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GREEN CITIES IN ASIA – CASE STUDIES

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ABSTRACT: The idea of the green city is gaining importance across the world due to the image of cities as well as some economical, social, and especially ecological reasons. The term and praxis of the green city is a material for research and analysis of various science disciplines. We can point out to different specificity of green cities due to their genesis, role of the government and local authorities in development programming, the role of private-public partnership etc.
The purpose of the article is to highlight specific elements of development of green cities in Asia on the basis of three case studies and to precise the possible categorization in terms of the mentioned term. The methodology is based on literature review and a study visit. The limitations of the research are related to the current construction of two out of three green cities being analysed. Practical implication of the paper is the issue of the level of activities undertaken to create green cities from scratch or with the use of a smart technology. The problem of green cities is not enough developed in Poland, neither in theoretical nor in practical aspects. More attention is put on the issue of sustainability or eco-cities.

KEY WORDS: green city, investment, sustainable development, Asia

Introduction

The concept of sustainable development gained importance thanks to "Our Common Future" report (1987) and then, the Earth Summit in Rio de Janeiro in 1992. Its operationalization, through a low-carbon economy, started from 2008 – the real economy crisis (Szyja, 2016).

The idea of the green city is based on *sustainable development* concept, which H. K. El Ghorab and H. A. Shalaby describe as "*a process by which we reason and a way we choose to live, a process that uses common sense and intuition as a baseline. Sustainability should be viewed as a philosophy, or ethic, affording people the ability to consider long-term consequences of actions and to think broadly across issues, disciplines, and boundaries*" (El Ghorab, Shalaby, 2016, p. 497), and on the idea of sustainable cities.

New approach to the issue of sustainable cities is defined as one of the goals in Sustainable Development Goals of the United Nation, also called Agenda 2030: *Make cities inclusive, safe, resilient and sustainable* (UN, *About Sustainable Development Goals*). This target aims at ten detailed areas (UN, *Sustainable Development Goal 11*):

- by 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums,
- by 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons,
- by 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries,
- strengthen efforts to protect and safeguard the world's cultural and natural heritage,
- by 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations,
- by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management,
- by 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities,

- support positive economic, social and environmental links between urban, per-urban and rural areas by strengthening national and regional development planning,
- by 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels,
- support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials.

The literature contains wide selection of terms, which may, but should not, be considered synonyms: "green city", "eco-city", "sustainable city", and "smart city". The term "smart" is used next to "green", Jedliński highlights an example of a "smart green city" (Jedliński, 2014). Polzonetti and Sagratella describe the differences in the meaning of the mentioned terms as follows (Polzonetti, Sagratella, 2018):

- The green city is a city that aims at developing infrastructures, spaces, facilities and urban activities with a low or even with no environmental impact.
- The sustainable city is a city that aims at developing a socio-economical urban context able to balance economic development with respect for the environment and social equity.
- The smart city is a city focusing on the use of technologies to improve life quality in urban areas.

They do not present explanation of "eco-city".

We can also point out to other definition. According to "The Environmental Magazine", "green cities movement" includes activities whose aim is to "*lessen their environmental impacts by reducing waste, expanding recycling, lowering emissions, increasing housing density while expanding open space, and encouraging the development of sustainable local businesses"* (*What are 'green cities'?*). In turn, eco-city was defined as "*a human settlement modeled on the self sustaining resilient structure and function of natural ecosystems. The ecocity provides healthy abundance to its inhabitants without consuming more (renewable) resources than it produces, without producing more waste than it can assimilate, and without being toxic to itself or neighboring ecosystems. Its inhabitants' ecological impact reflect planetary supportive lifestyles; its social order reflects fundamental principles of fairness, justice and reasonable equity"* (*What Is An Ecocity?*). The same elements may be found in explanation of the term of "sustainable city": "*as one that is able to retain the supply*

of natural resources while achieving economic, physical, and social progress, and remaining safe against the environmental risks that can undermine any development achievement" (Hassan, Lee, 2015, p. 1271). In this way, the two last terms may be considered identical.

Smart cities are strongly related with technological aspects in all the cities' functional areas: transport, energy and water service utilities, waste management, buildings, and communication systems (Anthopoulos, 2017). However, Giffinger with his team describe it including six areas: smart economy, smart people, smart governance, smart mobility, smart environment, smart living (Giffinger, 2007, p. 10).

Summarizing the terminological aspects of the abovementioned terms, we can highlight key word or phrase of each of them as follows:

- green city by "reducing impact on environment",
- eco-city by "healthy by appropriate system of consuming",
- sustainable city by "rational supply of natural resources",
- smart city by "technological improvement".

