Learning from Asian and a European experiences for Eco-cities of the future
A contribution to the International conference on Creative design for sustainable urban development

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Abstract
Cities have introduced policies and programs to deal with issues like climate change and pollution. They want to become more ecological or eco cities. Initiatives taken to become a more sustainable city or to create ecological neighborhoods or eco-cities have been documented. Elements that come back are: closing the water cycle; reducing greenhouse gas emissions; go for waste minimization and integrated waste management; develop integrated infrastructure and transport policies. The challenge is to achieve integration in framework of urban management. Efforts to create environmental sustainability in Indian, Chinese and European cities will be reviewed, determining to what extent they have contributed to the development of livable, productive and inclusive cities. What were the key policies that contributed to their success and which lessons can be drawn from successful examples of eco cities or neighborhoods that can inform rapidly urbanizing cities in developing countries how to achieve sustainability?

I. WHAT ARE ECO-CITIES?

This conference is about creative designs for sustainable development of future cities. However, I struggled with the definitions eco and smart city and I suggest focusing in this contribution on the major dimensions of an eco city, after putting such an eco city in the context of CO2 neutral, resilient, smart and sustainable cities. Smart or creative cities emphasize the importance of innovations, such as the digital town hall and using IT for other purposes. Green cities want cities to be more livable, while other cities have as an objective CO2 reduction, building a Resilient city, an Eco-city, a Smart city or Sustainable and livable city (the CRESS approach). The whole range of cities of the future, with each time a definition, the most important characteristic and something specific of each type of city is listed in table 1. The question is whether we can expect all these objectives to be achieved at the same time. Probably it is possible to say at the national level that this is the ambition, but we found at the local level that the focus is often on one aspect, and besides the CRESS objectives we find other labels for the city of the future, which will not be discussed in this paper: promoting the circular economy or creating a green, clean, healthy and or vibrant (in economic terms) city. We originally focused on
eco-city dimensions (Van Dijk, 2013), but now also check for the desire to be a smart city. This shows that half of the cities studied recently expressed the ambition to be a smart city as well. Criteria used for the Smart Cities Awards are mobility, IT infrastructure, water management, renewable energy and reuse, safety, cultural development, globalization and governance.

<table>
<thead>
<tr>
<th>Table 1 Characteristic of each type of city of the future</th>
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<td>Objective to be achieved:</td>
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<td>Achieving CO2 reduction</td>
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<td>Building a Resilient city</td>
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<td>Building an Eco-city</td>
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<td>Building a Smart city</td>
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<td>Building Sustainable &amp; livable cities</td>
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<td>Definition</td>
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<td>Carbon neutral</td>
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<td>Able to react to challenges</td>
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<td>Attention to pollution &amp; environment</td>
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<td>Make use of information technology</td>
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<td>Sustainability and good quality of life</td>
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<td>Characteristic</td>
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<td>CO2 reduction &amp; or storage</td>
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<td>Climate change proof cities</td>
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<td>More green, less polluted &amp; integrated</td>
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<td>IT at the city &amp; at household level</td>
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<td>Different types of sustainability</td>
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<td>Specific</td>
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<td>Compensate for negative effects of emissions</td>
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<td>Which challenges to prepare for?</td>
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<td>A different type of planning</td>
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<td>Would be more competitive</td>
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<td>People, profit &amp; planet, requires participation</td>
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**A strategy of encouraging urbanization and eco cities**

China is the only country in the world which has changed from a policy restricting urbanization to a policy of encouraging urbanization. This new type of urbanization is new according to Lan Xinzhen (in Beijing review April 3, 2014: 34-36) because it focuses on people's rights, because 'the plan emphasizes the integrated development of new-type urbanization, new-type industrialization, IT application and agricultural modernization', and thinks in terms of urban clusters, while taking cultural continuity and ecological factors into account. As such the integrated development of new-type urbanization contrasts with the city level approaches, which often focus on one objective to be achieved.

