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Sustainable Infrastructure In India
"With Special Reference To Blue Green Infrastructure Technique For The Sustainability Of Natural Resources In Urban Areas"

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I. Introduction:

Blue-green infrastructure can be defined as an umbrella of nature-based solutions that have a direct impact on climate change, urban resilience, and health and wellness Blue-green infrastructure can be defined as an umbrella of nature-based solutions that have a direct impact on climate change, urban resilience, and health and
wellness

The idea of sustainable cities is all about eco-friendly practices, developing green spaces, and supporting new technologies in the urban environment to reduce air pollution, water pollution, noise pollution, and CO2 emissions. By facilitating manufacturing services and trade environmental infrastructure is a vital element in driving economic growth in many countries. Infrastructure includes roads, bridges, ports, power plants and water supply. But it is not the only reason for the development and growth of any country in a true sense. The achievement of moral development is more important on a planet that is under stress due to climate change and resource depletion.

Nowadays climatic risk is increasing in urban areas and becoming a threat to people's life and comfort. Global risk is all about perilous situations which are steadily negative and have decadal consequences for towns and cities through temperature increases, natural disasters, extreme weather, and biodiversity loss along with climate unbalances. These causes create many challenges in respect of environmental sustainability and it is the major reason for creating more attention and a significant role of blue-green infrastructure that is related to the creation of green parks and playgrounds, planting more trees, developing gardens, and protecting forests and maintaining blue infrastructure by sustaining sea, rivers and be attentive towards cleaning of lakes, pressure wetlands and develop water utility space in the cities to understand the concept of green and blue infrastructure.

II. Objectives of the Study?

- To understand the importance of Blue-Green Infrastructure (BGI) to obtain sustainability of the Natural Resources.
- To analyze the utility of the techniques related to the BGI in India for environmental sustainability.
- To evaluate the people's apprehension regarding BGI as an environmentally beneficial concept.

III. Methodology of the study:

- The study is based on secondary data for descriptive analysis but to create more authentic interpretations through a questionnaire technique for primary data collection.
- The sample size is 55.
- Samples collection is done through questionnaire techniques of the heterogeneous groups consisting of students, academicians, and the local public.

IV. Review of Literature:

- July 08th 2022, Blue-Green Infrastructure: "Key to Sustainable Urbanization" emphasized the aim and concept of sustainability of natural resources. They explained about Indian cities' related pollution problems, congestion, and un-equitable access to resources. They showcase problems due to rapid

urbanization/ industrialization and reasons are given like excessive pressure on freshwater supplies, sewage capacities, living environment as well as public health.

- November 19th 2019, Sustainable Blue-Green Infrastructure: A social practice approach to understanding community preferences and stewardship by panel Jessica Lamond, Glyn Everett demonstrated the benefits of BGI and its sustainable design along with all identified user-groups in order to understand existing and potential practices in respect of Blue-Green Infrastructure.
- May 26th 2021, Blue-Green Infrastructure: An Opportunity for Indian Cities, Sayli Udas–Mankikarberjis and Driver elaborated in the research paper about urban planning and design approaches to establish nature-driven solutions to sustain conventional infrastructure practices blue-green infrastructure by analyzing existing plans and projects in India.
- July 20th 2022, Delivering Blue-Green Infrastructure: Innovation Pathways for Integrating Multiple Values, Lizet Kuitert and Arwin van Buuren explained in research the techniques of BGI and the significant impact on the environment of these techniques. Protection of rain gardens, green roofs water squares, etc. They talked about a variety of techniques of BGI. The paper emphasized local governments' existing structures and procedures adopted by them towards urban development along with the conservation of natural resources. The paper focused on innovative governance approaches at different levels to capitalize to get benefits from BGI schemes.
- January 3rd 2023: Why Delhi must invest in blue-green infrastructure by Charu Bhanot and Sonia Grover elaborated in the article on BGI and its requirement in Delhi, one of the city in India. It said that green infrastructures have been developed in the city however the government should look upon the blue infrastructure to make systematic water drainage and cleanliness of rivers and ponds in the city. It is needed especially in Delhi to sustain environmental benefits due to climatic changes and pollution all around the city.

