RESEARCH ARTICLE

Study & analysis of urban green spaces and an integrative approach to sustainable development in historic city Patna

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Abstract

This paper explains the benefits and challenges of urban green spaces based on the critical discussion of study results from different studies in different cities with special emphasis on historic city Patna. The important roles played by green spaces are social, economic, cultural and environmental aspects of sustainable development. Urban green spaces can be a comprehensive tool for long term protection of environmental sustainability through improving the quality of life and air quality, increasing property value due to their amenity and aesthetic characteristics, and reducing the energy costs of cooling buildings. Urban green spaces also can provide ecosystem services in which the recreation and relaxation facilities are especially available to urban dwellers and tourists too. To confirm the multiple roles played by green spaces, certain level of qualitative improvements and distribution of green spaces within the urban area of Patna should be considered and incorporated effectively into the environmental sustainability agenda for social infrastructure planning. To do this, an integrated approach regarding the planning, monitoring, designing and maintaining of urban green spaces is required for improving the environmental sustainability in Patna.

INTRODUCTION

Urban green spaces as an important contributor can be a significant part of sustainable development. Developments of urban green spaces need to consider interdisciplinary and integrative approaches such as economic, political, social, cultural, management and planning aspects to improve existing urban green spaces' facilities and services, and to optimize urban green space policies [1]. The definition of urban green spaces which is agreed on by ecologists, economists, social scientists and planners is public and private open spaces in urban areas, primarily covered by vegetation, which are directly (e.g. active or passive recreation) or indirectly (e.g. positive influence on the urban environment) available for the users [2]. Based on the studies of different cities, different researchers provide some guidelines to evaluate the nature of green spaces. Firstly, one of the main factors in determining the nature of green spaces is their quantity in the city [3]. Secondly, existing qualities like activities and experiences, and perceived benefits to the users determine the utilization of green spaces [4]. Thirdly, the functionality of those green spaces is equally influenced by the location and distribution (accessibility) in the whole city [4-6].

Irrespective of level of development of any country, many countries are facing one of the most important challenges: the adequate development of sustainable cities. In this regard, urban green spaces can provide social, economic, cultural and psychological services especially for the wellbeing of the urban dwellers and for tourists as well. Sustainable development of cities and development of urban green spaces are very important, since almost

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half of the world population now live in urban area where the pace for rural-urban migration and pressure from international migration in developed countries is still high, as most of the immigrants in developed countries live in central or big cities of the country. Moreover, it is an urgent need to improve the lifestyles of urban people and there should be a special focus on the consideration of environmental impact of human activities by raising awareness to the rational use of energy, water and food consumption and natural resources for environmental sustainability. Finally, the role played by green spaces in our urban environments can no longer be ignored by today's policy makers. To get maximum level contribution from urban green spaces, local approach and integrative approaches should be focused to overcome the challenges faced by different cities in different countries including the land allocation, size and number of green spaces based on the number of urban dwellers, accessible facilities for dwellers or tourists. Finally, the paper is based on the relevant studies and literature reviews to explain the benefits of green spaces, functionality of urban green spaces. And how and what ways the application of integrative approach can contribute to a potential solution to environmental sustainability in different cities, especially in developing countries in consider to the challenges usually coming from socio- economic factors, culture, population growth, inadequate management, lack of proper implementation of environmental policies, excessive unplanned rural-urban migration.

2. Benefits of Urban Green Spaces

2.1. Environmental Benefits

2.1.1. Ecological Benefits

Urban green spaces supply to cities with ecosystem services ranging from maintenance of biodiversity to the regulation of urban climate. Comparing with rural areas, differences in solar input, rainfall pattern and temperature are usual in urban areas. Solar radiation, air temperature, wind speed and relative humidity vary significantly due to the built environment in cities [7]. Urban heat island effect is caused by the large areas of heat absorbing surfaces, in combination of high energy use in cities. Urban heat island effect can increase urban temperatures by 5˚C [8]. Therefore, adequate forest plantation, vegetation around urban dweller's house, management of water bodies by authorities can help to mitigate the situation.

