UNIT 14 GREEN INFRASTRUCTURE

Structure

14.0 INTRODUCTION

Let's start with very interesting statics, our planet's surface area has been composed by 71 percent ocean and 29 percent land which is around 361 Million KM^2 and 149 Million KM^2 respectively. That means land space or more specifically the land resources of this planet are limited/finite. Among this 149 Million KM^2 land, only the 71 percent land (around 102 Million KM^2) is habitable and rest of land is glacial and barren land now (15 and 28 Millions KM^2 respectively) and the 50 percent of this habitable land is the agricultural land use area (51 Million KM^2) while rest of the land is nonagricultural land included forests, urban as well as buildup land etc. (Ellis et al., 2010; FAO).Now let's look at the human population scenario which is increasing day by day and the current world's populations is around 7.5 billion now.

These above statistical data raises a curiosity about the increasing population will need for sure the place and land to live and settle but as the land resources are already limited, so what will be the solution or future strategy to manage this need?

There are some another important issues that are also connected with the curiosities such as the old infrastructures and city arrangements are already not well planned and settlements have been also not well scheduled, the frequencies of natural disasters and/or manmade tragedieswithin the cities are also increasing and environmental issues like climate change, pollution, biodiversity lose as well as socio-economic and political issues related with settlements etc. These issues further enhance the need of the understanding

about settlement issues and urgently call the issues related to the city design, set-up design, sustainable use of resources and ecofriendly use of resources to develop future infrastructures.

The Sustainable infrastructure design and green infrastructures are among very attractive solution for these interconnected topics towards the development, implementation and management of a future arrangement plans for the population to meet the environmental requirements and gain a better sustainable solution towards the sustainable development goals for future of this planet.

14.1 OBJECTIVES

After reading the unit, you will be able to

- Define Green Infrastructure
- Describe the importance and scope of Green Infrastructure

14.2 GREEN INFRASTRUCTURE: DEFINITION, HISTORY, CONCEPT AND PERCEPTION

The Green infrastructure is often defined based on the scale that is being discussed.The green infrastructure is a concept about built with nature or build along with the protection or care or to help the nature. Thus, the concept lays in the infrastructure developments or city/town building in such a way to mainly target and utilize the apparatuses of green or blue spaces to gain a better ecosystem services within or between the planned projects of infrastructure development.

As a concept, it has been initiated in the mid-1990s in the US to entertain the idea of land cover – land uses under the discipline of ecological planning and to understand the importance of natural environments in these developments. Thus, initially the term Green Infrastructure done not had a widely recognized definition. Green infrastructure has been seen as an approach to conservation planning that combines the efforts of previous planning methodologies and practices in the United States into a systematic framework that can encompass larger landscapes and broader planning goals (McDonald et al. 2005).

Currently the two common understandings are regarding with the definition of Green Infrastructure (GI). One deals with a rather broader aspects of GI by inclusiveness of inter-connected network of green open spaces that provide a range of ecosystem services - from clean air/ water to wildlife habitat and carbon sinks. While another one uses more limited definition or more specific description that isencouraged by the E.P.A. which deals with the small-scale green systems designed to be urban storm water management infrastructure.

So, with the common understating of the definitions are the solely merging the togetherness of natural and built environments and using the landscape as infrastructure.Thus, the green infrastructures represent a beautiful opportunity to create economic benefit while serving environmental and equity goals.

Asthe industrial economy of the twentieth century has transformed into a "service-based knowledge economy," city planners and city leadershave been realizing the economic value in environmental quality (Daniels, 2008). Potential economic benefits of greeninfrastructure include providing job and business opportunities, stimulating economic activity, increasing property values,and providing cost savings from reduced energy, healthcare, and gray infrastructure expenses (Rouse, 2013).

In that sense cities with green infrastructures have been showing that cities don't necessarily have to trade jobs for environmental quality, and "increasingly footloose" skilledworkers have drawn to these cities (Daniels, 2008). However, the green infrastructures have rarely focused onthe economic benefits that may be provided through ecosystem services, missing vital policy arguments for investment inthe greening of cities and opportunity for cultural expression, and production of local resources.

The more recent focus of GI practices has been shifted towards its applications as a stormwater management strategy.