All the mentioned types of new cities are being created all over the world. These projects are encouraged by international organization (the United Nations Human Settlements Programme and the United Nations Environment Programme by Sustainable Cities Programme), regional integration group (the European Union by European Green Capital initiative), policy of governments (Singapore, China, South Korea), local authorities, and local initiatives.

Summarizing, it should be highlighted that the discussed terms, with reference to the practice of their implementation, can be presented as successive steps on the path to reduction of human pressure on the natural environment in order to achieve the most desired effect in the form of the green city. This is the most appropriate form of the urbanization processes in the context of human impact on the environment. And this may be improved by technological solutions, which allow formation of smart green cities. Figure 1 presents development of mentioned terms related to city, taking into account historical genesis and aspect of progress in creating really green urban space.

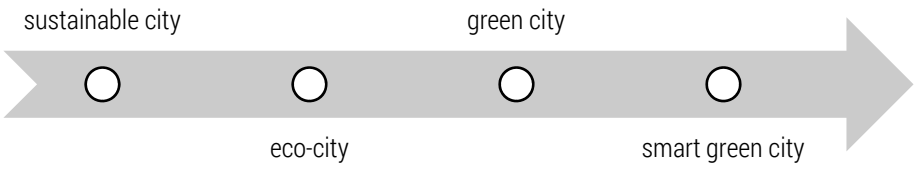

Figure 1. Phase of reaching the green city

Source: author's own work.

An overview of the literature

The literature on the mentioned issue includes a wide selection of detailed thematic scope. Primarily, authors take into consideration the term of the green city and its relation to other ones, such as: sustainable, eco-, low-carbon, and smart city (Kankaala et al., 2018). These considerations are strongly related to the concept of sustainable development (Leźnicki, Lewandowska, 2016). And that is why there are terms such as sustainable urbanization.

Some green cities are old ones, which were or are subjected to the process of green modernization called "transformation towards eco-city" (Hu et al., 2016). Some of them are new ones, which are currently under construction or are to be constructed. Literature presents a wide selection of case studies, mainly in Asia – such those in Pearl River Delta in China (Wang et al., 2018), Europe – Freiburg in Germany (Freytag et al., 2014), or North America – New York City in the USA (Sánchez et al., 2018), but also in South America – Curitiba in Brasil (*What are 'green cities'?*) or Africa – Sub-Saharian Cities (Lindley et al., 2018).

Another issue in the area of the green city is related to socio-economic aspects. Articles take into consideration the role of such cities for various stakeholder groups and for shaping city branding (Fok, Yi, 2018). The role of governmental projects and policies, *the relationship between eco-city building and local economic development*, is also important (Lin, 2018).

Next area of researchers' interest is related to attributes of the green city. They point out to aspects of planning and organizing space. Particularly important elements affect organization of spatial order through creation of urban green spaces (Ye et al., 2018), green spaces (Anguluri, Narayanan, 2017), or green zones and city forests (Fan et al., 2019). In the last case, the author undertakes the problem of forestation in relation to natural conditions of cities' location, which determine high temperature and specific microclimate. This is a reason to create conditions aimed at improving living quality (Fan et al., 2019) i.e. by cooling effect of urban green spaces. Not only do the authors take into consideration the role of trees, but they also make research in line with methodology which allows to diagnose results of forestation in different urban form of cities (Masoudi, 2019). Then they describe multifunctionality of green infrastructure (Hansen et al., 2019) through its ecosystem services (urban ecosystem services, Lindley et al., 2018, p. 328-329), or creation of green open spaces. The problem of adaptation to the climate change by promoting urban green spaces is also important (Sánchez et al., 2018).

Next element refers to development of sustainable transport: organization of public transport, which should be more environmentally friendly, as well as creating a model to enable route planning for green vehicles (Pamučar et al., 2016).

Transport issue is related with the "green logistic", which is defined as "*an integrated management of all activities required to move the product along the supply chain to meet the expectations of customers at minimum global cost including also the external costs related to, among others, climate change, air pollution, noise, vibration and accidents"* (Jedliński, 2014). Another important problem for the green city is appropriate energy system, e.g. one based on solar energy (Freytag et al., 2014), and its construction and implementation.

No less important is the question of water for the inhabitants of the green city. There are papers which describe the role of quality of ground water and appropriate system of its management. Scientists make research to elaborate instruments for measurement of groundwater sustainability (Tirupathi et al., 2019). Authors also describe the problem of flood risk and adequate adaptation policies to address plausible impacts of climate change (Chan et al., 2018).

