutionally it is durable. An easy definition of an ecological city would be one emphasizing what should be or should not be there. The positive points of environmentally friendly cities are: they are livable and energy saving, promote integrated water and sanitation, better urban waste collection and processing, more gardens and trees, bio diversity and better public transportation and deal with climate change. On the negative side one could mention: do away with air, water and soil pollution, congestion, flooding and the lack of green areas. This paper deals with three questions:

a. What would the ecological city of the future look like?
b. To what extent do these examples satisfy the criteria for sustainable urban development formulated in the literature?
c. What can we learn from these experiences for the ecological city of the future?

Besides the "what is an ecological city" question, the why question will also be answered and some examples of the how will be given.

3.2 What Would the Ecological City of the Future Look Like?

To explore how the ecological cities of the future would look like it is necessary to assess what the relevant dimensions for an ecological city are. What makes a city an ecological city and what does sustainable urban development really mean? An overview of experiences with stimulating more sustainable urban development

will be given. We will first review why we are concerned about more ecological cities and what sustainable urban development means. Subsequently we introduce the approach of the Switch project, which embodies a more ecological attitude towards water and environmental issues.[1] This will also mean a discussion about a theoretical framework for sustainable cities and explaining what following a more integrated approach to environmental problems means. Ten dimensions for sustainable city development in the Third World were developed by Kenworthy (2006: 67). They will be presented as a possible analytical framework to decide whether certain initiatives qualify for the ecological city label. His ten dimensions for sustainable city development in the Third World give a good impression of the issues at stake. A sustainable city is characterized by:

a. A compact, mixed urban form that protects the natural environment, biodiversity and food-producing areas
b. The natural environment permeates the city's spaces and embraces the city, while the city and its hinterland provide a major proportion of its food needs
c. Freeway and road infrastructure is deemphasized in favour of transit, walking and cycling infrastructure, with a special emphasis on rail. Car and motorcycle use is minimized
d. There is extensive use of environmental technologies for water, energy and waste management – the city's life support systems become closed loop systems
e. The central city and sub-centers within the city are human centers that emphasize access and circulation by modes of transport other than the automobile, and absorb a high proportion of employment and residential growth
f. The city has a high quality public culture, community, equity and good governance. The public realm includes the entire transit system and all the environments associated with it
g. The physical structure and urban design of the city, especially its public environments are highly legible, permeable, robust, varied, rich, visually appropriate and personalized for human needs
h. The economic performance of the city and employment creation is maximized through innovation, creativity and uniqueness of the local environment, culture and history, as well as the high environmental and social quality of the city's public environments
i. Planning for the future of the city is a visionary debate and decision process, not a predict and provide computer-driven process
j. All decision making is sustainability-based, integrating social, economic, environmental and cultural considerations as well as compact, transit-oriented urban form principles. Such decision making processes are democratic, inclusive, empowering and engendering of hope.

We would like to use a list of characteristics to find out if certain initiatives in Asian cities qualify for the label *ecological city* or ecological neighbourhood. Kenworthy's principles are quite broad and come from someone with a transport background (points c, e, f and j). There is a vision behind these dimensions and an integrated strategy is necessary to implement the envisaged solutions for the implicit

problems. The importance of appropriate technologies for water and sanitation is only mentioned under point four.

Urban management should help take steps towards more ecological cities. My definition of a more ecological approach to urban development, based on the existing literature, would be that such a city requires a strategy combining:

a. Integrated water resources management: closing the water cycle
b. Energy management, reducing greenhouse gases
c. Waste minimization and integrated solid waste management
d. But also a different approach to sanitation
e. Integrated transport policies
f. A policy dealing with pollution issues
g. Anticipation of climate change
h. A different housing policy
i. Objectives concerning justice, for example promoting an equal distribution of the benefits
j. Integration in the framework of sustainable urban management, while also managing urban risks.

3.3 Three Levels of Eco Practices

Ecological initiatives can be taken at three levels. In the first place at the level of the city, a new town, or a neighbourhood would be an example. We will point to all kinds of ecological neighbourhoods appearing. Secondly at the level of buildings one notes ecological villas, blocks of houses, or apartment buildings with common heating/cooling systems or a shared grey water re-use facility. Finally individual initiatives can be noted at the household level, spontaneously or triggered by incentives or price increases. There are a number of Chinese eco-city initiatives that are interesting and have been studied. The reaction of these cities to climate change should be evaluated.