However, in summary, the underlying idea of all these definitions portrays that GI practices can provide multiple strategiesthat can contribute in developing resilient cities. GI practices can be implemented within urban areas in different scalesfrom the local level through engineered structures to a broader level through landscaping. The GI practices which areimplemented at the local level are known as structural GI. Some of the examples of structural GI practices are wetlands,green roofs, rain gardens/bioretention systems, vegetated swales, permeable pavements, infiltration trenches, retentionponds, sedimentation basins, and green walls. At the broader level, GI practices are considered as non-structuralcomponents such as preservation and restoration of natural landscapes (e.g., forests and floodplains). The primary focusof the review presented in this paper will be on structural GI practices (Naumann et al., 2011).

GI practices can be integrated into the existing features of the built environment such as streets, buildings, parking lots and landscaped areas. One of the critical features of GI practices compared to traditional grey infrastructure is the cost effectiveness during their operational period. Even though the initial installation costs of GI can be potentially high in redevelopment and retrofit settings, from their life cycle perspective, the long term operational and maintenance costs make them economically feasible than the conventional infrastructure. In urbanized land uses, industrial areas are generally located close to residential and commercial areas due to the ease of access for material and human resources.

These industrial areas can pose several threats to the environment and surrounding communities in the long term. GI practices can be implemented in industrial areas to mitigate major environmental problems that occur in these areas such as degradation of water resources through contaminated runoff and air pollution.

Check Your Progress Exercise 1

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit.

1) Explain the concept of green infrastructure

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2) Describe the scope of Green Infrastructure

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14.3 IMPORTANT TYES OF GREEN INFRASTRUCTURE

The major demand of Green Infrastructures are for the planning of sustainable cities, urban sustainability, or eco-cities. Thus the important question rises – "Could an approach to planning and development that recognizes the social, environmental and economic value of green infrastructure not only increase access to public green space, but help make urban areas more resilient to climate change?"

Several previous studies in the literature have highlighted the importance and the benefits that can be achieved for industrial areas by implementing GI practices. There are several different GI practices available which can provide different benefits for industrial areas with different associated costs for their implementation. Regardless of the wide acknowledgement of the applications of GI practices within industrial areas in the literature, there are less systematic methods available in the current practice to identify optimum GI practices suitable for such areas. In the current practice, the GI

optimization for such land areas is performed through expert judgments and using simulation models which is an ad-hoc process. The analysis of strengths, weaknesses, opportunities and threats (SWOT) conducted for the assessment of the applications of GI practices within industrial areas further highlighted the lack of knowledge and research gaps in GI optimization for industrial areas. GI planning requires knowledge from different disciplines such as landscape ecology, urban/regional planning, landscape architecture and engineering which rely on the partnership between different local authorities and stakeholders for its successful implementation. The preferences of these different stakeholders are elicited in the planning process to support the knowledge transfer and ensure environmental justice.

The important types may be defined as

1) Water management/ harvesting assemblies
2) Permeable Paving
3) Green open spaces and Street trees
4) Green roofs Green walls
5) Phytoremediation / bio retention or appropriate plant selections

14.3.1 Water Management/ Harvesting Assemblies

This type of green infrastructure planning referees towards the planned use of water bodies along with the city infrastructures. It is like restoration of associated hydrology or water cycle in a way that can mimic the natural hydrology and manage the water resources along with infrastructures settings.

The water harvesting assemblies deals with the following important questions along with the city design or infrastructure design such as –

- The management of water and water bodies as well as different infiltration levels of water in different places in a settlement such as run off and infiltration in woods, fields, meadows, foresters, agricultural land, residential and urban places.
- The water quantity and associated urban heat set ups.
- Urban storm water treatment and management at small to heavy rainfall.
- The problems related to the raw sewage and urban storm water dumping waterways treatment during large rainfalls.

These above issues are major points in building a planning along with hydrological cycle thus it can develop a well green infrastructure settlement.

14.3.2 Permeable Paving

This is also a type of green infrastructure setting that implement the water quantity management and water - heat island management in the infrastructure in a very cheap and ecofriendly manner.

The permeable paving smartly uses the already present ground space to manage the rain fall water in the capturing and assembling the water and restoring needs. Permeable paving helps to increase the permeability of urban place to increase the evapotranspiration and increases the water capacities. As the water transports towards the soil downwards direction to gravels and other ground water bodies thus deals with water quality and quantity as a same time.

