

# ROLE OF GREEN STRUCTURE AND ECOLOGICAL SERVICES: A CASE STUDY OF BAHAWALPUR CITY, PAKISTAN

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## ABSTRACT

*Cities can make broader contribution to achieve the goals of sustainable development as they are considered major consumers of resources and ecological services. Ecological services provide a range of benefits at local, regional and global levels. Terrestrial ecosystem has different components in urban environment that provides ecological services to its inhabitants. Cities not only benefit from the internal urban ecosystem but also depend upon other ecosystems beyond the city limit. Green structure is an important component in terms of making city more sustainable and habitable. Green structure in urban environment means green infrastructure that is planned and supports sustainable urban development. From planning perspective, spatial structure of green space provides a basis for sustainable urban development. In sustainable perspective, green structure is more than the sum of green spaces. It is considered as spatial network of open spaces, public and private gardens and parks, sports fields, allotment gardens, woodlands and recreational grounds. Therefore, it is considered as a significant part of built-up environment and major source of ecological services. To structure urban areas for sustainable development, it is necessary to develop a proportion between grey and green cities. Keeping in view, research has been conducted to investigate spatial network of green structure in planned areas of Bahawalpur City of Pakistan. This study analyzes the ecological services generated from the investigated green structures, and helped develop an approach of inter-relation between green environment and urban society. Moreover, strategies for better land-use planning in green and sustainable perspective have been proposed.*

**Keywords:** Green Structures, Ecological Services, Sustainable cities, Greening.

## 1. INTRODUCTION

World urban population is growing and expanding massively. Developing countries face many problems regarding urban population expansion, such as excessive use of energy and water, overproduction of waste, air pollution, that has severe societal consequences. As Davis (1991) shows that public amenities are radically shrinking, parks are becoming derelict, libraries and playgrounds are closing and

streets are becoming more desolate and dangerous. Many social and environmental problems are arising in cities. One of these problems is the destruction and reduction of green structures in the cities. Growth of urban centers and use of urban land only for residential and commercial purposes has reduced the natural and greenery structures within the city. Closely built buildings and roads with minimum spaces of greenery characterize compact urban areas. It encompasses a high density of built forms and artificial structures. The destruction of vegetation and inadequate plantable spaces degrade the environment quality (Jim, 2000), quality of life and human health (Jackson, 2003). The long history of urban development has generated a diversity of forms and functions due to organic growth or conceived plans. The phenomenal city expansion and intensification in recent decades have somewhat diluted the greening tradition. While some cities manage to retain or even extend their green spaces, others experience degradation and destruction (Jim, 2004). Compact cities tend to encounter more inherent restrictions to greening, and many cities in developing countries have inherited the old compact form. In the course of environmental transition, cities could attempt to keep as many as possible of the environmental-sustainability ingredients, including green spaces (Marcotullio, 2001). So there is a dire need to develop and preserve green structures in the cities so that ecological and sustainable development can be realized. The green city is an ideal appeal as it has spatial, temporal and cultural diversity (Hestmark, 2000). Humanity is increasingly urban, but continues to depend on nature for its survival. Cities are dependent on the ecosystems beyond the city limits, and also benefit from internal urban ecosystems (Bolund and Hunhammar, 1999). It is human nature to make psychological attachment with natural object such as amenity vegetation (Kaplan, 1984; Ulrich, 1986).

Greening is practiced to different extent in cities, often subject to societal attitudes and political climate (Mumford, 1961; Attorre, et al., 2000). The brown agenda is essential for making a city work for a healthy and livable environment and for creating the human and economic opportunities, which have driven cities throughout their history (UN-Habitat, 2009). All cities consume land and resources, such as energy, water and materials, which they use for buildings and transport. In the process of making a city functional,

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## Role of Green Structure and Ecological Services: A Case Study of Bahawalpur City, Pakistan

these resources are turned into wastes. It is now possible to quantify this impact in one parameter called ecological footprint. The brown functions of a city generally consume its green resources and degrade its processes, unless interventions related to urban planning and environmental management are made. The green natural systems of a city have real limits and capacity issues associated with their use. The challenge for urban planning is to find ways that cities can integrate these two agendas: to respect the natural environment and to improve the human environment.

