

GREEN INFRASTRUCTURE FOR URBAN DEVELOPMENT IN CITIES OF INDIA

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ABSTRACT

Green infrastructure is a unique combination of economic, social, and environmental goals and profit that require a flexible skeleton for planning, implementing, and evaluating. In this study, we propose an experimental framework for policy, realization, and successive estimate of green storm water infrastructure within the framework of socio procedural systems and urban experimentation. Socio technical systems explain the border of multiple systems with quantitative and qualitative impacts. Urban experimentation—traditionally referencing climate change programs and their impacts—is a process of evaluating city programs as if in a laboratory setting with hypotheses and evaluated outcome. We come together these two concepts into a singular scaffold creating a policy feedback cycle (PFC) for green infrastructure to evaluate municipal green infrastructure plans as an experimental process within the context of a socio technical system. After proposing and discussing the PFC, we utilize the tool to research and evaluate the green infrastructure programs of 27 municipalities across the United States. Results indicate that green infrastructure plans should incorporate group of people taking part and communication, estimate based on project enticement, and an iterative process for knowledge production. We suggest knowledge brokers as a key resource in linking the estimate stage of the feedback cycle to the policy phase. We see three vital needs for green infrastructure testing:

- (i) *A fluid description of green infrastructure in plan;*
- (ii) *protection and estimate components of a green infrastructure plan; and*
- (iii) *Announcement of the plan to the population.*

Keywords: *green infrastructure; urban water policy; urban experiments; socio technical systems*

1. INTRODUCTION

Green infrastructure or blue-green infrastructure is a network providing the “ingredients” for solving urban and climatic challenges by building with nature. Green infrastructure, Holds with in the triplebottom- lineframeworkacts as the ecological structure needed for environmental, social and financial sustainability Despite sustainable development making in roads into the Indian economy and going ‘green’ becoming a trend amongst businesses, infrastructure sector is still to realize its potential. Eco-friendly infrastructure, which is an established paradigm world over including quite a few developing countries, is still in its nascent stages in India despite its immense scope and relevance in the evolving set-up in the country. Infrastructure development, per se, is obligatory to India’s economic growth. According to a Mc Kinsey research it is said that 2/3 of India is yet to be built and this will happen over the next 20 years. For a Potential demographic dividend to actualize and pay out, India needs vibrant and sustainable infrastructure, for its villages, towns and cities. Given India’s geographic immensity, rising population and steady urbanization rate, infrastructure development will play a critical role in strengthening its position as the next economic powerful. And adopting eco-friendly practices will not only preserve our existing resources but also make them more sustainable.



Figure-1.1 Green Infrastructures

The Urbanization has become an indivisible part of the global state. Thus, to tackle the harms related to urbanization, Green Infrastructure i.e. green buildings has become the central approach to landscape planning and grown in celebrity since it was first discussed in the late 1990's and is known and implemented in the UK, Western Europe and North America. This concept has been related with positive result as case studies of Europe and USA are success stories and it has developed as an approach to landscape planning that address the disjointed and fractured approach associated with urbanization. Green infrastructure so far has not been holistically tried as a part of retrofitting in Indian cities. This research proposal intends to study the current urban issues with unplanned sprawling and environmental repercussions and propose green infrastructure for the cities of India as case study.

Indian cities have grown considerably in past couple of decades. The opening up of Indian economy in 90's meant a huge amount of investment had been made in India by foreign nationals because of readily availability of resources in form of people. This had created huge job opportunities and had increased the revenues of the country, but also this boom had started taking toll on the cities green cover. The findings of Indian institute of science study which used satellite borne sensors compared images over decades and modeled past and the future growth has revealed the rate of urbanization in four Indian cities. The researchers classified land use into four groups : built up, vegetation, others (rocks, quarries, bare land etc.) And mixed which included areas other than above three categories like lakes reservoirs etc.

Delhi the capital of India has grown to be one of the greenest capitals in the world. Delhi constitutes 19% of its geographical area as green cover i.e. 8722 ha. Making per capita green space availability to 22 sq.m (UDPFI suggest -12-14sqm-capita). Besides environment and forest of national capital territory (NCT) Delhi, municipal corporation of Delhi (MCD) , new delhi municipal council (NDMC) and Delhi development authority (DDA) are many agencies working for green capital mission . recently the parks and garden society have been set up to coordinate the activities related to increase the green cover of Delhi. The city has some well- maintained parks and gardens like Lodhi Garden, Mughal gardens, deer park, budha jayanti samarak park, indraparastha park And the garden of five senses. Unfortunately the green of the capital is doing well, but the blue infrastructure is in a bad condition. The major natural feather and eco-system of Delhi are the river Yamuna and its network of streams, and are in a state of considerable degradation. A large number of traditional water bodies in the form of ponds have been encroached or have become defunct. (NCT).

