Green Urbanism for the Greener Future of Metropolitan Areas

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Abstract. Intensive urbanization is swallowing municipal green areas which causes intensification of erosion, decrease in biodiversity and permanent fragmentation of habitats. In the face of these changes, a risk of irreversible damages to urban ecosystems is growing. That is why planning of solutions within the framework of Green Urbanism in metropolitan areas inhabited by over 55% of the global population is of extraordinary importance. The task of the paper is to present patterns of the Green Urbanism using selected examples of metropolitan areas as case studies. The main goal of the research is to make comparison between GU practices in different countries, in various spatial settings. The principles of triple zero framework: zero fossil-fuel energy use, zero waste, zero emissions (from low-to-no-carbon emissions) introduce not only the contemporary trends in theoretical urban planning but are dictated by practical considerations to create a healthy environment for a healthy society with a minimized environmental footprint. The research results help to identify Green Urbanism techniques used for multiple functions, including ecological, recreational, cultural, aesthetic and other uses and present opportunities for implementation of Green Urbanism solutions in metropolitan areas. To achieve healthier society and environment, highly congested and polluted cities have to be recreated through working with the existing landscape, topography and natural resources particular to the site.

1. Introduction

The vision of sustainability and greener future of contemporary cities emerged in 1992 at the Rio Earth Summit as Local Agenda 21, and renewed during Rio+20 United Nations Conference on Sustainable Development in 2012. Although cities occupy only about 2% of Earth, they account for 75% of total resource use.

Rapid urbanization increases energy and infrastructure demand, destroys ecosystems, and creates pressure on supply of fresh water. Urban sprawl causes a negative ecological footprint and extensive and frequently irreversible changes in a rural environment. The main goal of the research was to identify various techniques used in Green Urbanism which were divided into three categories: Energy and Materials, Ecosystem and Urban Planning. The idea was to present significant Green Urbanism practices such as: Green Infrastructure, Green Belts and Transport Oriented Development (TOD) on selected examples of metropolitan areas as the case studies. The basic idea was to make a comparison between Green Urbanism practices in different countries to conclude what direction in urban development is prominent. The questions were: how to change urban environment and introduce spatial integration, health and accessibility for multiple functions as recreation, water management, health, biodiversity, renewable energy and sustainable transport.
2. Green Urbanism planning solutions.
2.1. “Urban metabolism” and ecologically sensitive urban planning
Cities incorporate a mix of environmental (energy, water and waste) information and communication technologies. In this context, urban environment can be described as the living organism which consumes and transforms materials and energy as other living creatures. The term of “urban metabolism”, based on an analogy with the metabolism of organisms, introduced by A. Wolman [1] fully corresponds to this phenomenon. In his studies, Wolman compared data on inflow and outflow rates (water, food and fuel use rates with solid refuse, sewage and air pollution rates) to determine the needs for consumption and show the flow of energy and materials in a hypothetical American city of one million people. The need for ecologically sensitive urban planning appeared in the crucial book of Ian McHarg’s: “Design with Nature” in 1969. In the following years, series of books devoted to ecological approaches to cities were printed (among others: F. Steiner’s: “The Living Landscape” in 1990, M. Hough’s: “City and the Natural Process” in 1995). The idea of ecologically sensitive planning influenced the birth of New Urbanism in North America, which put emphasis on building the sense of stronger, social communities. Green cities create possibilities to apply environmentally friendly technologies as public transport, district heating, green buildings and green design concepts (e.g. Green Infrastructure). Beatley [2] defines Green Urbanism based on design qualities and characteristics. According to Beatley, cities that correspond to the Green Urbanism idea are living within their limits with causing minimal negative ecological footprints, they function in ways analogous to nature and follow circular metabolism rules through e.g. recycling of waste and waste water treatment. Green, self-sufficient in economy, regional food and energy production cities promote a more sustainable, healthful lifestyle for local communities.

2.2 Green Urbanism techniques
Green Urbanism principles integrate various techniques to minimize the usage of water, energy and materials, which take into account above other things the location of cities and the local climate which is used to optimize natural assets as sunlight and wind flow. Generally, green technologies help to make savings in costs of energy, food and materials at every stage of city life-cycle Lehman [3]. The three important components of Green Urbanism indicated by UNESCO Chair in Sustainable Development for Asia and Pacific as were Energy and Materials, Water and Biodiversity (here Ecosystem), and Urban Planning and Transport, which deliver the background for division of the Green Urbanism techniques. The field of Energy and Materials includes solutions such as supply chain integration with recycling of waste on place, energy and materials management, renewable energy solutions and introduction of new energy sources. In the field of Ecosystem, the techniques are used to maximize ecosystem sustainability through delivering new greenery to urban environment, increasing the biodiversity, climate change mitigation and urban water management (e.g. potable water resources management, grey water recycling, storm water management, irrigation). Lehman in his book: “Green Urbanism: Formulating a Series of Holistic Principles” [3] identifies characteristic features which correspond to Green Urbanism.