The use of photosynthetic processes in cities reduces their ecological impact by replacing fossil-fuels and can bring substantial ecological benefits through emphasis on natural systems. There has been a positive trend in planning the direction of an expanded notion of urban infrastructure, that includes the idea of 'green infrastructure'. Green infrastructure refers to the many green and ecological features and systems, from wetlands to urban forests that provide a host of benefits to cities and urban residents.

There is no accepted definition of a 'sustainable city', and as it happened with the concept of sustainable development, many interpretations exist as to which characteristics a city should be considered sustainable, and many criteria and indicators have been developed to assess them (Chiesura, 2004). The idea of livable and ecological cities has blossomed in sustainable cities. The concept of sustainable cities includes a number of fundamental objectives, such as:

- minimization of the use of non-renewable resources;
- achievement of the sustainable use of renewable resources; and
- staying within the absorptive capacity of local and global waste absorption limits.

Action to attain these objectives provides the link between the natural and the built environment, or between the green and brown agendas. Urban planning is one of the few occupations with a specific remit that encompasses the three pillars of sustainable urbanization – economic, environmental and social – and should, therefore, be at the centre of attempts to define new approaches that integrate solutions seamlessly. As Redcliff (1993) states:

“It soon becomes clear that we cannot achieve more ecological sustainable development without ensuring that it is also

socially sustainable. We need to recognize, in fact, that our definition of what is ecological sustainable answers to human purpose and needs, as well as ecological parameters. By the same token, we cannot achieve more socially sustainable development in a way that effectively excludes ecological factors from consideration.”

So when keeping in view sustainable cities, all its needs of social, economic, ecological and cultural development must be taken in context (Jenks & Jones, 2010). There are many planning aspects which should be covered in sustainable cities. But greening a city is really very important because it not only fulfills the city's aesthetic needs but also has consideration for a resource base, wildlife habitation, free air filtration and many ecological services to the residents. As Mayur (1990) believes:

“A green city is a living city by definition. It is an existing city where the full potentials of all intricately interconnected forces of nature are realized. A green city is complete in its survival capacity.”

So it must be made sure that urban residents are not divorced by nature and green both as a resource provider and as source of personal well-being. Leff (1990) argues that:

“Greening the city implies the articulation of urban function in an overall sustainable development process. It implies new function for the city and its reintegration into the overall productive process through a more balanced spatial distribution.”

Sustainable urban development must consider social, economic and environmental problems, and take into account how air pollution, poverty, HIV, crime rate, lowering of water table and other problems are linked to each other. By understanding this mechanism it becomes clear that sustainable urban development must be linked with sustainable community development. As many problems of urban growth can be solved with the help of technology and machines, but the problems of community suffocation, peace of mind and aesthetic reduction can only be sorted out with the help of changing the patterns and planning of city development and management.

There is a growing realization that urban green structures are valuable resources for creating

sustainable cities. A city with high quality of green spaces optimizes good planning, a healthy environment for its residents, vegetation and wildlife population (Adams, 1987; Johnston, 1990). These sites can fulfill the increasing needs of many people who harbor the ecocentric form of environmental value and prefer informal and wild sites that provide solitude and respite from city life (Thompson, 2002). 'How green is the city' and 'how green it must be', need a complete set of assessment tools and sustainability indicators (Devuyt, et al., 2001).

## 2. TYPES AND FUNCTIONS OF GREEN STRUCTURES

Every city has its own distinctive type of green structures that result from the interaction of certain natural and human processes. Multiple functions and benefits of urban vegetation are widely known (Mole, 1992; Petit, 1995). Based on their origin three green structure, layers can be identified (Werquin, et al., 2005):

- i. The pre-urban layer of natural landscape that were already there before the city came into existence. It includes rivers, forest, wetlands, arable land and pastures;
- ii. Urban layer or the amenity green structures. This layer includes public parks, playing fields and cemeteries. Gardens in residential areas, institutional grounds and commercial parks are also included in this layer.
- iii. Infrastructures, such as roads, railway lines and canals can include important linear green spaces.

