Sustainable Urban Futures: An Ecological Approach to Sustainable Urban Development

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Abstract

In recent years, cities show increasing signs of environmental problems due to the negative impacts of urban activities. The degradation and depletion of natural resources, climate change and development pressure on green areas have become major concerns for cities. In response to these problems, urban planning policies have shifted to a sustainable focus and cities have begun to develop new strategies for improving the quality of urban ecosystems. An extremely important function of an urban ecosystem is to provide healthy and sustainable environments for both natural systems and communities. Therefore, ecological planning is a functional requirement in the establishment of sustainable built environment. With ecological planning human needs are supplied while natural resources are used in the most effective and sustainable manner. And the maintenance of ecological balance is sustained. Protecting human and environmental health, having healthy ecosystems, eliminating environmental pollution and providing green spaces are just a few of the many benefits of ecological planning. In this context, the paper briefly presents a short overview of the importance of the implementation of ecological planning into sustainable urban development. Furthermore, the paper defines the conceptual framework of a new method for developing sustainable urban ecosystems through ecological planning approach. In the future of the research, this model will be developed as a guideline for the assessment of the ecological sustainability in built environments.

Keywords: Sustainable urban development, environmental sustainability, ecological planning.

Introduction

> *"Cities consume significant quantities of natural resources and have a major impact on the environment, well beyond their borders. These unsustainable trends need to be substantially curbed and eventually reversed." (Newman and Jennings, 2008, p. 80)*

In the last few decades, important changes have occurred in the quality of built environment. Due to rapid industrialisation and urbanisation, there have been serious effects on climate, biodiversity and natural resources. As a result of development pressure on green fields, urban green areas become small, scattered and polluted. Development of transportation networks caused negative impacts such as energy consumption, emission of air pollutants, traffic congestion and noise. On the other hand, the degradation and depletion of urban landscapes threaten health related quality of life of the population. According to the causes of these environmental problems, it becomes necessary to revise the current urban policies and develop new planning models for sustainable urban development.

To achieve sustainable urban development, cities must be planned and managed to form a balance between human being and natural environment by using resources carefully and transferring them to the next generations. In order to protect and enhance environmental conditions of future generations, it is essential to provide the sustainability of urban ecosystems. Therefore, the concept of ecological planning

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(eco-planning) becomes a functional requirement in achieving sustainable built environment. It is an effective tool that aims to form an urban development in harmony with ecological, social and economic values. According to Thompson and Steiner (1997), with eco-planning human needs are supplied by using natural resources in a sustainable manner and the maintenance of ecological balance is sustained.

Eco-planning provides specific benefits for long-term sustainability by ameliorating the environmental impacts of cities in terms of the following objectives; improvement of air, water and soil quality, energy saving, reduction of stormwater runoff and urban heat island effect, aesthetic improvement of the city and enrichment of urban biodiversity. According to these benefits, the focus of this research is to investigate the issue of eco-planning as an effective tool for the establishment of a sustainable and qualified urban life and to be considered as a guide for governments, planning institutions and designers. In this context, a methodology shall be proposed for the integration of eco-planning into the urban planning process by proposing solutions and suggestions to the arising problems (UNEP, 2007; Usha, 2007).

This paper is structured in four parts. The first section reviews the literature on the role of eco-planning in sustainable urban development. This section addresses the major environmental problems arising from the process of urban development in cities, existing policy frameworks for tackling these problems and the necessity and benefits of using eco-planning as a tool in urban development process. The second section presents an international best practice of eco-planning in the case of Berlin, Germany. The third section introduces the conceptual framework of this study and the schedule for the future research program. The last section summarises the findings of earlier sections.

The Importance of Eco-Planning for Sustainable Urban Development

> *"We are faced with a whole series of global environmental problems which are harming the biosphere and human life in alarming ways that may soon become irreversible. The great challenge of our time is to create sustainable communities; that is, social and cultural environments in which we can satisfy our needs without diminishing the chances of future generations." (Capra, 1996, p. 4)*

Cities are complex human-dominated ecosystems and human activities make them different from natural ecosystems in several aspects such as climate, soil, hydrology, biodiversity composition, population dynamics and flows of energy and matter (Alberti, 2008). Main human impacts of urban ecosystems are rapid population growth, unplanned urbanisation and inadequate infrastructures. Rapid population growth affects the quality of city services such as housing, public infrastructure, social facilities and causes a crisis in living conditions. Unplanned urbanisation provides a threat to the health and safety of human beings, as well as urban productivity, and combined with inadequate infrastructures, it accelerates environmental degradation (Ichimura, 2003). This brings us to the main point: to build a sustainable community for future generations, cities need to redesign many of their technologies and functions with ecological principles (Capra, 2002).

