

# New Eco-Cities, New Open Spaces: the Future of Green and Blue Infrastructures

Fabiano Lemes de Oliveira <sup>\*1</sup>

<sup>1</sup> Senior Lecturer, Department of Architecture, University of Portsmouth, UK

---

## Abstract

This paper analyses how some key eco-city models have proposed the creation of networks of green and blue spaces and discusses how these strategies can be relevant for new greenfield cities in 2050. New urban settlements being planned from scratch, such as Dongtan and in China and Masdar in Abu Dhabi, are hoping to become models of sustainable urbanism for the future. In its first part, the paper discusses the emergence of the eco-city ideal and the conditions we expect to face in 2050. Secondly, it investigates how some of the newly created cities organize their green and blue infrastructures, and how they envisage their role in contemporary life and in the future urban environment. Finally, building on this analysis and focusing on the environmental, social and economic challenges that are expected in 2050, the paper discusses its findings and presents a vision for the role that the networks of green and blue spaces can play in future cities. To conclude, this work aims to inform discussions on the future of open urban spaces in the design of cities in the 21st century.

**Keywords:** eco-city, sustainable cities; sustainability; urban planning, urbanism

---

## 1. Introduction

In the context of climate change, the expectation that 70% of world's population will be living in cities by 2050 and that the population will have grown to more than 9 billion people, the role that cities will play in the future of mankind is absolutely crucial. The phenomena of urban and population growth in many regions around the globe, coupled with the fact that shrinking cities are also verifiable events, particularly in the developed countries, poses us the problem of how to promote better sustainable cities, environmental policies and programs, and improve urban environmental management across the globe under these circumstances. The climate change imperative and the need to guarantee the right to quality urban settlements to all in an increasingly

urbanized world need to be observed. In this context, a series of 'eco'-cities have been presented as models for the future, such as Dongtan and Masdar. The paper investigates the role green and blue spaces have in such proposals and discusses how important they are in helping cities achieve the levels of sustainability, connectivity, well-being and food production expected for 2050.

## 2. Cities and eco-cities in 2050

The exponential urbanization process and population growth, occurring mostly in developing countries, will not be counterbalanced by the shrinkage observed in other parts of the world. In fact, by 2050 the population of developed countries is expected to remain at 1.2 billion (United Nations, 2007), with 80% of those citizens living in cities, while the population of less developed countries will grow to around 8 billion (Peirce, 2008). In addition, the prediction is that more than 60% of the globe's population will be urban. It is widely held that urbanization and climate change are directly linked, which makes it fundamental that cities are treated as parts of the solution – a centerpiece of all the activities and programs towards a sustainable future (UN-HABITAT, 2010, WWF, 2010, Ewing, 2010).

---

\* Contact Author: Dr Fabiano Lemes de Oliveira, Senior Lecturer, Department of Architecture, University of Portsmouth, address: Portland Building, Portland street, Portsmouth PO1 3AH, Hampshire, United Kingdom  
Tel: +44 2392842090 Fax: +44 2392842087  
e-mail: [fabiano.lemes@port.ac.uk](mailto:fabiano.lemes@port.ac.uk)  
(The publisher will insert here: received, accepted )

The role that cities will play can assume different forms and dimensions according to the literature, but it is usually assumed that sustainable urban planning should encompass aspects of economic, environmental and social sustainability.

