Chapter 1
Cities and the Sustainability Dimensions

Sudhakar Yedla

Abstract Cities are the epicenters of economic prosperity, and that makes them vulnerable to various stresses both of environment and social dimensions. However, due to their higher per capita incomes and improved systems and infrastructure, they are equally capable to respond to certain corrective and futuristic measures. For the urban systems to sustain, they need to have abundant supply of resources as well as improved systemic efficiency in using the resources available to them. This accounting to both internal and external sustainability would be possible only by embarking onto ecological efficiency in various segments of the urban system accounting to production and consumption. Therefore, the cities have to develop a combination of policies to address in tandem and realize ecologically efficient production, ecologically efficient landscaping, ecological friendly culture, ecologically efficient and secured services provision, and ecologically efficient sanitation system. These five components as part of eco-city would help cities not only for their environmental sustainability but also on social equity and economic prosperity.

1.1 Introduction

Asian region has been experiencing faster economic growth for the past few decades resulting in excessive environmental load. Having achieved higher economic growth rates, countries such as China and India look for inclusive growth which could last longer. Particularly, the societal and environmental inclusiveness is considered important to make the development more sustainable. Given the economic, social, and environmental relevance of urban areas, the way cities are planned, developed, and managed will have a major bearing on the sustainable development of the region. This is particularly relevant with Asia expected to have 50 % of its population living in urban area in the next few decades.

Urban centers are the growth centers for any country, and one of the main obstacles in exploiting the potential of urbanization is the lack of an integrated planning,

S. Yedla (✉)
Professor of Environmental Policy, Indira Gandhi Institute
of Development Research (IGIDR), Goregaon, Mumbai 400065, India
e-mail: sudhakar@igidr.ac.in

which takes into consideration environmental and social aspects. This lack of integration is reflected in lack of integration of economic, environmental, and social aspects in policies and in institutions and across sectors. On the other hand, integrated and people-centered planning in cities like Curitiba (Brazil) and Bogotá (Colombia) has delivered substantial economic, environmental, and social benefits, while more recent eco-city development initiatives in Asia such as in Bangalore, India, as well as the proposed Dongtan City, and China are at the frontiers of applying sustainability concepts to urban areas.

In an attempt to find the limiting factors hindering the integrated and sustainable urban development in Asian and Pacific region, UNESCAP, in its recent works, has highlighted on lack of political support and widespread lack of awareness of sustainability concepts as applied to urban planning and infrastructure development (UNESCAP 2006a). Political support and inspired leadership have been among the reasons for the success stories of the cities cited above, as well as in other recent interventions, such as those in the cities of Seoul and Daegu, Republic of Korea (UNESCAP 2006b).

1.2   Potential of Cities

Geographical pattern of the world is on a rapid change. Both size and population of cities are on rise, and this pattern is being observed in Asia and the Pacific in the past few decades (Imura et al. 2005). Cities are the economic centers and possess high potential of employment generation. Most of the cities have higher per capita income than their respective national or regional average per capita. This coupled with lack of decentralized city planning and agrarian and other livelihood crisis results in raising rural-urban migration. It is expected that within the next few decades, fifty percent population in most populous countries like China and India would be living in urban agglomerations. It is for no dispute that Asian cities are fast growing both economically and geographically. UN-HABITAT had reported that majority of the World Mega cities would be from Asia in the near future (UN-HABITAT 2001). Thus, cities and their characteristics would define the regional dynamics.

Cities in this region have a particular characteristic of "intensity." Targeting for annual growth rates of their economy in the range of 8–10 %, Asian countries have been stressing their cities beyond their capacity. As a result the big cities in this region are the areas with most severe environmental problems in the world. These problems include overpopulation, lack of city planning with scientific considerations, uncontrolled and unreasonable expansion of city boundaries, severe traffic congestion, and formation of fragile urban-rural fringe areas. With higher-growth objectives, cities attract a large number of factories, which are environmentally unfriendly. This jeopardizes the urban sustainability. The economic system in its conventional pattern considers various segments of urban ecology as independent entities and also considers industry as an exchangeable consumer of resources and producer of products without much links with the city. This has resulted in a linear

production model with least ecological efficiency. Further, increasing per capita incomes due to the concentrated growth resulted in changing consumption patterns, which are ecologically unfriendly. Uncontrolled sprawling has been a root cause for the increased travel activity, and lack of infrastructure and eco-culture had resulted in excessive motorization and increased number of personal vehicles. Therefore, cities, which are the centers of economic activity and prosperity, have also been "centers of unsustainability."

With the increasing population on this finite planet with finite resources, we are not too far from a point where the endowment of natural resources can no longer be able to provide the life-supporting system for our economy and the society. Therefore, many international agencies as well as national governments have zeroed on an opinion that the present linear production system is not sustainable and should adopt "material cycle models." Given the importance of cities in our economy, strategies for sustainable urban development should be given priority in the overall sustainable development. This leads to various programs, viz., green cities, sustainable cities, industrial ecology, industrial symbiosis, eco-cities, etc. As the cities have been the centers of "unsustainable patterns of life," most of these green initiatives are centered on cities. While national and provincial governments have a role to play, it is the city governments who need to internalize the "green thinking" and "ecological principles" into their policy making, planning, and administration. In the economy of eco-cities, industry is interlinked with other industries and other segments of urban metabolism and is integrated in local and regional context which helps in achieving eco-efficiency. Therefore, the city administration has to play a key role of pivoting all the coordination required for eco-city development.

Cities, while they are the most exposed units to various problems, are equally equipped to handle solutions (Linan et al. 2004). As the countries and regions gear up for green and sustainability movements, they look at cities to implement those initiatives, which need trained human resources and technological and systemic support. Cities have conditions that are necessary to implement significant strategies for sustainable development. With abundant human resources and solid foundations of science and technology, cities have favorable conditions for carrying out sustainable development strategies oriented by knowledge and technology. Cities, which are the political, cultural, and educational centers, can play a critical role in demonstrating and promoting sustainable development strategies. With higher population densities and rich pool of resources, cities provide much brighter scope to achieve eco-efficiency. This in turn provides an opportunity to turn them into the "centers of sustainability." This argument is supported by UNFPA's report on "State of World Population 2007" (UNFPA 2007). With cities serving as the nodal points of economic prosperity, achieving eco-efficiency among them presents the most practical pathway for sustainable development. Therefore, sustainable urban development should get a priority while attempting sustainable development initiatives with particular focus on cities and urban agglomerations.

