NATURAL RESOURCE PROTECTION AND MANAGEMENT : GREEN INFRASTRUCTURE

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Abstract

Green infrastructure is our nation's natural life support system- an interconnected network of waterways, wetlands, woodlands, wildlife habitats, and other natural areas; greenways, parks and other conservation lands; working farms, ranches and forests; and wilderness and other open spaces that support native species, maintain natural ecological processes, sustain air and water resources and contribute to the health and quality of life. The present paper is aim to give brief idea about Green infrastructure, main elements of it and discuss about urban forests, constructed wetlands, green roofs, green walls, green streets and the planning approach and also the main benefit. This paper highlights reasons why the development of green infrastructure should remain a priority.

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Introduction

Ideas for green urban structures began in the 1870s, with concepts of urban farming and garden allotments. Green Infrastructure is a concept originating in the United States in the mid-1990s that highlights the importance of the natural environment in decisions about land-use planning. However, the term does not have a widely recognised definition. Also known as "blue-green infrastructure or "green-blue urban grids" the terms are used by many design-, conservation- and planning related disciplines and commonly feature stormwater management, climate adaptation and multifunctional green space.

The term "green infrastructure" is sometimes expanded to "multifunctional" green infrastructure. Multifunctionality in this context refers to the integration and interaction of different functions or activities on the same piece of land. The term "blue-green infrastructure" is applied in an urban context and places a greater emphasis on the management of stormwater as an integral part of creating a sustainable, multifunctional urban environment.

There are different types of Infrastructure- road, water and sewer are called as Grey Infrastructure. The goal is to move from grey to green infrastructure. Grey infrastructure includes "man-made single purpose systems." Green infrastructure is defined as "man-made structures that mimic natural systems." As an example, networks of man-made wetlands, restored flood plains or infiltration basins would all qualify as green infrastructure. The benefits of such systems include: evaporation, transpiration, enhanced water quality, reduced erosion / sedimentation, and restoration. Some grey / green infrastructure feature integrated systems that create hybrid detention ponds or holding tanks, which are designed to slow water's release into stormwater management systems.

Green Infrastructure, use naturalized systems to treat stormwater close to its source Green infrastructure uses naturalized systems to infiltrate, evapotranspire, and/or recycle stormwater runoff close to its source. Green infrastructure often uses vegetation, engineered soils, and permeable surfaces to intercept stormwater before it reaches the wastewater system, reducing the burden on the grey infrastructure system, limiting the amount of polluted stormwater runoff entering waterways, and reducing the number and volume of combined sewer overflows. These naturalized systems seek to complement rather than replace existing grey infrastructure, often linking green infrastructure to existing sewer and stormwater systems.

Benefits of green infrastructure can include:

• Reduced and filtered stormwater, minimizing total suspended solids (TSS), peak discharge volumes, and combined sewer overflows (CSOs)

• Reduced flooding

• Reduced wastewater pumping and treatment costs

• Added urban green space and wildlife habitat

• Sequestered CO2

• Improved air quality

• Shade and reduced urban heat island effect

• Recharged groundwater

Objectives

The main objectives of the paper are

1) To understand the concepts of green Infrastructure

2) To identify the different types of green infrastructure; green roofs, walls, streets etc.

3) To discuss about the Green Infrastructure Planning Approaches.

4) To discuss about the Benefits and few Barriers and Economic effects involved in it.

Methodology

This paper is prepared only by using secondary data, which provide a detailed overview of the Green infrastructure and it done by collecting the sources being published material, books, brochures and video cassettes that were available at Internet.

Discussion and Explanation

Green infrastructure is "Planned & managed networks of natural lands, working land scopes, & other open spaces that conserve ecosystem values & functions & provide the associated benefits to human populations". It can involve preserving a mixed hardwood forest which absorbs amounts of rainfall, helping protecting the nearby communities from runoff, flooding & drought, while purifying the air & providing green space.

I. **The Origins of Green Infrastructure-** Green infrastructure is a new term, but it's not a new idea. It has roots in planning and conservation efforts that started a hundred and fifty years ago. Green infrastructure has its origin in two important concepts:

(1) Linking parks and other green spaces for the benefit of people, and

(2) Preserving and linking natural areas to benefit biodiversity and counter habitat fragmentation.

Green infrastructure encompasses a wide variety of natural and restored native ecosystems and landscape features that make up a system of "hubs" and "links."

Hubs anchor green infrastructure networks and provide an origin or destination for wildlife and ecological processes moving to or through it. Hubs come in all shapes and sizes, including:

- Reserves — Large protected areas, such as national and state parks and wildlife refuges;
- Managed Native Landscapes —Large publicly owned lands, such as national and state forests, managed for resource extraction as well as natural and recreational values;
- Working Lands— Private farms, forests, and ranches that are managed for commodity production yet remain in a predominantly open and undeveloped state;
- Regional Parks and Preserves — Less extensive hubs of regional ecological significance; and
- Community Parks and Natural Areas — Smaller parks and other sites at the community level where natural features and ecological processes are protected and/or restored.