Examples of some Chinese eco-cities and eco-provinces (Wang 2006) will be presented to show how China, a country which is considered to grow at the expense of its environment, deals with urban environmental issues. Are these cities introducing a very different, more integrated approach to a number of related environmental issues? Urban environmental policies in Asia are also illustrated by the positive example of Singapore, where special attention is paid to the issue of building in a sustainable way. Subsequently we will present how Rotterdam in the Netherlands tries to deal with climate issues in its plan Rotterdam Climate Proof (Stadshavens Rotterdam 2008b), before some conclusions will be formulated.

The possibilities for Third World cities, particularly those located in Deltas, to prepare themselves for climate change, will be identified. We focus on what it means for water and sanitation, but drainage and flooding would also need to be considered.

Integration could take place in the framework of urban management (van Dijk 2006). Issues discussed are the integration of the different sectoral interests, the role of planning and management, the importance of economic, financial, social and environmental criteria (and how to combine them), who are the decision makers and how do we deal with the strict and the loose meaning of sustainable urbanization? After all sustainable development is a normative concept. In 1987 the World Commission on Environment and Development provided a definition of sustainability that is still often used. Brundland (1987) defines sustainable development as development that meets the needs of the present generation without compromising the needs of future generations.

The literature keeps struggling over what to put into the sustainability concept, while the environment continues to degrade. Mohan Munasinghe, Vice-Chairman of the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC) tried to bring together the economic, human and environmental aspects of development. His analytical framework is called sustainomics (Munasinghe 2007). Through sustainomics he offers alternative mechanisms to help us bring environmental degradation and social cost into the analysis and applies his methodology to greenhouse emissions and the transport sector in Sri Lanka. At the same time he criticizes the traditional cost benefit analysis. Earlier we suggested letting the weight of the issues play a role in the definition of urban sustainability (van Dijk and Zhang 2005).

There are definitional problems as shown in the literature (Finco and Nijkamp 2001). One can find very idealistic, very sectoral, or issue based definitions of ecological cities and sometimes norms and values play a role such as the distributional issue: should the Chinese be denied the level of energy consumption of average citizens in the United States? Sen (2009) provides a theory of comparative justice, judgments that tell us when and why we are moving closer to or farther away from realizing justice in the present globalized world.

3.4 Why More Ecological Cities?

Not only higher energy prices and increased emissions of carbon dioxide (CO_2) force a reconsideration of the priorities for the future of cities in developing countries. Besides traditional urban environmental issues such as urban pollution, traffic congestion and inappropriate waste collection, the results of rapid urbanization and of climate change force cities to think more about their future.

Water stress can be noted in many countries (Seckler et al. 1998). A deteriorating environment accelerates the trend towards a gradual shortage of fresh water. While freshwater supplies are clearly limited, for most people water scarcity is caused by competition between water uses and by political, technological and financial barriers that limit their access to water (Falkenmark and Lundqvist 1998). The Switch program intends to generate new efficiencies from an integration of actions across the urban water cycle in order to improve the quality of life in cities.[2] It also promotes urban agriculture projects, as part of the integrated approach to water use and reuse (Box 3.1).

Box 3.1 Switch Project on Ecological Cities of the Future

The UNESCO-IHE Institute for water education in Delft in the Netherlands carries out a European Union supported Switch project on ecological cities, where sustainability is defined as the process and the ecological city as the result. Global changes such as climate change and volatility, urbanization and industrialization, population growth, urban sprawl, and rural-urban migration put pressure on cities. A sustainable urban water system is a basic feature of an ecological city, but is it enough?

The Switch project according to the proposal, intends to improve water governance and to translate scientific innovations into improvements of day-to-day management of urban water and sanitation. The approach is focused on closing the urban water cycle, defined as the link between the resource, its use for drinking water and eventual reuse to allow the water to flow back into the resource. From the literature we know that reuse is currently at a price of 30–40 euro cents per m^3, while desalinated water may cost around one euro per m^3. Unfortunately the latter is always produced at sea level, implying transportation costs in most countries.

3.5 Monitoring Sustainable Urban Development

Achieving sustainable urban development also includes considering water and sanitation integral parts of urban infrastructure planning. The Switch vision relates to storm water to drinking water and waste water treatment. It emphasizes:

a. Thinking in terms of systems of interrelated components (system engineering)
b. A more ecological approach to sustainable urbanization
c. A more integrated approach to different water related issues.

Part of the first approach would be developing indicators to monitor constantly the score of city with respect to the quality of the aquatic urban environment and to take corrective actions if certain variables reach threshold levels. Modeling the system and emphasizing decision support systems is inherent to this vision.

A more ecological approach to sustainable urbanization implies moving from traditional environmental technologies to more ecosan options in the ecological city of the future. It will be necessary to focus more research on the topic of ecological cities, to study certain phases in the process of becoming more environmentally conscious as well as finding ways to interest some of the major urban actors in these issues. However the coordinating role of local governments and urban managers should not be underestimated. In fact it is their task to coordinate a multiplicity of actors. That is the essence of urban management: participatory, inclusive and with all

actors concerned taking into consideration equality, the environment and economic development.