Measured in terms of the number of conferences, papers and websites, eco-cities are popular. This is important since cities face environmental challenges, have to introduce policies and programs to deal climate change and are looking for examples. Often they want to become more ecological or eco-cities. In this contribution we will look at some examples in Asia and Europe to identify the approach they followed. There are sectoral and issue based definitions and more strategic and integrative approaches. Given there is no generally accepted definition of ecological cities claims to be ecological cities are difficult to sustain. Many definitions have been suggested for eco-cities (for example Bhatnaghar ed., 2009) and some authors have put their own subjective view of what is important in these definitions. Kenworthy (2006) emphasizes the role of transport, Rombout (2009) stresses the importance of green (he talks about garden or lobe cities) and Raj (2009) stresses a culture environment parity in urban development planning.

The eco-city concept "suggests an ecological approach to urban design, management and towards a new lifestyle” (Wong and Yuen, eds, 2011: 3). The focus is on the urban metabolism
or a different way of dealing with the cycles of energy, water, waste and pollution. We suggest distinguishing five main policy dimensions for moving towards a more ecological city. The approach can be contrasted with the Eco²cities approach launched by the World Bank (Suzuki et al., 2010) to help cities in developing countries to achieve greater ecological and economic sustainability. Five main dimensions of eco-city policies can be found in the literature about eco-cities, which will be analyzed before dealing with the Asian and European experiences:

1. Ecological aspects
2. Water and waste related aspects
3. Energy aspects
4. The role of infrastructure and transportation
5. The management and implementation of eco city ideas

II. THE METHODOLOGY

This paper is based on a number of case studies. The following criteria for including a city in the study were used:

a. Presented in publications as an example of an eco city
b. The ideas are actually implemented
c. Possibility of a visit to collect information on the different activities on the five dimensions and four levels distinguished
d. Possibility to collect data on indicators for the different dimensions and levels

Four levels of ecological activities will be distinguished: the city, neighborhood, building and household level. Burnett (2007) points to the possibility of providing eco-labels to a city. Secondly the focus could be on a new town, or a neighborhood. We will also give examples of ecological buildings: ecological villas, blocks of houses, or apartment buildings with common heating/cooling systems or a grey water re-use facility. Finally individual initiatives can be noted at the household level, spontaneously or triggered by incentives or price increases.

III. THE ECOLOGICAL ASPECT

We will consider dealing with the consequences of climate change and with efforts to create a greener city. Different climate change scenarios combined with increased pollution reveal the threat of temperature increases, more rain or bigger droughts for cities. Climate change forces cities to go for mitigation activities, or for climate adaptation policies. Cities aware of their environmental challenges have introduced policies and programs to deal with these issues. Research points to the importance of policies for climate mitigation and adaptation and of leadership at local government level to deal with the issue (Howe et al. eds, 2012).

Betancourth (2011) emphasizes the importance of nature conservation. Trees have been part and parcel of cities and deserve a place, even if they may hinder the circulation. Open and green spaces in an eco city can serve several functions. Duc Uy and Nakagoshi (2007) introduce land suitability analysis to optimize the benefits of urban green spaces. The percentage of green space to total space would give an indication of the success of these policies. How does a city deal with pollution, the opposite of what is expected in an eco-city (Van Dijk and Zhang, 2005).
IV. WATER AND WASTE RELATED ASPECTS

Due to climate change cities may face floods or water shortages. They may have problems with drinking water, waste water or solid waste treatment. Relevant questions are how can the projected changes in water supply result in adaptation policies in the concerned cities? Solid waste is also an important issue in cities and dealing with waste in a different way is required, for example because waste can also block drains, or cause health hazards (Usunju et al., 2011). Solid waste minimization and integrated waste management are important. Solutions considered are integrated water resources management, which means closing the water cycle as argued by the Switch project (Howe et al. eds, 2012). Policies suggested are efforts to close the water cycle.

V. THE ENERGY ASPECTS

How does the city deal with energy issues? Energy management, usually means reducing greenhouse gas emissions, an important reason for climate change, which has an indirect negative effect on cities. Glaeser and Kahn (2010) focus on the possibility to reduce emissions. Smith Morris (2011) shows how in the 'New urbanism' in England CO2 reduction played an important role. Different projects wanted zero carbon buildings and the eco-towns concept only later broadened its meaning. There is an extensive use of environmental technologies for energy management to make the city’s life support systems become closed loop systems.