2.1.2. Pollution Control

Pollution in cities as a form of pollutants includes chemicals, particulate matter and biological materials, which occur in the form of solid particles, liquid droplets or gases. Air and noise pollution is common phenomenon in urban areas. The presence of many motor vehicles in urban areas produces noise and air pollutants such as carbon dioxide and carbon monoxide. Emissions from factories such as sulphur dioxide and nitrogen oxides are very toxic to both human beings and environment. The most affected by such detrimental contaminants are children, the elderly and people with respiratory problems [9]. Urban greening can reduce air pollutants directly when dust and smoke particles are trapped by vegetation. Research has shown that in average, 85% of air pollution in a park can be filtered [8].
Noise pollution from traffic and other sources can be stressful and creates health problems for people in urban areas. Urban green spaces in over crowded cities can largely reduce the levels of noise depending on their quantity, quality and the distance from the source of noise pollution. In the contemporary studies on urban green spaces consider the complex urban ecosystem, conservation of the urban green spaces to maintain natural ecological network for environmental sustainability in cities. For the cities in fast urbanizing and growing economy, country like China should consider the dynamic form of urban expanding to manage effective urban green spaces which will contribute to reduce the overall CO_2 by maintaining or even increasing the ability of CO_2 absorption via natural ecosystem [10]

2.1.3. Biodiversity and Nature Conservation

Green spaces do functions as protection centre for reproduction of species and conservation of plants, soil and water quality. Urban green spaces provide the linkage of the urban and rural areas. They provide visual relief, seasonal change and link with natural world [11]. A functional network of green spaces is important for the maintenance of ecological aspects of sustainable urban landscape, with greenways and use of plant species adapted to the local condition with low maintenance cost, self sufficient and sustainable [12].

2.2. Economic and Aesthetic Benefits

2.2.1. Energy Savings

Using vegetation to reduce the energy costs of cooling buildings has been increasingly recognized as a cost effective reason for increasing green space and tree planting in temperate climate cities [7]. Plants improve air circulation, provide shade and they evapotranspire. This provides a cooling effect and help to lower air temperatures. A park of 1.2 km by 1.0 km can produce an air temperature between the park and the surrounding city that is detectable up to 4 km away [7].

2.2.2. Property Value

Areas of the city with enough greenery are aesthetically pleasing and attractive to both residents and investors. Indicators are very strong that green spaces and landscaping increase property values and financial returns for land developers, of between 5% and 15% depending on the type of project [7].

2.3. Social and Psychological Benefits

2.3.1. Recreation and Wellbeing

People satisfy most of their recreational needs within the locality where they live. Green spaces within urban areas provide a sustainable proportion of the total outdoor leisure opportunities. Urban green spaces serve as a near resource for relaxation; provide emotional warmth [7].

2.3.2. Human Health

People who were exposed to natural environment, the level of stress decreased rapidly as compared to people who were exposed to urban environment, their stress level remained high [8]. In the same review, patients in an hospital whose rooms were facing a park had a 10% faster recovery and needed 50% less strong pain relieving medication as compared to patients whose rooms were facing a building wall. This is a clear indication that urban green spaces can increase the physical and psychological wellbeing of urban citizens. In another research conducted in Swedish cities showed that the more time people spend outdoors in urban green spaces, the less they are affected by stress [5]. Certainly, improvements in air quality due to vegetation have a positive impact on physical health with such obvious benefits as decrease in respiratory illnesses. The connection between people and nature is important for everyday enjoyment, work productivity and general mental health [9].