2.3 Green Urbanism – the case studies
The case studies (Mueller community, Metropolitan Green Belt, Curitiba BRT) are based on examples of the principal practices for increasing the sustainability of cities which include green system regeneration (through Green Infrastructure), transport remodelling (through Transport Oriented Development TOD) and increasing of compactness and density of cities (through implementation of Greenbelts policies). These practices at the same time help to control the urbanization, transportation and green pattern of contemporary cities and influence the energy and materials generation and management.

2.3.1 Mueller community (USA)
Mueller strategy for Green Urbanism combines a few principles, namely protecting Air Quality (using low-emitting materials and green areas management-implementation of extensive vegetation, tree
planting and open space preservation), mitigating Urban Heat Island (through a well-thought-out hydrologic, landscape and building approaches), protecting the Night Sky, Light (minimizing light pollution, direct light downward, introducing vegetative cover) and Creating Green Buildings [4]. In Mueller, transformed from industrialized brownfield into a green compact urban community Green Infrastructure was used in two major planning approaches: in the City of Austin Reclaimed Water and in the Community Stormwater Treatment Programs [4]. Apart from other solutions in the field of urban water management, Austin’s Water and Wastewater Department has introduced a “purple pipe” of reclaimed water system to deliver irrigation water to public open spaces and streetscapes. Stormwater treatment system combines rainwater catchment, wet ponds, green roofs, permeable pavements, used to manage stormwater on site [4].

2.3.2 Metropolitan Green Belt (London).
Howard’s Garden City vision and the Campaign to Protect Rural England, formed in 1926 by Sir Patrick Abercrombie, inspired the London County Council to develop London’s Green Belt plan in 1935 with the central idea to provide a reserve of public open spaces and recreation land around London. The urban planning task was to stop the increasing pressure of a densely packed city on countryside by implementation of series of preserved green spaces around the capital. The Town and Country Planning Act introduced in Great Britain in 1947 allowed to include Greenbelts in urban planning documents and policies and Minister of Housing finally implemented Greenbelts into planning practice in 1955. Over the next years, Metropolitan Green Belt extended so significantly that it now surpasses three times the area of the GLA boundary and covers 3.7% of the total land area of England (London Greenbelt Council). The National Planning Policy Framework (2012) identifies five purposes of the Green Belt: stop urban sprawl, prevent merging of neighbouring cities, help in safeguarding of the countryside and cultural values of historic towns, and assist in urban regeneration [5].

2.3.3 Curitiba BRT (Bus Rapid Transit) (Brasil)
As one of the first cities in the world Curitiba developed a comprehensive Transport Master Plan approved in 1966. In 1974, the first BRT line was opened in one of the transit corridors. Currently, the BRT, operates along segregated median flow lanes, constitutes the backbone of the Transit-Oriented Development in the city and connects transport centres over long distances and short distance buses [6, 7]. The BRT combines differentiated services: express and direct radial routes, inter-neighbourhood circumferential routes, feeder services (connecting local neighbourhoods to the higher speed traffic), downtown lines using small buses and the special services for hospitals, tourists and students. The bus stops (tubes-special stops for special vehicles, terminals – stops for express lines) are evenly distributed at a distance of 500 m from each other. BRT network of public transport corridors – the central element in the city’s network of transit ways allows to keep the city at a human scale and constitutes the link between transport and land use. In 1990, the new plan for connecting the Curitiba metropolitan area through the RIT system was implemented in strong cooperation between the State of Paraná and the City of Curitiba. A revolutionary system includes three parallel roadways – the central green avenue dedicated to bus transit and local traffic with access to the high density, mix used blocks standing along and two parallel one direction streets (leading towards the city centre or suburbs) dedicated to higher speed traffic [7]. Further from the avenue, the density of development is lower, the highest blocks are located along the main avenue. The RIT integrates not only transport but also diverse services grouped in mid points and in proximity of terminal stations. In 2009, the bus system was modernized and the Green Line– the sixth BRT corridor which includes the operation of 100 percent bio-diesel articulated buses was developed. The Green Line, conceived in 2002, has a total length of 16 km and accommodates 10 traffic lines dedicated to buses, grass and trees, lines for pedestrians and cyclists, [7].