As they are stressed to their resource limits, cities have no way but to go through sustainable development phase, and it should be the ultimate goal of city development to achieve eco-efficiency. This goal should encompass various objectives, viz.,

harmonious increase of urban economic benefits, improved and modernized industrial structure, rational environment conservation, efficient utilization of resources, optimized city functions, ideal management of social services, and a higher standard of living. All these can be achieved if cities implement sustainable urban development strategies integrating all functional segments toward providing a superior living in an ecologically efficient way. When sustainability efforts are made in an administrative unit by means of utilizing and managing the local resources, setting up an ecologically sound institution and influencing people's behavior, such a unit is termed as eco-city. National or global sustainable development can become reality only when cities become ecologically efficient. The following section presents the concepts of eco-city and sustainable development in general.

1.3   Sustainability Science and Cities: The Basic Constructs

Ever since the environmentalism got into the existence, several definitions are given to sustainability. While some of them have limited the criteria of sustainability on maintaining ecosystems and natural resources, others considered social, economic, and ecological issues, well-being, and equity issues. In a generic presentation, sustainability is nothing but sustaining a system, may it be an institution or a human cluster. Considering these entities as operating systems, sustainability refers to sustaining these systems. There exists two ways of sustaining these systems. As in the case of systems approach, consider these systems as a black box, may it be an industrial production or an institution, and do not deal with it. Instead, deal with the external connections to the outer environment. This boils down to dealing with an input-output matrix. Therefore, a possible condition for sustainability of the systems is that the outer environment be able to supply the needed inputs on permanent basis and also accept its output. By its nature, this can be termed as external sustainability (Fleischer 2002). Based on this argument, if the environment can offer unlimited and the needed conditions, the system can sustain.

However, it is a well-known fact that economic growth is limited by two important aspects of the environment:

1. Finite nature of nonrenewable resources that environment can offer
2. Limited waste-receiving capacity of the environment (Turner et al. 1994)

Another dimension to the resources limit is that the rate of use of renewable resources cannot be greater than the rate of their regeneration. Therefore, unlimited and unrestricted support of input-output array from the environment is not a mere possibility. Thus, it is the human system (black box) that needs to adapt itself to the endowments of the natural environment. Therefore, targeting the criteria of external sustainability alone would not help sustain this system.

This leads toward examining the inside of the system. It is easy to understand that the rate of use of nonrenewable resources has to be limited so that its pace cannot be greater than the rate at which that source can be substituted by renewable

source. It is easily understood as criteria for sustainability. But the individual decisions are influenced by many factors such as economic status, education level, social background, cultural background, etc. By creating incentives to use energy resources more judiciously, one can make this individual decision closer to the global interest. Attempting to improve the systemic efficiency by considering these conditions could be termed as internal conditions for sustainability.

Task of achieving sustainability needs to fulfill both external criteria of sustainability and meet different internal conditions within a system. In the literature, the internal system of human settlement is subdivided into three subsystems, namely, economics, environment, and social. While these subsystems do not lead to sustainability in themselves, their interaction results in sustainability (Camagni et al. 1998). The overlapping field between environment and social sets gives the environmental equity subset which talks about inter- and intragenerational equity issues. Interactions between economics and social sets and environment and economics sets result in distributive efficiency and long-term allocation efficiencies, respectively. These interactions are shown in Fig. 1.1. Camagni et al. (1998) argues that the interacting subsets result in various externalities, both positive and negative. A city or human settlement is considered sustainable only when its three subsystems interact in a way that the sum of positive externalities resulting from such interactions is larger than the negative externalities of their interaction. Thus, for any city or a human settlement to be sustainable, it must integrate the operations of its subsystems.
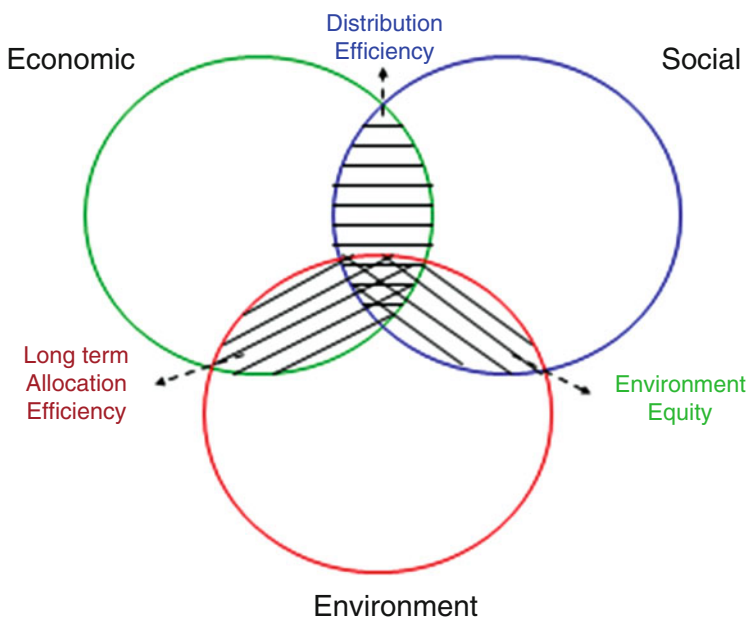

Fig. 1.1 Sustainability of the interaction of social systems (Source: developed by the author)

Different scholars choose different center points of the triangle of the three subsets, and it is interesting to see someone's central theme of sustainability may be an overlapping subset for some others. Therefore, definitions and the efforts toward sustainability depend on the subset triangle and the perceived interaction among them. Connecting the input-output matrix to the internal sustainability criteria shows the material flow goes through the city. A linear metabolism of cities is where the input is unrelated to the output which is thrown away as it comes out of the system. In contrast, circular metabolism uses every output as an input in another process (Girardet 1992). In order to handle these internal conditions of sustainability, literature had drawn on numerous classifications. However, there are issues common to all classification as explained in the next few paragraphs.

