SMART GROWTH AND SUSTAINABLE DEVELOPMENT: NEW TRENDS IN LAND DEVELOPMENT

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Abstract

Constantly increasing demands on the environment, energy efficiency, quality of infrastructure together with the spontaneous development of new technologies and materials persistently forcing to re-evaluate the access to all previously established practices of all aspects relating to any human activities, including land development, land use or individual construction of buildings. Increasingly the case comes to the fore an individual - "sensitive" approach to land, to its specific location and its unique characteristics and specificities which further affects all subsequent development areas. The following article is focused on issue of new approaches to land development and innovation trends in real estate development process. The main objective of this paper is to analyse and summarize innovative approaches in development process oriented mainly on land and its development. The methodology is based on the analysis of this issue which is researched through the selected examples of smart cities: Tianfu and Dongtan in China and Masdar City in the United Arab Emirates. These studies wants to show the unique approaches to addressed projects using the latest innovations and trends in conceptual and implementation project phase. Exactly these approaches results in significant convergence to the concept of sustainability. The main, common feature of these selected case studies is a unique use of the locality of given land in favour of the proposed projects, although the potential of these lands was not so clearly visible.

Key words

Land; innovations; smart development; sustainability; smart cities

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1 INTRODUCTION

Urbanization has increased, particularly in developing countries with an average annual urban growth rate of 3.6% between 1950 and 2005. However, during the same period, industrialized countries experienced an urban growth rate of only 1.4% [1]. It has been estimated that 45% of the population of developing countries (1.97 billion) and 75% of those in developed countries (945 million) were living in cities in 2000 [2]. It is expected that by 2025, the urban population will reach 5.5 billion, with an estimated 2.5% annual rate of increase. The urban population in developing countries will reach 4.3 billion; that is, more than three times that of developed countries (projected to be 1.2 billion) [3]. Finally, Shen has estimated that 70% of the total global population will live in urban areas in 2050 [4].

Constant economic and technological changes in last decades were caused by extensive processes of integration and globalization. By these processes many cities have been and still are constantly forced to face the common challenges in the context of competitiveness, sustainable development and now also engage into smart concepts.

The concept of smart cities describe an urban system of systems that modifies its behaviour in response to changes in the environment, monitoring its various components and acting accordingly to potential or actual changes of state in order to achieve a desired goal [5].

Cities require accurate and real-time information about the status of urban services in order to improve public safety and provide adequate infrastructure-based services such as safe drinking water, reliable electricity, and sustainable, safe and reliable transportation and communication. However, traditional cities cannot optimize this provision of services due to constantly changing conditions. In other words, a smart city provides the required infrastructure for citizens and officials to make more intelligent decisions [6].

Growing demands on existing real estate projects are not important only in terms of energy and economic efficiency and friendly approach to the use of natural resources. They are also very closely related to the land use, land itself and its surroundings and also to urban development.

2 MATERIALS AND METHODS

The main objective of this paper is to analyse the land use potential and summarize approaches to the land on selected examples of large-scale projects of smart cities. These specific approaches to land refer to its unique characteristics such as location, natural conditions and specifications, genius loci, etc. The selected examples of smart cities: Eco-city Dongtan in China, Masdar City and Tianfu Ecological City in this paper were chosen primarily on the basis of their development and specific concepts of land use.

All above mentioned Smart cities are completely newly-built projects on greenfield land. Another common feature is the specificity of the locations in which they are located, although the potential of these lands was not so clearly visible (inter alia, desert and wetlands). In the view of these conditions it has to be taken into consideration highly individual approach in terms of urban design. The main purpose of this paper was filled mainly through the analysis of selected examples. The study wants to show unique approaches using the latest innovative trends in conceptual and implementation phases of projects. Precisely these approaches reflect the application of the concept of sustainability along with use of the latest smart technologies and approaches.

The key information and data for these individual examples were collected from main sources of projects developers. Theoretical concepts about smart cities were taken from various authors: Khansari, N., et al. (2013); While, A. et al. (2004) and Jepson JE. J., Edwards, M. M. (2010). Land uses as an aspect of sustainable urban development were drawn from sources: Minne, E. A. et al. (2011); Häkkinen, T. et al. (2013) and others. Then was carried out research of selected journal articles on sustainable development issues of these three projects by: Sigrist, P. (2009); Chang, I. C. and Sheppard, E. (2013); Nnamdi O. Madichie, (2011), Lau, A. (2011); Rahaman, M. (2014).