There is a need for innovation in creation of appropriate building construction, water and energy systems, waste management systems, green spaces, and green infrastructure (Murzyn, Szyja, 2015). For example, Fei et al. point out to the role of innovation and classify it into three types: green technological innovation, green institutional innovation and green business-model innovation (Fei et al., 2016).

In polish literature there are no publications which would describe the specificity of development of the green city in Asia, distinguishing between those that are created from scratch and those that are subject to green transformations (with socio-economic aspects of them taken into account). The aim of this paper is to present three cities in three different countries of Asia: Tianjin (China), Singapore, and Songdo (South Korea), to analyse the idea of the green city of varying genesis, government policy and praxis, as well as to analyse and categorize the term of the green city.

Research methods

The research method applied to solve the abovementioned gap in research, which is related to presentation and explanation features of green cities in Asia in terms of their genesis. Therefore author has carried out the analysis on the basis of literature review, considering the problem of terminology, the issue of green cities development progress in Asia, conditions of

development, the role of governmental programming, sources of funds for these kind of endeavours, and researchers' opinions. The opportunity to complete a study visit in Singapore together with a seminar and meetings in selected institutions was also important.

Transformation to the green city – example of Singapore

The issue of the green city is very well know in Asia, which is evidenced not only by the number of activities or related projects, but also that of papers and science publication, and by high positions in the rankings of sustainable cities. As for the latter, Asian cities rank as follows in the 2018 Sustainable Cities Index: 4th (Singapore), 9th (Hong Kong), 13th (Seoul), 24th (Taipei), 41st (Macao), 66th (Shenzhen), 67th (Kuala Lumpur), 73rd (Bejing), 74th (Guangzhou), 76th (Shanghai), 80th (Bangkok), 83rd (Tianjin), 87th (Wuhan), 88th (Chennai), 89th (New Delhi), 90th (Chengdu), 91st (Bengalure), 93rd (Mumbai), 94th (Jakarta), 95th (Manila), 98th (Hanoi), and 100th (Kolkata) (Arcadis, 2018, p.11). As for the rankings of green cities in Asia and Pacific, 10 best cities in 2011 were: Tokyo, Seoul, Melbourne, Singapore, Osaka, Sydney, Auckland, Busan, Taipei, and Hong Kong (Solidiance, 2011, p. 4). Comparing 2011 and 2018, we can point out that Singapore scored high in both rankings, regardless of the passage of time. This is *de facto* a city-state called *Asia's greenest city*. Singapore started its transition to the sustainable city after gaining independence in 1965. The most problematic issue for the new country was a dramatic pollution of land, waters and air. "*Keeping Singapore clean was thus one of the foremost challenges that government had to tackle (...). It was a challenge born out of necessity. Moreover, during the early days of nationhood, a clean living environment was seen as a boost to the national morale and civic pride of a nascent state, helping to motivate the people to strive for higher standards of performance"* (Soon et al., 2009, p. 51). Activities were properly planned and coordinated. All the work related to four components – "*providing good and reliable public cleansing services and collecting refuse daily; educating the public on the need to keep the environment clean; strict law enforcement; and investing in infrastructural improvements"* (Soon et al., 2009, p. 51). Over time, the issue of improving the environmental conditions has become important for one more reason, namely creating friendly conditions for foreign investments (Soon et al., 2009, p. xxiv). Ghesquiere, who writes about "an ecologically sustainable growth" (Ghesquiere, 2007, p. 18; Szyja, 2016, p. 97). Currently, the most significant element of Singapore's image are gardens: the Botanic Gardens (figure 2), the Gardens by the Bay (figure 3), the Bukit Timah Nature Reserve, the East Coast Park, the Sungei

Buloh Wetland Reserve, the West Coast Park, the Hort Park, the Pasir Ris Park, and the Changi Beach Park (*10 best green spaces in Singapore*...).

Figure 2. The Botanic Gardens
Source: author's own work.

Figure 3. Gardens by the Bay
Source: author's own work.

What is really remarkable, Singapore's surface is only 720 km^2 and we can still find there so many green spaces. What is more, it should be highlighted that the idea of urban farming is strongly developed in this city, especially in housing estates, schools, or offices (Zachariah, 2017). At the beginning, the idea was aimed at integrating the society, especially elderly people, but also to yield crops, due to no agriculture in Singapore and the need to import food. Over time, it began to stimulate cultivation of balconies and roofs of residential buildings. Such activities have one more result: green space which is building's natural isolation. It is possible due to natural conditions. Nowadays, we can observe progress in farming space in Singapore, due to high-tech solutions, i.e. those based on aquaponics methods.