The above-discussed principles of sustainable development are generic in nature, and applying them to the society as a whole is not as practical. Therefore, it is initially applied to the cities and urban settlement. Roots of eco-city concepts are drawn from urban ecology. Urban ecology as a concept took shape during late 1970s of the nineteenth century and gathered real moment in the late 1980s with the publication of Register's Eco-city Berkeley (Register 1987), a visionary book on rebuilding of Berkeley. As defined by the first International Eco-city Conference held in Berkeley in year 2002, Eco-city is a "… living whole system, a natural and human-made unit having economically productive and ecologically efficient industry, systematically responsible and socially harmonious culture, and physically beautiful and functionally vivid landscape." Eco-cities are the places where living is made with least of human intervention that encompass all sectors, viz., mobility; energy; resources such as water, air, and soil; and social and ecological aspects as well. Mission of creating eco-cities follows ten principles as mentioned by Roseland (1997), which are extracted and presented below:

- Revise land-use priorities to create compact, diverse, safe, and vital mixed-use communities
- Revise transportation priorities to favor nonmotorized modes and transit over automobiles and to emphasize "access by proximity"
- Restore damaged urban environments
- Create decent, affordable, safe, convenient, and economically mixed housing
- Nurture social justice and create improved opportunities for women and other disadvantaged sections
- Support local agriculture, urban greening projects, and community gardening
- Promote recycling, innovative appropriate technology, and resource conservation while reducing pollution and hazardous wastes
- Work with business to support ecologically sound economic activity while discouraging pollution, waste, and the use and production of hazardous material
- Discourage excessive consumption of material goods
- Increase awareness of the local environment and bioregion

According to Roseland (1997), the major paradigms contributing toward eco-city concepts are appropriate technology, community economic development, social ecology, the green movement, bioregionalism, and sustainable development. The

central theme of "appropriate technology" is that a technology should be designed to be able to be compatible with its local settings. "Community economic development" is a process by which communities can initiate and generate their own solutions to their common economic problems and thereby build long-term community capacity and foster the integration of economic, social, and environmental objectives. "Social ecology" is a study of both human and natural ecosystems and, in particular, of the social relation that affects the relation of the society with the nature as a whole. Social ecology goes beyond environmentalism insisting that protecting environment is not just sufficient but to create an ecological society in harmony with nature. It brings forth the considerations of social justice and equity linking them to the energy efficiency and appropriate technology issues. Among numerous definitions given for sustainability, the one given by the UN is the most accepted, which states that sustainability is nothing more than meeting the needs of the present without compromising the ability of future generations to meet their own needs. The paradigms explained above provide general direction for the application of such concepts to develop eco-cities all around the world.

With increasing attempts to apply these concepts in practice to structure/restructure cities toward sustainability, ecology-centered development of cities has taken different shape depending on the scale of operation. Eco-city relates to relatively small and limited areas within the urban agglomeration in absence of which it would be practically no-hope situation for the implementation of the conception. On the other hand, eco-city aims at a complex and holistic solutions in the selected area. Given the complexities in implementing, application of ecological principles is practically easier when tried with a small community and segments of the larger city. Developments of eco-towns and eco-industrial parks are such attempts, which are not eco-city movements in themselves but only a contributing part toward the development of an eco-city (GEC 2005). While eco-cities focus on overall urban planning and urban ecosystems, civil society and greening of cities, eco-towns focus on industrial systems, 3R, life cycle economics, etc. Eco-industrial parks focus only on industrial area, ISO 14001, and individual factories.

Development of eco-cites is a long and slow process. There exists other approach of end-of-pipe which is not only partial in nature but also applied only to "already damaged/polluted" entity. Another approach of linking environment to economy to avoid the formation of environment-damaging actions fails to encompass the maximization of resources utilization. In contrast, eco-city movement considers a spatially limited area and tries to create a livable and sustainable urban life by considering each element of urban life. As explained by Juergen and Rusong (2005), eco-city development is a healthy process toward sustainable development within the carrying capacity of local ecosystem through change of production mode, consumption behavior, and decision instrument based on ecological economics and systems engineering. Integration, demonstration, citizens' participation, and scientists and technician's catalyzing are the key instruments for the implementation of the eco-city plan (Juergen and Rusong 2005).

With sustainability concepts as foundation and the urban ecological principles providing the guidance, eco-city development requires an evolution of its
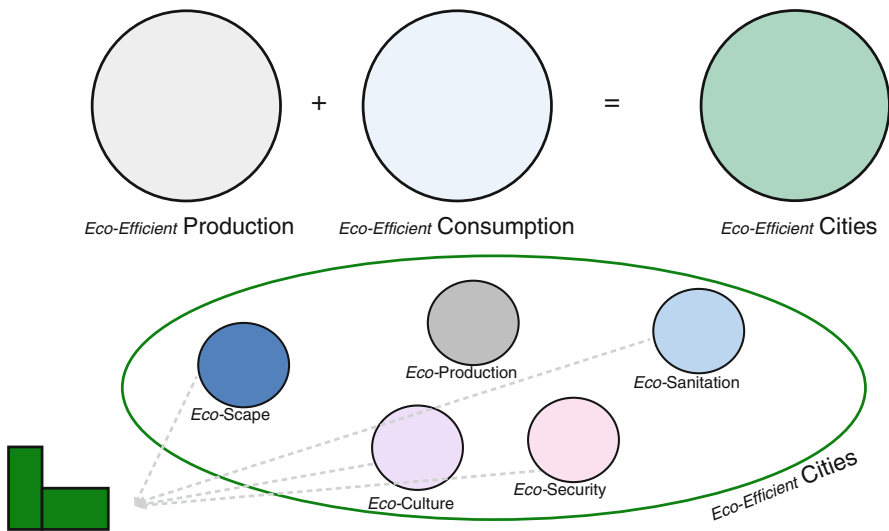
Fig. 1.2 Components of cities and their sustainability (Source: developed by the author)

components/units, which is a long and adaptive process based on the carrying capacity of the eco-systems. Juergen and Rusong (2005) have identified five such evolutionary components/goals to bring eco-city into practice. They are ecological sanitation, ecological security, eco-industry/ecological metabolism, eco-scape (eco-landscape), and eco-culture. Figure 1.2 presents these concepts.

Ecological sanitation provides citizens with a clean and healthy environment through encouragement of ecologically oriented, cost-affordable, and people-friendly eco-engineering for treatment and recycling of human wastes, sewage and garbage, reducing air pollution and noise, etc. *Ecological security* provides citizens with ecologically safe basic living conditions: clean and safe supply of water, food, service, housing, and disaster prevention. *Eco-industry/ecological metabolism* emphasizes on industrial transition from industry focusing on traditional products, to function-oriented and process-closed industry, through coupling of production, consumption, transportation, reduction, and regulation. *Eco-scape (eco-landscape)* emphasizes on alleviation of heat island, hydrological deterioration, greenhouse effects, and landscape patterns and processes. *Eco-culture:* Ecologically conscious man with ecologically sound and historically continuous culture grounded on the ecological principles of totality, harmony, recycling, and self-reliance. Eco-culture should be encouraged in eco-city development in the area of cognition (philosophy, science, education), paradigm or norm (religion, values, morality), behavior (production and consumption mode, customs), tangible cultural products (architecture, landscape, arts), and institution (organization, legislation, and policy making) (Juergen and Rusong 2005).