3. Study area

Patna is the capital city of Bihar and has experienced renewed impetus on economic growth in recent years. It also carries historical significance and serves as a gateway to Gaya and Bodhgaya, the former being of great religious significance to followers of Hindu religion and the latter being a spiritual centre of global significance for followers of Buddhism. It is also evident that the city is going to experience rapid growth in the coming years and the aspirations of its citizens are rising towards higher quality of services.
Patna is located Latitude: 25D 37M North & Longitude: 85D 12M East, & lies on the south bank of the Ganga River. It has a very long river line, & surrounded on three sides by rivers-the Ganga, Sone, and Poonpun. Just to the north of city the river Ganga flows in to river Gandak making it a unique place having four largish rivers in its vicinity. The bridge over the Ganga, named after Mohandas Gandhi, is 5850m long is said to be the longest single river in the world. The city is approximately 35 km long & 16 to 18 km wide. The entire city is divided into three circle and 72 wards.

## 3. Challenges toward Management of Urban Green Spaces in Patna

3.1. Socio-Economic and Demographic Factors

High urbanization and the high pace of socio- economic development in Patna resulted the increase of population in
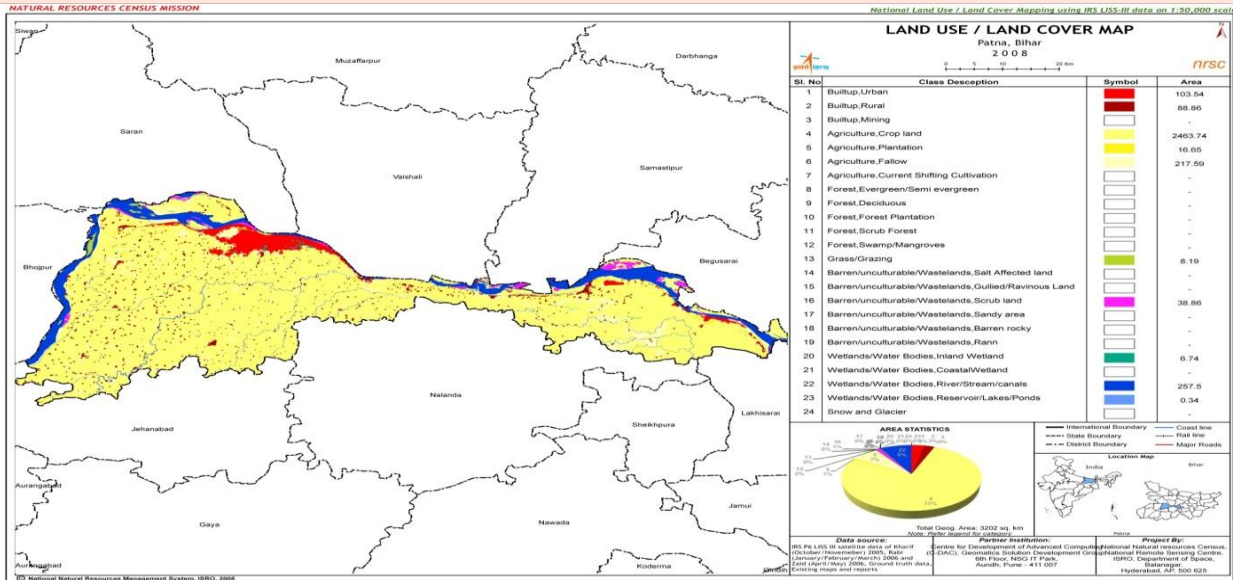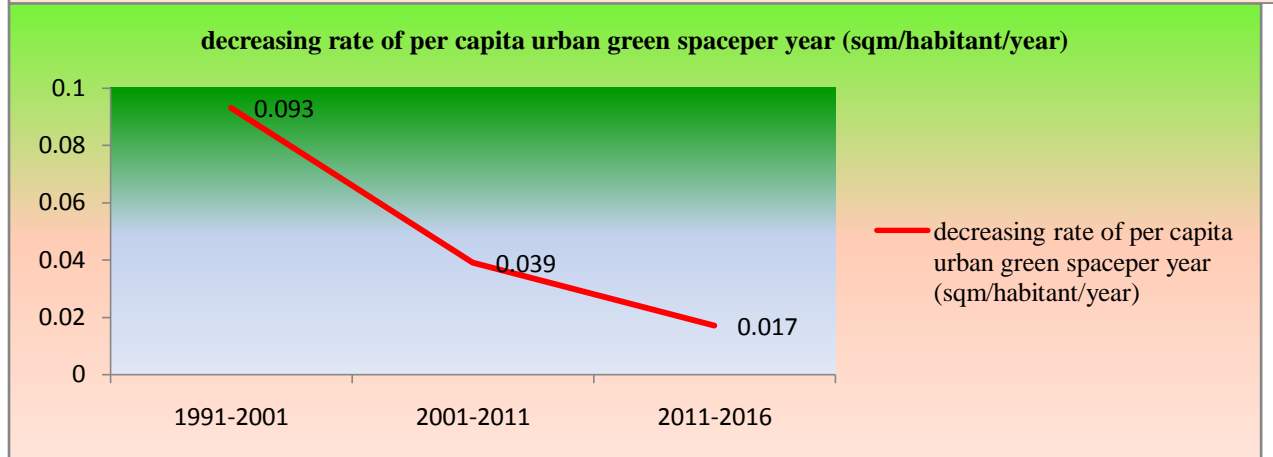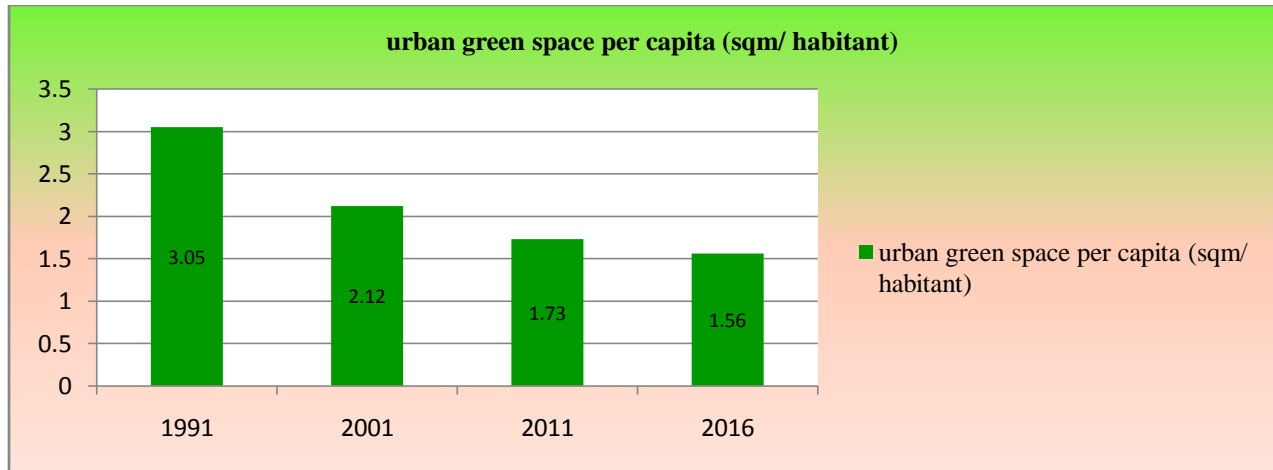
city, lack of infrastructure, congested traffic, environmental degradation and a housing shortage which are major issues faced in their sustainable development [13].The great threat to health and safety in Patna comes from water and air pollution. Especially those who are poor and do not have adequate ventilation systems, air pollution is hazardous for women and children because they expose regularly and waterborne diseases are found most commonly in low income groups because of inadequate sanitation, drainage and solid waste collection services [13]. Another most important challenge facing in Patna city due to over urbanization is the conversion of agricultural land for urban uses and the development of infrastructure in urban areas. As a result, widespread removal of vegetation to support urban eco-system, ground water overdraft and put additional pressure on the city sanitation & services.