2. LITERATURE REVIEW

The Urbanization has become an inseparable part of the global scenario. Thus, to tackle the problems related to urbanization, Green Infrastructure has become established as the central approach to landscape planning and grown in prominence since it was first discussed in the late 1990's and is known and implemented in the UK, Western Europe and North America . This concept has been related with positive result as case studies of Europe and USA are success stories and it has developed as an approach to landscape planning that addresses the fragmented and fractured approach associated with urbanization. Green infrastructure so far has not been holistically tried as a part of retrofitting in Indian cities. Retrofit approach will address issues with least possible disturbance to existing urban scene.

This research proposal intends to study the current urban issues with unplanned sprawling and environmental repercussions and propose green infrastructure for the city of Jammu the winter capital of the state of Jammu and Kashmir, India as the case study. Green Infrastructure shall be as typically incorporated into the progression for urban greening and pursue region based approach to develop urban planning and sustainability for the city.[1]. Green infrastructure planning in India has the potential to rationalize current development issues relating to economic growth and rapid urban expansion. Independence from the British facilitated progressive shift to an economically driven development based on modernization and partial-deregulation of infrastructure provision. The impact of this process has been a decoupling of human-environmental approaches to urban planning and reliance on the utilization of landscape resources beyond their capacity.

Utilizing a discussion of Nehruvian and Gandhian perspectives to urban development, this paper argues that whilst both approaches offer valuable mechanism for growth, an integrated analysis which links them provides a more responsive and effective structure for planning to deliver change. Green infrastructure approaches to urban investment are proposed in this paper to create equilibrium between the difficulties of balancing economic growth with sustainable urban development.[2]. GI's can be Categorized in Several System With Set Of Functions under Each Of Them Policies And Strategies For development And Implementation Of these GI are Evolving With Time To Accommodate Citizens Aspiration There are certain Implementation Issue Which Requires Redressal From Various Authorities Who Develop Or Maintain GI's.[3]. The development and maintenance of infrastructure is crucial to improving economic growth and quality of life (WEF 2013). Urban infrastructure typically includes bulk services such as water, sanitation and energy (typically electricity and gas), transport (typically roads, rail and airports), and telecommunications. The focus of this chapter will be on greening bulk services and roads.

Despite the importance of infrastructure to economic growth and social wellbeing, many countries struggle to meet the increasing demand by growing cities for infrastructure services (ULI 2007; WEF 2013), especially in developing countries including South Africa (SAICE 2006), and many consumers struggle to afford the increasing costs associated with the services they use (National Treasury 2012).[4]. While infrastructure undoubtedly can lead to an improvement in the quality of life of users, in many instances this contribution comes at the expense of environmental quality. The expanding network of roads, for example, covers many thousands of kilometers of land – in excess of 747,000 km in South Africa (SAInfo 2013) – with significant impacts on the ecosystem resulting in diminishing ecosystem services, as does the damming of rivers (McCully 2001). Road surfaces also decrease the ability of the land to absorb rain water resulting in an increase in runoff. Bulk services require energy to pump water to reservoirs and buildings, and to pump effluent away from buildings for both sewerage and storm water (Cohen, R., Nelson, B., and Wolff, G., (2004). The energy required is mainly generated by the burning of fossil fuels such as gas, oil, and coal, with a concomitant release of greenhouse gases.[5]

3. METHODOLOGY

The range of events that use plant or soil system, permeable pavement or other leaky surfaces or substrates, storm water reap and reuse, or landscaping to store, break into, or evapo transpire storm water and reduce flows to sewer systems or to surface waters."

Green infrastructure is a cost-effective, flexible approach to operation wet weather impact that provide many community benefits. While single-purpose gray storm water infrastructure—straight piped drainage and water behavior systems—is designed to stir urban storm water away from the built environment, green infrastructure reduce and treats storm water at its source while deliver environmental, social, and monetary payback. The Main Green Infrastructures in India are:

Downspout Disconnection: - This simple perform reroutes rooftop drainage pipes from draining rainwater into the storm sewer to draining it into rain barrels, cisterns, or permeable areas. You Can Use it to store storm water and/or allow storm water to infiltrate into the soil. Downspout detachment could be especially beneficial to cities with combined sewer systems

Rainwater harvesting: - Rainwater harvesting systems collect and store rainfall for later use. When designed appropriately, they slow and reduce runoff and provide a source of water. This practice could be particularly valuable in arid regions, where it could reduce demands on increasingly limited water supplies

Permeable Pavements:- Permeable pavements infiltrate, treat, and/or store rainwater where it falls. They can be made of pervious concrete, porous asphalt, or permeable interlocking pavers. This practice could be particularly cost effective where land values are high and flooding or icing is a problem

4. MATERIALS USED FOR GREEN INFRA STRUCTURES

1. Smart Bricks
2. Thatch
3. Solar panels
4. Wood
5. Limestone

5. REEN INFRASTRUCTURE TERMINOLOGY

As stated earlier, green infrastructure essentially makes use of and/or mimics natural processes: in this sense green infrastructure focuses mainly on water management in general, and storm water management in particular. To better understand the concept of green infrastructure some generally used terms are described below.