VI. THE ROLE OF INFRASTRUCTURE AND TRANSPORTATION

There are many infrastructural options and different modes of transportation. The choice between them is often conditioned by history, culture and climate and in some countries bicycles have survived because a proper infrastructure was provided (separate bicycle lanes), or the current regulation protects cyclists (in the Netherlands). Kenworthy's (2006) emphasizes the need to move away from a car dominated city and to build cities around foot paths, bicycle lanes and public transportation. Transport is an important issue, since it is crosscutting: it has to do with different means of transportation and their fuel consumption and with the design of a city. Transport can be an important source of air pollution and causes a lot of noise. Finally, transportation is an important issue in physical planning, which can also help to deal with the issue. Integrated transport policies are desired, but often specialized departments and different levels of government deal with different modes of transportation and different types of roads. What has been achieved in terms of reducing travel time and congestion? Has a rapid transit system been introduced, or an alternative type of transportation been promoted in our eco-city?

VII. THE INTEGRATED PLANNING AND MANAGEMENT OF ECO CITIES

Wong and Yuen (eds, 2011) emphasize the importance of planning of eco-cities. Within urban development a distinction can be made between the urban planning and urban management approach. In the first case the design, the planning process and resulting urban plan receive most of the attention. The urban management approach emphasizes the importance of putting a plan into practice, with the help of all relevant stakeholders. The urban manager may take an activist stand, trying to achieve the necessary investments by promoting participation of all stakeholders.
VIII. SOME CHINESE ASIAN AND EUROPEAN EXAMPLES

China probably has the largest number of new initiatives for eco-towns. Wu (2012: 170) notes that more than 100 Chinese municipal governments are proposing to build eco-cities or eco-towns. These are often new towns and low carbon cities and often international partners are used to achieve the desired status. To what extent do the examples contribute to the development of livable, productive and inclusive cities? What were the key urban policies that contributed to their success and which lessons can be drawn from successful examples of eco cities or neighborhoods that can inform rapidly urbanizing cities in developing countries how to achieve sustainability?

**Beijing**

Beijing, the capital of the People’s Republic 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 average precipitation is 640 mm per year, 80 per cent 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 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 figure of 2.48 per cent. 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). The city introduced 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. Earlier sectoral efforts undertaken concerned the promotion of rainwater harvesting (Liang and Van Dijk, 2011) and separating grey and brown water (Liang and Van Dijk, 2010). In 2013 air pollution was a big issue in Beijing and undermines its eco claims. However, China is to create a fund to help tackle air pollution in heavily affected cities, with Rmb10bn ($1.6bn) allocated to help industry comply with new environmental standards. (Hornby, 2014)

**Dalian**

Dalian in China aspires to be an environmentally friendly city and Yong et al. (2009) evaluate the results in terms of water use, energy use, waste generation per capita and its reclamation and treatment. It is mentioned that this wave of initiatives is linked to a certain degree of economic decentralization and the rise of the entrepreneurial city. However, the initiatives are also part of international pressure on China and a movement within China to reduce its greenhouse gas emissions. China has formulated specific objectives in its 11th plan (2005-2010) concerning per unit GDP energy consumption and wants to reduce its carbon intensity by 40 to 45% between
2005 and 2020. The interesting aspect of these projects is that they are not state-funded, but built with real estate developers.

**Dongtan**

Shanghai planned to build Dongtan, the city of the future (Economist 23-9-2006; Financial Times 15-9-2006) on an island at the mouth of the Yangtze River. The city would have been self-sufficient in energy and water and generate almost no carbon emissions. Petrol and diesel vehicles would have to be banned in favor of solar-powered boats and fuel-cell-driven buses. The city should have around 500,000 inhabitants in 2040 and would house an agro park to grow food in a sustainable way (Trouw, 9-11-2007). 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 much press coverage, but the question is what happens to diminish pollution in neighboring Shanghai with 20 million inhabitants and many polluting industries. Because of corruption the Dongtan project failed and was abolished (Van Dijk, 2011).