In the contribution were used standard research methods as empirical research, by which are created a summary of approaches applied within the development process; collection, processing, analysis and evaluation of data from domestic and foreign sources; method of analysis through case studies. The approach adopted in this work consists of a review of the relevant literature.

3 LAND DEVELOPMENT OF SMART CITIES

New urbanism, smart growth, and the ecological city are three sustainable urban development approaches. Smart growth refers to natural resource protection, regional collaboration, and economic development based on local capacity and resident participation [6].

In the process of developing urban sustainability, limitations in natural resources, intra- and intergenerational equity, integration of economic, social and environmental priorities, and expansion of public participation in decision-making should all be considered [7].

In the eco-city, land-use policies reflect the use of renewable energy, diverse transportation options, short travel distances, and urban density [8]. For planners, the city should be considered a complex system consisting of both economic and environmental subsystems. Accordingly, planners require tools to manage natural resources, pollution, information, and trade [9].

Another component of urban infrastructure is land use. To improve urban sustainability, land use strategies that rely on public transportation and compact living, and are aimed at reducing natural resource consumption, should be encouraged. Officials should, therefore, pursue a walkable, mixed-use model integrating high-performance buildings and infrastructures. Two important values of urban sustainability are compactness (density) and biophilia (human access to nature) [10]. In urban sustainability process, the personal appeal and societal benefits of neighbourhood living, where daily needs can be met on foot, are greatest in those neighbourhoods that have all the necessary attributes of compactness, completeness, connectedness and biophilia [6].

Land use according Nibel et al. (2011) [11] is related to the availability of natural resources and the protection of ecosystems, biodiversity, and climatic systems. According to Finnveden et al. (2009) [12] land use will affect three of the areas of protection directly, namely, natural environment, natural resources and manmade environment, and human health indirectly. Changes in land use can have wide-ranging environmental consequences, including biodiversity loss, changes in emissions of gases affecting climate change, changes in hydrology and soil degradation [13]. The higher the ecological value of the land area converted into built-up area the more significant the negative impacts on the environment. On the other hand, changes of land use may also have positive effects on the environment. This is the case if contaminated area is turned into building area and thus has to be decontaminated before conversion [14].

The way land is used is one of the main drivers of global environmental change. In turn, environmental change, in particular climate change, increasingly affects the use of land as communities strive to adapt to, and mitigate, the effects of a changing climate [15]. Land consumption caused by residential development, economic growth and transportation belongs to the most serious environmental pressures on landscapes, particularly in urbanised areas [16]. According Milà i Canals et al. (2007) [17] defines three main impact pathways for land use: impacts on biodiversity, biotic production potential and ecological soil quality.

4 NEW TRENDS IN LAND DEVELOPMENT ON SELECTED EXAMPLES

4.1 Eco-city Dongtan, Chongming, China

The literal translation of the name means "East Beach" and is derived from the fact that it is located 25 km east from the city of Shanghai. The city was designed by the British group Arup in collaboration with Shanghai Industrial Investment Company as the concept of a living organism which is to be constantly develop - grow. "In the first phase of the project is a city designed for about 10,000 inhabitants, but this number should grow rapidly and by 2050 should reach 500 thousand inhabitants". [18] This fact creates a presumption that the Dongtan city will be even more with this population still meet the requirements of ecological city, or whether further construction turns it into chaotic, un-conceptual process and will suppress the original ecological approaches. The concept of the city is established on the principle of town without cars but without cars will be just some of its parts where services will be provided by electrified vehicles. The city has to be a counterpoint to the city of Shanghai, which is one of the largest emitters of CO2 emissions and one of the biggest polluters in China. [19] The main objective of the Dongtan project is therefore to provide new housing for inhabitants, which would correspond to the highest standards, but also encourage modern trends in urbanism. That's why this city was designed as a maximum ecological and smart. Basic characteristics of the Dongtan project are shown below in the Table 1 [18]. Sigrist (2009) [20] argued that "while Dongtan project is considered as a progressive model of urban sustainability with the potential for successful replication throughout the world and holds great promise for applying new technologies toward the reduction of pollution and resource consumption, it also risks further marginalizing less powerful sectors of the population and counteracting ecological benefits by developing on protected land and paving the way for automobile commutes to the mainland. In addition, the construction of new eco-cities outside of urban centres does not solve the problems of existing cities, where the majority of the world's population lives. Therefore, such development cannot be considered a comprehensive model of urban sustainability". According Chang and Sheppard (2013) [21] "the Dongtan seek to develop green technologies as a way to resolve the dilemma of being caught between urbanization and agriculture. This approach is also shaped by geography as enabling a self-sufficient development trajectory, and also its desire to attract a cosmopolitan population".