Singapore has also achieved a great progress in the process of "water production", which is based on four facilities in which water is being cleaned (by using membrane technique and UV) and then supplied for the industry. 2% of processed water is enriched to be fit for consumption. In the area of water supply in Singapore, a huge progress has been made since 1965 as for infrastructure development: there are 17 water reservoirs; sanitary conditions have been improved; a dam aimed at recreation and flood protection, as well as being a reservoir of water, has been constructed; the seawater desalination plant has been opened (Szyja, 2016, p. 106-108).

Energy production from renewable energy sources in next element of transition to sustainability. The Building and Construction Authority is engaged in modernization of a building to make it a "zero energy building", and Singapore is the current regional leader as for technical solutions (BCA).

Knowledge and experience gained by scientist and engineers from governmental agencies, research institutes and also the National University of Singapore have impact on sustainable transition in other countries of Asia, particularly in China with its Tianjin City being constructed.

Contemporary Singapore may be called a green city due to two reasons. First is related to the development of green spaces, and second to the development of rational management of water, land and space, as well as using renewable sources in energy system and lowering emissions (through a special regulation system, well-developed public transport system, and high costs of buying a car for private purposes). A problem for Singapore is growing waste production. The Semakau Landfill is an island near the main part of Singapore, which should allow trash storage until 2045. "*But with the use of disposable products growing at a rapid rate, the ministry's most recent estimates show that Semakau could be full a decade earlier"* (Geddie, 2018).

At the beginning of Singapore's way to sustainable development, all activities were concentrated on improving living conditions. Then, further goals and increasing level of living conditions set the new directions of activities, as

a result of which improvements were achieved. Nowadays, emphasis should be put on the role of technology (e.g. in water production or zero-energy building construction) and export of knowledge and experience in the mentioned area. In this way Singapore may be called a smart green city.

Eco-city Tianjin – building a green city from scratch

The project of Eco-city Tianjin is being constructed next to (40 km distance) industrial and port centre of Tianjin (115 km to the southeast of Beijing). It is an example of cooperation of two governments: the Chinese and the Singapore (Sino-Singapore Tianjin Eco-City, https). Such type of endeavour in this part of China is dictated by the fact that the region has been chosen as a test area for many economic experiments. It is also related to the fact that the eastern coast of this country has always been more developed than other regions. It was here where the first special economic zones were created. The contribution of Singapore is related with the state authorities' experience in creating special sustainable policy (commented above) and knowledge of experts, i.e. those of the Building and Construction Authority. The choice of location was dictated by the need to meet two key conditions: land not suitable for agricultural cultivation and water shortages. The first criterion is to prevent takeover of land suitable for cultivation, and the second – to create a special infrastructure from scratch.

The Sino-Singapore Tianjin Eco-City is based on appropriate sustainable spatial planning, with the following principles:

- areas separated by their functions (housing estates, service centres, light industry),
- each district should have specific service and institutional facilities,
- the distance between housing estates and workplaces should not be too large for walking or cycling,
- creation of an extensive network of pavements, bicycle paths, and public transport infrastructure,
- designing a large amount of green space,
- connection to main water reservoirs to increase water circulation,
- construction of 75-acre park [to restore] stormwater retention in order to clean the river, cool the Central Business District and provide refuge for residents and visitors among native plants, trees and walking paths (Karlenzig, 2015),
- introduction of specific waste management rules,

- modern energy system based on environmental friendly solutions: solar power, wind power and EV charging centers and a national smart grid pilot (Karlenzig, 2015),
- development of ecological construction,
- locating in the city only plants which are related mainly to the IT sector,
- the obligation for the residents to comply with certain standards in the scope of limiting the negative impact on the natural environment.

Eco-city Tianjin is a politically initiated project, realized in cooperation of two governments. Furthermore, it is ecologically justified, also due to ecological problem of the city of Tianjin (chemical industry).

Songdo – The South Korean „smart green city"

The Songdo International Business District is, according to M. L. Clifford, "*a smart city built from scratch* (…)*. More than 40 percent of its area is reserved for green space, and all of its major buildings meet or exceed LEED expectations*" (Clifford, 2015, p. 81). The city is located 64 km from Seoul and is connected to Incheon International Airport with a 12 km long bridge. The project is intended for implementation in the period of 2003-2020 and the assumed costs of the endeavour are estimated at USD 40 billion. The project is a joint venture of the City of Incheon, Gale International (61%), POSCO E&C (30%), and Morgan Stanley Real Estate (9%) (*South Korea Conceptualizes*…).