It needs to be clear what will be integrated, how and by whom? Integrated Urban Water Management (IUWM) can be achieved in each of the cities if we work towards a plan. A major assumption of this approach is that if we follow a holistic approach we will have better results. We assume that such an integrated policy will be the result of scientific research, rather than consultancy reports. Such integrated environment friendly urban development plans may be too ambitious for big cities like Beijing and we may have to content ourselves with providing strategic direction for moving towards a more ecological city.

Strigl (2003) stresses that a real improvement in eco-efficiency requires a fundamental change in culture, structure (institutions) and technology. Switch intends to develop, apply and demonstrate a range of scientific, technological and socio-economic solutions that will be tested to determine their contribution to the achievement of sustainable and effective urban water management schemes. It implies a multi-disciplinary approach for Switch that is the integration of the technological means, socioeconomic aspects, environmental concerns and health considerations.

Each flash in the figure represents a point where costs are made and revenues can be obtained. It is also possible to deal with the water cycle process in an integrated way, as is done in Singapore. In that case the costs and charges could also be integrated in one exercise (for the costs) and one bill for the customers (Fig. 3.1)

How do we hope to achieve all this in the Switch project? Learning alliances have been created consisting of interested stakeholders to discuss the issues and to identify directions for research (van Dijk 2008). The researchers hope to provide a broader perspective to the members of the learning alliance and to increase the range of options between which they can now make an informed choice. Why is Switch different? Because the project promotes sustainable and integrated urban water management, to make the city a better place to live. It suggests closing the urban water cycle for the city of the future.

The point of departure is closing the urban water cycle. In Singapore no water gets lost between the resource, the use for drinking water and the treatment and

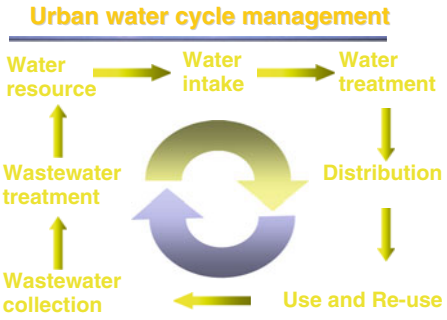

Fig. 3.1 The closed urban water cycle. *Source*: van Dijk (2007a)

reuse. This is the work of NEWater, a company with the mission to go from "Sewage to Safe". The city is also using reverse osmosis technology for the process of transforming sea water into drinking water, if additional water is necessary in the closed urban water cycle.

3.6 Examples of Urban Environmental Policies in Asia

We will provide some Asian examples of urban environmental policies and ask the question: do these examples satisfy the criteria for sustainable urban development formulated in the literature (for example Kenworthy 2006)? Special attention is paid to a number of Chinese cities and in Singapore to the issue of building in a sustainable way and the role of housing finance. At the end we briefly present how Rotterdam in the Netherlands deals with these issues (Stadshavens Rotterdam 2008b), before drawing some conclusions.

3.6.1 Ecological Initiatives in China

A number of ecological initiatives have received support from the Chinese government. They range from alternative building methods (emphasizing the need to isolate houses better) to promoting other ways of dealing with drinking water and sanitation. The question is to what extent these disjointed initiatives also contribute to building the much-needed ecological city of the future.

In the integrated urban water cycle, managing water resources, drinking water supply and wastewater treatment are three important stages, each with specific problems in China. The risks in the water cycle are substantial. The water situation in northern China can be described by the term, water scarcity. In the north, there is not enough water for the different types of use and for the big cities, which have high per capita consumption figures, probably due to substantial water loss. For that reason, China has embarked on a number of river linking projects (WWF 2005). The main problems with water and pollution in China can be summarized as follows:

a. Water prices are not realistic (*Financial Times* 20-3-2003), but efforts to increase water prices by 30% have not been approved by the Municipal Commission of Development and Reform (*China Daily* 2-7-2004). Recently a small increase was announced.
b. The river transfer project is extremely costly (*Financial Times* 20-3-2003)
c. Pollution has led to algae in the Yellow Sea (*NRC* 17-6-2004)
d. The Three Gorges Dam may cause serious ecological risks (Financial Times 2009).