Tab. 1: Basic characteristics of the Dongtan project (Source: [18])

Size	The number of inhabitants	The beginning of construction	Urban structure	The original function of territory
86 sq. kilometres	10,000 – 500,000	2010	open	greenfield

Specific approach to land use

In the past, urban area was used for agricultural production but mainly its attractive location makes it predestined to another function. There began extensive development of land and started here un-conceptual process of forming plots that used inhabitants of Shanghai for rest

and recreation activities. Already, the Dongtan City project should prevent uncontrolled development of this area. The project takes full account of the use of natural conditions and predisposition in this area and tries to maximize their benefits. For example, ensuring the production of electricity from waste in the processing of rice, of which there is plenty, whereas in the surroundings of the city are numerous rice fields and this area is characterized by major producing of rice. The City is able to produce energy from rice waste so much that it has a surplus. In addition to the area of rice fields there are also large areas of natural wetlands. This location of wetlands is an important home for migratory birds; therefore, the project takes into account the return of some parts of the agricultural land to the original state of wetlands and so was created a 3.5 km wide buffer zone across the island at its narrowest point. According to the project has preserved wetlands share reach almost 40% of the total area of the city, while being sufficiently protected against pollutants produced in the city.

The City is located on the coast of East China Sea, as there were problems related to sea-level rise and the flooding. This problem was solved by building of artificial lakes linked underground to the sea in various parts of the city, serving as communicating vessels, and regulates the level of the sea through water level of lakes built within the city (fig. 1, [22]).

Fig. 1: Eco-city Dongtan (Source: [22])

In Dongtan has also been developed intelligent waste management, in which the waste is considered to be a potential source for further use and recycling.

Up to 65% of the city is formed by parks, public gardens, and area around the town is preserved and consists of original wetlands and farms (fig. 2, [22]). The actual buildings in the city are designed to use prevailing winds to produce electricity and have green roofs with photovoltaic cells.

Fig. 2: Eco-city Dongtan (Source: [22])

Nevertheless, by 2010, when the first phase was supposed to be finished, the completion of Dongtan was indefinitely postponed and most construction work was suspended. [23] The reasons for the apparent abandonment of the project included uncertainty concerning whether it would be funded by Arup or the government, as well as the failure of the developers to engage the local community in the planning process. [24]

4.2 Masdar City, Abu Dhabi, United Arab Emirates

The project of the Masdar City is realized by a development organization Masdar, which is a subsidiary organization of Mubadala Development Company and the project was designed by British architects Foster and Partners (fig. 3, [25]). The city is located 17 km from Abu Dhabi and has form a home for 50,000 inhabitants. It is expected that an additional 60,000 people here will commute because it is assumed that there will be located more than 1,500 companies. [26] It covers an area of approximately 6 square kilometres, which means that the City is relatively compact. All vehicles equipped with combustion engines have no entry into the City. For cars will be built around the perimeter of the City several support parking. City transportation will be provided by overhead railway, electric vehicles and underground, which will connect the Masdar City with the metropolis of Abu Dhabi. Individual car traffic will be able to be used only in the case that these vehicles will use clean energy sources. "According to experts, Masdar knowledge of technology and management coordination centre can be used for benefit of the whole planet". [27]

Primary objectives to be achieved through Masdar City include: being powered by state-of-the-art renewable energy technologies (i.e. through photovoltaics, concentrated solar power, and waste-to-energy technology); optimizing water resources through water recycling, use of advanced technologies to treat water, and an overall reduction in water demand; the provision of a setting for a zero-waste lifestyle through reducing, reusing, recovering, and recycling waste materials; ultimately redefining urban transport through use of personal rapid transit and material rapid transit. [28] According Lau (2011) [29] one the main disadvantages for the project, especially since the planning process has been controlled by the government for its own purposes, rather than responding to the concerns and desires of the local community. Indeed, the City is isolated from any other community by the surrounding deserts, and the high concrete base would prevent Masdar City from being naturally integrated with any nearby neighbourhoods that might exist in the future, raising the issue of social exclusion. Basic characteristics of the Masdar City project are shown below in the Table 2.