Different ideas of ecological developments and, lately, sustainable living and urban spaces have been applied to planning and urban design in the last 30 years in many forms, with more or less emphasis on one or some of these three aspects. Since Register's book *Eco-city Berkeley* (1987) the concepts surrounding the idea of Eco-City have been developed (Roseland, 1997) and spread across the world. A large amount of research has been done on the relation between urban form and sustainable indicators (e.g. Beatley, 2000, Jenks and Burgess, 2000, Jabareen, 2006, Roaf et al., 2009, Jenks and Dempsey, 2005). Not only adopted in the retrofit of existing cities, these research results started to be used in the construction of new purpose-built greenfield urban settlements. Although it is a fact that European countries are mostly concerned with the reconstruction, regeneration and revitalization of the inner city, there are also examples of new cities being proposed anew, such as Whitehill-Bordon Eco-Town, in the United Kingdom, and MVRDV plan for Logroño in Spain. Nevertheless, the recent boom of eco-city projects is taking place mainly in China and other non-European countries, which have started a movement of building cities from scratch not seen since the New Towns of the early post-war period. In reality, the impact of these projects could be extremely significant for achieving the levels of sustainability expected for the next decades, taking into consideration that the population in these countries will reach 8 billion people as mentioned before and that levels of urbanized land tend to grow at similar rates. Bearing that in mind, the questions faced by planners and architects involved with the planning and design of eco-cities can be encapsulated as follows: how should these places be designed? What form should they have to best meet sustainability indicators? How can cities become the solution to the problems of an urban world?

There are many definitions of Eco-Cities (e.g. Roseland, 1997, Kenworthy, 2006), but they can be summarized in a set of principles related to the Bruntland Report's concepts of environmental, economic and social aspects of sustainability. The literature usually discusses the need to: a) promote healthy and less-consumerist living behaviors, b) reduce their ecological footprint, c) increase resource efficiency, d) provide affordable housing, e) provide good public transport and quality facilities, f) promote walking and cycling, g) work at regional and local levels, h) be compact and aim for medium-high

density, i) adopt mixed-uses and a diverse social mix, j) increase social equity and economic efficiency, k) promote biodiversity and greater access to quality green spaces, l) engage in food production; among others.

In this paper we focus our attention on key relationships between adopted eco-city principles and the role that green and blue infrastructures can play in achieving these, in selected case studies.

The history of integrated and cohesive systems of greenery is large and dates back to Olmsted (1870) in the 19th century. Evidently, the concept has acquired different facets in the decades since, but it has remained as an idea in the minds of planners since its original formulation. Nowadays, it is being presented, particularly in the UK and US, under the term "Green Infrastructures" (Benedict et al., 2006) and has become part of a set of necessary strategies in planning policy and practice aimed at achieving urban sustainability (e.g. CABE, 2004, LUC, 2009, TEP). For instance, Tokyo has recently established a strategy to transform itself into a 'City of water and greenery', while London has now presented its East London Green Grid Framework (TMG, 2010, GLA, 2008). In most, if not all, eco-city projects observed there is a clear intention to create a network of green and blue spaces as element of planning. They have become essential elements of the new "typology" of cities we are theoretically and in practice constructing now, the "Eco-City".

Green infrastructures are usually conceived of as a network of interlinked open green spaces, public or private, including a variety of uses and typologies. Their aims are manifold, but can be summarized as to: a) promote healthy living, b) improve air quality and biodiversity, c) preserve natural settings and water tables, d) enhance the amount of quality green spaces for the citizens, e) control or organize the growth of the urban settlement, f) connect urban and rural settings at regional scale, g) sew or "fill in" the urban fabric at city scale, h) encourage pedestrian mobility, among other benefits. More and more they are also used for the production of local biomass, food and renewable energy. Their main typological elements are gardens, allotments, playing fields, sports fields, all kinds of greenways, green wedges, parks (on all scales), greenbelts, forests and agricultural land. Most of these typologies fall within the categories of "hubs" or "links", although some elements perform both roles. Hubs are larger or more hierarchically significant elements within the structure. They anchor it down and are significant reference points, for instance, parks, woodland or playing fields. The links are elements of connection – as greenways or parkways – hierarchically less significant, but quality places in themselves as well. Some elements can

acquire aspects of both hub and linkage according to the project.