There are numerous problems with the water cycle in China. Just to mention some examples: the impact of climate change on water resources and development

in China (*China Daily* 2-7-2004), as well as the risks linked to the current practice of water management for Chinese rivers (CICED 2006). Flooding is common just like pollution. However, the river is also important for irrigation, drinking water, transport and fishing activities. In the northern port city of Tianjin, the river became polluted and consequently the population could not drink the water for weeks. This is a big city and the impact of upstream pollution was enormous. The risks this time are not so much the risks of flooding, but of not supplying clean drinking water to the big cities on the coast (Pahl-Wostl and Kabat 2003). There were reservoirs to serve Tianjin and Beijing, but the water was not available at the crucial moment. Currently the city is using a desalination plant, but it will also benefit from the south-north river linking program, which connects the northern Yellow and southern Yangtze rivers.

There are a number of other eco-city initiatives in China, ranging from simple water and sanitation technologies for the western part of the country (through a project financed by the Netherlands) to sophisticated ecological projects in the framework of the 2008 Olympic Games in Beijing. The Chinese authorities exhibit a preference for large modern high tech solutions; even if they know they cannot always manage the technology properly. They are less willing to pay for management support, training or software; while given the high energy use per unit of Gross Domestic Product (GDP) and the huge water consumption in per capita terms, there is scope for improvement of the efficiency of the system through better management.

There is in China this trend to focus on obtaining the most advanced technology, counting that this will be sufficient to deal with the issue. The emphasis is on the hardware and not enough attention is paid to managing water systems in a more optimal way. Not enough attention is paid to managing existing water supply and waste water treatment systems properly. Hence many water resources are polluted, drinking water is scarce and the quality of the water produced by the waste water treatment plants is not always appropriate. Environmental norms have been put at a high level in China, unfortunately the strict norms are not always implemented seriously. The State Environmental Protection Agency (SEPA) is not very powerful, compared to Provincial governments, or the Ministry of Construction, which is responsible for the construction of water and sanitation facilities. SEPA will be upgraded and obtain the status of a Ministry, which will make it easier to deal with the environmental issues in different Chinese provinces, because they would be administratively at the same level.

The goals to be achieved in the water sector according to China's 11th Five-Year Plan are ambitious. The planners want to reduce for example water consumption per industrial unit by 30% and to increase the coverage for water and sanitation facilities in line with the Millennium Development Goals (MDGs). The governance structure to achieve this is relatively simple because the governance structure in China is still highly centralized and hierarchical. The role of the Ministry of Construction and the corresponding line offices at the city and district levels is very important. However, this excludes broader participation of all stakeholders. Water and sanitation facilities are for example not owned and managed by local authorities, which hinders innovative local solutions, innovative ways of financing.[3] It also means that very

little cost recovery is achieved. It is normally possible to recover the cost for water treatment through the drinking water bill, however. The current price per m^3 is only 3.5 Yuan, of which 0.5 Yuan is for wastewater treatment, which is much too low.[4] Unfortunately in the case of ecological initiatives taken at the neighbourhood level to recuperate grey (lightly polluted) water, the treatment charge will not be repaid to the inhabitants, while they do pay the 0.5 Yuan for large scale treatment (Liang and van Dijk 2010).

3.6.2 Examples of Chinese Eco-cities

Chinese cities are facing the pressure of a water crisis. More than 400 cities are lacking water resources and more than half the rivers are polluted. In 2004, 5.548×10^{12} m^3 water was used for agriculture, industry and domestic activities. Meanwhile 6.930×10^8 m^3 waste water was discharged from Chinese cities, but no more than half the amount of wastewater is subject to secondary treatment (China Bulletin of Water Resources 2004). We will look at initiatives in Beijing, Shenzhen, Shanghai (a new neighbourhood and the Thai lake) and Wuhan in that order.

Beijing is the capital of the People's Republic of China, lies in the northern part of the country and is geographically on the edge of a desert. Because of its geography, Beijing has low average rainfall. Beijing's total precipitation is 640 mm per year, 80% of which is concentrated during the period of June to September. The population of Beijing is 15.38 million, of which 3.2 million people reside in the peri-urban districts and rural counties of the metropolitan area. Because of the dramatic economic development during the last 20 years, Beijing has been urbanizing rapidly, with an average annual official population increase of 2.48%. Ground water is the primary source of water for agriculture and industry, and recently has shown a gradual decrease. Water scarcity, depletion of underground water stocks and environmental degradation are the main problems faced by Beijing. Given the negative effects on the environment, Beijing has decided to direct businesses, which utilize large amounts of water, out of the city (*China Daily* 10-4-2004).

In Beijing there are thousands of ecological initiatives and other Chinese cities are also doing their best. The question is, whether this is enough to counter a looming environmental crisis. Praising sustainable development is a beginning, but not enough. One example is the development of urban agriculture in Beijing. Beijing being a metropolitan region has large rural areas as well and urban agriculture has a very specific background with practices that can be repeated elsewhere. The projects are examples of eco sanitation (re-using urine and compost for urban agriculture) and could be elements of a more ecological city.