Achieving eco-efficiency and social inclusiveness is the most difficult task in eco-city development, which needs both scientific and administrative motivation to change people's lifestyle, production mode, and eco-consciousness.

1.4 Cities and Sustainability: Attempts and Lessons

Eco-cities are human settlements that respect the natural environment and use the least possible resources (by means of eco-networking in production process and changed consumption behavior) and keep waste and pollution to a minimum. Their economies are labor intensive, and buildings make good use of sun, wind, and rain. Food and goods are sourced locally, and transportation is limited to walking and cycling, with public transport for longer journeys. They encourage biodiversity by preserving natural habitats. Eco-cities offer their residents an excellent quality of life.

Based on concepts presented above, many countries have attempted to develop eco-cities, some with a great success. Such efforts are varying in degrees with some that have been comprehensive development strategies as in the case of Hannover Kronsberg, Germany. There are few more eco-cities being planned comprehensively such as Dongtan City, China and Masdar City, Abu Dhabi. Apart from such comprehensive projects, there exist numerous cases of eco-town and eco-industrial park development and also sustainable urban planning initiatives like Curitiba, Brazil. Though they do not qualify for an eco-city, they are certainly necessary steps toward achieving ecological sustainability of cities by addressing various segments of urban living. The following are such attempts made in various to achieve ecological efficiency in cities.

1.4.1 Dongtan Eco-City Project in China (Girardet 2004; Zhao and Girardet 2006)

Shanghai Industrial Investment Corporation has commissioned the world's first purpose-built eco-city – Dongtan. Built on Chongming Island in the Yangtze River Delta, Dongtan takes an area of 86 km^2 and houses 25,000 people and would have 500,000 people by 2030 (Girardet 2006). China, with 400 new cities planned to be developed in the next 20 years, aim to develop Dongtan Eco-city with a minimal ecological footprint which can be a template for future urban design. Its success would be crucial for Chinese city development program for the future.

Dongtan's design is based on the principle that all its citizens can be in close contact with green open spaces, lakes, and canals. It aims to ensure that people will take no more than 7 min to walk from any part of the city to a bus or tram stop. It aims to have buildings with high energy efficiency and largely powered by renewable energy – the wind, sun, and biomass. The city aims to create development with low energy consumption that is as close to carbon neutral as possible. Dongtan would produce its own energy from wind, solar, biofuel, and recycled city waste. Clean technologies such as hydrogen fuel cells would power public transport. A network of cycle and footpaths will help the city achieve close-to-zero vehicle emissions. Farmland within the Dongtan site will use organic farming methods to grow

food. Most of Dongtan's waste output will be recycled and composted. It is expected to be a vibrant city with green "corridors" of public space ensuring a high quality of life for residents. The city is designed to attract employment across all social and economic demographics in the hope that people will choose to live and work there.

Dongtan will be pioneering eco-city that could become a template for sustainable urban development, in China itself and elsewhere in the world. It holds a promise of high-efficiency, small-footprint urban design.

1.4.2   *Masdar Eco-City Project, Abu Dhabi*

The first project as a result of the Masdar Initiative is a new six million square meter sustainable development that uses the traditional planning principals of a walled city, together with existing technologies, to achieve a carbon neutral, car-free, and zero waste community. The city is being built to highlight innovation in energy efficiency, sustainable practices, resource recycling, biodiversity, transportation, and green building standards. Every building in the city is being designed and constructed to provide a model for sustainable living and working. The city, estimated to cost $22bn and take 8 years for construction, is planned to house 50,000 people and 1,500 businesses. Masdar is an attempt to offer a sustainable urban blueprint for the future. Launched in 2007, it is an ambitious project providing a mixed-use, high-density city.

The principle of the Masdar development is a dense walled city to be constructed in an energy efficient two-stage phasing that relies on the creation of a large photovoltaic power plant, which later becomes the site for the city's second phase, allowing for urban growth. Masdar will be linked to surrounding communities, as well as the center of Abu Dhabi and the international airport, by a network of existing road and new rail and public transport routes. With a maximum distance of 200 m to the nearest transport link and amenities, this provides best conditions for walking and personalized use of public transport system. With expansion carefully planned, the surrounding land will contain wind, photovoltaic farms, research fields, and plantations, so that the city will be entirely self-sustaining. The city will have low-energy buildings, with natural air conditioning from wind towers. A solar-powered desalination plant is expected to provide water to the city. The city is designed in a way to use only a quarter of the power required for a similar-sized community, while its water needs are expected to be lower by 60 %. As a part of the plan, Abu Dhabi will become home to the world's largest hydrogen power plant.

There exist other attempts to develop eco-cities, though not in complete framework as in the case of Dongtan. The following are such efforts in different cities around the world.

1.4.3 Project Agastya: An Eco-City Initiative in Bangalore, India

Project Agastya is an initiative of a nongovernment organization (NGO). It is a citizens' voluntary initiative with active support, cooperation, and participation of the Central and Karnataka governments, the industry, educational and research organizations, NGOs, residential associations, community-based organizations, facilitators, experts, etc. for transforming Bangalore into a sustainable eco-city by 2025.

Project Agastya seeks to achieve this transformation through efficient participation of government, various stakeholders, and NGOs, and deployment of environmentally sound technologies. Several initiatives taken up by Project Agastya in the pursuit of its objectives are urban water resources management (including water conservation, stakeholder participation, pollution control, rain water conservation, etc.), integrated (solid) waste management, E-waste management, eco-tourism, urban planning/eco-cities, and integrated and sustainable energy management.

1.4.4 Yangzhou City: Attempts of Eco-City Planning

Under the program of Chinese Agenda 21, Yangzhou city has developed a plan for eco-city development with three main goals, viz., promote economic transformation from traditional economy into resource type, knowledge-type, and network-type sustainable economy with high efficiency; promote regional eco-environment development to create a good ecological basis for social and economic development; and promote the conversion from local people's traditional production, lifestyle, and values into environment-friendly, high-efficient resources, harmonious system, harmonious society, and eco-culture. Under the eco-city development plan, the city has developed the following short-term goals – create more employment opportunities, increase average education years; incubate large eco-industry groups and enterprises, higher GDP growth rate, recover abandoned mine areas and wetlands, set up natural conservation areas, purify rivers, and increase green space in the cities and towns. A series of capacity-building measures from institution, legislation, technology, education, finance, and safeguards have been made and put into implementation.