Links are the connections that tie the system together and enable green infrastructure networks to work. They range in size, function and ownership, including:

- Landscape Linkages— Large protected natural areas that connect existing parks, preserves, or natural areas and provide sufficient space for native plants and animals to flourish while serving as corridors connecting ecosystems and landscapes. Landscape linkages may also provide space for the protection of historic sites and opportunities for recreational use;
- Conseravation Corridors— Less extensive linear protected areas, such as river and stream corridors that serve as biological conduits for wildlife and may provide recreational opportunities;

- Greenways'— Protected corridors of land managed for resource conservation and/or recreational use;
- Greenbelts — Protected natural lands or working lands that serve as a framework for development while also preserving native ecosystems and/or farms or ranchland; and
- Ecobelts — Linear woody buffers that can ease the zone of tension between urban and rural land uses while providing ecological and social benefits for urban and rural residents

II. Types of green infrastructure

1) **Urban forests** Urban forests are forests located in cities. They are an important component of urban green infrastructure systems. Urban forests use appropriate tree and vegetation species, instead of native species also provide aesthetic value while reducing cost. Diversity of plant species should also be considered in design of urban forests to avoid monocultures; this makes the urban forests more durable and resilient to pests and other harms. In the United States, a federal legislation known as The Energy Conservation Through Trees Act, authored by Congresswoman Doris Matsui of Sacramento, encourages residents to plant shade trees to reduce heating and cooling costs.

Benefits

- Energy Use: According to a study conducted by the Lawrence Berkeley National Laboratory and Sacramento Municipal Utility District, it was found that urban trees can provide up 47% energy savings.
- Urban Heat Island: Maximum air temperatures for tree groves were found to be lower than that of open areas without trees. This is because of a process called evaporative cooling.
- Water Management: Urban forests helps with city water management on diverting storm water from water channels. Trees intercept a large amount of rainfall that hit them.
- Air Pollution: Trees hold carbon, which improve air quality in cities.
- Property Values: Having more trees increases property value, which suggests that people value greenery and trees wherever they are. This implicates that trees contribute to the preferred living conditions. Urban greenery can also improve mental health and well-being.

2) Constructed wetlands

Constructed wetlands are manmade wetlands, which work as a bio-filtration system. They contain wetland vegetation and are mostly built on uplands and floodplains. Constructed wetlands are built this way to avoid connection or damage to natural wetlands and other aquatic resources. There are two main categories of constructed wetlands: subsurface flow system and free water surface system. Proper planning and operating can help avoid possible harm done to the wetlands, which are caused by alteration of natural hydrology and introduction of invasive species.

Benefits

- Water efficiency: Constructed wetlands try to replicate natural wetland ecosystems. They are built to improve water efficiency and water quality. They also create wildlife habitats by using natural processes of plants, soils, and associated microorganisms. In these types of wetlands, vegetation can trap parts of suspended solids and slow down water flow; the microorganisms that live there process some other pollutants.
- Cost-effective: Wetlands have low operating and maintenance costs. They can also help with fluctuating water levels. Aesthetically, constructed wetlands are able to add greenery to its surrounding environment. It also helps to reduce unpleasing odours of wastewater**.**

3) Green roofs and green walls

Green roofs improve air and water quality while reducing energy cost. The plants and soil provide more green space and insulation on roofs. Green roofs also help reducing city runoff by retaining rainfall.

Benefits of green roof,

a) Reduces stormwater Run off

b) Reduce Energy Use

c) Improves Air Quality

d) Reduce Atmospheric CO_2

4) Green Streets

Create bicycle- and pedestrian friendly streets Green Streets are designed for all users, contrary to the conventional car-dominated streets most prevalent today. They create safe, convenient, and comfortable access for all users, regardless of age, ability, income, or mode of transportation, and prioritize the health, safety, and comfort of a city's residents and visitors.

Through the use of designated bike lanes, safe pedestrian crossings, trafficcalming elements, and accessible transit systems, Green Streets create healthier, more pleasant streetscapes that offer opportunities to walk and bicycle daily and to safely and comfortably navigate the street. Benefits of Green Streets can include:

• Beautified streetscapes

• Increased bicycle, pedestrian, and vehicular safety

• Decreased car dependence

• Decreased CO2 emissions

• Increased physical activity and improved health

• Increased social equality

• Improved traffic flow and connected forms of transit

A green street design begins before any BMPs are considered. If building a new street or streets, the layout and street network must be planned to respect the existing hydrologic functions of the land (preserve wetlands, buffers, high-permeability soils, etc.) and minimizing the impervious area. If retrofitting or redeveloping a street, opportunities to eliminate unnecessary impervious area should be explored..