Cities cover 2% of land space worldwide but consume 75% of the resources [14]. Exposing city dwellers to local biodiversity can also trigger interest in environmental issues, especially since people's first encounter with the environment is often in one's home city or town rather than in distant places [14]. To meet socio-economic, environmental, psychological needs of urban dwellers, in Patna there should develop some criterion based on the attitudes of perceived user to shape adequate uses of land and provide facilities within urban green spaces [15]. Planning authorities were advised to adopt a strategic approach and plan positively for providing green spaces. This was to provide strong protection for existing ones, resist new development opportunities which might diminish recreational provision, ensure accessibility, and to provide good quality green spaces and recreational facilities [16] The lack of civic sense of urban dwellers of Patna is also a cause of concern for management of green spaces across the city landscape.

3.2. Quantitative Aspects of Urban Green Spaces
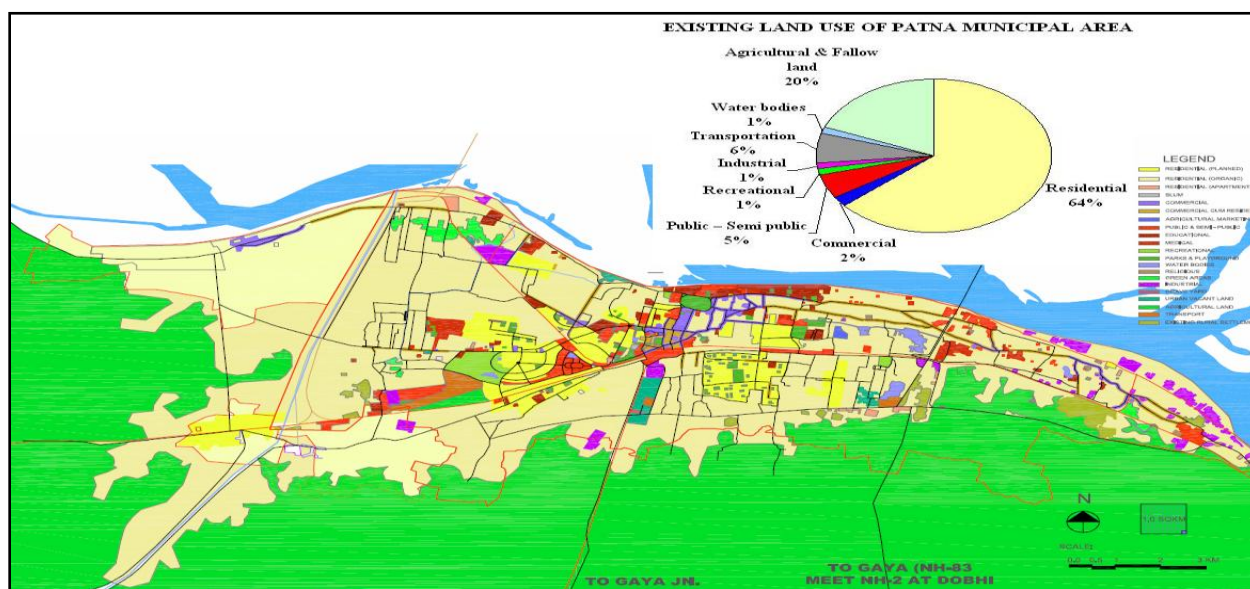
The percentage of land use segregation & land use map reveals the very fact that urban green space is inadequately and nonuniformly distributed across the city landscape. The total urban area of the city is 135.79 sqkm [Patna municipal corporation (99.45 sqkm)] & total built-up area is103.54 sqkm which is 76.25% of total area. Hence there is very less area available for potential urban green space in the city. [26] The area of total urban green space in the Patna city is 2.92 sqm which is only 2.15% of total urban area & majority of these green spaces has not fully converted to recreational area [1%]. If the urban green spaces in the city remains constant till 2016 then city dwellers will get only 1.56 sqm/habitant of green space.