1.4.5 Curitiba, Brazil: Three Decades of Thoughtful City Planning

The city of Curitiba successfully demonstrates to the world on how to move toward sustainable systems by means of thoughtful city planning integrating sustainable transport considerations into business development, road infrastructure

development, and local community development. In order to fulfill the goals of the master plan in providing access for all citizens, the main transport arteries were modified over time to give public transport the highest priority. Separating traffic types and establishing exclusive bus lanes on the city's predominant arteries helped to mold two defining characteristics of the city's transport system: a safe, reliable, and efficient bus service operating without the hazards and delays inherent to mixed-traffic bus service; and densification of development along the bus routes. Curitiba's busses carry 50 times more passengers than they did 20 years ago, but people spend only about 10 % of their yearly income on transport. As a result, despite the second highest per capita car ownership rate in Brazil (one car for every three people), Curitiba's gasoline use per capita is 30 % below that of eight comparable Brazilian cities. Other results include negligible emission levels, little congestion, and an extremely pleasant living environment. Curitiba boasts over 580 square feet of green space per inhabitant.

1.4.6   Other Green City Initiatives

Reykjavik, Iceland Reykjavik has been putting hydrogen busses on its streets, and, like the rest of the country, its heat and electricity come entirely from renewable geothermal and hydropower sources, and it is determined to become fossil-fuel-free by 2050.

Malmö, Sweden Known for its extensive parks and green space, Sweden's third largest city is a model of sustainable urban development. With the goal of making it to eco-city, several neighborhoods have already been transformed using innovative designs and are planning to become more socially, environmentally, and economically responsive.

London, England Under its Climate Change Action Plan, London will switch 25 % of its power to locally generated and more efficient sources, cut CO_2 emissions by 60 % within the next 20 years, and offer incentives to residents who improve the energy efficiency of their homes. The city has also set stiff taxes on personal transportation to limit congestion in the central city, hitting SUVs heavily and letting electric vehicles and hybrids off scot-free.

San Francisco, California, USA Nearly half the population takes public transit, walk, or bike each day, and over 17 % of the city is devoted to parks and green space. San Francisco has also been a leader in green building, with more than 70 projects registered under the US Green Building Council's LEED certification system. In 2001, San Francisco voters approved a $100 million bond initiative to finance solar panels, energy efficiency, and wind turbines for public facilities. The city has also banned nonrecyclable plastic bags and plastic kids' toys laced with questionable chemicals.

Bahía de Caráquez, Ecuador After it suffered severe damage from natural disasters in the late 1990s, the Bahía de Caráquez government and nongovernmental organizations working in the area forged a plan to rebuild the city to be more sustainable. Declared an "Ecological City" in 1999, it has since developed programs to protect biodiversity, revegetate denuded areas, and control erosion. The city, which is marketing itself as a destination for eco-tourists, has also begun composting organic waste from public markets and households and supporting organic agriculture and aquaculture.

Bogotá, Colombia Enrique Peñalosa, mayor from 1998 to 2001, used his time in office to create a highly efficient bus transit system, reconstruct sidewalks so that pedestrians could get around safely, build more than 180 miles of bike trails, and revitalize 1,200 city green spaces. He restricted car use on city streets during rush hour, cutting peak-hour traffic 40 %, and raised the gas tax. The city also started an annual "car-free day," and aims to eliminate personal car use during rush hour completely by 2015 (Wright 2001).

Kampala, Uganda This capital city is overcoming the challenges faced by many urban areas in developing countries. Originally built on seven hills, Kampala takes pride in its lush surroundings, but it is also plagued by big city ills of poverty and pollution. Faced with the "problem" of residents farming within city limits, the city passed a set of bylaws supporting urban agriculture that revolutionized not only the local food system but also the national one, inspiring the Ugandan government to adopt an urban–agriculture policy of its own. With plans to remove commuter taxis from the streets, establish a traffic congestion fee, and introduce a comprehensive bus service, Kampala is on its way to becoming a cleaner, safer, more sustainable place to live.

Eco-Towns in Japan Eco-town concepts originally focused on the individual systems related to 3R have now expanded to include eco-industrial parks and industrial symbiosis to focus on collective area within the urban setup. In addition to 3R (reduce, reuse, and recycle), eco-town concepts also involve green procurement, green consumerism, industrial ecology, extended producer responsibility, socially responsible investment, integrated waste management, green labeling, global reporting initiative, corporate social responsibility, EMS, and ISO 14001. In a nutshell, eco-town is a defined area where various eco-concepts can be developed and implemented. In Japan, eco-cities are originated through subsidies from various ministries such as Ministry of Economic, Trade and Industry (METI) and Ministry of Environment (MoE). Japan has one of the widest networks of eco-towns with strong legislation supporting the development of eco-towns. By March 2005, 23 cities were approved as eco-towns in Japan and received subsidies (GEC 2005). Eco-town projects in Japan include – Kawasaki, Kitakyushu, Iida, Oomuta, Sapporo, Chiba, Akita Prefecture, Uguisuzawa, Hokkaido, Hiroshima Prefecture, Kochi, Minamata, Yamaguchi Prefecture, Naoshima, Toyama, Aomori Prefecture, Hyogo Prefecture, Tokyo, Okayama Prefecture, Kamaishi town, Aichi Prefecture, and Suzuka. Eco-towns apply enterprise approach in achieving the optimal system of resources

utilization with industrial cluster forming the core. It mostly concentrates on both sides of sustainable production as well as sustainable consumption by means of 3R principles and people participation.

1.5   Sustainability of Cities in Asia: A Review

Asia and the Pacific as a region is characterized by surging population, increasing urbanization and the proportionately increasing share of slum (informal settlements) population, increasing size of cities and so the travel distances and time, higher income disparities (as expressed by GINI coefficient), higher GDP growth rates, increasing travel activity with disproportionate development of infrastructure, excessive reliance on personalized cars resulting in huge green house gas emissions, increasing production with considerably inferior technologies, excessive utilization of resources with very least to almost no recycling, and, most importantly, lack of strong legislation at local level to handle various environmental and resources-related issue coexisting with lack of awareness among public and other key stakeholders (Imura et al. 2005). Providing basic civic and environmental services to growing urban agglomerations in the region presents a major challenge to the local policy makers, particularly in the case of informal human settlements. Lack of capacity to implement potential financial mechanisms such as PPP furthers the complexity of the situation (IGES 2005).