14.3.3 Green open spaces and Street trees

The green open spaces and street trees also make the infrastructure a more ecofriendly approach and beauty enhancement along with benefits. They make habitability more organic and combination of nature interlinks thus gives far better organized structure of any city or town. The open green spaces often help to maintain a fresh environment such as fresh air, increase air quality, reduce erosion and sediment transports, also helps in water quality/ quantity and heat index managements, improve in-stream biota and increase the ground water recharge etc. the best thing with green open spaces and street trees associated green infrastructure designs are, they are simply very basic, they work at very places, very cost effective and easily manageable planning along with minor maintenances. The green spaces are also a dynamic setting of an infrastructure planning under the eye of exchangeable future conditions such as hydrological simulations, estimations of various changeable land uses and their attributed economic benefits calculations.

14.3.4 Green Roofs and Green walls

Green roofs are the roofs having plants assembling on or up on them and same kind of arrangements one can often build on walls also to develop a greener arrangement with exceptional direct as well as indirect cost saving opportunities for owner.The green roofs are far more popular green infrastructure choice among the ecofriendly home building lovers. The green roofs not just give an enhancement in the green infrastructure creation but also can provide remarkable benefits such as increasing the insulation values thus a direct benefit towards the savings in the energy heating or the cooling costs of these green structures thus they are often called self-sustained structures. Green roofs have the potentials for greenhouse gas emissions exchange credits. integration of green roofs into simplifying the impervious coverage restrictions is a great importance.The exceptional provision of amenity space and aesthetic appeal also an eye-catching attracting and choice for green roofs or walls building because this increases the direct value of the property and the marketability of the city as a whole. They are also a great solution towards the green land use land cover making and restoration of natural hydrology. They are beneficial in rainfall capturing, increase the permeability, enhancement in evapotranspiration as well as to slow it down.

14.3.5 Phytoremediation / bio retention or appropriate plant selections

Phytoremediation or bio retention is an important and innovative aspect to make green infrastructure because of associated vision linked with enhance natural processes (e.g., filter strips, drainage swales, and naturalized detention ponds) along with elimination of environmental pollution in a desired rate. The use of plants in bio retention helps to improve the underdrain facilities with controlled manner. It also promotes the ground water recharge phenomenon of the place. Sometimes an additional impervious liner can be used with the bio retention builds that facilitates the elimination of ground water contamination thus improves the water quality and natural resources values specially nearby industrial or ultra-urban hot spots or specific contamination targeted places. The phytoremediation oriented green infrastructures are proven great technology for site specific contamination mitigations because the contaminant specific plant selection can help the removal of pollutants in a very cheap as well as ecofriendly ways. The phytoremediation often uses different processes such as direct uptakes, accumulations, biodegradation or volatilization of pollutants and enhance the biodegradation processes along with rhizospheric processes or bioremediation processes.

14.4 BENEFITS OF GREEN INFRASTRUCTURE AND FUTURE PROSPACTS

The green infrastructures are green infrastructure is fantastic choice of city – urban thus they are win – win condition for environment and humans because in general they provide shades, reduces wind speeds, help to reduce water runoff and atmospheric pollutions.

In briefly explanations the urban forest in the form of bulky species trees, street plants, grassland and open space of our city forest are immensely significant as they deliver shade and protection from UV radiation and localized the processes of cooling and shading in streets, towns and cities. It is also very well known that the trees can help to decrease local wind speeds and offer shelter for constructions and houses, thereby dropping the electricity or fuel bills for heating. The urban trees and forests are also efficient and cost saving ways in the reduction of impact of floods and rain storms even one study elucidated a very interesting finding that every 5% intensification in tree cover area can reduce the 2 % of the run-off.Very recent studies on reducing strategies in atmospheric pollution levels and their mitigations said the benefits of green infrastructures having urban forests can reduce pollutants from air thus save lives, reduce hospital visits and reduce the number of days taken off work.

The important benefits of green infrastructures are interconnected such as societal, economic and environmental. They may be at various levels also

such as house levels, city dwellers levels, developers levels, business levels, retailers levels, tourists levels, landowners levels and others levels. The basic benefits of green infrastructures are sharable for all such as cleaner water and air, health care savings, reduced food risks, enhancement in biodiversity, carbon and energy savings, reduced costs of pollutants and contaminants, reduce unused land, improves workspace, reduced heating, cooling cost saving, increasing the property values, high salability of properties, increase the attractiveness of shopping/working environments and improve the microclimate. The table below is representing the interlinking benefits.