> *"In terms of urban development, ecologically oriented principles related to sustainability include compact urban form (which saves open space, reduces driving and produces walkable communities), transit-oriented development (which likewise reduces automobile and fossil fuel use), close-loop resource cycles (ensuring that water, metals, wood, paper and other materials are recycled), environmental justice (integrating environmental and equity concerns), pollution prevention and the restoration of ecosystem components within cities and towns. These and other strategies are ways to move towards a radically greener society, one which can coexist with the Earth's limited resources and often fragile ecosystems in the long run." (Wheeler, 2004, p. 55)*

In the 1970s, discussions occurred about prevention of environmental problems were followed by intensive debate on sustainable development. However in recent years ecological approaches and planning concepts gained more widespread attention and importance. The increasing concern has enforced the integration of environmental protection into national and local policies. Various international meetings and agreements were established in addressing issues of ecological degradation. In addition, various legislation, plan and programs were constituted in protecting the natural environment. However, countries still carrying on various studies and practices on finding ecological solutions to environmental problems. Consequently, this concern has led to the development of ecological priorities for urban planning process and it has become a necessity to develop new frameworks for preventing the degradation in nature while ensuring the sustainability of resources.

Sustainable development is a continuous improvement of life quality that protects and balances the ecological, social and economic environments. World Commission on Environment and Development in its report Our Common Future describes sustainable development as: "*Meeting the needs of the present without compromising the needs of future generations." (1987, p. 23)* So it is an attempt to provide the best outcomes for the human and natural environments both now and into the indefinite future. Higher living standards, better quality community services, social equity, ecological health and environmental quality are all essential components of sustainable development. Therefore, one of the important strategic planning approaches according to the principles of sustainable development is 'eco-planning'.

As cited by Williams (2000, p.11), eco-planning refers to "strategies and techniques that combine urbanism and nature to create healthy, civilising, and enriching places to live". It means "a living area governed more by nature than legislature; and a sustainable human settlement based on ecological balance, community self-reliance, and participatory democracy". Eco-planning is a fundamentally multi-dimensional concept, providing a wide range of environmental, economic and social benefits to local governments, developers and the community as a whole. Environmentally, it creates ecologically effective green areas, reduces ecological risks, and improves the quality of water, air and soil. Economically, it prevents urban sprawl and traffic congestion, provides better utilisation of existing infrastructure. Socially, it reduces health risks, improves the quality of urban life and city services (e.g. health, education, transportation, recreation) (Galifianakis, 2006). So with all these benefits, this research will present further opportunities to turn unsustainable urban areas from a problem to a future resource as sustainable environments.

An International Best Practice of Eco-planning: The Case of Berlin

In many parts of the world, new or current developments are shifting to a more ecological direction. Many cities around the world are now developing integrated solutions to the major environmental challenges and transforming themselves into more sustainable and self-sufficient communities. There is a set of initiatives and implemented policies which have been carried out through so called 'green factors'. It started in Berlin, Germany during the 1990s by the biotope area factor (BAF). Also recently the green space factor was implemented in an urban development, 2001, in Malmö, Sweden; and even more current, in 2007, the green factor in Seattle (Roehr et al., in press). The main environmental quality objectives of these green factors could be summarised as follows:

- Safeguarding and improving the microclimate and atmospheric hygiene,
- Safeguarding and developing soil function and water balance,
- Creating and enhancing the quality of the plant and animal habitat, and
- Improving the quality of built environment (SenStadtUm, 2009).