Blue infrastructures have not been sufficiently studied. They are often intrinsic elements of green infrastructure projects, but are acquiring more importance in recent projects as water supply, efficiency and management have also become crucial to tackling climate change and social inequality (ARUP, 2011, WWF, 2010). Sustainable water resource planning and management are fundamental aspects of eco-cities not only with regards to water supply and treatment, food production, recharging of water tables and flood control, but also as environmental amenities that have a positive psychological effect on citizens. They can be treated typologically in a similar manner as anchor points and/or linkage elements. In the sequence the paper discusses how the two Eco-Cities flagships have used green and blue infrastructures.

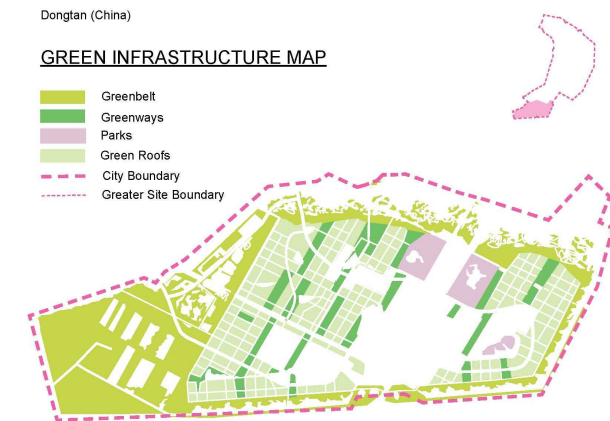
## 2.1 Dongtan

Dongtan was one of the first examples in China of an attempt to develop a city in a sustainable manner. It was initially designed by Arup in 2006, but the plan is yet to be implemented. As the designers stated, it was intended to be a zero carbon city for up to 500,000 people (in 2050) and serve as an example to the world “to inform sustainable masterplanning” (ARUP, 2009). As such, Dongtan was since the beginning intended to be a model for the future. The Eco-City would occupy an area of 8,600 hectares and eventually the developed land would cover just 40% of the total. The remaining would be part of a network of open spaces.

In the regional context, the whole proposal stands as a “linear city” composed of six urban nodes connected together by an arterial line and surrounded mainly by eco-farms. The creation of a multi-centered strategy is a shared approach between different eco-cities – such as in Changchun by AS&P – as it minimizes the impact of urbanization across the land, creates compact and dense urban settings, allows for more direct integration with extra-urban green spaces and creates greenways connecting the ecosystems around the urban development. In Dongtan, there would also be an “eco-park” and “wetland park”.

As Lord Rogers stated, one of the common principles of an Eco-city is that it should be compact, clearly defined and contained (Rogers, 2011, Jenks and Burgess, 2000, Jabareen, 2006). Dongtan and many other eco-cities adopted this concept and used the idea of a greenbelt to determine the confines of the urban fabric. In addition, the greenbelt works as a buffer zone between the urban area and the wetland. The other key elements of Dongtan’s green infrastructure

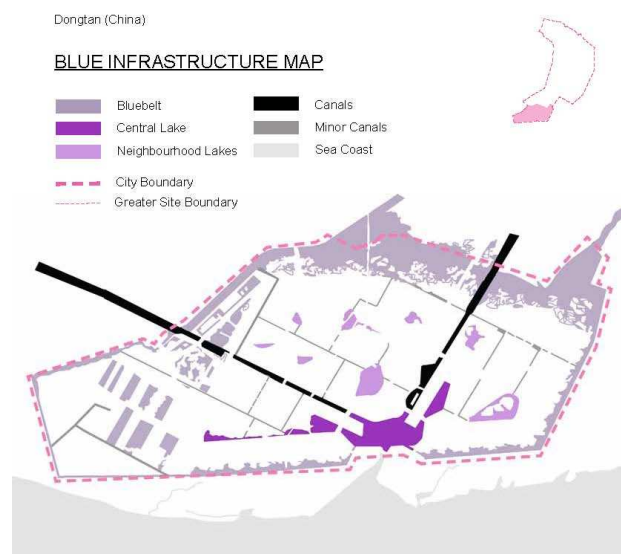
plan within the greenbelt include: staggered north-south greenways, cutting through the urban fabric from one side of the greenbelt to the other; urban parks, mainly located on the main gateway to the city; courtyards within the blocks; tree-lined streets and green roofs, as can be seen on Figure 1.