**Nanjing**

Even Chinese provinces want to get the label eco-province 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 a province 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. Nanjing, the capital of Jiangsu province developed a proposal for further eco development (Nanjing, 2008). The initiative concerns the city level and has not really been implemented.

**Rotterdam**

Rotterdam an important European port, located in the Netherlands, tries to deal with climate issues in its plan Rotterdam Climate proof (Rotterdam, 2008). The brochure Rotterdam climate proof gives a good overview of the main issues for a city wanting to deal with the climate change problem. It describes the consequences of climate change formulates the challenges for Rotterdam and suggests climate adaptation policies for a safe Rotterdam. The Rotterdam Climate Initiative concerns climate adaptation, the strategy if prevention is not possible. Most policies concern combating pollution at the source, or end of pipe solutions. The objective is that the emissions of Rotterdam in 2025 would be 50% less. Rotterdam (2008) not only gives an overview of the main issues for a city wanting to deal with the climate change problem, it also describes the consequences of climate change and suggests an adaptation strategy (defined as adjusting to the new reality) for a safe Rotterdam. However, besides formulating the challenges for Rotterdam, it also wants to promote Rotterdam as a centre of knowledge (on climate), a place to experiment and demonstrate. Rotterdam wants to be a city for climate and water and it suggests a planning of the necessary activities.
Rotterdam also wants to invest in adaptation to ensure the security and health of the population, to limit the damage through climate change and to increase the return on investments in preventive physical planning and the existing infrastructure. Finally the brochure stresses: the societal value of innovative and attractive solutions. Novel aspects of the plans in Rotterdam are: public and private parties are supposed to provide a contribution and the city will get involved in strategic alliances with different levels of government, with knowledge institutes and construction and consultancy firms.

Rotterdam is also on the list of the 20 Smartest Cities in 2014 (announced 31-3-2014). These New Economy Smart Cities Awards have been awarded to those cities that through efforts to achieve sustainable development can be considered cities of the future. Rotterdam for example is praised because it wants to be climate change proof in 2020 and is active to become the most sustainable port in the world. Examples given concern
1. Its transport network
2. The water management in the city.
3. Extra water storage
4. A greening of the open space
5. Rotterdam wants to be a laboratory for innovative solutions, interesting for other cities as well.

The mayor Aboutaleb in his reaction emphasized that “together with universities and the private sector we are looking for solutions for the challenges faced by modern cities.” Rotterdam has a climate adaptation strategy developed with major stakeholders.

**Shenzhen, building an ecological harbor**

Shenzhen wanted to become an eco-city and now the initiative to develop an ecological harbor in Shenzhen is unique. It uses inputs from the state-owned Overseas Chinese Town Group (OCT) and the port has been designed as part of overall urban development, rather than as a tourism destination outside the city. The boulevards, plazas and beach at OCT Harbor are already a popular destination for people from Shenzhen. The emphasis is on the way polluted water is treated and the natural environment is restored. It is also hoped to save energy and to reduce emissions. The initiative has been taken by the OCT Group which wants to provide a new model for how China can transform cities.

**Singapore**

Urban environmental policies in Asia can also be illustrated by the positive example of Singapore, where special attention is paid to the issue of building in a sustainable way. The approach in the city state focuses 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. No water gets lost between the resource, the use for drinking water and the treatment and reuse of waste water. This is the work of NEWater, a company with the mission to go from “Sewage to Safe”. The company is using reverse osmosis technology for the process of transforming sewage into new, clean, safe drinking water.
**Tianjin**

In Tianjin, the river became polluted and the population could not drink the water for weeks. Now the city has achieved the designation eco-city from the central government in China. A flagship eco-city project is located 45 km from the city of Tianjin and is developed in cooperation with Singapore and partially financed under the Global Environmental Facility. Dunn and Jamieson (2011) evaluate it in terms of the relation between eco-city development and sustainable tourism. The objective of the project is to develop an economically sustainable, socially harmonious, environmentally friendly and resource conserving city. Fulong Wu (2012) notes that it is located in a newly established district, which is a national strategic location comparable to Pudong in the 1990s. Total investment is expected to reach 30 billion Yuan, while China and Singapore each controls half of this investment. It is largely located on unusable land, which makes the investment less sensitive to outside critique.