According to the functions, green structures can be categorized as given in Table-1 (Dunnett et al., 2002):

## 3. MATERIALS AND METHODS

This research study mainly concentrates on Bahawalpur city of Pakistan, where a survey was conducted in March 2011. The study area, Satellite Town, is located on the eastern side of the city. 'Satellite Town' or 'Satellite city' is a concept of urban planning near any metropolis, these are smaller municipalities near urban city having all commercial, residential, educational and other facilities.

According to the Physical Housing and Town Planning Department of Bahawalpur, the Satellite Town is a planned area built at some distance from the core city to accommodate the increasing population. It was built in 1978 and was extended in 1985 to Bahawalpur.

This planned residential area provides all the facilities for good standard of living. The distribution of built-up area also contains reasonable proportion of open spaces for health and recreation purposes as shown in Figure-1. According to the Planning Department, each block contains an open space in the center for all the block residents. There are a total of 18 open spaces in the planning of Satellite Town. This planned area also contains a large neighborhood park in the center of the town, named as "Madir-e-Millat Park" or "Central Park". According to the National Reference Manual on Planning and Infrastructure Standards, the Government of Punjab and the local Government have proposed some standards for the planned

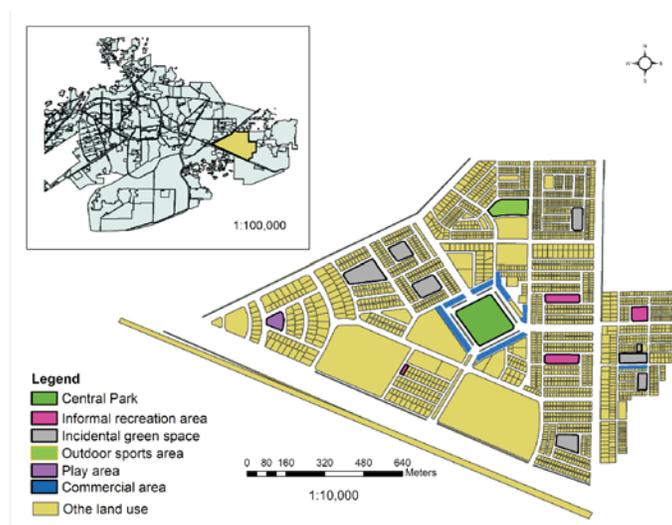


Figure-1: Classification of green spaces in Satellite Town, Bahawalpur

Table-1: Definition of Types of Urban Green Structures

<p><b>AMENITY GREEN SPACE</b></p> <p>All land which is designed primarily for amenity, both visual amenity and enjoyment for access and recreation. It consists mainly of publicly owned land but also includes private land, such as domestic gardens, which can contribute greatly to the green fabric of towns and cities. Sub-types of amenity green space are:</p>	<p><b>Parks and Gardens:</b> Areas of green space specifically designed for public access and enjoyment and combining a variety of landscape and horticultural elements (sometimes including semi-natural habitats) and facilities for the public (including buildings) and in some cases incorporating sports facilities and/or play areas. At the smaller scale may include community gardens.</p> <p><b>Informal Recreation Areas:</b> Areas of green space available for public access and enjoyment but with only low key provision of facilities. Usually consist mainly of grass areas for informal recreation, but may also have trees, a play area, paths and sometimes toilets and parking area.</p> <p><b>Outdoor Sports Areas:</b> Green space designed to accommodate sports; including sports pitches, playing fields, golf courses, and other outdoor activities. Often occur within parks, but may also be separate, especially in the case of golf courses.</p> <p><b>Play Areas:</b> Green space designed specifically for children’s play, with various levels of provision of equipment and facilities. May occur separately but also often incorporated within parks, informal recreation areas and outdoor sports facilities.</p> <p><b>Incidental Green Space:</b> Areas of green space that, although publicly owned and managed, and accessible for public enjoyment, have no clear recreation function and little significant value as habitat. Their function is usually as a green ‘landscape backdrop’ but their landscape value can sometimes be minimal because of poor design. They include the ‘left over’ green spaces within housing and other forms of development.</p> <p><b>Domestic Gardens:</b> Green space within the cartilage of individual dwellings, which is generally not publicly accessible, but which often makes a significant contribution to the green fabric of urban environments.</p>
<p><b>FUNCTIONAL GREEN SPACE</b></p> <p>Green space which has a primary function other than amenity or recreation, although some of these areas may also be publicly accessible and available for people’s enjoyment. The primary functions include farming, horticulture, burial grounds and educational and other institutional use. Access to these green spaces may go hand in hand with the primary function (for example cemeteries, churchyards and allotments) or be by public right of way, or by agreement, for example where school grounds are made available for public use.</p>	<p><b>Farmland:</b> Green space under agricultural management. Includes farms which also have a recreation and education function such as City Farms.</p> <p><b>Allotments:</b> Green Space available for members of the public who occupy them to cultivate vegetable or fruit crops for their own use.</p> <p><b>Burial Grounds:</b> Land used as burial grounds, including cemeteries and churchyards.</p> <p><b>School Grounds:</b> Green space in the grounds of schools including sports pitches, other outdoor sports facilities, play areas, gardens, nature areas, school farms and growing areas and incidental green space.</p>