Given a number of the problems are related to water governance, an institutional analysis is required to identify the different bottlenecks. In the example of Tianjin in the north where the river became significantly polluted because of an upstream industrial accident, there was no riverbank infiltration system to mitigate the negative effects of the pollution. In addition constructed wetlands, which help to clean the water, were not used in Beijing as this approach required too much land.

Riverbank infiltration projects may be an alternative for constructed wetlands, which require much space, while river banks are available for this purpose. The model of Singapore, closing the urban water cycle completely, may also be an appropriate option and could help to economize the expenditures for this kind of projects. The example of Beijing shows how difficult it is to be an ecological city.

Shenzhen is another example of a major Chinese city trying to become an ecological city (see Box 3.2).

Box 3.2 Is Shenzhen Already an Ecological City?

In 2002, the State Environmental Protection Administration (SEPA) and the Ministry of Construction jointly formulated a series of standards and rules on the construction and recognition of ecological cities, which are related to economic development, environmental protection and social progress. All detailed standards are published on the website of SEPA www.sepa.gov.cn. SEPA is the decision-maker to approve or disapprove cities' applications. On June 2, 2006, SEPA for the first time awarded the title of the ecological city to the following cities: ZhangJiaGang City, ChangShu City, Kunshan City and JiangYin City of Jiangsu Province.

The city has set this target for the year 2010. Shenzhen's urban greening ratio has reached 51.1%, with 16.01 m^2 of green area per person, ranking top among other cities of the country. With 218 parks and 5,000 ha of ecological scenic forests, Shenzhen takes the lead in both land area and quantity of greening compared to other cities. The City has been awarded titles including "China's Best 10 Cities for Greening", "National Garden City", "Nations in Bloom", "National Greening Pioneer". At present, Shenzhen is on her way of thriving development with the aim of building itself into an "ecological city with high tastes".

Source: Taken from the website of the Shenzhen Bureau of Trade and Industry.

Box 3.3 summarizes the initiative in Shanghai to create an environmental neighbourhood.

Box 3.3 Shanghai's an Environmental Neighbourhood

Shanghai plans to build on an island at the mouth of the Yangtze River the city of the future (*Economist* 23-9-2006; *Trouw* 9-11-2007; *Financial Times* 15-9-2006). The idea is that the city will be self-sufficient in energy and water and will generate almost no carbon emissions. Petrol and diesel vehicles will be banned in favour of solar-powered boats and fuel-cell-driven buses, according

to the *Economist*. The city should number around 500,000 inhabitants in 2040 and will house an agro park of 27 km^2 to grow food in a sustainable way (*Trouw*, 9-11-2007). Finally the *Financial Times* describes energy conservation at the level of the house and shows the use of water conservation (rain water harvesting). The houses will use only one third of the energy consumed by a normal house, while the energy will be renewable, for example through windmills. The project received attention and press coverage, but the question is how to diminish pollution in neighbouring Shanghai city, with 20 million inhabitants and many polluting industries.

In 2003 an environmental study of Tai Lake near Shanghai carried out by a Dutch consulting firm together with UNESCO-IHE showed the seriousness of pollution of the water resources and the need to introduce wastewater treatment plants. What has been done so far and to what extent the risk of pollution of the water resources have been limited by treating used water properly is not clear. It is our experience that the Chinese started building water treatment plants before the feasibility study was finished. Now they are not always working at full capacity nor turning out the expected quality of water. Recently another effort to clean Tai Lake was announced. Ten billion euro will be spent to clean it (*De Pers* 29-10-2007). According to these plans, it would take 5 years to clean the lake while the problem would be totally solved in 8–10 years.

Another example is Wuhan, one of the largest cities in China, with total area of 8,494 km^2 and a population of 8.3 million.[5] Unlike Beijing, Wuhan has much richer water resources, ranking first among the largest Chinese cities. Called *water city* in China, Wuhan is located about halfway along the several thousand kilometres reach of the Yangtze River and has nearly 200 lakes of various sizes. The water area makes up 25.8% of Wuhan's entire territory. Although Wuhan has abundant water resources, the Yangtze River and many lakes suffer from serious pollution. In 2000, Wuhan's wastewater discharge totalled about 2 million cubic metres per day with domestic sewage and about 25% of that was industrial wastewater. Water quality in Wuhan has significantly decreased over the last 15 years, making the concern for sustainable urban water management in this city greater than in other cities.

Other Chinese provinces want to get the eco-province label and take initiatives to achieve this. In China this usually means that competition is created and a prize may be given to the most ecologically friendly province or city. The Jiangsu province is an example that is implementing a policy for sustainability. It will implement the Jiangsu Eco-Province Plan with the Nanjing Eco-city Project as a major component.