5) **Rain garden** A rain garden is a planted depression or a hole that allows rainwater runoff from impervious urban areas, like roofs, driveways, walkways, parking lots, and compacted lawn areas, the opportunity to be absorbed. This reduces rain runoff by allowing stormwater to soak into the ground (as opposed to flowing into storm drains and surface waters which causes erosion, water pollution, flooding, and diminished groundwater). They should be designed for specific soils and climates. The purpose of a rain garden is to improve water quality in nearby bodies of water. Rain gardens can cut down on the amount of pollution reaching creeks by up to 30%. Rain gardens are beneficial for many reasons: improve water quality by filtering runoff, provide localized flood control, are aesthetically pleasing, and provide interesting planting opportunities. They also encourage wildlife and biodiversity, tie together buildings and their surrounding environments in attractive and environmentally advantageous ways, and provide significant partial solutions to important environmental problems that affect us all.

Water Harvesting

Benefits from water harvesting are based on the volume in gallons of stormwater runoff stored onsite. To determine this volume, the following information is necessary:

• Average annual precipitation data (in inches)

• Rainfall intensity

• Size of the water-collecting surface (in square feet)

• Capacity for temporary water storage and release

• Frequency of harvested water use for building needs, irrigation or evaporative cooling (e.g. whether the captured rainwater is used before a subsequent rain event)

III. Green Infrastructure Principles

There are six guiding principles and strategies that have been identified as critical to the success of green infrastructure initiatives. Taken together, these principles provide a strategic approach and framework for conservation that can advance the sustainable use of land while providing an interconnected system of green spaces that benefit people, wildlife and the economy. They are intended to help provide design, planning, acquisition and other decision-making guidance for community-based sustainable development. It is our hope that

planners, developers, landowners, state and local officials, and others will use these principles as benchmarks for incorporating a green infrastructure approach into existing and future plans and policies as well as future land conservation and land development project .They are

1: Green infrastructure should be the framework for conservation and development.

2: Design and plan green infrastructure before development.

3: Linkage is key.

4: Green infrastructure functions across multiple jurisdictions and at different scales

5: Green infrastructure is grounded in sound science and landuse planning theories and practices.

6: Green infrastructure is a critical public investment.

IV. Green Infrastructure Planning Approaches

Just like our built infrastructure, our green infrastructure should be carefully planned, designed, and invested in far in advance of development. Green infrastructure planning should be the first step in the land-use planning and design process. Green infrastructure planning should also be coordinated with planning for gray infrastructure — roads, bike trails, water, electric, telecommunication and other essential community support systems. Integrated planning and design should connect the two in a more effective, economic and sustainable network. Green infrastructure initiatives should use approaches similar to those used for the planning, design and financing of built infrastructure.

Green infrastructure should be:

DESIGNED HOLISTICALLY — like our transportation system, green infrastructure should be designed to link diverse green space elements into a system that functions as a whole, rather than as separate, unrelated parts.

PLANNED COMPREHENSIVELY — Like our electric power and telecommunication systems, our green space systems need to be planned comprehensively to provide ecological, social and economic benefits, functions, and values.

LAID OUT STRATEGICALLY — Like our roads and water systems, our green space systems need to be laid out strategically to cross multiple jurisdictions and incorporate green space elements at each level of government.

PLANNED AND IMPLEMENTED PUBLICLY — like our built infrastructure systems, our green infrastructure systems should be planned and implemented with input from and involvement of the public, including community organizations and private landowners.

GROUNDED IN THE PRINCIPLES AND PRACTICES OF DIVERSE PROFESSIONS— like the design and planning of our transportation, water, electrical and phone systems, green space systems should be based on sound science and should build on the knowledge of professional disciplines such as landscape ecology, urban and regional planning, and landscape architecture.

FUNDED UP-FRONT — Like other infrastructure systems, our green space systems need to be funded as a primary public investment. In other words, green infrastructure should be funded up front with other essential services, rather than with money that is left over after all other services have been provided.

Green infrastructure planning should take place at all scales: from the individual parcel, to the local, regional and statewide scales. At the parcel level this could mean designing homes and businesses around green space. At the community level this could mean creating greenways to link existing parks. And at the statewide level this could mean protecting broad wildlife movement corridors to connect state and national forests.

Grey to green infrastructure plan

Buildings	1) Green Roofs
	2) Green walls
Lanscope	1) Bioretention
	2) Green streets
	3) Rain gardens
Hardscare	1) Previous pavements
	2) perforated pipe
	3) over flow inlets
water	1) Condensate harvesting
	2) Rain Harvesting
	3) Gray water harvesting
	4) passive irrigation

i. ABC Water Design Guidelines by PUB in Singapore

Since 2009, two editions of the ABC (Active, Beautiful, and Clean) Waters Design Guidelines have been published by the Public Utilities Board (PUB), Singapore. The latest version in 2011 contains planning and design considerations for the holistic integration of drains, canals and reservoirs with the surrounding environment. PUB encourages the various stakeholders — landowners, private developers to incorporate ABC Waters design features into their developments, and the community to embrace these infrastructures for recreational & educational purposes.