Tab. 2: Basic characteristics of the Masdar city project (Source: [27])

Size	The number of inhabitants	The beginning of construction	Urban structure	The original function of territory
6 sq. kilometres	50,000	2009	closed	greenfield

Fig. 3: Masdar City Master Plan (Source: [25])

Specific approach to land use

On the place of the current project was before the construction desert. Thus this place was greatly limited. The developer was able to exploit the strengths such as strong sunlight, wind climate and proximity of the attractive city and to adapt the project to these aspects. Even before the construction of the city itself was built near 22-hectare solar power plant with 87,777 solar panels, which took care of supplying the entire project during the construction process. The city in addition to solar power is also supplied by wind, geothermal and hydrogen power plant. Wind flow is ensured by windbreaks and ventilators located at the entrance to the city. Along the perimeter of the entire city is a buffer green zone, which serves as a protection against windblown dust and sand from the desert. Water areas are placed exclusively in shaded places in order to minimize their vaporization (fig. 4, [30])

Fig. 4: Masdar City (Source: [30])

This project assumes a 60% lower water consumption, gained through solar desalination plant, 80% of the water used will be recycled and used long as possible, at the end is used for the cultivation of agricultural crops. The city is trying to reduce waste by means of biodegradable waste which is used as fertilizer, recyclable waste is recycled and the remaining waste is combusted at a local plant which converts the waste into energy. As Masdar City is located in the desert, it was necessary to provide coolness. This problem has been secured by architects through narrow streets on which adjacent buildings shall provide enough shade and whereas they are straight and air is blown into them by windbreaks is also secured sufficient air movement. The temperature on Masdar's streets is generally 15 to 20°C cooler than the surrounding desert. On the main square are located 54 large-scale umbrellas, which are adapted to sunlight and moving together with the sun. Umbrellas are covered with solar panels and in addition to shielding they produce electricity. "There are also no light switches or water taps in the city; Movement sensors control lighting and water in order to cut electricity and water consumption by 51 and 55 percent respectively". [30]

4.3 Tianfu Ecological City, China

This project is implemented by the developer Beijing Vantone Real Estate Co., Ltd. together with massive support of the Chinese government. Tianfu Ecological City is a project of organic, sustainable, car-free city covering an area of 1.3 square kilometres, which is a satellite city outside Chengdu (fig. 5, [31]). This is the first project in China, which could be replicated in other locations throughout the country. The city should form housing for 80,000 residents, where also will be enough job opportunities. Pedestrian access within any sites in the city should be up to 15 minutes. "Tianfu City will be linked with the neighbouring city of Chengdu thru public transport network". [31] Transportation will be provided by the electric shuttles and space on the surface will be arranged as park landscaping and will serve as a communication for pedestrians and cyclists. Basic characteristics of the Tianfu Ecological City project are shown below in the Table 3 [31].

Tab. 3: Basic characteristics of the Tianfu Ecological City project (Source: [31])

Size	The number of inhabitants	The beginning of construction	Urban structure	The original function of territory
1.3 sq. kilometres	80,000	2014 - 2015	closed	greenfield

Fig. 5: Tianfu Ecological City Master Plan (Source: [32])

Specific approach to land use

Construction will be realized in the territory, which has so far been used only as agricultural land – so this will involve greenfield land. The project takes into account the preservation of farmland outside the city, which will be reserved for farming and public spaces at least 60% of the total of 800 acre area. Complete natural topography including valleys, rivers and water bodies will naturally be incorporated into the project without other significant artificial interventions (fig. 6, [31]). All residential units will be within the two-minute walking distance from public parks.