3.6.3 Initiatives at the Level of Buildings

Although many initiatives are taken at the level of the city, the real promotion of ecological innovations comes from the national level through subsidies. For example a

30% subsidy of the construction cost is possible in the case of an ecological housing project. An interesting case of an ecological neighbourhood can be found in Wuhan and concerns a project of about ten buildings with seven or eight floors per building. The project would receive a 30% subsidy for using energy saving techniques, but one of the conditions was that the project would also recycle their grey water.[6] Energy savings is based on double-glazing and the use of ground source heat pumps. The geothermal heat pump uses a system of pipes absorbing latent heat from the ground and transferring it to the home's heating and hot water systems. The details are provided in Box 3.4.

Box 3.4 The Taiyue-Jinhe (Tai) Residential Project in Wuhan

The Taiyue-Jinhe (Tai) project is about establishing an ecological residential area with low energy consumption and a water recycling system. It is located in Jinyin Hu district, which is a suburban area of Wuhan city. Because there are two big lakes: Jin Lake and Yin Lake, the district is called Jinyin Hu (lake). Jinyin Hu district was an agricultural production field 20 years ago, mainly for rice production. Presently Jinyin Hu district is being developed as a residential space and ecological park.

The Tai project began in 2006, and the residential building was completed and sold out in 2007. The water recycling system was estimated to be completed in 2008 (see Fig. 3.2). The Tai project is involved in a national level energy saving program (initiated by the Ministry of Construction) on the condition that energy saving and water recycling systems are included. This program was organized by the Chinese Ministry of Construction which also issues permits to build water recycling systems. Moreover the Tai project could get a subsidy from the Ministry of Construction. At present there is no policy on water reuse system construction in Wuhan.

There are two main parts to water recycling: water reuse and rainwater harvest. The water reclamation technology used by the Tai project is Membrane Bio-Reactor (MBR) with wetlands. Two pipes are constructed in the residential buildings to collect wastewater: one for grey water and another for black water. Only grey water is recycled, the black water goes directly to the municipal sewage system. The MBR method is the first step and wetlands is the second step for wastewater cleaning. Rainwater is collected through drainage pipes in the buildings and beside the paths. After the rainwater is collected, it moves directly into the wetlands. Finally the reused water is pumped from the wetlands and used to water the green areas and wash cars.

The wetlands consist of three lakes: North Lake, Middle Lake and South Lake, which are shown in Fig. 3.3. The water moves from the south to the north due to water level differences. In the middle, there is a windmill, which

transfers the water from outside the lake into the wetland in order to keep enough water in the wetland. There are several pumps in the northern lake to transfer reused water. Unfortunately we found during our fieldwork in October 2007 that the houses were almost finished (to be occupied in December 2007), but the grey water treatment facility was not yet built. The question is whether this will still happen, since the project developer considered thermal isolation more important and expected to get the subsidy anyway. When we checked in the summer of 2008 it had still not been finished. For the apartment buyers thermal isolation is an asset, but they were not very interested in separating grey and black (heavily polluted) water, since this would incur additional cost and they would not get the money back.

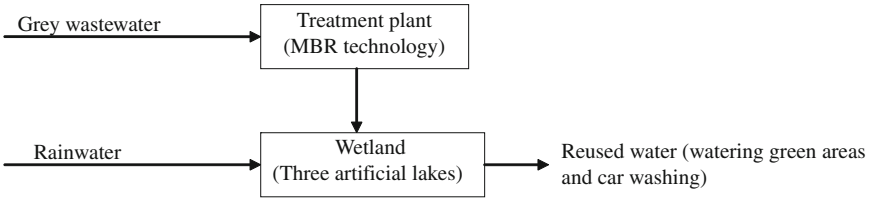

Fig. 3.2 Water recycling in the Taiyue-Jinhe project. *Source*: Interview with the manager of the Tai project