3. Results and Discussions
Green, sustainable cities, designed following the nature and its needs, using good planning practices as the Green Infrastructure, Transit Oriented Development (TOD), Greenbelts (allowing to follow the
pattern of a compact city), have a beneficial effect on general health of inhabitants and vitality of urban ecosystems in the form of clean air, better quality of water, flood and drought protection, and wider accessibility of recreational grounds. In urban, highly modified landscapes, Green Infrastructure is a bonding element, joining three Green Urbanism components (Energy and Materials, Ecosystem and Urban Planning) to deliver to city’s environment biodiversity, help to reduce energy demands, GHG emissions, reduce and delay of storm-water runoff volumes, enhance groundwater re-charge, lower incidents of combined storm and sewer overflows (CSOs), improves air quality, human health and creates additional recreational space [8]. In Mueller (USA), planned as a demonstration of the Austin Energy’s Green Building Program for the United Nations Earth Summit in 1992, Green Infrastructure was one of the major elements of the Green Urbanism strategy for the community development divided into: Green Community Design, Green Buildings and Green Infrastructure [4]. Compactness of cities, a major strategy of Green Urbanism can be achieved by intensification (increasing the density of development and activity of cities) but also by urban containment policies: greenbelts, urban growth boundaries and urban service areas [9]. Urban containment policies allow to control urban expansion and pattern, and to direct development to outlying areas. Greenbelts, buffer zones of preserved open space created around cities, help to stop urban sprawl and restrict residential development in agriculture areas. This planning policy refers also to urban regions of significantly reduced development. Transit Oriented Development (TOD) is defined as development centred around and coordinated with public transportation service. TOD strengthens economic development, it benefits not only developers and local governments economically, but also creates pedestrian-friendly environments, interesting and vibrant places for local communities. The combination of mix-use development and bus-based serviced in Curitiba influenced economic increase in transit ridership rates [6]. More compact cities with limited urban sprawl, mixed-use functions around green transit-oriented developments with easy access to public green areas deliver a wide range of benefits to inhabitants (such as social sustainability, local identity, repopulation of cities centres, preservation of land resources, better accessibility and lower infrastructure cost). The interrelated system of greenery and transport can be easily supplemented with the micro-scale eco-solutions (such as micro-generation of electricity through solar or wind generation technologies, rainwater harvesting and efficient waste management).

4. Conclusion
Urban Planning techniques incorporate urban with ecosystem design practices (e.g. New Urbanism, Green Infrastructure, Transit-Oriented Developments TOD) to create socially sustainable cities, equipped with public transport links and energy efficient buildings. Well though-out urban planning uses individual conditions of cities with regards to topography and climate prerequisites (e.g. solar radiation, wind, humidity) to apply different solutions, such as natural ventilation system. The decentralized energy generation is based on local renewable energy sources (e.g. solar PV, solar thermal, geothermal power, wind turbines, biomass). In the scale of architecture, green technologies are incorporated into buildings (e.g. solar PV, urban wind turbines, micro CHP and solar cooling). [3]. Cities in many areas of the world suffer from potable water shortage. The reduction of water consumption, protection of water habitats, more efficient but sustainable usage of water resources are primary challenges of contemporary urban societies. To solve these problems, the technologies of water retention, water storage, and sewage recycling infrastructure have to be integrated into the Green Infrastructure.

References
[1] Wolman A, The metabolism of cities. Scientific American, 1965;213(3): p.179-190.
[2] Beatley T, Green Urbanism: Learning from European Cities. Washington, D.C: Island Press; 2000.
[3] Lehmann S, Green Urbanism: Formulating a Series of Holistic Principles, Sapiens, 2010,Vol.3 / n°2, (https://sapiens.revues.org/105, date of access: 12.05.2016)
[4] City of Austin, Catellus Development Corporation, 2004. Mueller Design Book. Roma Design Group, 2004 (http://www.muelleraustin.com/plan/design/, date of access: 12.05.2016)

[5] Natural England, Green Belts: a greener future. Campaign to Protect Rural England, final report, 2010 (www.naturalengland.org.uk, date of access: 12.05.2016)

[6] Cervero R, The Transit Metropolis. A Global Inquiry. 4th edition. Washington, D.C. Island Press; 1998

[7] Lindau, L.A., Hidalgo D, Facchini D, Bus Rapid Transit in Curitiba, Brazil. A Look at the Outcome After 35 Years of Bus-Oriented Development. Transportation Research Record, 2010; Vol. 2193: p. 17-27

[8] Zaręba A, Multifunctional and Multiscale Aspects of Green Infrastructure in Contemporary Research, Problems of Sustainable Development, 2014; vol. 9, no 121: p.149-156

[9] Jabareen Y.R., Sustainable Urban Forms. Their Typologies, Models, and Concepts. Journal of Planning Education and Research, 2006; 26: p.38-52