Fig. 6: Tianfu Ecological City (Source: [25])

In the project is proposed a complete reduction of energy consumption by 48% by using of large amounts of greenery, new materials and green roofs that naturally regulate the temperature of environment without the use the technology of air conditioning. All consumed electrical energy will be produced directly in the city from renewable sources by using solar panels, wind and water turbines. The heat will be accumulated during the summer months and in the winter months will be used for heating. The latest combined production of electricity and water heating will be implemented in the power plant. One of the project goals is to

reduce water consumption by 58% through its recycling and reuse and also will be used the system of rainwater capturing and its re-use as service water. "Another project goal is the reduction of waste production by 89% and by 60% of carbon dioxide, compared to a conventional city with a similar composition of the population" [31].

5 DISCUSSION

As pointed out by individual authors: Aubry, C. et al. (2012) [2]; Shen, L. Y. et al. (2010) [4]; Yovanof, G. S., Hazapis, G. N. (2009) [5]; Khansari, N., Mostashari, A., Mansouri M. (2013) [6]; While, A. et al. (2004) [7]; Jepson Jr, E. J., Edwards, M. M. (2010) [8] and others, concepts of smart cities in themselves take into account economic, social, environmental and technical aspects. It can be said that all the examples of projects has relatively sophisticatedly concepts regarding the urbanistic point of view (more e.g. Smith, A., Hill, G. (2012) [31]; Masdar City web-site [25]). All of the above-mentioned projects have been implemented in the greenfield area. Currently the specifications of each particular territory creates limits for their design and realization. It shall also be said that the projects display other various deficiencies and have many critics:

Eco-city Dongtan project is considered as pioneering work leading to a more sustainable future. However, the project was not quite successful since in that project only the availability and quality of the smart infrastructures were considered, and the human dimension was ignored. As mentioned above, smart cities should aim at improving the quality of life for residents. In other words, in smart cities, governments and businesses invest in ICTs to improve sustainable development and quality of life, by providing smart urban infrastructures that will inform residents about the desired environmental agenda [33]. This project has relatively a lot of critics who argue that one sustainable project does not address the issue of existing large unsustainable Chinese cities where most of the population lives.

Masdar City project is considered by some sceptics only as an example of a luxury development of Abu Dhabi, which is designed especially for the rich population. It is also often criticized as an example of a global phenomenon of increasing division of the world into a highly technical, vast shapeless ghettos where issues such as sustainability has very little direct relevance.

Tianfu Ecological City is also considered a very promising project of sustainable modern city, but like the above mentioned projects does not address the current problems of other existing sites.

Approach to the design and implementation of similar projects are drastically different from the issue of the concept of sustainable concepts in existing urban structures. There currently stands out a different approach to the solved area (prevails built environment, especially brownfield areas) and in particular the social aspect (human dimension - participation of the population).

6 CONCLUSION

Smart cities offer a very promising solution to this need, by helping citizens and officials to develop sustainable behaviours and planning. The new information made available from such implementation can shift the social behaviour of citizens towards a more efficient and sustainable utilization of city resources, while allowing service providers and city government to provide services more efficiently and sustainably. In other words, smart cities will require innovation when it comes to planning, management and operation of their infrastructures and resources if they are to cope with the future demands of their citizens [34].

The above-mentioned case studies of selected development projects have several common features, such as:

- specific approach to planning with respect to local conditions,
- energy efficiency,
- sustainable and energy self-sufficiency,
- environmental friendliness,
- high technological advances.

All these aspects are directed towards meeting concepts of sustainable Smart Cities. To achieve this objective fully are using technological innovations and innovative approaches in the creation of spatial plans, technical solutions for urban design and also proposals for the building itself, as well as innovative tools in the areas of financing and project management.

Last but not least here can be seen a different approach to the natural characteristics of the territory, through which projects are trying make the best to adapt. Each of the presented projects excelled at something else. In Masdar City, it was difficult adaptation to natural conditions of the desert and eliminating the negative effects by innovations in aerodynamics, such as the wind blowing into the city streets to cool them down, or appropriate placement of water surfaces into the city area.

In Dongtan City project it was mainly about the best use of given natural factors such as the use of waste from the rice to produce electricity and use physical principles as a protection against tidal waves.

