GREEN INFRASTRUCTURE STRATEGIES FOR URBAN CONSERVATION OF HISTORICAL AND NATURAL HERITAGE CASE OF BANGALORE CITY

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Abstract: Globalization has direct impact on the growth of our cities. As cities grow, the consumption of resources is also growing at a very rapid pace. Loss of green cover is directly proportionate to the growth of cities. The aim of this paper is to demonstrate how Green Infrastructure can be integrated and implemented to create a sustainable and green city by considering the case of Bangalore, Capitol city of Karnataka.
Bangalore was once known as garden city, pensioner's paradise, air conditioned city. But with the impact of globalization, today Bangalore is known as IT hub, Silicon Valley. With rapid urbanization and subsequent population increase, Bangalore's image has changed to garbage city, most polluted city. Bangalore is facing many environmental issues such as water crisis, floods during monsoon, loss of wet land and biodiversity, ground water depletion etc.
The multi scale approach to solve these issues is **green infrastructure**. Green infrastructure supports the blue and green network for the city, in order to save environment.
Green infrastructure provides urban design opportunities for designers and planners. It should be integrated with other land uses like residential neighbourhoods and transportation hubs.
This paper explores possible green connection routes to connect neglected Urban Heritage sites, Parks and Lakes to neighbourhoods. Implementation of the network would provide a citywide network of safe streets for residents to walk or bicycle to the neighbourhood parks.

Keywords: Climate, Urban Design, Environment,Sustainable, Green Infrastructure, Community.

1. Introduction: Green infrastructure or blue and green infrastructure is defined as an "interconnected network of green open spaces that conserves natural ecosystem values and functions and provides associated benefits to human population".

1.1. Objective: Aim of this paper is to explore sustainable and creative ways to protect and enhance urban natural resources, open spaces and heritage. And to create a self-sustainable and eco-friendly green network.

1.2.

This paper explores to identify, analyse and evaluate blue green network and make connections between green infrastructure and other activities within and beyond the community. And to explore urban design opportunities in green infrastructure for recreational benefits.

1.2. Functions of Green Infrastructure:

- Natural systems restoration
- Protection of Flora and Fauna
- habitat linkages
- favoured pedestrian use
- Expanded park land and open spaces
- Recreational benefits for citizens by providing interactional green open spaces

1.3 Green Infrastructure At Various Scales: *Green Infrastructure can be implemented at various scales from Site level to city level.*

TABLE 8: GREEN INFRASTRUCTURE AT VARIED SCALE

At site level: • Green roofs & Living walls • Gardens or grounds • Rainwater harvesting systems • Driveways (permeable)	 Image 1 green building(Image source:www.timepose.com)
At street level: • Boundary features eg hedges • Street trees • Swales • Porous paving • Sustainable Urban Drainage Systems (SUDS) • Pedestrian paths & Cycling tracks	 Image 2 Green street(Image source: http://www.nyc.gov)
At city level: Interconnected network of Informal recreation spaces, community growing spaces, Playing fields ,Sports areas, Urban parks and protected heritage and cultural sites, Ponds, Water courses	 Image 3 green infrastructure(Image source: www.webarchive.nationalarchives.gov.uk)
At regional level: Green network of rivers, forest lands , coastal lines	 Image 4 green connections(Image source: http://www.esri.com/about-esri/greeninfrastructure)

1.4. Components of Green Infrastructure:
Hubs are large green open spaces, lakes or historical sites which serve as the anchor of the network.
Links provide a connection between the hubs.
Sites are similar to hubs, but they are much smaller and localized.

1.5. Urban Design Based on Principles of Green Infrastructure: Urban Design based on principles of green infrastructure focuses on environmental-based integration of the built and natural environments—seeking out innovative opportunities for building nature and public amenities into the infrastructure of a city. Green infrastructure can transform urban blight into urban destination. It can help to create an iconic identity for a city based on the city's natural and cultural features.

2. Purpose of Study-Bangalore City: Bangalore was known as garden city, once well known for its gardens, and lakes. Today it is known as Silicon Valley, IT hub. Due to urbanization, we are encroaching into natural resources by harming the natural eco system .Today Bangalore has grown to total area of 741 square kms. The city is facing various challenges related to environmental, social and cultural issues.

2.1. Challenges of Bangalore City:
Environmental:
Lakes: Encroachment of lakes and catchment areas, blockage of valley and drainage areas, disposal of garbage around lakes and nalas, mixing of sewage pipes and storm water pipes.
Floods: Encroachment into catchment areas, blockage of valley and drainage areas
Lack of ground water recharge (impervious surfaces) all these are leading to urban floods.
Water crisis: There is a lack of water resources in Bangalore which can be used by people. The quantity of water pumped from borewells annually is 3.78 times the recharge from rainfall.
Loss of bio-diversity: Loss of wetlands and open spaces in the city has led to loss of habitats for various biodiversity. The lost lakes have made many migratory water birds disappear.
Loss of green cover: Due to urbanization, Bangalore has lost its green cover and today the number of trees per person is only 0.1 and total number of trees only 14,78,412.
Social /cultural: As the city is growing there is a Lack of outdoor recreation spaces.
Potential public spaces are underutilized due to lack of proper connectivity. Modern lifestyle has increased stress level in people. Less open space per capita (6.4 sq. Mts) due to increased population and urbanization can be solved.
Unsafe pedestrian and bicycle network: Pedestrian network is very poor and walkability index is 63. Number of vehicles have increased to 2 vehicles per person in Bangalore city.

2.2. Green Infrastructure for Bangalore City: This paper explores the ways in which Green Infrastructure can enhance the eco system and heritage of Bangalore city. Bangalore in earlier days was very well known as "the city of lakes". Kempe Gowda, the founder of Bangalore who had broad vision, established several tanks and lakes to impound runoff water, so that the same could be utilized for various purposes like agriculture, and domestic purposes.