Biodiversity – Encompasses the number, abundance and distribution of all species of life on earth. It includes the diversity of individual species, the genetic diversity within species and the range of habitats that support them. Biodiversity also includes humans and human interactions with the environment (Dale et al, 2011).

Bio infiltration – Bio retention systems are soil-and plant-based facilities systems employed to filter and treat runoff from developed areas. Bio retention systems are designed for water infiltration and evapotranspiration, along with pollutant removal by soil filtering, sorption mechanisms, microbial transformations, and other processes (American Rivers et al, 2012).

6. GREEN INFRASTRUCTURE FUNCTIONS

Green infrastructure systems are therefore those systems that can replace traditional grey Infrastructure by utilizing and/or mimicking natural systems. It involves the integration of all aspects of the design and construction in civil engineering projects to deliver a strategically planned network of natural and man-made green (land) and blue (water) spaces that sustain biodiversity and natural processes. Well-designed green infrastructure has the potential to have many different functions, as it can provide a broad range of ecosystem services with benefits to the economy and society.



Figure 4.3- Delhi

7. APPROACHES OF GOVERNMENT TOWARDS GREENING OF INDIA

In Indian scenario, green infrastructure comprehends to three major aspects, environmental, social and economic sustainability. With India's economy boosting at rapid pace, there began a race to cope up with infrastructural needs, but this race fails to capitalize on sustainability with the negative effects cropping up as a result of massive urbanization led to awareness amongst the citizens as well as authorities and companies who became conscious about the importance of green infrastructure.

Many initiatives have been taken by government and state level which comprehends green infrastructure

7.1 National level approach National environmental policy, 2006

The nexus environmental degradation with poverty is one of the key environmental challenges India is facing in many dimensions. Degradation is intrinsically connected with environmental resources such as land, water, air flora and fauna Drivers of degradation: Population growth, unsuitable technology and expenditure choice, shortage and progress behavior such as exhaustive agriculture, polluting industries, and unplanned urbanization leads to change in relation between people and ecosystem. Lack of enforcement of rights of access and use of environmental resources, policies those disincentives environmental conservation governance constraints.

Objectives of policies:

- Livelihood security for the poor
- Conservation of critical environmental resources and its enhancement
- Integration of environmental concerns in economic and social development
- Efficiency in environmental resources use.

Strategies suggested by NEP:

Objectives stated above are to be realized through various strategic interventions by different authorities at central, state and local government levels

1. Polluter pays
2. Sustainable land use in practice
3. To identify environmental management plans.
4. Monitoring environmental plans
5. Preparation and implementation of action plans
6. Developing models of public private partnership
7. Strategies for increasing forest and tree cover

7.2 National action plan on climate change

The achievement plan was released on 30th June 2008. it well combines number of governments existing plans on water, renewable energy, efficiency agriculture and others. The plan document elaborates on unique approach to reduce climate

change and uses the poverty-growth linkage to make its point.

The guiding principles are :

1. Inclusive and sustainable development strategies to protect poor
2. Developing efficient and cost effective strategies
3. Implementing strategies through linkages with society, local government and public private partnership
4. International co-operation, transfer of technology and funding

National mission:

NAPCC's action plan consists of 8 missions who would be responsible for achieving broad goals of adaptation and mitigation

1. National solar mission (increasing use of solar thermal technologies)
2. National mission for enhanced energy efficiency (trade energy saving certificates)
3. National mission on sustainable habitat(extending energy conservation building code, urban waste management and recycling, incentive to use public transportation)
4. National water mission (20% improvement in water use efficiency)
5. National mission for sustaining ecosystem
6. National mission for green India (a forestation of 6 million hectares of degrading land)
7. National mission for sustainable agriculture (climate adaptive agriculture)
8. National mission on strategic knowledge for climate change

Implementation:

The lead of the each mission are to develop objectives, implementation strategies, timelines and monitoring and evaluation category to be submitted to PM's council of climate change. The council will be responsible for periodic reviewing and reporting each mission. to be able to quantify progress by developing appropriate indicators and methodologies. Furthermore as of July 2015, 27 states and 5 UT's prepared SAPCC focusing on state specific issues related to climate change and strategies to tackle them.