The main benefits outlined in the ABC Waters Concept include:

- Treating stormwater runoff closer to the source naturally, without the use of chemicals through the use of plants and soil media, so that cleaner water is discharged into waterways and eventually our reservoirs.
- Enhancing biodiversity and site aesthetics.
- Bringing people closer to water, and creating new recreational and community spaces for people to enjoy.

ii. The United States Environmental Protection Agency (EPA)

It has extended the concept of "green infrastructure" to apply to the management of stormwater runoff at the local level through the use of natural systems, or engineered systems that mimic natural systems, to treat polluted runoff. This use of the term "green infrastructure" to refer to urban "green" best management practices (BMPs), although not central to the larger concept, does contribute to the overall health of natural ecosystems.

The main strategies fell into several categories:

- Reducing the need, space and stormwater impact of motor vehicle parking by way of increased densities, height limits and floor area ratios; shared, stacked, indoor and unbundled automobile parking; making the best use of on-street parking and pricing strategies; car-sharing; free city-wide mass transit; requiring one secure indoor bicycle parking space per bedroom and better bicycle and pedestrian roadway infrastructure.
- Sustainable landscape design features, such as tree preservation and minimum rootable soil volumes for new tree planting, use of structural soils, suspended paving systems, bio retention and bio filtration strategies and requiring the use of the holistic practices of Bay-Friendly Landscaping.
- Water storage and harvesting through cisterns and rooftop containers.
- Other strategies to handle or infiltrate water on development and redevelopment sites.

iii. Geographic Information System applications

A Geographic Information System (GIS) is a computer system for that allows users to capture, store, display, and analyze all kinds of spatial data on Earth. GIS can gather multiple layers of information on one single map regarding streets, buildings, soil types, vegetation, and more. Planners can combine or calculate useful information such as impervious area percentage or vegetation coverage status of a specific region to design or analyze the use of green infrastructure. The continued development of Geographic

Information Systems (GIS) and their increasing level of use is particularly important in analysis of many layers of geographic information.

iv. Green Infrastructure Master Plan

According to the Green Infrastructure Master Plan, developed by Hawkins Partners, civil engineers use GIS to analyze the modelling of impervious surfaces with historical Nashville rainfall data within the CSS (combined sewer system) to find the current rates of runoff. GIS are able to help planning teams analyze potential volume reductions at the specific region for green infrastructures, including water harvesting, green roofs, urban trees, and structural control measures.

Benefits of Integrating Green Infrastructure Into the Land Planning Process

Just as there are many benefits to green infrastructure, there are many benefits to utilizing a green infrastructure approach to conservation and development planning. Green Infrastructure planning:

a) Recognizes and addresses the needs of both people and nature;
b) Provides a mechanism to balance environmental and economic factors;
c) Provides a framework for integrating diverse natural resource and growth management activities in a holistic, ecosystem-based approach;
d) Ensures that both green space and development are placed where most needed and most appropriate;
e) Identifies vital ecological areas and linkages prior to development in suburban and rural landscapes;
f) Identifies opportunities for the restoration and enhancement of naturally functioning systems in already developed areas;
g) Provides a broad, unifying vision for the future that diverse people and organizations can buy into;
h) Enables communities to create a system that is greater than the sum of its parts;
i) Helps provide both communities and developers with predictability and certainty; and
j) Enables conservation and development to be planned in harmony, not in opposition to one another.

Suggestions

1) Document and promote the benefits of green infrastructure.
2) Make green infrastructure a primary budgetary item.
3) Draw from the theories and practices of a variety of disciplines in designing green infrastructure systems.
4) Work with all levels of government and private landowners at various scales to plan and implement green infrastructure.
5) Make connections between green infrastructure initiatives and other activities within and beyond the community.
6) With regard to water, to harvest water locally, recycle it, and integrate storm water management into every day infrastructure.
7) Indian government must publish guidance on Green Infrastructure planning and Indentify areas where green infrastructure may play critical role in helping to overcome issues such as risks of flood or poor air quality.

CONCLUSION

Green infrastructure is an emerging idea about how urban forests and green spaces can optimally generate benefits in cities using systematic planning, design and management of trees and other living materials. More science and professional practice is needed to improve understandings of how to install and manage green infrastructure most effectively in cities. With vision, green infrastructure can become an urban system that delivers human benefits and services in both the environmental and social dimensions. Green Infrastructure can be promoted as an effective and efficient response to projected climate change. Man-made green infrastructure is also great.

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