**Figure 1 - Dongtan's green infrastructure map**

Source: Image by Andrea Verenini

The blue infrastructure proposal for this Eco-City (fig.2) is also structural to its organization and supports the aims of creating sustainable and likeable communities. The outer element is the equivalent of the greenbelt, taking the form of a “bluebelt” running along the city’s edge. The core of the city is clearly marked by water, with the creation of a central lake. From it, two perpendicular canals divide the city up into three villages. These are then split up into districts by smaller streams. A series of neighborhood lakes are placed across the city, reinforcing communities’ sense of identity and creating moments of interest, anchor points within the mass of buildings and greenery.



**Figure 2 - Dongtan's blue infrastructure map**

Source: Image by Andrea Verenini

The green and blue infrastructures for Dongtan work together as a system. They shape the form of the city, control its sprawl, tie it back to the territory, define the spatial arrangement of the city at different scales and play crucial roles in the creation of an environmentally sustainable city. The characterization of the city centre with water highlights the importance it plays in the whole vision for the site. The canals tie the city back to the territory and define the districts, while the streams work even at a smaller scale, visually delineating neighborhoods. The Lakes are main hubs in the system, placed along the main route, in conjunction with the greenways and functioning for the neighborhoods in the same way the central lake does for the whole city. The greenways, the streams and the lakes work together to construct a sense of place for the different parts of each village. In addition, the greenways bring cooling breezes into the city. The connection between city and the countryside is provided through the greenways and the canals. Food production is a main function of some of the open spaces, as well as energy production, water management and recycling.

As discussed, the urban framework for Dongtan, as well as its image, is highly defined by green and blue spaces. These spaces undoubtedly support many principles set forth for eco-cities, and specifically for Dongtan, such as: healthy living, reduced ecological footprint, promotion of walking and cycling, preservation of wetland and fauna, conservation of biodiversity, the need for compactness, access to fresh air and quality green spaces, and the production of food – as well as places for the production of renewable energy, local biomass and recycling.

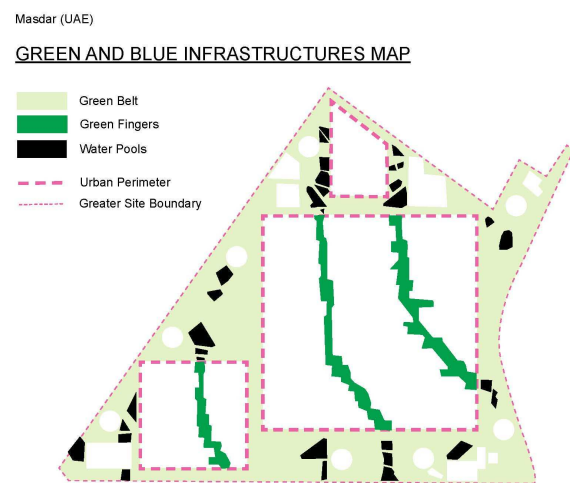
## 2.2 Masdar

Located near Abu Dhabi, Masdar is another world famous eco-city model for the future. Designed by Foster + Partners in 2007, the Eco-City is, like Dongtan, supposed to become a role model and demonstrate to the world how highly aspirational environmental, social and economic goals can be met (Masdar City, 2010). The city is intended to house 40000 people, be based upon a series of eco-principles such as carbon neutrality, low energy demand, recycling and renewable energy, among others. Due to the last economic crisis, the scheme was placed under scrutiny and some of its elements have been re-designed.