According to the forecast, the proportion of urban population would be more than 50 % in the next two decades. Due to this process, huge areas of former agricultural and natural land are being converted to build up areas and traffic ways. Share of area for industrial use would go up, and this additional requirement of land for industry may force them to the periphery of the cities giving rise to peri-urban areas. Peri-urban areas are the most vulnerable and fragile urban systems. To solve the current and upcoming ecological problems of the region's urbanization in their huge dimensions and complexity, single measures and scattered strategies on environmental protection are not sufficient. The transformation of the cities into eco-cities by a holistic approach is the need of the hour.

Along with the basic tenets of eco-city development as explained in the previous sections, following issues need attention while attempting to develop eco-cities in Asia and the Pacific:

From the discussion in the previous sections on sustainability concepts, it is clear that in order to achieve sustainable cities, one has to integrate the operation of its subsystems, viz., economic, environment, and social. Further, the individual attributes of these three legs forming a sustainability triangle determine the boundary of sustainability of the system. For instance, Moomaw (1996), using the same concept of sustainability, considered culture, economy, and environment as three corners of the sustainability triangle that enclose well-being, making it the central goal. This well-being could also be seen as a particular principle of social subsystem. While one considers economy, environment, and community as three corners with health as a central theme, sustainability could be an overlapping subset of environment and

economy subsets. Therefore, it is essential to define the individual attributes of the subsystems of the sustainability triangle to reach the "desired dimension" of sustainability in Asia and the Pacific.

Asia and the Pacific as a region have a significant presence of peri-urban fringe areas. Development of eco-cities needs to internalize these fringe areas in order for it to be inclusive.

Poor systemic efficiency in civic services, low-end technology, and negligible recycling in production process present considerable scope for the implementation of *eco-efficiency* principles. A major share of the resources is wasted in the process of producing food, machines, vehicles, and infrastructure. It was reported that factor ten efficiency in the resource use needs to be targeted. Otherwise, a scarcity of resources would eventually lead to increase in the costs of production resulting from higher commodity prices. Eco-efficiency is often expressed as the creation of more value with fewer resources and less impact (UNESCAP 2006a).

Transportation system is highly inefficient in most of the Asian developing countries. Expansion of cities without proper city planning only adds to this problem. It gets more complex with the presence of slum population who are vulnerable to certain social implications of such unplanned system. Hence, improvements in travel behavior and traffic patterns need to get attention.

Many countries in this region suffer from poor governance and social inclusiveness. These two aspects play an important role in achieving eco-city development and hence need to be focused. Transparency and good governance along with multi-stakeholder participation are reported to be the success elements in various eco-town and eco-city initiatives around the world. With the presence of sections of varying social status, such social inclusiveness plays the key for successful development of eco-cities in Asia and the Pacific.

Change in individual consumption patterns is necessary by means of promoting environmental consciousness and 3R principles. Due to the presence of informal settlements, peri-urban fringe areas, and scattered industrial clusters, it is necessary to attempt eco-town development and make it a part of larger plan of eco-city development. With the vast nature of social strata and conditions, it may prove too complex to attempt a holistic execution. It is better to plan big and implement in parts. At the same time, piecemeal approach as it appears to be the case in many countries would not result in eco-living in urban agglomeration in this region.

Achieving eco-efficiency in industries plays a crucial role and development of eco-industrial parks, and promotion of industrial symbiosis plays an important role. Eco-industrial networking would help in making an eco-friendly production process. The decline of traditional industries and the dramatic change in industrial production patterns and global networking in the last two decades have opened new opportunities for ecological production. Clean production and ecological industry are key elements in comprehensive development toward an eco-city. In traditional economy, industry is mainly an exchangeable consumer of resources and a producer of products, which have not much to do with the city or region. In the economy of an eco-city, industry is interlinked with other industries and the location and is integrated in local and regional context which helps achieving eco-efficiency.

Promotion of cleaner production and eco-industry is appropriate measure to solve problems in the existing conglomerations in the region without total redevelopment and also to organize new eco-industrial parks with a well-balanced proximity of residential, working place, and other urban activities like shopping, education, recreation – avoiding the long commuter distances. They would also help integrate production, consumption in a comprehensive ecological-based economy. Developing eco-industrial projects needs time and a phase of orientation. Just like other high-tech development, particular setbacks cannot be completely avoided, and one has to work with a long-term perspective. Universally, the expectations of the authorities, entrepreneurs, planners, and public media in a rapid industrial and eco-industrial development are always higher. In Asia and the Pacific, with bigger challenges hanging over the heads, the temptation is high to trade long-term sustainable solutions for short-term results. The development of eco-city might take a little more time than conventional, resource-wasting urban development, but it will reward with sustainability. Eco-city and eco-industry development needs a strong, long-standing driving force, and a firm commitment for ecological living.

Ecological security is especially urgent for poor peri-urban areas in developing countries. Ecological security covers not only the tangible impacts on human health but also intangible or long-term impacts on human health and city's sustainability.

1.6   Policy Measures and Instruments for Promoting Ecological Efficiency of Cities

Development of eco-cities needs a systems approach where administration, eco-efficient industry, people's needs, culture, and eco-landscape are integrated. This implies a functional integration of these aspects which are presented as three segments, viz., "eco-industry," "eco-landscape," and "eco-culture." While eco-industry segment focuses on achieving resources conservation through industrial transformation and circular economy concepts, eco-landscape and eco-culture focuses on built environment and cultural aspects and consumption patterns, respectively (Juergen and Rusong 2005). Working toward eco-culture aspect is the most difficult part of developing eco-city. It needs both scientific and administrative motivation to change lifestyles and improve ecological consciousness. Promoting eco-city development needs a wide range of policy measures/strategies categorized into administrative, management, technological, and legislative.

Linan et al. (2004) have outlined a set of strategies to promote eco-city development. Such strategies include enhancing people's ecological consciousness and advocate and publicize ecological concept, drawing up of action plan to make the city development ecologically friendly, strengthening legislation for ecological society, establishing functional organizations that suit urban ecological development, developing and applying ecological technologies, and stressing on the inter-urban and interregional cooperation.