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	<p><b>Other Institutional Grounds</b> :Green space in the grounds of institutions such as universities and colleges, hospitals and nursing homes, and associated with commercial and industrial premises, including gardens, sports pitches, other outdoor sports facilities, play areas, semi-natural habitats and incidental green space.</p>
<p><b>SEMI-NATURAL GREEN SPACE</b></p> <p>Green space that is made up of semi natural habitat. These habitats may be encapsulated areas of the countryside that existed before the urban area expanded. Alternatively they may have been formed by the natural processes of colonization and succession on abandoned or disturbed ground or by deliberate creation of new habitats through initiatives such as urban forestry and reclamation of derelict land. All these habitats make a vital contribution to the urban landscape but may or may not be accessible for public enjoyment. In some cases where there is access it may be unofficial, but still extremely important to local people.</p>	<p><b>Wetland:</b> Green space dominated by wet habitats, including water bodies, running water and fen, marsh, bog and wet flush vegetation.</p> <p><b>Woodland:</b> All forms of urban woodland including deciduous woodland (both ancient semi-natural and woodlands of more recent origin) and mixed and coniferous woodland (including plantations and shelterbelts). Includes newly planted woodland.</p> <p><b>Moor and Heath:</b> Areas of moorland and heathland vegetation consisting mainly of ericaceous species, and including moorland grass, shrub moor, shrub heath and bracken. Likely to include some Commons within urban areas.</p> <p><b>Grassland:</b> Grassland which is not agriculturally improved and not formally part of an amenity green space, including calcareous grassland, acidic upland grassland and unimproved meadows. Could include established vegetation on reclaimed derelict land which is not part of a formal recreation green space.</p> <p><b>Disturbed Ground:</b> Land which has been disturbed by previous development or land use but is now abandoned, waste or derelict and is becoming re-colonized by processes of colonization and natural succession.</p>
<p><b>LINEAR GREEN SPACE</b></p> <p>Green space that occurs in association with linear features, especially transport routes such as roads, railways and canals, but also rivers and streams. It is a matter for debate whether this category should be considered separately, since these spaces might also be defined as either semi natural habitat, or functional green spaces whose primary function is transport, or incidental green space with a visual amenity function. These spaces are, however, distinguished by their linear character and are often an important part of strategic green space designations such as green links and green corridors and for this reason we suggest that they should be considered separately.</p>	<p><b>River and Canal Banks:</b> Green space occurring along the margins of canals or rivers and forming part of the river or canal corridor.</p> <p><b>Transport Corridors:</b> The often substantial areas of green space associated with transport Includes: the variety of habitats, associated with railways, which are often inaccessible but when they fall into disuse can become an important part of an open space network; green space associated with roads, and especially the large areas of grassland, scrub, trees and woodland found along major roads and motorways; and green space along cycle ways and walking routes.</p> <p><b>Other Linear Features:</b> Cliffs and other natural areas of linear green space.</p>

## Role of Green Structure and Ecological Services: A Case Study of Bahawalpur City, Pakistan

residential areas, in which open spaces and parks should cover 5 to 10 % of the total built-up area. The green space area of satellite town covers 7 % of the total area.