Berlin's 'biotope' strategy is one of the good examples for eco-planning approach. In order to promote high quality urban development with respect to the ecosystem, protection of biotopes and species, the appearance of the landscape and recreational use, Berlin Senate Department for Urban Development and Environmental Protection developed a planning tool entitled 'Biotope Area Factor' (SenStadtUm, 2009). Similar to the urban planning parameters used in development planning, the BAF is a tool that is used to measure the ecologically effective land area of a development. The ecologically effective area is defined as the area of a development that is somehow contributing to ecosystem function through stormwater drainage or habitat (Ngan, 2004).

$$BAF = \frac{\text{ecologically-effective surface areas}}{\text{total land area}}$$

Figure 1: Calculating the 'Biotope Area Factor' (SenStadtUm, 2009)

The BAF expresses the ratio between the ecologically effective surface area and the total land area (Figure 1). The BAF covers urban forms of use - residential, commercial, and infrastructural - and formulates ecological minimum standards for structural changes and new development. For each type of urban form, planners set a particular BAF target value. For example, new residential structures and public facilities for cultural or social purposes have a BAF target of 0.60; new commercial structures, education complexes, outdoor sports facilities and technical infrastructure have a target of 0.30. Each type of surface on the proposed plan is measured and assigned a measure of relative importance according to its 'ecological value' (Figure 2). For example, a surface of concrete or asphalt would get a score of 0.0 while a green roof would get a score of 0.7 and a surface covered with vegetation would get the highest score of 1.0. This rating is then multiplied by the total area that features covers of the development. Adding up all of these scores gives you the ecologically effective area. This ecologically effective area is then divided by the total area of the development to give you a final green area score (Ngan, 2004).