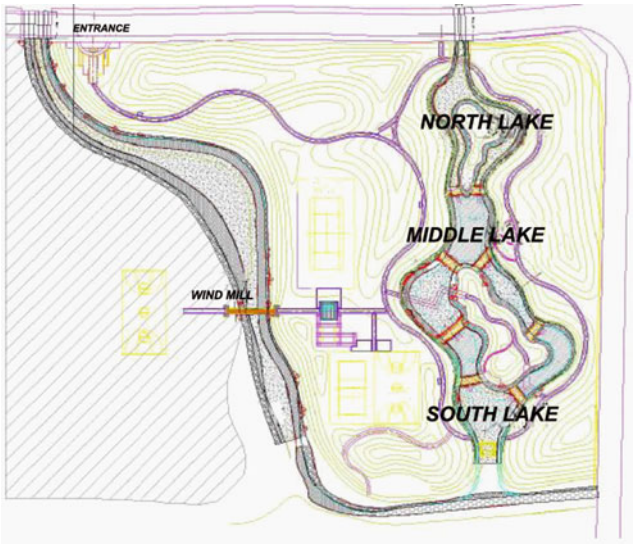

Fig. 3.3 The wetland. *Source*: The Tai project introductory document

Our research aims at completing a financial and economic analysis of the decentralized system of urban water management (also Zhang 2006). The expected outcome of the research may contribute to developing and selecting sustainable plans for urban water management by:

a. Determining costs and benefits for the alternative systems from the point of view of social economics
b. Financially appraising the alternative systems
c. Exploring the sustainable financing plans
d. Comparing the economic competitiveness of the alternative systems with that of the existing centralized system.

3.6.4 Initiatives at the Household Level

Finally individual initiatives can be noted, spontaneously or triggered by incentives. Environmental awareness may not yet be very developed in China and more time and policies that raise the consciousness of the people may be needed to achieve more activities at this level. However, people may save energy and tend to use less water than in developed countries, but this is partly due to the level of development, availability and price. Individual households usually install water heaters on the roofs of houses. In certain cities this is becoming a trend; the question is whether the systems are efficient enough to be recommended to large numbers of people and to have a substantial impact.

3.6.5 The Example of Singapore

Singapore is a city-state, an island of 20 × 30 km counting currently 4.5 million inhabitants. Its government has the ambition to almost double this number in the next 50 years. Singapore became independent in 1965 and started as an Asian tiger producing low-tech labour intensive products. In the 1980s it deliberately increased wages substantially, since it wanted to become an economy based on technologically more advanced products. Currently a third transformation is envisaged where Singapore wants to become a high-tech service economy in Southeast Asia. Yuen (2006: 414) notes that the "planning, design, and management of the urban environments are much admired by other Asian nations".

In the remarks of Roberts and Kanaley (2006), the country is also presented as an example of good practice, in particular its approach to sustainable urban development. Singapore is one of the four Chinese cities/regions figuring on the list of most competitive locations in Asia (on the list also figures Taiwan, Hong Kong and Zhejiang Province in China). There are some of the reasons for Singapore's economic success since its independence:

a. Political stability
b. Long-term vision and a development strategy
c. Leadership
d. Strategic location with a booming port, which is first in the world in terms of throughput of containers (measured in TEU)

Singapore is a kind of laboratory for housing and environmental policies in Asia. It also shows a coordinated effort to become a green city. The Ministry of Information of Singapore (2008a) published a brochure on "Green Singapore" and one on "Sustainability" (Ministry of Information of Singapore 2008b). The first publication details Singapore's urban planning and community involvement to make it a green city. In Singapore the shortage of water led to integrating wastewater treatment in an innovative way in the drinking water cycle, under the lead of the Singapore Public Utilities Board.[7] Having learned from this experience Singapore now wants to become a hydro-hub.

3.7 Rotterdam in Europe: Different Approaches to Urban Water Management

Rotterdam (in the Netherlands) is also an example of a city trying to become more ecological. It takes part in the Clinton initiative and is currently considering storing carbon dioxide in its port area. Rotterdam wants to become a climate proof city by 2020 (Rotterdam 2008a). Every city needs enough water for its population and industries, and hence it needs water resources. However, a city also needs institutions that secure good use of water. The current set-up in the Netherlands is complicated and the fragmentation of institutions makes integrated water management at the city level difficult. Given the need for a city like Rotterdam to deal with the risks involved in urban water management, we suggested three alternative approaches (van Dijk 2007a).

The first option is an integrated approach to water management, combining drinking water and surface-water management perspectives, which are currently institutionally separated in the Netherlands. However for such an approach, the current institutional context is too complicated and not appropriate for the problems Rotterdam is facing. Integrating the production of drinking water with surface water management was the option chosen by another Dutch city, Amsterdam. The authorities announced a merger between the water board and the municipal water company, which would lead to water chain management, where the customer would eventually pay only one bill for all water related services.

The second alternative is closing the water cycle to deal with water in a more efficient way. Closing the water cycle means not losing any of the scarce resource and controlling the quantity and quality constantly. Such an approach would favour integrating the management of the whole water cycle. Singapore has managed for example to close the water cycle and in principle, no water gets lost between

resource and users. All of it is cleaned and made available for reuse. In the Dutch context this would mean a closer cooperation between the water utilities and the water boards. It would also imply a different role for the municipalities. However this may be easier than continuing to clean dirty water from the rivers to discharge it again after treatment to the North Sea.