urban green space per capita (sqm/ habitant)

decreasing rate of per capita urban green spaceper year (sqm/habitant/year)

LAND USE / LAND COVER MAP
Patna, Bihar
2 0 0 8

TABLE 1: SOME IMPORTANT INDIAN CITIES WITH PER CAPITA GREEN SPACE		
CITY	**GREEN SPACE**	**PER CAPITA GREEN SPACE**
	(sqkm)	(sqm/inhabitant)

Gandhinagar	32.56	162.8
Chandigarh	49	54.45
Delhi	297	21.52
Bangalore	97	17.32
Jaipur	5.43	02.30
Patna	2.92 [PARK (1.28) PLAYGROUND (0.64) WATER BODY (1.00)]	01.73
Source : http://www.censusindia/gov.in/ & Draft master plan Patna 2021(PRDA)		

As per the world health organization norms there should be 9 sqm green open space per city dweller & according to the norms of UDPFI guideline there should be 10-12 sqm per city dweller green open space on overall town/city level.
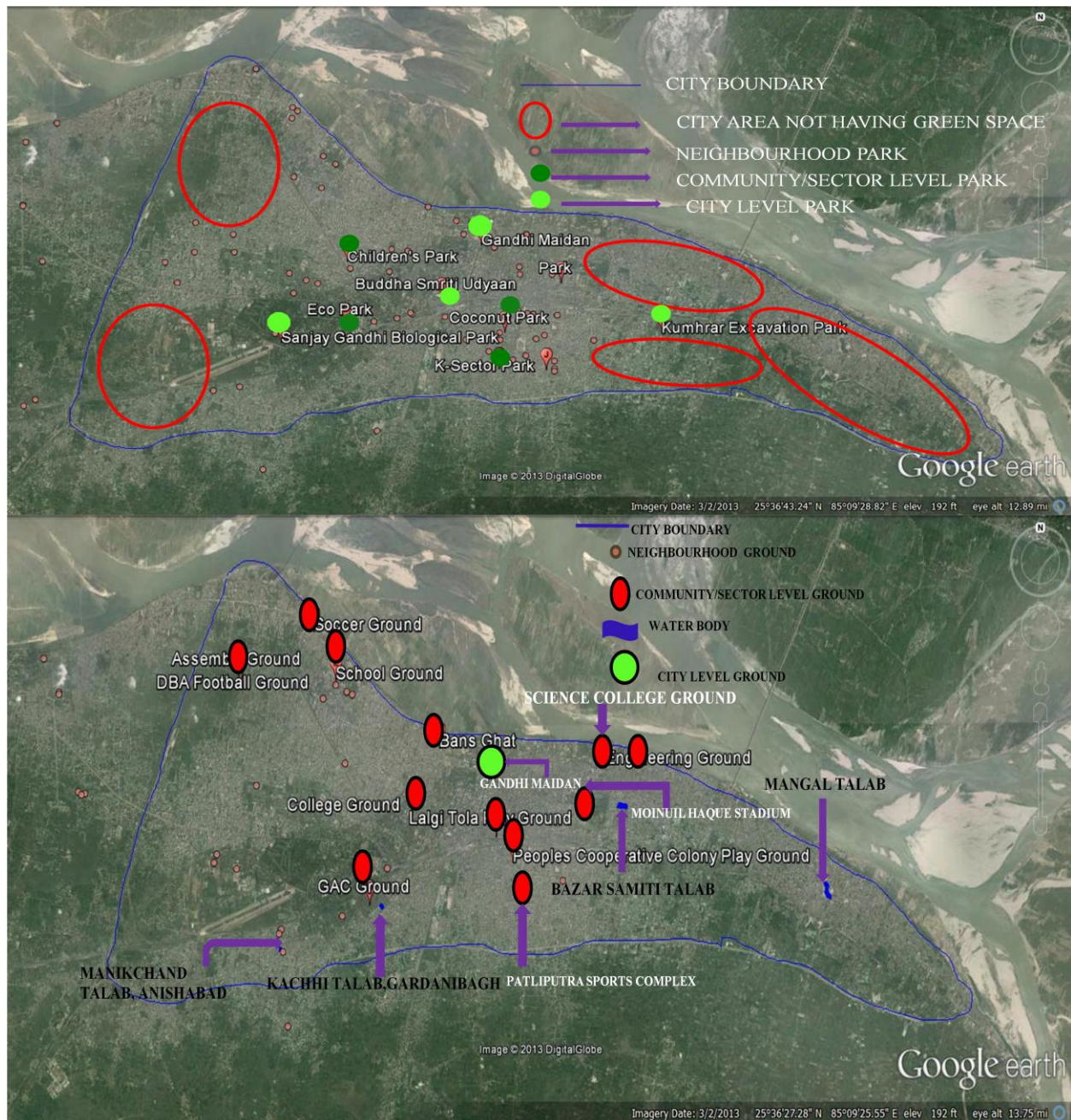
3.3. Qualitative Aspects of Urban Green Spaces