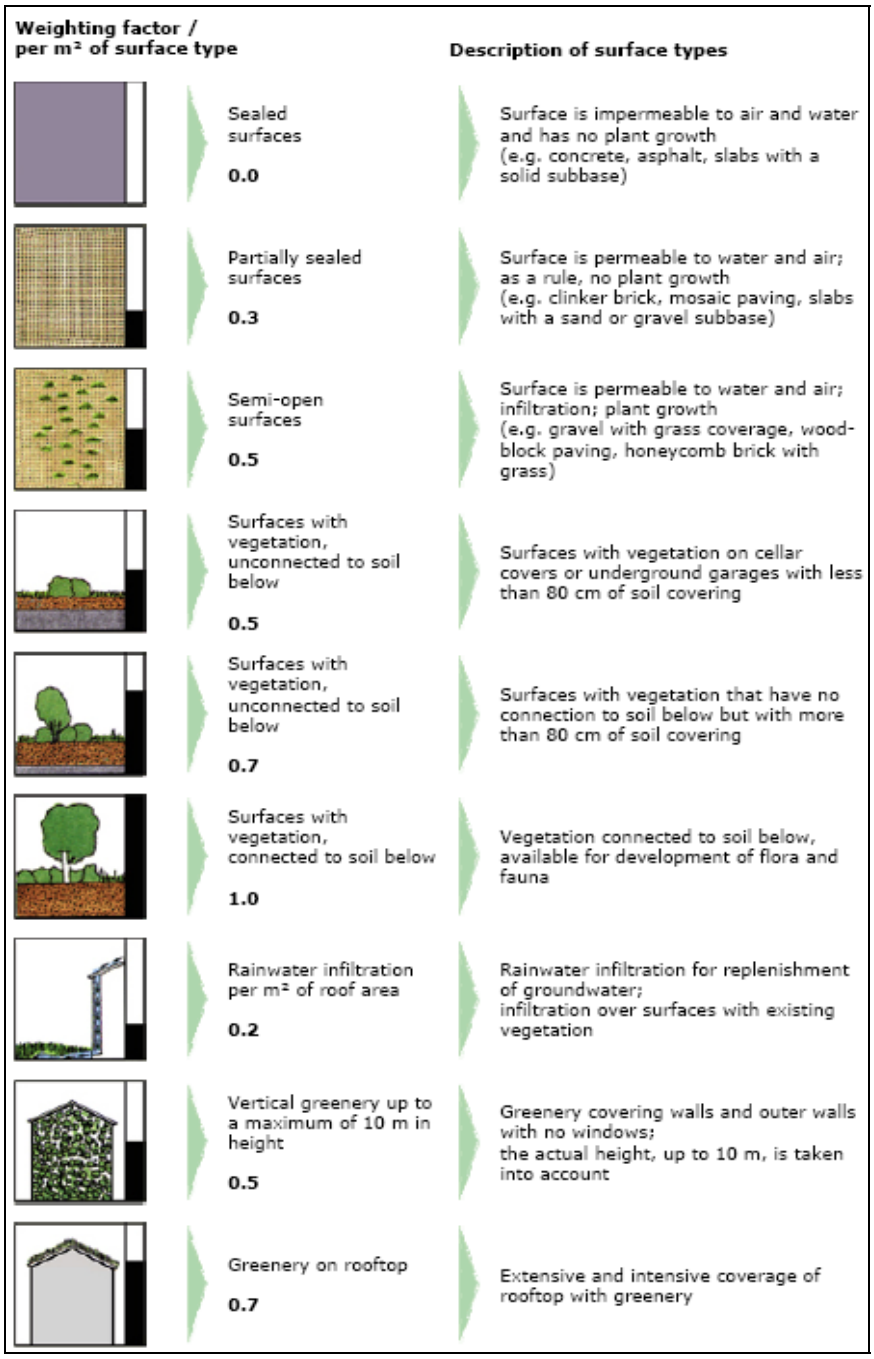
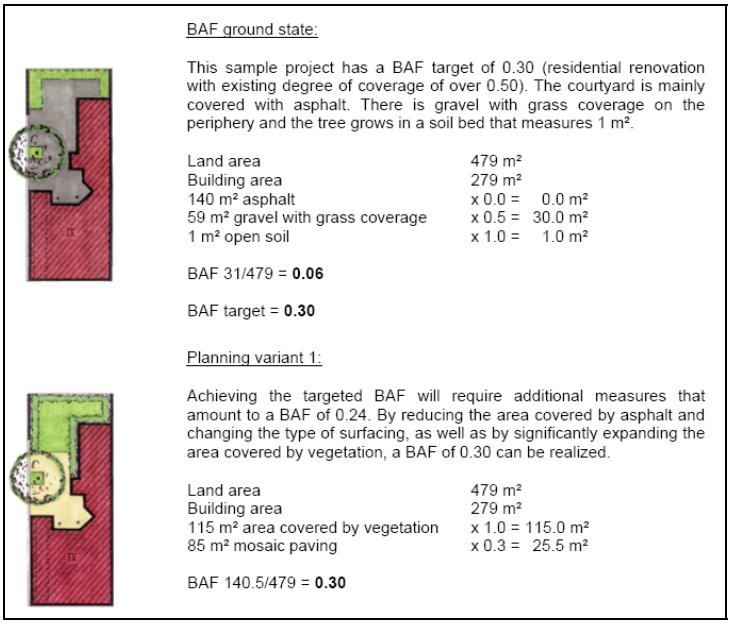


Figure 2: Weighting Factors (SenStadtUm, 2009)

The City of Berlin sets minimum standards for what this score has to be. The planners and decision makers have the freedom to implement any number of planning variants including green features to reach the score (Figure 3).

> *"The environmental benefits achieved by such a green surfaces intervention by analysing the contribution to ameliorate the environmental impact of cities including the following: reduced cooling and heating demand; improved air quality; reduced stormwater runoff; the enrichment of urban biodiversity and urban agriculture; a reduced urban heat island effect; a contribution to carbon neutral architecture; an aesthetic improvement to cities' skylines; and an assessment of the economic evaluation." (*Roehr and Laurenz*, 2008, p.1)*

Street / Land Calculation example		Total area (m²) 479	Developed area (m²) 279	Undeveloped rea (m²) 200	Existing-BAF 0.06 BAF 0.3
Surface type / weighting-factor per m²		Portion of each surface type relative to the total area in m²			
		Amount	EEA* Amount	Planned	EEA* Planned
1.	Sealed surfaces **0.0**	140	0		
2.	Partially sealed surfaces **0.3**			85	25.5
3.	Semi-open surfaces **0.5**	59	30		
4.	Surfaces with vegetation unconnected to soil below and with < 80 cm of soil covering **0.5**				
5.	Surfaces with vegetation unconnected to the soil below and with > 80 cm of soil covering **0.7**				
6.	Surfaces with vegetation connected to the soil below **1.0**	1	1	115	115
7.	Rainwater infiltration per m² of runoff area **0.2**				
8.	Vertical greenery up to a maximum of 10 m in height **0.5**				
9.	Greenery on rooftop **0.7**				
	Ecologically effective surface area		31		140.5
BAF = ecologically effective surface area / total land area			* **EEA** = Portion of the **E**cologically **E**ffective surface **A**rea		
BAF = 140.5 / 479			Existing BAF 0.06		Planned BAF 0.3