Tianfu City project is characterized by its placement into the original natural environment and adapt to it without significant topographical interference, while keeping a large amount of greenery in the city, while the project should be duplicated in the future for several territories in the country.

Even these projects represent profound progress in the central task of demonstrating the feasibility of "human-benefits" cities that purposefully connects environmental protection, economic opportunity, and an improved quality of life in a unified and potent vision. Specially designed, self-contained eco-cities can be effectively used to stimulate sustainable development in existing neighbourhoods, but their architects should expect them to be incorporated into the larger community as environmentally conscious design is more broadly adopted in the future. [29] Finally, it should be noted that these projects require for its realization a huge amount of funds which by its volume are far from projects realized at present for example in Europe. However, despite different scale of projects, the access to land usage also differs significantly from projects in Central and Eastern Europe (CEE). Only with some minor exceptions in countries of CEE are still prevalent reckless, uncontrollable, and in particular non-conceptual interventions to land undertaken only with a vision of quick profit without implying the direct responsibility for these activities.

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REFERENCES

[1] Sahely, C. A. et al. (2005). Developing sustainability criteria for urban infrastructure systems. *Canadian Journal of Civil Engineering*, **32**(1), pp. 72–85. ISSN 0315-1468.

[2] Aubry, C. et al. (2012). *Urban agriculture and land use in cities: an approach with the multifunctionality and sustainability concepts in the case of Antananarivo (Madagascar).* Land Use Policy, April, **29**(2), pp. 429–439.

[3] Choguill, C. L. (1996). Toward sustainability of human settlements. *Habitat International,* **20**(3), pp. 5–8.

[4] Shen, L. Y. et al. (2010). The application of urban sustainability indicators? A comparison between various practices. *Habitat International*, **35**, pp. 17–29.

[5] Yovanof, G. S., Hazapis, G. N. (2009). An architectural framework and enabling wireless technologies for digital cities & intelligent urban environments. *Wireless Personal Communications*, **49**(3), pp. 445-463. ISSN 0929-6212.

[6] Khansari, N., Mostashari, A., Mansouri M. (2013). Impacting Sustainable Behaviour and Planning in Smart City. *International Journal of Sustainable Land Use and Urban Planning*, **1**(2), pp. 46-61. ISSN 1927-8845.

[7] While, A. et al. (2004). The environment and the entrepreneurial city: searching for the urban 'sustainability fix' in Manchester and Leeds. *International Journal of Urban and Regional Research*, **28**(3), pp. 549–69. ISSN 1468-2427.

[8] Jepson Jr, E. J., Edwards, M. M. (2010). How possible is Sustainable Urban Development? An Analysis of Planners' Perceptions about New Urbanism, Smart Growth and the Ecological City. *Planning, Practice & Research*, **25**(4), pp. 417-437. ISSN 1360-0583.

[9] Campbell, S. (1996). Green cities, growing cities, just cities?: Urban planning and the contradictions of sustainable development. *Journal of the American Planning Association,* **62**(3), pp. 296-312. ISSN 0194-4363.

[10] Minne, E. A. et al. (2011). Water, energy, land use, transportation and socioeconomic nexus: a blue print for More Sustainable Urban Systems. *Sustainable Systems and Technology (ISSST),* 2011 IEEE International Symposium on, May, 1–4.

[11] Nibel, S. et al. (2012). *Description and explanation of the selected indicators and related measurement and assessment methods with special focus on reliability, comparability and compatibility*. SuPerBuildings Deliverable 4.2, Available at http://cic.vtt.fi/superbuildings (Accessed 1 October 2014).

[12] Finnveden, G., et al. (2009). Recent developments in Life Cycle Assessment. *Journal of Environmental Management*, **91**(1), pp. 1–21. ISSN 0301-4797.

[13] Marshall, E., Shortle, J. (2005). Urban development impacts on ecosystems. *Goetz, S., Shortle, J., Bergstrom, J. (eds.), Land Use Problems and Conflicts: Causes Consequences and Solutions. Taylor & Francis*, 2005, New York, pp. 384

[14] Häkkinen, T., et al. (2013). Land Use as an Aspect of Sustainable Building. *International Journal of Sustainable Land Use and Urban Planning*, **1**(1), pp. 21-41. ISSN 1927-8845.