The parameters for studying the qualitative aspects of urban green space in Patna are functionality and accessibility. The functionality is measured in terms of existing qualities & experience and perceived benefits. The accessibility is the measured in terms of location & distribution of urban green space in city landscape. From the survey of city dwellers it is observed that existing qualities & experience and perceived benefits are of lower order due to lack of city management, lack of civic sense, inadequate space allocation by planning & development authority, unwillingness to provide quality level of services, fast pace of urbanization, lack of proper zoning & density control etc. The urban green spaces in the city are distributed nonuniformly across the city landscape. This leads to lower level of services in terms of accessibility. The poor socio-economic characteristic of average household of the city also lowers the accessibility parameter. A study in Helsinki, Finland, showed that a good amount of green areas and easy access (*i.e.* short distance) to a recreational space increase the number of visits and people living close (<0.5 km) visited the green spaces more frequently (>4 times per week) [6]. For instance, a study in Swedish cities showed that in overall, people with immediate access to fine and verdant gardens or green yards are also more likely to visit public green spaces. Indeed, those with gardens of their own also spend more time in public green spaces than those without a garden of their own [5]. Public green space should be at the centre of neighborhood and not more than five minutes walk for most residents, public buildings or shops [17]. Therefore, accessibility and proximity are very important factors to consider during planning and design of an urban green space. During the planning and management process, a consideration of users' perception should be considered. If the urban green spaces development strategies fail to include stakeholders' participation, which will be the reflection of the neglect of social and environmental functions [15]. A study in Patna city shows that the green space users' preference are such as sitting on bench, walking and running facilities, pleasant landscape, visual elements, nearness to water and peaceful atmosphere [3].

3.4 Typology of urban green space

Neighborhood Park ══════▷ Community Park ══════▷ Sector Park ══════▷ city park

The typology of urban green space in Patna is good but the there is inadequate number and size makes it inaccessible to all city dwellers. The ideal typology for Patna should consider important considerations like size, function, activities, governance, land use history, security, location, conditions, user's, biodiversity, development philosophy, level of services.

4. Integrative Approach and Environmental Sustainability

The quality of cities depends on how the urban green spaces are designed, managed and protected. The management, planning, design, policy implementation of urban green spaces as the key discussion issues of sustainable environment are highly integrated and incorporated into the sustainable development at local and global level.[2] Urban green spaces not only play role to environment but also it contributes to socio economic, recreation, cultural, visual aspects and commercial developments in cities. The social aspects of urban green spaces include diversity of land uses, contribution to health and active life styles in cities, social justice by incorporating all groups and ages of people into green spaces, opportunities to interact and expand social network [18], enhancement of cultural life for different communities living in the city by providing a platform to share views, feelings and to celebrate different groups occasions and, a venue for environmental education for the schoolchildren [2] and a play ground for children [19] for the social, mental and physical development. From the planning aspects, urban green