The third option is to strive for a more ecological city, where integrated water management would be part of a broader approach to the urban environment. The term ecological city could be used as an approach to urban management that combines water with environmental management and focuses on long-term urban sustainability. The perspective is broader than just water related environmental issues. Examples in the European context are Hanover and Hamburg and invite debate on the ecological city of the future.

Considering these options, a more effective management of the water system and making it more sustainable is needed. Water management can be undertaken by central government or by communities. In Europe the task is usually allocated to the city level, which makes it interesting for Rotterdam as they develop plans to deal with water in a different way (van den Berg and Otgaar 2007).

3.8 What Can We Learn From the Ecological City Experiences for the Future?

What can we learn from these different experiences to build the ecological city of the future? There is currently no definition of what an ecological city would really be, so we need to agree on what we consider the important criteria for sustainability and I would go for stakeholder planning to assure that all partners will work together for the common future of the city. Stating that it requires an integrated approach is not enough, because this could mean integrating the analyses of the issue (look at them in relation to each other). But also an integrated approach to deal with the issues can be chosen and finally the activities undertaken to solve the problems can be integrated.

Ecological cities are more than ecologically managed closed urban water systems. Sustainable urban water management is just the beginning. Changes in the behaviour of consumers will be required, just like a combination of better water management, collection and treatment of solid waste and striving toward integration (van Dijk and Oduro-Kwarteng 2007). Water demand management may be a good start at the household level, just like separation at source and composting at home is a good start for ecologically friendly solid waste management.

In China the initiatives are undertaken at three distinct levels, but there is no real integrated approach at the provincial (Fujian province for example, *China Daily*, 27-8-2002), or at city level. The institutional framework of provinces taking the initiative, provincial capitals trying to do something and a state level Ministry of Construction to approve projects are in place, while the state level Environmental Protection Agency that does the regulation, does not function properly at the moment.

Consultancy firms claim that sustainable urban development starts with integrated design (DHV 2007). However what's important is convincing people that it is essential to do something to improve one's environment. As the Dutch government claimed in a media campaign: The environment starts at home. More is necessary than consultancy reports. Good research shows what works and why help is needed with realistic suggestions for ecological cities of the future. Private developers are looking for new ideas, but they are also mainly interested in cost savings and offering attractive alternative options for the customers for their projects. In Europe we may need besides a "cultural capital" an annual example of a good eco-city initiative.

3.9 Conclusions

Urban development means forging new partnerships between parties that have not often worked together: government officials, non-governmental organizations (NGOs) and private sector businessmen. This requires "organizing capacity" (van den Berg et al. 1996) and the ability to develop an integrated approach to the key issues facing the city. This is the job of an urban manager (van Dijk 2006). Ideas about ecological cities change over time and this affects the design of policies and projects to improve the urban environment in which we live. We assume the ideas will change again, once the consensus thinking of the 1990s will start to fall apart because we will start to realize that countries, cities and wards differ from one part of the world to another, as anthropologists, non-western sociologists and geographers keep telling us. Pollution, solid waste and wastewater problems, all aggravated by climate change require a different urban management approach to build the ecological city of the future!

However, the eco-city of the future is not just about dealing with environmental issues. Such a city will also need a sound economic basis, appropriate solutions for its transport systems and requires urban amenities. The presence of sufficient amenities is an important factor to make a city attractive and receives more attention because it is contributing to the quality of life in cities. In the European Union this element is emphasized in its program of choosing periodically "a cultural capital of Europe". This is usually an opportunity for such a city to show what it has to offer and to make additional investments to increase its attractiveness. In the future we may need to choose an eco-city as well.

Notes

1. The paper is based on research carried out in the framework of the Switch project, where work on modelling floods has been quite prominent, but where also the question has been asked how to link the results of such modelling efforts to the existing decision making structures (Van Dijk 2009a).

2. Nine cities around the world serve as demonstration cities and a learning alliance framework will be established in each demo city. Through the learning alliance platform, the barriers to information sharing are broken down and the process of technological and institutional innovation is sped up.
3. There are even some Build, Operate and Transfer [BOT] projects of local investors in this sector.
4. The current rate is 10 yuan to the euro.
5. The case study has been undertaken in Wuhan in November 2007 with a doctoral student, Mrs. X. Liang.
6. Grey water is wastewater generated in households, excluding water containing human excreta or urine, but including water from kitchens, bathrooms and laundry rooms.
7. The water utility in Singapore functioned already well for a long time, although it was only a municipal department, not even corporatized to separate its finance from the regular municipal finance. However, the authorities did not interfere!

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