To conduct the study in the Satellite Town, urban green spaces were classified into three categories: (i) Amenity Green Spaces; (ii) Functional Green Spaces; (iii) Semi Natural Green Spaces; and (iv) Linear Natural Green Spaces. Data was collected by researchers through field survey method in two steps: 1<sup>st</sup> step was to identify the green structures by surveying the area. All green structures were visited and located on the map and coded in their respective category of the questionnaire.

In the 2<sup>nd</sup> step, a questionnaire and a checklist was prepared, the cultural, environmental and social functions were observed, counted and listed in the table of functions for all types of green structures.

### 4. RESULTS AND DISCUSSION

Satellite Town is one of the main residential sectors of the city. It has a large commercial area in its center, around which residential pattern grows in blocks designated as A, B, C and onward. Due to the continuous expansion of area and population green spaces are changing their functions within the research study. Figure-2 shows the distribution of green structures in the planned area of Satellite Town.

There is a central green space in the middle of the

town and each block of the residential area has its own central green space to fulfill the needs of the environment and community as well. By following the classification given by Dunnett, et al. (2002), these green spaces are divided according to their functions (Figure-3). The green spaces situated in different residential blocks can be categorized differently. The central green space of the town performs duties of central park, around which a busy commercial area comprising of shops, plazas, medical clinics, school, colleges, and salons is present. So it may be said that it is one of the busiest parks in the town giving different services to the community. Other partly and non-functional green spaces are identified, which shows that conservation and preservation of these grounds were not taken into account by the authorities. Due to the ignorance of the residents and authorities, some green spaces are now abandoned, wasted or derelict, and are becoming re-colonized. The detail of every green structure identified and classified is as follows:

- Central green space of Satellite Town is classified as park and garden area. Park and garden area of Satellite Town is provided with all type of recreational facilities. The visitors perform several activities. It is the central park of the Town that reduced inflow of the visitors on the other green spaces.
- In some blocks of the Town three informal recreation areas are present. These green spaces provide outdoor recreational facilities. These green spaces are provided with basic recreational facilities like grassy plots, boundary walls,

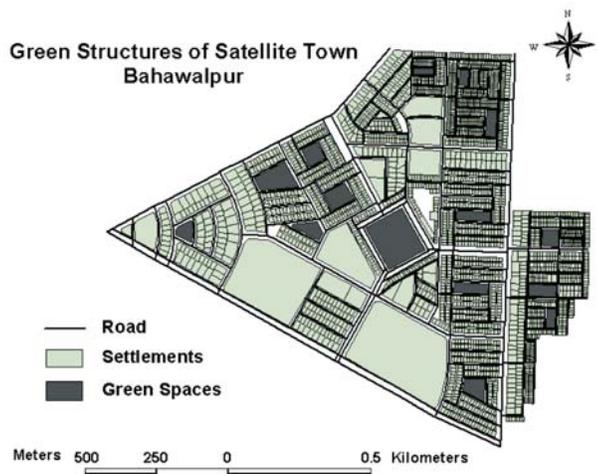


Figure-2: Identification of Green Spaces in Satellite town Bahawalpur

**Table-2: Landuse by Area in Satellite Town Bahawalpur**

Land use plot	Area in ha
Residential	54 ha
Commercial	1.26ha
Green spaces	8.58ha

benches, and lighting facilities. Visitors have undertaken various activities like walking, enjoying the environment, and social meeting.

- One open space of the Town is classified as outdoor sports area. This open space serves as sports area. Although it is not equipped completely but partly enable various sports activities like basketball, cricket, and football.
- There are seven incidental green spaces present in the other remaining blocks of Satellite Town. These green spaces are not in good condition for any activity. People perform very few cultural and sports activities.

These green spaces perform different functions for the residents and the environment. The number and quality of functions a green space provides to its community not only assures its ecological services but also enhances its social standing in terms of its benefits. There are a number of functions which these green spaces can perform for community. The checklist in Table-3 prepared on the basis of observations classifies qualitative parameters of green spaces.