spaces include business, retail, leisure development, tourism development; employment centers besides residential areas [18] and the good planning of urban green spaces can play a role as a visual screen, a function of noise protection and a place for commuting and recreation by providing well-designed networks within the park and with the other areas [20]. The economic aspects of urban green spaces incorporate as a place for production and supply of fruits, wood to green business centers, and as a place for new jobs creation and increasing economic value of the area by integrating the environment friendly behavior and attracting tourists provided with convenient atmosphere, security and facilities for the tourists [2]. Most importantly the ecological perspective considers urban green spaces as a facilitator to reduce the impact of human activities through absorbing pollutants and releasing oxygen [21]; contributing to the maintenance of a healthy urban environment with clean air, water and soil [21] and preserving the local natural and cultural heritage with a diversity of urban wildlife and urban resources [2].

In the pursuit to establish environmental sustainability and sustainable management of urban green spaces, the local development authorities of Patna city should maintain a database of actual and potential green spaces graded according to landscape and ecological values. This would help in developing a management plan [22]. A conservation plan should be prepared to protect the urban green spaces enclaves from intrusion by other land uses and to ensure that the natural ingredients of flora, fauna, landforms, soil and water continue to flourish. Urban green spaces management plans should be in place early before the inception of the design process. When considering the cost of developing a green space, one should keep in mind this direct relationship; if you build it, you must maintain it [23].

5. Conclusions

Urban green spaces fulfill many functions in urban context that benefits people's quality of life. There is therefore a broad consensus about the importance and value of urban green spaces in cities towards planning and constructing sustainable or eco-cities of 21st century. Steadily growing traffic and urban heat especially in the developing countries is not only damaging the environment but also incur social and economic costs. The ecological benefits bestowed in green spaces which range from protecting and maintaining the biodiversity to helping in the mitigation of change cannot be overlooked in today's sustainable planning. Inner-city green spaces are especially important for improving air quality though uptake of pollutant gases and particulates which are responsible for respiratory infections. Green spaces also help in reduction of the energy costs of cooling buildings effectively. Furthermore, due to their amenity and aesthetic, green spaces increase property value. However, the most sought benefits of green spaces in a city are the social and psychological benefits. Urban green spaces, especially public parks and gardens provide resources for relaxation and recreation. Ideally this helps in emotional healing (therapeutic) and physical relaxation.
In order to meet social and psychological needs of citizens satisfactorily, green spaces in the Patna city should be easily accessible and in adequately optimal in quality and quantity. Green spaces need to be uniformly distributed throughout the city area of Patna, and the total area occupied by green spaces in the city should be large enough to accommodate the city population needs. Cities are responsible for most of the consumption of the world's resources and are home to most of the world's citizens as well. Bringing green space to the urban landscape can promote and inspire a better relationship with the environment while supporting important services. Green space is part of and also represents habitats and ecosystems. The promotion and conservation of green space in Patna city is in the hands of local and regional development authority (Patna Regional Development Authority).

Integrative approach should not be discussed only in writings as a source of contributing instrument to environmental sustainability, but it is also important that how it could be fostered in Patna city in which different economic, political and cultural factors influence. And there are many intermediary factors such as lack of investment, proper management, designing an appropriate planning and public policy, and political instability, social values, economic circumstances influence to how and what extent the application of integrative approach can contribute to environmental sustainability. High population density is the major cause of concern in underdevelopment of urban green spaces in Patna city [average population density (164.15 pph) maximum population density (890.91 pph, ward no. 40)] [25]. Scientific and technological development of a country is both dependent on social context and political [23]. In this regard, integrative research with incorporation of participation from different level stakeholders *i.e.* academic and non-academic is essential to foster sustainable development in the context of challenges toward urban green spaces.

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