[15] Lobley, M., Winter, M. (2009). *Introduction: Knowing the land.* What is land for? The food, fuel and climate change debate. Winter, M. and Earthscan, E.M. (Ed), pp. 362. Available at www.google.at/books (Accessed 5 October 2014).

[16] Nuissl, H., Haase, D., Lanzendorf, M., Wittmer, H. (2008). *Environmental impact assessment of urban land use transitions – A context-sensitive approach. Land Use Policy.* Available at http:// www.elsevier.com/locate/landusepol (Accessed 15 October 2014).

[17] Milà i Canals, L., Bauer, C., Depestele, J. et al. (2007). Key elements in a framework for land use impact assessment within LCA. *International Journal of Life Cycle Assessment*, 12(1) 1, pp. 5-15. ISSN 0948-3349.

[18] Baeumler, A., Ijjasz-Vasquez, E., Mehndiratta, S. (2012). Sustainable Low-Carbon City Development in China. *World Bank Publications*, pp. 44-45. ISBN 9780821389881.

[19] Cohen, N. (2011). *Green Cities: An A-to-Z Guide.* SAGE, 547, pp. 146-147. ISBN 9781412996822.

[20] Sigrist, P. (2009). Dongtan Eco City: A model of urban sustainability? *The Urban Reinventors Online Journal, Issue 3/2009. The Urban Reinventors Paper Series, 2005-2009. The Urban Reinventors*. Available at: www.urbanreinventors.net (accessed 17 April 2014).

[21] Chang, I. C., Sheppard, E. (2013). China's Eco-cities as Variegated Urban Sustainability: Dongtan Eco-city and Chongming Eco-island. *Journal of Urban Technology*, **20**(1), pp. 57-76.

[22] Wood, R. (2007). *Dongtan Eco-City, Shanghai.* National Congress, Perth, WA. 2007. Available at: http://www.arup.com/_assets/_download/8cfdee1a-cc3e-ea1a-25fd80b2315b50fd.pdf (Accessed 20 March 2014).

[23] Sanford, L. (2010). *A Tale of Two Eco-Cities*. Modern Power Systems 2010, pp. 20-22.

[24] Brenhouse, H. (2010). Plans Shrivel for Chinese Eco-City. *International Herald Tribune*. 24 June 2010.

[25] Masdar City. (2011). Available at: http://masdarcity.ae/en/78/master-plan/ (accessed 11 April 2014).

[26] Bueren, E. (2011). Sustainable Urban Environments: An Ecosystem Approach. *Springe*r, 448 p., pp. 332. ISBN 9789400712942.

[27] Špirková D., et al. (2013). Economic aspects of sustainable development of built environment in Europe. *MCDP International UG, Germany*. 1st ed., 232 p., pp. 99. ISBN 978-3-9810884-2-7.

[28] Nnamdi O. Madichie, (2011). IRENA – Masdar City (UAE) – exemplars of innovation into emerging markets. *Foresigh*t, **13**(6), pp. 34-47. ISSN: 1463-6689.

[29] Lau, A. (2011). Masdar City: A model of urban environmental sustainability. *Journal of Social Sciences*, pp. 77 – 82.

[30] Kingsley, P. (2013). *Masdar: the shifting goalposts of Abu Dhabi's ambitious eco-city*. 17 December 2013. Wired magazine. Online available on: http://www.wired.co.uk/magazine/archive/2013/12/features/reality-hits-masdar.

[31] Smith, A., Hill, G. (2012). *Tianfu Ecological City. Chengdu, China.* Available at: http://smithgill.com/work/tianfu_ecological_city/ (accessed 12 May 2014).

[32] Rahaman, M. (2014). *One Platform-Different Cities: An Automated Plug and Play Modular Building Construction & City Planning System.* In: Bock, T., et al. (2014). Proceedings of the CIB*IAARC W119 CIC 2013 Workshop, Technische Universität München (TUM), Germany.

[33] Harter, G., Sinha, J., Sharma, A., and Dave, S. (2010). *Sustainable urbanization: the role of ICT in city development.* Booz & Company Inc. Available at http://www.booz.com/media/uploads/Sustainable_Urbanization.pdf

[34] Naphade, M., et al. (2011). Smarter cities and their innovation challenges. *Computer*, **44**(6), pp. 32-39.