BAF ground state:

This sample project has a BAF target of 0.30 (residential renovation with existing degree of coverage of over 0.50). The courtyard is mainly covered with asphalt. There is gravel with grass coverage on the periphery and the tree grows in a soil bed that measures 1 m².

Land area	479 m²
Building area	279 m²
140 m² asphalt	x 0.0 = 0.0 m²
59 m² gravel with grass coverage	x 0.5 = 30.0 m²
1 m² open soil	x 1.0 = 1.0 m²

BAF 31/479 = **0.06**

BAF target = **0.30**

Planning variant 1:

Achieving the targeted BAF will require additional measures that amount to a BAF of 0.24. By reducing the area covered by asphalt and changing the type of surfacing, as well as by significantly expanding the area covered by vegetation, a BAF of 0.30 can be realized.

Land area	479 m²
Building area	279 m²
115 m² area covered by vegetation	x 1.0 = 115.0 m²
85 m² mosaic paving	x 0.3 = 25.5 m²

BAF 140.5/479 = **0.30**

Figure 3: Calculation and Planning Variant Example (SenStadtUm, 2009)

Briefly, the goals of this policy are numerous and aimed at improving the general quality of the urban landscape. City planners have received positive feedback from architects and property owners because it is easy to use and there are immediate visual improvements as well as energy savings. (Ngan, 2004).

A Conceptual Framework for the Future Research

> *"Strategic decisions about urban infrastructure and growth management are based on our assessment of the past and our expectations for the future. How we think about the future has important consequences for how we define the problems to be addressed and how we searched for solutions. Traditional approaches to planning and management typically rely on predictions of probable futures extrapolated from past trends. Planners and managers need to rely on a much broader and diverse knowledge of the past to build a view of the 'long now'." (Alberti, 2008, p.226)*

Figure 4 illustrates the conceptual framework of this study. Ecological sustainable development is defined as the integration of human activities into natural systems with ensuring the long-term sustainability of these systems. Human activities such as population growth, urbanisation, transportation and industry cause pollution and depletion of natural systems. In this context, new planning approaches needed to be developed in order to protect and enhance the environmental conditions for future generations.