It is worth mentioning that Masdar is considered within the Abu Dhabi Plan 2030, which sets out an urban framework for the region. The plan defines the creation of a National Park, a green gradient from it to the capital city, a “sand belt”, in the fashion of a greenbelt, and “desert fingers”, like corridors for

wildlife (ADUPC, 2007, p.51-2).

Masdar takes on, at the city scale, the ideas of belt and fingers. The use of greenery and water is restricted in this proposal. Traditional Arab city principles, such as high density, compactness, walkability and narrow streets, among others, were used by the design team as a means of integrating the city into its wider context, and to better take advantage of the climate conditions. The use of greenery is historically less significant in Arab cities, where hardscapes tend to prevail. Although Masdar is being built in a desert, there is an attempt to construct a greenbelt around the city and “green fingers” that would run through the urban development.



**Figure 3 - Masdar's green and blue infrastructure map**

Source: Image by Andrea Verenini

As in Dongtan, there is a clear intention to delimit the city, which should have a well-defined form and be contained. In Masdar (fig.3), the main urban areas are defined by walls and are surrounded by green and blue spaces extending out to the outer edge. The greenbelt – whilst controlling sprawl – houses energy production facilities, stores water, provides parks, productive gardens, habitats for endangered species, and sports and leisure facilities.

The “green fingers” are the primary inner-city green spaces. They would be one of the few grassed spaced within the urban area and would take advantage of the east-west orientation to help cool and ventilate the city (AECOM, 2011). They cut through the whole city, connecting different areas of the greenbelt. They would provide a wide range of quality spaces for the citizens, as well as collect water to be treated and reused in the city.

In terms of the use of water as an element of planning, there is little visible on ground floor. The round towers punctuate the greenbelt and are usually related to the green fingers. Water pools seem to

provide extensions to the green fingers when they leave the urban space (now blue fingers). They would help humidify and cool the area.

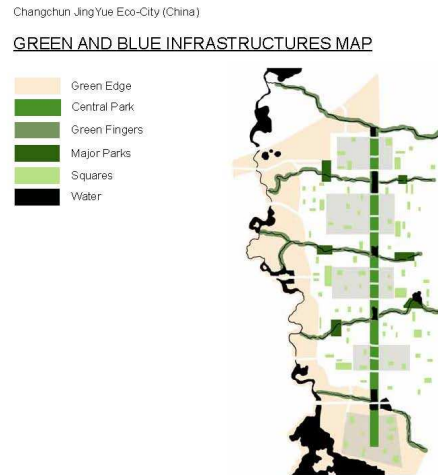
In synthesis, the green and blue infrastructure strategies for Masdar seem still to be under development. So far, they consist of applying the idea of greenbelt on the outskirts and green fingers within the urban areas, similarly to what has been proposed in Dongtan. The use of water does not acquire the same strength as the green elements mentioned above, and appear on the plan as sequences of storm pools along the extension lines of the green fingers. Nevertheless, these spaces in the proposal also aim at helping to reduce the ecological footprint of the whole city; are used to manage energy, water and waste efficiently; promote biodiversity; help cooling the city and provide fresh air; and control growth and connect distinct parts of the urban development. They help create a new oasis.

### 2.3 Other Eco-Cities and their approaches to green and blue infrastructures

Several other eco-cities have emerged in the last decade following the high-profile flagship examples of Dongtan and Masdar. Changchun (fig.4), in China, planned by AS&P in 2007, is another very interesting example of the application of sustainable principles in city design. The idea of a definite edge is also present here, where the western city boundary is defined by a river and a green buffer zone alongside it. Green/blue fingers cut through the city, reaching another buffer zone towards the east. The green infrastructure project also includes a central longitudinal park, interconnecting the different centralities – and a series of squares, courtyards and tree-lined streets. The water determines the creation of the axes and punctuates the districts. Waterways are also key to the design of another eco-city: Tianjin. It has been designed as a Sino-Singapore undertaking, aimed as the previous discussed examples, at becoming a zero-carbon/low-energy urban development for 350000 people and a model that could be replicable (Singapore Government, 2010). The network of green and blue spaces in this proposal integrates the idea of an “eco-grid”, occupying the land defined by the curves of the river. The river is the edge and the driving force of the scheme. From it, greenways along streams cut through the land dividing the districts up, in a similar manner to Dongtan and Changchun.