Green spaces in the cities facilitate sustainable urban planning. Planned urban areas in the city are provided with a range of amenity green structures that are

termed as functional green spaces. The provision of ecological services by these spaces increases the sustainability of the planned areas. Figure-3 shows the distribution of functional green structures through qualitative analysis.

The interview conducted from the local administration department of Satellite Town showed that the green spaces being continuously supervised by authorities are more functional. As the Figure-3 represents, most qualitative green spaces in terms of functions is Central Park of Satellite Town. Interviews conducted with park visitors also verify that most functional and green space present in the study area is Central park. Table-4 presents visitors' response towards the use of green spaces in the study area. The highest visiting frequency by the users on daily basis of Central park is 65 % and then 61 % for the users who also prefer their home garden along with Central Park. However, 100 % use of the Park is by children for playing sports daily. Table-5 presents the cross tabulation result of most liked green space and time spent there. The result shows a significant relationship between them as 72 % users who like Central Park for recreation spend upto one hour for their activities and remaining 27 % spend upto two hours. Similarly, as sports and play area of the Park is mostly preferred by children, therefore 100 % users spend two hours for games. Table-3 also



**Figure-3: Functional green structures in Satellite Bahawalpur**

**Role of Green Structure and Ecological Services: A Case Study of Bahawalpur City, Pakistan**

**Table-3: Checklist for Services Analysis of Green Spaces in Satellite Town**

Active and passive Recreation	Central Park	Informal recreation area	Play areas	Outdoor sports	Incidental green space
Morning walk	√	√	√	√	x
Playground activities	√	√	√	√	√
Community gathering	√	√	x	√	√
Festivals (marriages etc)	x	x	√		√
<b>Health Benefits</b>					
Exercise	√	√	√	x	x
Psychological relaxation	√	√		x	x
<b>Educational Benefits</b>					
School grounds	x	x	x	x	x
College grounds	x	x	x	x	x
<b>Environmental benefits</b>					
<b>No of trees or plants</b>					
Nil					
2-5			√		√
6-10		√		√	
<10	√				
Fauna (Present)	√	√	√	√	
Fauna ( Absent)					√

**Table-4: User s Perception on Different Aspects of Visit to Green Spaces (%)**

Type of green space	Visiting time			Visit frequency			Easily accessible		quality		Gender	
	Morning	Evening	Night	daily	Once a week	Twice a week	Yes	No	good	Not good	Male	Female
Central Park	20	45	35	65	10	25	90	10	60	40	76	24
Informal recreation area	37	50	12	50	13	37	87	12	62	38	75	25
Home garden and central park	28	66	4.8	61	10	28	95	5	52	48	95	5
Play and sports area	0	100	0	100	0	0	100	0	50	50	100	0

depicts that all green spaces are used mostly by males rather than females, and also that informal recreation

**Table-5: Results of Cross Tabulation between visit to Green Space and Time Spent**

Most liked green space Vs time spend in hours	Upto one hour	Upto 2 hours
Play and sports area	0 %	100 %
Central park	72 %	27 %
Home garden	87 %	12 %
Informal recreation area	47 %	52 %

area is mostly used for group activities and by various users, therefore time spent there is mostly upto two hours.

The presence of greenery in an area ensures the cleansing and cooling of local environment. By performing different functions, it gives a relaxing effect on local and surrounding community. Keeping in view the services and function of green areas, planners and urban developers must take into account the importance of greenery in sustainable urban planning and design.

## 5. CONCLUSIONS

Green is not only a color; it is a state of mind. Greening a city can bring it closer to its sustainable development goals. Environmental and societal impact of compactness in cities can be reduced by insertion and allocation of green structures in the planning. These green spaces not only help to sooth the atmosphere and combat pollution but also perform a number of ecological services for the surrounding community. Preservation and restoration of these amenity parks by the authorities is very essential. The planner could guard such “gap sites” against conversion to preserve the high degree of naturalness and wildlife habitation, and to enhance their essential contribution to urban environmental and scenic qualities (Parsons, 2002). The allocation of green structures in the area of Satellite Town, Bahawalpur, is very well planned. All the green spaces perform many functions for the community. But proper management and restoration of play grounds and amenity parks can enhance the services and positive impacts of these spaces on overall city environment.

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