7.3 Urban Development Plan Formulation And Implementation Guidelines:

The ministry of urban affairs and employment, government of India organized a national workshop on master plan approach during February 24-25, 1995. The workshop's research study was awarded as UDPFI-guidelines. The UDPFI guidelines incorporate innovative techniques and implementation mechanism for planned spatial and socio- economic development of urban centers. UDPFI guidelines have evolved a dynamic, efficient and proactive planning system and a time-bound process for formulation, approval, monitoring and review of plans. These guidelines also provide norms and standard for various planning processes and plans. The norms and standards provided for various areas: distribution of land use, infrastructures, commercial facilities, residential facilities, traffic and transportation the guidelines relevant to GI are mainly covered under recreational facilities

Planning unit	Area in sq m per person
Housing cluster	3-4 local parks and playgrounds
Sector	3-4 local parks and playgrounds
Community	2-3 community level parks and open space
District	1 district level park and sports center
Sub-city centre	1 city level park, sports complex, botanical/zoo garden, maiden
Over all town/city level	10 sq. m to 12 sq. m per person

Table - Norms for per capita green open space

7 CONCLUSION AND RECOMMENDATION

Green Growth Strategies for Indian Cities is a project aimed at developing a framework for actions that exemplify the 'Green Growth' approach to understand and achieve sustainability. The Indian Urban system consists of over 7000 towns and cities, the majority of which fall under the medium and small category. While due to economies of scale large cities will witness a considerable growth, the majority of it is expected to happen in medium and small towns. The Green Growth approach is very relevant for these cities as they are at an early stage of growth where the majority of systems and infrastructure have not been put in place yet. A few premises were established before commencing the field research:

- (i) That the strategies would be locally derived and locally applicable;
- (ii) That it would be applied to Tier II and Tier III cities spread across India; and
- (iii) That the framework would cover eight critical sectors: land use and density, ecosystem and biodiversity, energy, economy and business, buildings and housing, transport, water and sanitation and solid waste management.

Green infrastructure provides an effective land use management strategy in at least four critical areas:

Green infrastructure can provide a less expensive and more cost-effective management strategy for storm water runoff and by so doing reduce the financial burden to the local authority, the property developer, and the occupier. A more localized storm water management system reduces the need for an extensive reticulation system of channels, pipes, pumps, and treatment plants.

Green infrastructure reduces energy demand by reducing the need to collect and transport Storm water to a suitable discharge location. In addition, green infrastructure such as green roofs, street trees and increased green spaces reduce the heating and cooling loads on buildings from the shading offered to buildings and impervious surfaces. Harvested precipitation can further reduce energy demands by reducing the demand on the water reticulation system.

Green infrastructure can reduce the economic costs and risks associated with flooding by reducing runoff volumes and by providing either permanent or temporary holding areas.

Green infrastructure enhances public health and reduces illness-related costs by reducing the extent of pollutants collected and dispersed throughout the storm water management system.

8 RECOMMENDATIONS

The recommendations and strategies are suggested after very careful understanding of the strategies or techniques used by best practices or successful cases of cities. The study also refers to guidance for enhancing green infrastructure provided by the institutions such as Natural England, US Environment Protection Agency, European Commission, American Planning Association etc.

Recommendation 1:

The following steps will help in incorporating Green infrastructures into development plan making process Firstly it is to be identified how green infrastructure will be addressed in the local development framework What are the local need for Green Infrastructure Functions to be established Deficiencies in existing Green Infrastructures (Amount and Type) To be Identified. Board opportunities and key agencies who will deliver to be identified Database for Green infrastructure to be prepared. Green Infrastructure opportunities to be identifying and supporting policy option to be developed. Green Infrastructure stake holders to be consulted. Spatial plan for Green Infrastructure network to be developed. Implementation and long term management mechanism to be defined.

Recommendation 2:

Define a multiple hierarchy of Green Infrastructure in terms of function, location and size use levels, by analyzing the natural, historic and landscape assets and identify the areas where there is requirement of additional Green Infrastructure.(Adopted by East Of England Plan)

Recommendation 3:

Preparation of an exclusive Green Infrastructures plan for the city which provides the visionary and strategies framework for integrated development and helps to maintain a consistent Database of Existing assets (Ecological, recreational, landscape and historical) which can be analyzed to identify gaps and opportunities in the ecological and recreational networks.

Recommendation 4:

Inclusion in Development plan process Even though the local authorities do not formulate strategies for Green Infrastructures. It is highly important that green infrastructure should be included in the plan making process. Green Infrastructures can be included in the plan making process at the following stages.

- At the visioning Stage
- When compilation of database is being done
- Development of policy and spatial options
- At the stage of implementation.

Recommendation 5:

Propose “Natural Improvement Areas” based on assessment of restoring opportunities and connection with nature at the significant level. These areas can be established through the partnership of local authorities, local communities, land owners, private parties, and conservation organization

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