Table.The interlinked Environmental, Societal and Economic benefits of GI.

Economic Benefits	Environmental Benefits	Societal Benefits
Enhancements in the price of Properties, lands, homes etc.	Increased Property Prices Regulation	Inspiring Physical Movements
Land Values increments	Increased Land Values	Cultivating Childhood Development
Faster rates in Property Trades	Quick Property Sales and deals with other ecofriendly buyers	Better-quality Mental Health and psychology
Cheering Inward Deals	Positive towards Inward Investment	Quicker Hospital Recovery Amounts
Bargain with Energy Charges via Microclimate Guidelines	Condensed Energy Expenses via Microclimate regulations and guidance	Improved Health recoveries
Improved Probabilities of Gaining Planning Approvals	Improved Likelihoods of Gaining PlanningPermission	Amended in Workstation Output and productivities
Better-quality Tourist and RecreationServices	Value-added Tourist and ReformationFacilities	Accumulative Social Steadiness
Lower Healthcare Budgets	Lesser Healthcare Charges	Decline in Crime rates

Some specific case studies and recent research examples for benefits of green and sustainable infrastructural approaches.

Where you live it matters a lot, the infrastructure and the planning/design matters a lot. There is an extensive history of employing pollution sources in

specific area such as more industrial area, less green zones near, no trees or green infrastructure planning or pre planning accordingly such as low-income areas and the health impacts are very well recognized. A very recent study says that the peoples more likely to live near a pollution source has more health risks. The peoples live a half-mile of natural gas facilities and face a cancer risk above the EPA's level of concern from toxins emitted by those facilities.

Economical and health benefits are also directly associated with a green infrastructure planning. The green infrastructure is not just to settle the infrastructures long with the green zones to make a collaborative frames and substructures, but it is far beyond that as a city planning towards the protection of wildlife and management of forests. The regulation, management and planning of infrastructures can enhance the possibility to reduce deforestation and increase the chances of wildlife protection as well as reduce the risk of human wildlife interactions. That in turn help in the way of economical benefits, biodiversity conservation and wildlife protection as well as reduce the chances of future pandemics transmission such as COVID or HIV to humans and other infections towards the domestic animals.A very interesting study by researchers found that various policies and environmental initiatives, such as direct forest-protection expenditures and protocols to stopover the interactions with wildlife present the greatest risk for different disease transmission, would cost as little as $22 billion a year—2% of the financial and death costs of responding to the global COVID-19 pandemic, which some economists predict could reach $10 trillion to $20 trillion. So it planning the infrastructures under the lens of sustainable world view and green infrastructures will help in a very broader way of economical as well as health benefits.

In addition to environmental and economic emphases, several works highlight the potential for promoting social equity through green infrastructure projects and policies. The social benefits of green infrastructure may include outcomes as diverse as providing outdoor recreation opportunities and the opportunity to connect with nature, improved public health resulting from improved environmental conditions, environmental justice, community building, improved aesthetic quality.

14.5 THE CHALLENGES OF GREEN INFRASTRUCTURE

The green infrastructures are having very crucial challenges to cover. Green infrastructure planning is more flexible, yet integrative, process through which to develop urban areas.

Green infrastructure is an approach to urban development and stimulates an equivalent role for ecological resources in urbanized area.Green infrastructure can be considered as the natural life support systems of

urbanized area. In rapidly developing cities, green infrastructure resource is a great challenge as open spaces are developed to meet urban infrastructure needs.

14.6 LET US SUM UP

Green infrastructure is an approach for greener future of urban areas with the relationship between green infrastructure, economic growth, and sustainable urban development. Green infrastructure is effective, economical, and enhances community safety and quality of life and a network providing the components for solving urban and climatic challenges.

14.7 KEY WORDS

Infrastructure- The basic necessary services for any city like buildings, transport, and water and power supplies.

Green roof-Roof of a building that is partially or completely covered with vegetation

Green wall- Avertical built structure intentionally covered by vegetation

14.8 REFERENCESAND SUGGESTED FURTHER READINGS

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14.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress Exercise 1

1) Infrastructure concerning the environmental costs, green roofs, green buildings, etc.

2) In view of environmental problems, growing indoor pollution, the scope is immense. Need inputs in infrastructure, design of buildings, roads, etc.