One of the important requirements for eco-city development is to "*internalize ecological principles*" in policy making and planning of city development. Ecology-centered strategies have to be made for cities, and priority development areas have to be designated. City of Curitiba in Brazil is one of those cities demonstrated on how to integrate ecological principles into urban planning and the corresponding benefits (ICLEI 1991, 1995). Movement toward eco-friendliness is at a very slow rate, and hence cities may have to develop a series of strategies to stimulate faster adaptation of ecological development. According to WBCSD, establishing framework conditions that foster innovation and transparency and that allow sharing of responsibility among stakeholders will amplify eco-efficiency for the entire economy and deliver progress toward sustainability (UNESCAP 2006a). Eco-planning of cities needs demonstration. In such an effort, China has initiated a movement for ecological demonstration districts involving the state environmental protection administration, research institutes, and local communities. The city of Dafeng in Jiangsu Province in China has started implementing eco-city strategy in 1986, and within 10 years time, its GDP has increased by 80 times while environmental quality remained at the same level of 1986. Such demonstration of eco-planning had resulted in greater dividends over long run with 82 cities and counties designated as "Ecological Demonstration Districts" by Chinese Government which implements eco-city planning strategies (Wang and Ye 2004). However, such demonstrations could have a negative effect as cities, by simply adopting the guidelines provided to them based on demonstration of pilots which may fail to achieve optimal solutions as their local conditions differ from the demonstration pilots. For the successful eco-city development, adaptation to local conditions holds the key. Therefore, to find a suitable path to sustainability of any particular city, local governments need to work with scientists to analyze current conditions and to adapt both domestic and international experiences to local conditions. City mayors and governors play a critical role in achieving such a development as demonstrated in the cities of Bogotá in Columbia and Curitiba in Brazil (ICLEI 1991; TCRP 2002).

However, eco-city planning suffers from serious lack of methodologies. Therefore, research needs to focus more on applying the methods and tools of industrial ecology to eco-city planning and methods of design for environment and to the design of eco-industrial parks (Lowe 2002).

Based on such demonstration pilots projects and research activities, it is possible to develop a set of indicators for the development of eco-town and eco-city. Such indicators classified as economic development indicators, environmental protection indicators, and social progress indicators (Wang and Ye 2004) can be used while devising an evaluation-based campaign such as sustainable development award or eco-city development award. Such approach was adopted by the National Eco-city Network in Japan to choose the winner of Japan's Eco-City contest where a questionnaire with 15 evaluation items and 80 questions was used to assess the degree of ecological efficiency attained in a city (municipality) (JSDN 2007).

Adaptation of ecological developmental plans for cities needs to be supported by law. Any action that is inconsistent with eco-development should be restricted by administrative and/or economic means, so that the plan will be implemented

smoothly. Governments both at city and national level can stimulate progress of eco-city development by enacting legislative, financial, and technical measures to create the right incentives for innovation and changes in performance (UNESCAP 2006a).

By creating government agencies at all levels of city, regional, and national, a better execution of eco-policies can be achieved. These agencies will coordinate and monitor functions in different sectors, supervise implementation of eco-city strategy, and facilitate projects and plans.

Eco-city development needs strong participation from the private sector/business community, and hence the government needs to provide the business community with strong economic incentives and regulatory facilitation to build eco-cities. The government has to adapt such policies that encourage investment in eco-city development.

Eco-city development is an integrated and extremely complex network of activities. Policy making and administering them has to be based on consultative and coordination process. Key to achieve such a development is to have an institution spanning different administrative departments. It helps in effectively organizing, coordinating, and supervising the implementation of urban eco-development. Such institutions can as well help effectively publicize the eco-city development.

Eco-development process, unlike traditional development process where the developmental planning and implementation remain specific to the domain of application, interacts with various segments within and outside the city administrative boundaries. Therefore, it is essential to have strong intracity, intercity, and interregional cooperation to achieve eco-development. Such cooperation should be based on symbiotic principles and multi-stakeholder partnerships.

While cities make their efforts toward achieving eco-efficiency, national governments have to make a set of policies guiding the recourses utilization and environmental conservation. Most of the countries in this region have developed their national environmental policies/plans (extracted from multiple sources). However, they are all in most case centered on conventional environmental protection and resources conservation based on single R (recycle) principles. Having experienced mass production, mass consumption, and mass disposal, Japan and China have enacted various policies toward the development of circular economy based on 3R (reduce, reuse, and recycle) principles (MITI, Japan; Yong 2005). Though eco-town concepts are being considered, they are still at demonstration stages. Along with national environmental plans/strategies, various countries have varying degree of national legislation protecting various domains of environment, viz., water, air, and soils. However, no significant act/legislation was enacted for resources conservation and also to increase the recourses utilization efficiency. For the cities to implement the eco-efficiency in their development pathways, it is essential to have an integrated framework sufficiently backed up by national policies.

Eco-culture segment of eco-city development process is most important and complex. First step toward that is to make the public and decision makers aware of the benefits of eco-city. This helps decision makers change their ideas, attitudes, and behavior. Ecological consciousness is an essential element to realize eco-city

development. At present, the eco-city development initiatives suffer from lack of awareness and public participation. Overcoming this barrier needs adequate education and training programs, capacity building and local skill development (Eco-city 2002). For such capacity development, multi-stakeholder partnership holds the key.

With cities focusing on growth and providing services to the ever growing populations, ecological balance often takes backseat. Due to lack of awareness of the benefits of ecological approaches and also lack of motivation, high-end city administration fails to place priority on environmental friendly growth of cities (green growth). A study conducted by UNESCAP had revealed that lack of political will is one of the major barriers for sustainable urban development. Active participation of high-end city administration such as mayors and governors plays a significant role in motivating the entire administration. In Curitiba, for instance, the mayor, Jaime Lerner, an architect and urban planner by background, was the main driver behind the social, ecological, and urban reforms that have made it a model city. Role of a champion and champion organization in implementing environmental friendly policies is well known, and there exists numerous examples around the world such as Bogotá, Curitiba, decentralized composting in Dhaka (ICLEI 1991; IGES 2007; TCRP 2002; Yedla 2007). Therefore, motivating such decision makers would be crucial in the development of eco-cities. One of the possible ways to motivate them is by establishing a regional award given away by a high-profile organization. Unlike research funds or infrastructure grants, this would provide high visibility which counts significantly for politicians and the leaders such as mayors and governors. This could even be a low-cost approach as their trickling down effect on successful implementation of eco-city would be significant.

Any effort to make cities sustainable should involve a matrix of policies aiming at addressing all the elements of eco-efficiency as described in previous sections (Yedla 2008).

This book attempts to address the sustainability issues of cities in the five-element ecological efficiency framework as presented above. Chapters 2, 3, and 4 addressed the issue of eco-production in cities. While the second and third chapters explain the principles of eco-industrial parks and their application and implementation in two contracting cities – Ulsan in South Korea and Chittagong in Bangladesh, the fourth chapter explains the concept of exclusive economic zoning in India cities and its practical application and the implications.