2.3. Elements of green infrastructure for Bangalore: Bangalore was known for its lakes, gardens and its fort built by King KempeGowda. The image of the city was identified by 4 important key elements known as **Kere(Lakes), Thota(Gardens), Pete(Market), Kote(Fort, Palaces, Heritage sites).** Bangalore is well known for its historical lakes like Ulsoor lake, Kempambudhi lake etc. and Lalbagh and Cubbon Park are the well-known Urban Parks which form the natural components of the city. Bangalore is also known for its markets like Gandhibazaar, Malleshwaram and Chickpet etc and heritage sites like Tippu Palace, Bangalore fort etc which forms the cultural element of the city. Integrating these natural and cultural components by green infrastructure can be a great idea to highlight the image of the city. Hence this paper tries to highlight these important components by connecting them with Green Infrastructure.

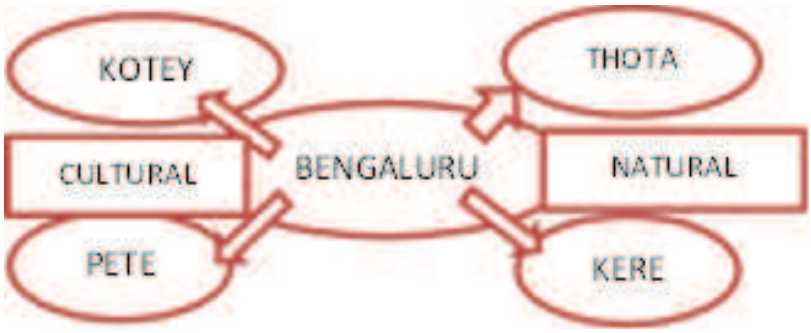

Figure 1: Four Elements of Bangalore City

3. Bangalore-Lake System: The earliest construction of lakes dates back to sixteenth century, Kempegowda built Ulsoor tank ,kempambudhi and dharmambudhi tanks.Lord Charles corniwallis, the then Governor General of India came to Bangalore, during the war with Tippu Sulthan, and ascribed its salubrious climate to its lakes and described Bangalore as The land of thousand lakes.("Deccan Traverses-the making of bangalore's terrain" by Anuradha mathur and Dilip da cuncha,2006)

As per the lake system of Bangalore, the terrain of Bangalore was used, when the lakes at higher elevation fill up, the excess water flows through the Raja Kaluves(outlets) to the next level of lakes and when they fill up ,the water flows to the next lower level and so on till the excess rain water flows onto the natural drain of the three major valleys of Bangalore namely,Hebbal, Challagatta and Vrishabhavathi.
Tanks were constructed, identifying the natural valley systems in the region.

- Nalas fed the tanks with surface runoff water, during rains.
- Tanks provided water for drinking, agriculture and other domestic purposes.

3.1. Strategies and Proposals:

- To protect the drainage system by green buffer

4.1. Open Spaces: Open spaces within and in close proximity to urban centres increase livability and enhance property values. Open spaces are essential for leisure activities, organized sports and cultural endeavours. Green open spaces can be considered "lungs" of the cities that offset the effects of air pollution. Architect FL Olmsted believed that "no single park, no matter how large and well designed, would provide the citizens with the beneficial influences of nature. Instead parks need to be linked to one another and to surrounding residential neighbourhoods". This idea of linking parks for the benefit of people has evolved into the modern greenways movement.

The green infrastructure not only provides healthy eco system but also recreational benefits to human beings like access to nature, encourage physical activities like jogging, walking and cycling. Urban open spaces fulfil the critical function of providing outdoor living spaces for exercise, strolling, relaxation, and gathering. They perform 3 critical roles of aesthetics, recreation, and ecological balance. There is a need to protect urban open spaces by connecting them for various benefits like ecological restoration and recreation. Connecting urban open spaces enhance ecological corridors. Ecological corridors help enhance the habitats for biodiversity.

4.2. Open Spaces of Bangalore City: There is drastic reduction in the amount of green open spaces in Bangalore due to unplanned urbanization.It is important to the fragmented green open spaces for added benefits of communities and environment. Global standards for urban open space-33% green cover for urban areas.

Figure 4: Green open spaces of Bangalore City

4.3. Best Practices: The green area per capita should be 20 m2 which translates into a minimum of 1.25 ha open space per 1,000 residents. The World Health Organization recommends 9 square metre of green open space per dweller should be the minimal norm for a city. While planned cities across the world have 80 sqm per dweller green space on an average. Central government recommends 10-12 sqm per capita of open space.

4.4. Strategies and Proposals:

- Protection and enhancement of natural resources.
- Establish linkages between major natural resources enhance biodiversity by planting native species of trees.
- Provide opportunities for urban farming
- Provide recreation opportunities in variety of open spaces
- Green ways with pedestrian and bicycle tracks
- Provide opportunities for community interaction

5. Heritage of Bangalore City: There are many heritage structures has potential to become great assets for the city. Today they are neglected for various reasons like lack of connectivity, lack of maintenance etc. To name few Tippu's palace and Mud fort, Gavi Gangadhareshwara temple etc.Historical sites are concentrated within the inner ring of the city. If developed and treated well, they become an asset to the city and can become great public places. They can also attract tourists from various places and enhance economy.

5.1. Strategies and Proposals:

- To connect historical sites with sustainable mode of transport like cycle rikshaws, bicycle and pedestrian network.
- Create different tourist loops as per the location and distance and enhance the hubs as major tourist attraction.

Conclusions: Combining the cultural trails with green and blue network can have the added advantages to the users. The heritage sites act as major land marks in the green network. Integrating these green ways with public transport network can be more effective.

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