Old and new typologies of green and blue spaces are coming together in a wide range of proposals. For instance, the Fibercity project for the city of Tokyo in 2050, by Professor Ohno (2006), shows how new concepts, such as “urban wrinkles”, can be integrated with more recognized typologies, such as green fingers and green webs. However, in a myriad of

projects it is possible to see similar typologies being reproduced, such as the park, allotments, greenbelts and greenways. Can we think of different typologies to help us tackle these new problems or shall we use the same elements historically present in networks of open spaces?



**Figure 4 - Changchun ‘s green and blue infrastructure map**  
Source: Image by Andrea Verenini

The wave of Eco-City projects is strong, particularly in the developing world. Arup is drawing up proposals for Wanzhuang in China, Baku in Azerbaijan, Destiny, the first Eco-City to be in the US, and Northstowe in the UK (RIBA Journal, 2009). We are in the process of constructing a new typology of city, in which the network of open spaces is of foremost importance. In this process, it is almost certain we will also need to think of new typologies of green and blue spaces for the cities of the present and of the future.

### 3. Conclusions

Since Dongtan, there has been a growing number of designs for Eco-Cities around the world.. Alongside Dongtan, Masdar also hopes to become a role model for the world in the creation of a new typology of city, the Eco-City. It is more than meeting some indicators and principles of sustainability. It is about a new city concept. This paper raised the question of how these examples set out to use green and blue infrastructures to meet their objectives.

It is possible to say that the green and blue infrastructures are playing key roles in the construction of Eco-City frameworks. Well-known and new ideas are coming together in this formulation, but despite the studies done so far, we seem to be at the beginning of the process. The eco-cities are still to be built.

It is clear that there is a general attempt to establish

integrated approaches between different disciplines, professionals and local residents. Within the scope and limited extent of this paper, it became clear how green and blue infrastructures cannot be taken away from the process. They need to be part of the discussion from the start. They have become intrinsic elements of the eco-city design, both at city scale and regionally. This paper discussed how hubs and links in networks of open spaces – “greenbelts”, parks, “green fingers”, food production fields, canals, lakes and other elements – have been used in these first significant Eco-City projects. From this analysis, it is clear that all these spaces can be at the same time shape makers, quality places and resource centers:

- a) *Green(blue)belts* can define a city’s shape and control sprawl. They can help create a buffer zone between city and country, be used to generate energy, manage water and waste, to produce food and provide park land for citizens, etc.
- b) *Green(blue)ways* can cut through a city, connecting different parts of the greenbelt, divide the city up into smaller districts and neighborhoods, offer community allotments and gardens, habitats for plants and animals, corridors of light and fresh air, corridors for fauna and produce/manage resources, etc.
- c) *Hubs* like parks, lakes, squares, courtyards, etc, are stabilizers in the urban fabric and can offer all kinds of activities at community, city and regional levels, including sport, leisure, food production, energy production, etc.

Green and blue infrastructures have been used to shape cities, to preserve nature, to generate resources and manage waste, to produce food and healthy places for people, and to promote healthy living and healthier cities. We believe that they should be at the forefront of discussions so that our cities in 2050 can indeed face all the challenges predicted.

## 5. Bibliography

ADUPC 2007. Plan Abu Dhabi 2030: Urban Structure Framework Plan. Abu Dhabi: Abu Dhabi Urban Planning Council.

AECOM. 2011. *Masdar City Public Realm* [Online]. Available:

<http://www.aecom.com/What+We+Do/Design+and+Planning/stories/Masdar+City> [Accessed 03/03/2011].