Investments in the city include those aimed at creating technologically modern and sustainable solution, including appropriate construction of building (certification in the U.S. Green Building Council's Leadership in Energy Efficiency and Design system), a central pneumatic waste disposal system to eliminate the need of garbage collection (*South Korea Conceptualizes*…), cycling routes, digitally advanced apartments, and remote solutions (White, 2018). However, despite the mentioned solutions, Songdo has only 70,000 residents while the planned number is 300,000. The problem is related to high costs of apartments and living. There are attempts to find buyers for both apartments and commercial spaces. In the first case, the target group are the Koreans living in the USA (White, 2018).

To sum up, Songdo is an example of the green city built from scratch, with smart solutions included. However, a currently highlighted problem is the cost of living there, which is a major obstacle for potential residents. In author's opinion, this results from too much pressure on technological solutions which are expensive. In addition, one can ask whether such technological advancement really serves the environment.

According to the three cases mentioned and presented above, some important issues should be highlighted:

1. Impressiveness of the quality and also quantitative level of green cities development in Asia, with those built from scratch taken into account.
2. An important role of government in green cities planning.
3. Technological progress in development of waste and water systems based on cooperation between countries.
4. Activities aimed at people integration.
5. New approach to the specificity of the term of the green city, which allows its categorization on a basis of case studies (figure 4).

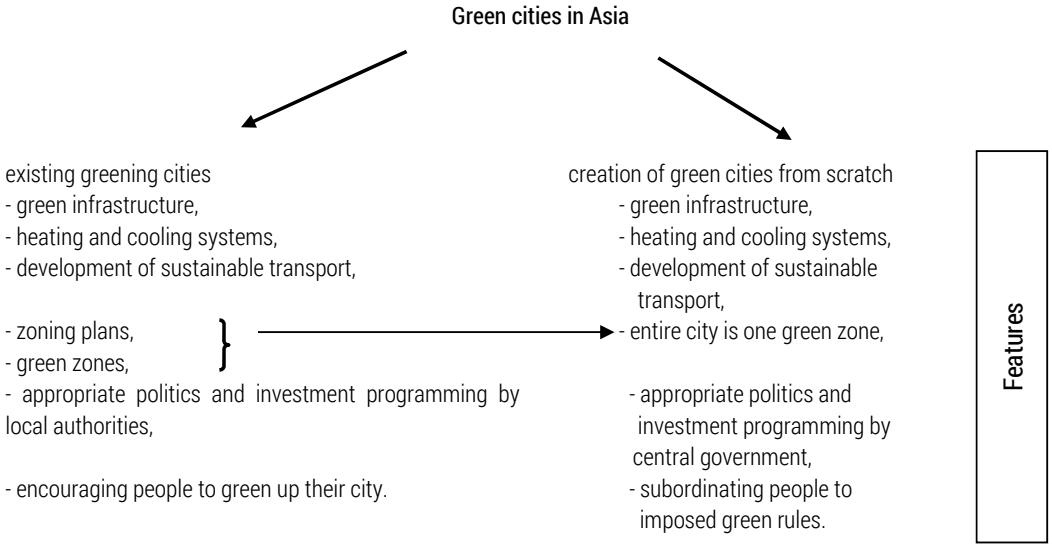

Figure 4. Categorization of the term of the green city, according to examples in Asia
Source: author's own work.

Conclusions

The issue of the green city is a very important aspect of development due to economical, social, and environmental aspects, which are highlighted in the Sustainable Development Goals of the United Nations. Actions aimed at transforming cities to sustainability are undertaken all over the world. Although countries differ in terms of the level of transformation, some of them try to achieve a more advanced level. We can pointed on green cities and appropriate categorization of them, included sustainable cities which change into green and some created from scratch. This opposition occurs in

presentation and analysis of the case studies from Asia: Singapore, Tianjin, and Songdo. Singapore began its transformation, stimulated by governmental policy, in 1965. Nowadays, it is called the greenest city in Asia; progress has been achieved in improvement of living quality, including ecological aspects and greening up the space, and technological aspects of water management system. In turn, Tianjin is a green city building from scratch, on the basis of cooperation between two governments, one with knowledge and experience (Singapore), and the other with willingness to introduce new urban solution due to ecological problems of an industrial city. Songdo is an example of a smart green city, also constructed from scratch. However, its distinctive feature is the use of technology in every functional aspect of living in the green city.

This approach may help to understand progress in transition to the green city. This is very important in relation to Polish cities, where emphasis is put on more environmental friendly solutions in a process aimed at formation of sustainable cities.

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