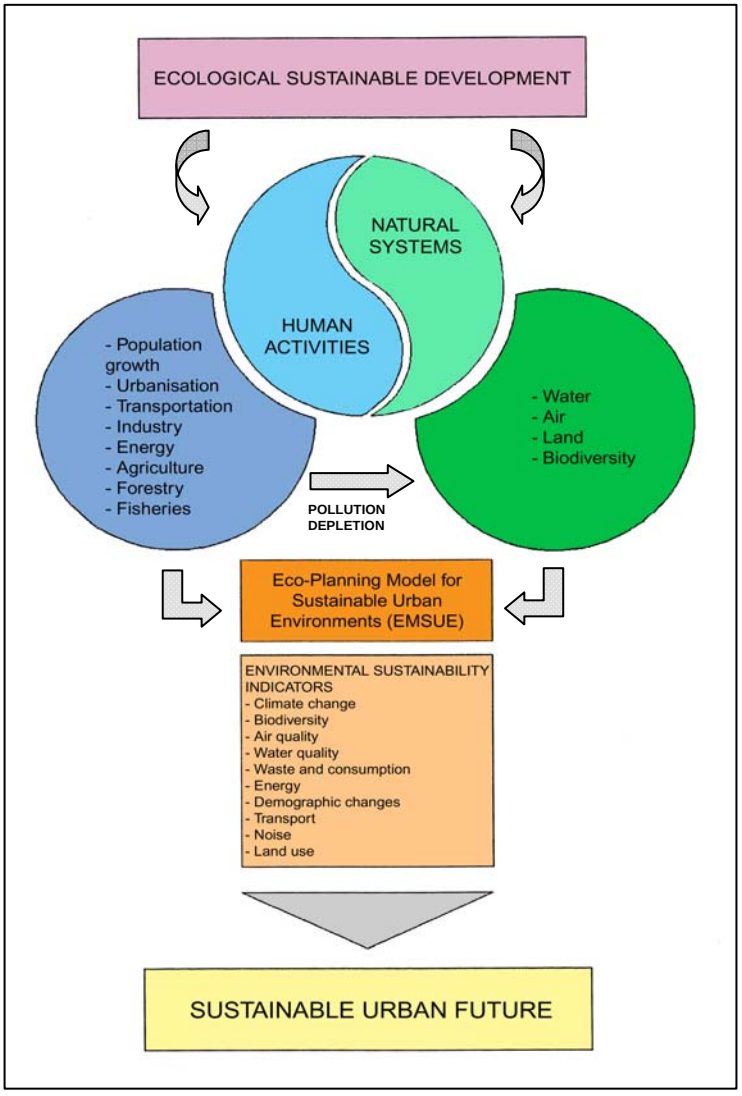


Figure 4: Conceptual Framework

Based on the conceptual framework, proposed 'Eco-Planning Model for Sustainable Urban Ecosystems (EMSUE)' will be used as a planning tool in achieving sustainable urban futures. This model will be developed from a set of environmental sustainability indicators. These indicators will provide information about the present environmental condition and will be used for measuring environmental progress. Briefly, this model will support the future urban development projects from an ecological perspective and propose solutions to the arising problems.

The research consists of the following steps; literature review and analysis of best practices, development of conceptual framework and the new eco-planning model, case study, scenario testing and policy development. Firstly, a critical review of literature, best practices and case studies on the subject of eco-planning and sustainable development will be conducted. Then, a conceptual framework and the new eco-planning model entitled EMSUE will be developed by synthesising the information from the literature and best practices review.

At the next stage, this model will be piloted with GIS-based method in the case of Gold Coast, Australia. The case study area will be divided into 25x25 meter grid cells. Each cell will be evaluated by various environmental sustainability indicators for measuring their ecological sustainability index. Finally, the results of the case study will be analysed and evaluated. The findings of the testing and analysis process will be used to develop policies in order to integrate eco-planning into urban planning process. Recommendations to implement ecological sustainable development policies in respect with the planning, management and protection of urban environments will be established.

Conclusion

At the turn of the millennium, the Earth’s human population has reached unprecedented levels and its natural resources are being pushed to the limit. Cities have begun to develop a new vision for a sustainable future. They have trying to find strategies to integrate urban planning and environmental conservation. As awareness of the environmental impact of metropolitan areas grows, sustainability takes on a decidedly urban flavour. Regulators have responded with a variety of zoning code proposals for ecological requirements (Lacasse and Clemmons, 2006). In this context, eco-planning has become perhaps the most important factor in ameliorating urban environments.

As a comprehensive planning approach, sustainable urban development refers to a city which its people and businesses continuously endeavour to improve their environments while maintaining the sustainability of ecological systems that supports the growth (Haughton and Hunter, 2003). Elkin et al. (1991, p.12) state that "sustainable urban development must aim to produce a city that is 'user-friendly' and resourceful, in terms not only its form and energy-efficiency, but also its function, as a place for living". Ecology is the relationship of all living things, including people and their biological and physical environments. Eco-planning is a tool that human should reasonably plan their activities, not to destroy nature but to coordinate with the environment. Furthermore, it is the basic of sustainable development.

In brief, eco-planning concept is a vital planning approach of our vision of creating sustainable cities in balance with nature. This research aims to answer the issue of building a sustainable urban future by developing a planning tool entitled 'Eco-Planning Model for Sustainable Urban Ecosystems (EMSUE)'. This model will be an effective tool for decision-making, used to evaluate the probable environmental impacts and identify the ecological sustainability of a proposed development. Furthermore by undertaking a case study, this research will demonstrate that ecological planning provides high quality urban development with respect to the protection of nature and biodiversity.

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