ARUP 2009. Dongtan Eco-City. ARUP.

ARUP 2011. Water resilience for cities: helping cities build water resilience today, to mitigate the risk of climate change tomorrow. ARUP.

BEATLEY, T. 2000. *Green urbanism learning from European cities*. Washington, DC: Island Press.

BENEDICT, M. A., MCMAHON, E. & CONSERVATION FUND (ARLINGTON VA) 2006. *Green infrastructure linking*

*landscapes and communities*, Washington, DC, Island Press.

CABE 2004. *Green Space Strategies: a good practice guide*. London: CABE.

EWING, B. G., STEVEN; OURSLER, ANNA; REED, ANDERS; WACKERNAGEL, MATHIS 2010. *Ecological Footprint Atlas 2010*. Oakland: Global Footprint Network.

GLA 2008. *East London Green Grid Framework*. Greater London Authority.

JABAREEN, Y. R. 2006. Sustainable Urban Forms: Their Typologies, Models and Concepts. *Journal of Planning Education and Research*, 38-52.

JENKS, M. & BURGESS, R. 2000. *Compact cities : sustainable urban forms for developing countries*, London, E. & F.N. Spon.

JENKS, M. & DEMPSEY, N. 2005. *Future forms and design for sustainable cities*, Oxford, Architectural Press.

KENWORTHY, J. R. 2006. The eco-city: ten key transport and planning dimensions for sustainable city development. *Environment & Urbanization*, 18, 67-85.

LUC 2009. *South East Green Infrastructure Framework - From Policy into Practice*. Government Office for the South East.

MASDAR CITY 2010. *Masdar City: Experience for a Better Way of Life* [Online]. Available: <http://masdarcity.ae/en/index.aspx> [Accessed 03/03/2011].

OHNO, H. 2006. *Tokyo 2050: Fibercity*. Tokyo: Ohno Laboratory, the University of Tokyo.

OLMSTED, F. L. 1870. *Public Parks and the Enlargement of Towns*. *American Social Science Association*.

PEIRCE, N. R. J., CURTIS W; PETERS, FARLEY M. 2008. *Century of the City: No Time to Lose*, New York, The Rockefeller Foundation.

REGISTER, R. 1987. *Ecocity Berkeley : building cities for a healthy future*, Berkeley, CA, North Atlantic Books.

RIBA JOURNAL. 2009. *China Blueprint* [Online]. Available:

[http://www.ribajournal.com/index.php/feature/article/china\\_blueprint\\_AUGSEPT09/](http://www.ribajournal.com/index.php/feature/article/china_blueprint_AUGSEPT09/) [Accessed 02/02/2011].

ROAF, S., CRICHTON, D. & NICOL, F. 2009. *Adapting buildings and cities for climate change : a 21st century survival guide*, Oxford, Architectural.

ROGERS, R. 2011. In conversation with Lord Rogers. *In conversation with...* [<http://www.ecocit.org/main.php>].

ROSELAND, M. 1997. Dimensions of the eco-city. *Cities*, 14, 197-202.

SINGAPORE GOVERNMENT. 2010. *Sino-singapore Tianjin Eco-City* [Online]. Available: <http://www.tianjinecocity.gov.sg/> [Accessed 03/03/2011].

TEP Green Infrastructure for the Liverpool and Manchester City-regions. Indigo Lithoprint.

TMG. 2010. *Tokyo's Urban Strategy. Tokyo's Big Change: the 10-Year-Plan* [Online]. [Accessed 03/03/2011 2011].

UN-HABITAT 2010. *Climate Change Strategy 2010-2013*.

UNITED NATIONS. 2007. *Urban Population, Development and the Environment*. United Nations, Department of Economic and Social Affairs, Population Division.

WWF 2010. *Living Planet Report 2010: Biodiversity, biocapacity and development*. Gland: WWF.