The ecologically efficient landscaping aiming mainly at transportation and mobility of people is addressed by Chaps. 5, 6, and 7. While there are issues at macro-level bothering the philosophical threads of urban transportation, the micro-level issues of rubbing efficiency to the mobility needs and means to improve "people's ability to move" are of equal importance in achieving ecologically efficient mobility. While fifth chapter presents the scenario of urban mobility in India and prescribes a few policies toward their improvement, Chap. 6 takes up the important issues and challenges at macro-level planning of city's mobility. Chapter 7 brings out the challenges that nonmotorized mode traveler face in India cities and prescribes possible ways to improve their ability to move "effectively" and "safely." Nonmotorized modes contribute more than 50 % of work trip and much larger the

number for urban poor. Hence, promoting this environmental, resources, and people friendliness holds the key for making the urban mobility sustainable.

The cities need to have ecologically secured services made available to them. In order to fulfill this important requirement, the cities need to have improved resilience for natural as well as climate change-induced catastrophic events and vulnerabilities. Energy access plays another important element in making the cities more secured. Chapters 8 and 9 address these important issues of eco-security.

Cities with vulnerability to various imposing situations can be further crippled with poor sanitation and waste management systems. While inefficient management of municipal solid waste (garbage) can cause tremendous damage to the city's ability to handle excess precipitation (such as cloud bursts), the mismanaged corporate waste (E-waste) can cause significant social damage and resources depletion. Chapters 10 and 11 explain the issue of waste management, their present situation, and the way forward in order to achieve ecologically efficient ways of managing these important services. Chapter 12 presents the important dimension of air pollution in Indian metropolitan cities with a specific study on Kolkata.

Provision of infrastructure holds the key for all the components of ecological efficiency in cities. Non-inclusive designs of infrastructure can lock cities into unsustainable consumption patterns for the next couple of decades. Therefore, it is important to green the infrastructure and find more meaningful and inclusive means of financing the same. Chapters 13 and 14 present such efforts made by a number of India cities. With its comprehensive coverage of issues, this book is an attempt to promote sustainability in cities by bringing the issues to the fore and develop a matrix of policy measures toward their sustainability.

References

Camagni R, Capella R, Nijkamp P (1998) Towards sustainable city policy: an economy – environment technology nexus. Ecol Econ 24(1):103–108

Fleischer T (2002) Prospects of an eco-city development in the Central and Eastern European urban areas. Institute for World Economics of the Hungarian Academy of Sciences, Budapest

Girardet H (1992) The Gaia Atlas of cities – new directions for sustainable urban living. Gaia Book Limited, London

Girardet H (2004) Cities, people, planet - livable cities for a sustainable world. Wiley-Academy, Chichester

Girardet H (2006) Business role/CSR ecosystems energy efficiency in buildings. WBCSD News, China, 31 July 2006

Global Environment Centre Foundation (GEC) (2005) Eco-towns in Japan – implications and lessons for developing countries and cities. Global Environment Centre Foundation, Osaka, Japan

ICLEI (International Council for Local Environmental Initiatives) (1991) Case study, land use/ transport, Curitiba, Brazil

ICLEI (International Council for Local Environmental Initiatives) (1995) Curitiba, Brazil: using existing infrastructure keeps fares low in successful transit system. In: Economic instruments to improve environmental performance, a guide for local governments. ICLEI, Toronto

IGES (Institute for Global Environmental Strategies) (2005) Urban environmental challenges in Asia. Institute for Global Environmental Strategies, Hayama

Imura H, Yedla S, Memon MA, Shirakawa H (2005) Urban environmental issues and trends in Asia: an overview. Int Rev Environ Strat IGES 5(2):357–382

Institute for Global Environmental Strategies (IGES) (2007) Air pollution control in the transportation sector: third phase research report of the urban environmental management project. IGES, Hayama

JSDN (Japan for Sustainable Development Newsletter) (2007) No. 63, October 2007. http://www.japanfs.org/en/newsletter/200711-2.html

Juergen P, Rusong W (2005) Clean production and ecological industry: a key to eco-city development. Chin J Popul Resour Environ 3(1):03–08

Linan Z, Bolin Y, Xu M (2004) Management strategies for eco-cities of sustainable development. Chin J Resour Environ 2(2):61–63

Lowe E (2002) Integrative action learning in eco-city planning. In: Eco-scope, eco-industry and eco-culture. Prof. Fifth international eco-city conference, Shenzhen, China

MITI (Ministry of Economy, Trade and Industry) Japan. http://www.meti.go.jp/policy/recycle/main/english/3r_policy/overview.html

Moomaw RW (1996) A sustainability postscript. EIA Rev 16(4–6):425–427

Register R (1987) Eco-city Berkeley: building cities for a healthy future. North Atlantic Books, Berkeley

Roseland M (1997) Dimensions of the eco-city. Cities 14(4):197–202

TCRP (Transit Cooperative Research Program) (2002) Bus rapid transit: case studies in bus rapid Transit. TCRP report 90. Transportation Research Board of National Academies, Washington, DC, USA

The Fifth International Eco-City Conference (2002) The Shenzhen declaration on eco-city development. Adopted by the attendees of the fifth international eco-city conference, Shenzhen, China

Turner RK, Pearce D, Batman I (1994) Environmental economics. Wheatsheaf, Harvester

UN-HABITAT (2001) The state of the world's cities 2001. United Nations Centre for Human Settlements (UN-HABITAT), Nairobi

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) (2006a) Sustainable infrastructure in Asia – overview and proceedings. UNESCAP, Bangkok

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) (2006b) Proceedings of the Seoul initiative policy forum on sustainable infrastructure, Seoul, ROK, 6–8 September 2006

United Nations Population Fund (UNFPA) (2007) State of world population 2007. UNFPA, New York. ISBN 978-0-89714-807-8

Wang R, Ye Y (2004) Eco-city development in China. Ambio 33(3):341–342

Wright L (2001) Latin American bus ways: moving people not cars. Nat Resour Forum 25(2):121–134

Yedla S (2007) Decision making in environmental management - prioritization of strategies for the replication of Dhaka's community-based decentralized composting model using AHP. IGIDR working paper WP-2007-10. Indira Gandhi Institute of Development Research, Mumbai

Yedla S (2008) Scoping paper for the establishment of a UNESCAP eco-city development award. Report submitted to United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), Bangkok

Yong R (2005) Policy and law framework for circular economy in China. Policy Research Center for Environment and Economy, State Environmental Protection Administration, Beijing, China. http://www2.minambiente.it/Sito/settori_azione/pia/docs/ce_3R_03_10_05/yong_policy_law_china.pdf

Zhao Y, Girardet H (ed) (2006) Dongtan, an eco-city, published by Arup and SIIC in February 2006