The story of the Sino-Singapore Tianjin eco-city is interesting and documented (for example, UNDP 2014). Its objective is to establish a harmonious and environmentally friendly city. A joint working committee has been established to study the major challenges. An eco-city management committee has been set up by the Tianjin Municipal government. Tianjin has learned from the experimental economic reforms and resulting business growth in the Binhai New area, the coastal are of Tinjian. The eco city has achieved:

a. The first smart power grid in China  
b. To set a standard and go for 100 percent solid waste trade treatment  
c. To reach at least 20 percent of the consumed energy is renewable.

**Wuhan**

Wuhan is one of the cities under study, in particular a neighborhood where wastewater treatment and reuse in the neighborhood would take place. Wuhan is also one of the largest cities in China, with total area of 8,494 km² and a population of 8.3 million. 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 kilometers reach of the Yangtze River and has nearly 200 lakes of various sizes. The water area makes up 25.8 per cent 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 totaled about 2 million cubic meters per day with domestic sewage and about 25 per cent 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 these cities greater than in other cities. However, some co initiatives at the level of buildings have been undertaken.

From the table we see that although the challenge is to achieve integration in framework of an urban strategy and plan, in many cities the initiatives are mainly sectoral (focusing on energy saving, water related issues, pollution abatement or ecological features) and sometimes only on one or two levels below the city level.
Table 2 Main emphasis in 10 eco-city initiatives

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Beijing</th>
<th>Dalian</th>
<th>Dongtan</th>
<th>Nanjing 2008</th>
<th>Rotterdam</th>
<th>Shenzen city</th>
<th>Shenzhen port</th>
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<td>Ambition to be a smart city</td>
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Legenda: B= building related E =energy related; P = pollution related; W = water related; S = subway system

IX. CONCLUSIONS

Developing smart or eco cities start with what a city wants to achieve? The term to choose largely depends on the objectives a city wants to achieve. If the emphasis is on the environment eco cities may be the term, if the emphasis is on the use of IT smart city may be more appropriate. The question was asked whether all the dimensions of these terms can be achieved in one single blow? We learned cities often focus on one or two elements and are not really following an integrated approach. Secondly some cities wanted to be eco cities in the 1990s and are trying to become smart cities now (Shenzhen and Beijing). Finally Chinese cities are compared continuously on a number of dimensions such as: their pollution (China Daily sometimes provides information on CO2, PM25 etc.), on per capita water resources and consumption, on areas in cities available for recreational purposes (China Daily 4-4-2014: 17), etc.

Eco cities can be seen as a new lifestyle and type of management, which is more in harmony with the natural environment and predicated on the objective of long term sustainability. Efforts to create urban environmental sustainability in a number of Asian and one European cities were analyzed and the question was to what extent have these cities followed a strategic city based or a more sectoral approach? Table 2 showed that almost half of the examples followed a more sectoral approach and in only half of the cases the emphasis is on the city level. The advantage of
separating different sectoral interventions is that it allows a comparison or benchmarking on these dimensions, taking different indicators and comparing the performance. The initiatives do not have to come from governments, project developers and private individuals can also take the initiative and the activities of these stakeholders should be incentivized.

Ideally the city would follow a system approach to assess the interaction between the different components distinguished so far. Objectives concerning justice such as equality are important, while also managing urban risks. All decision making should be sustainability-based, integrating social, economic, environmental and cultural considerations as well as compact, transit-oriented urban form principles. Such decision making processes would be democratic, inclusive, empowering and engendering hope. The evidence collected for these eco-cities using different indicators shows that their approach is often not integrated nor based on a strategic vision document. Integration could take place in the framework of urban management, but the emphasis should be on involving stakeholders in implementing sectoral initiatives, facilitating their initiatives at the city, neighborhood, building and household level.

**BIBLIOGRAPHY**