What is Blue-Green Infrastructure?

Blue-Green infrastructure, explains itself as the infrastructure of the earth consisting of resources available on earth in the color of blue and green. It is important to understand that how these two-colored resources can be protected and sustained on the earth is the basic issue of the environment. In this regard, people have to preserve all the blue resources like sea, lakes, rivers, wetlands etc, and grow green infrastructure like parks, gardens, and forests across the cities. It is found to be a very positive step towards sustainability of the natural resources which are under UN goal -11. The fundamental aim of BG infrastructure is to make the earth a better place to live through BG techniques used in urban development while protecting natural resources. The techniques used in Blue-Green infrastructure are cost-effective and viable for an extended period and lead to multi-functionality.

For example: If we have a small piece of land and the correct approach toward the environment it can have various benefits. In urban areas people are maintaining plantations on their roof for pure organic vegetables, and terrace gardens to keep their houses cool during the summers. People are preparing water tanks to collect water during rains which leads to rain water conservation and if it is done efficiently the same water can further be used for agriculture or industries. These all environment protection activities support sustainable and resource-efficient development. Basically, it is an idea of urban development through Blue Green infrastructure along with an adequate ecosystem to live.

Benefits of Blue-Green Infrastructure

1. **Environmental benefit includes** green infrastructure which plays a vital role to guard and protect the environment from harmful effects. It also helps in improving biodiversity that provides habitat for distinct species.

2. **Social benefits-** The ground plan and beauty of the landscape and topography can contribute to making an identity of the city's character and ambiance. Trees on the side path, benches on the side of the road, and gardens can provide shelter, comfort, and peace in public spaces as well as it reduces the urban temperature. Green surroundings attract tourism and other outdoor activities which encourage more social gatherings.

3. **Economic benefits**–

- Nature's beauty is always appreciable. A natural environment with a peaceful atmosphere has increased the value of that place. The Blue green approach leads to planting more trees, homemade gardens, green parks and proper cleanliness and conservation of water resources through building manmade waterfalls, fountains, and canals to create the beauty of that place. It all together develops its tourism value which is directly related to the economic development of that city. As well as with the help of such green infrastructure techniques the temperature of building surfaces could be controlled. With that, demand for cooling

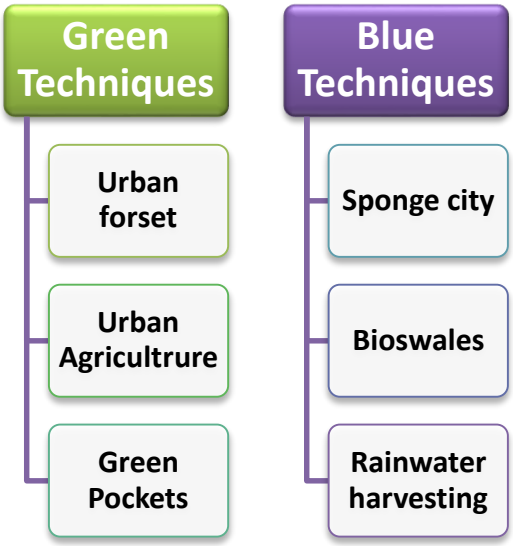
equipment like AC and other shields can be avoided. It helps in decreasing energy needs. People can save money and the cities would grow economically.

- Green streets and natural landscapes with trees and benches on the side paths enhance the aesthetic and righteous value of that place. The value of property increases in the areas.

4. **Mental and Physical Benefits**:

- Nature creates inner peace and happiness and it is known that green color reduces stress. So green cities definitely develop stress free and peaceful environment for the people living in that cities. It also maintains and conserves biodiversity because it is connected to the green natural surroundings to protect all kinds of animals which leads to mental and physical well-being.
- BGI makes the environment cleaner and healthier with immaculate water, clean air and also contributes to diverse biodiversity.

Techniques to Promote BGI



Green Techniques:

- **Urban forest**- Urban forestry is organizing the plantation, invigilation, preservation and maintenance of vegetation and organic farming on the roof of the accommodation or dwelling area. It consists of a variety of plants, trees and vegetables. It is always providing various environmental benefits as it cleans the air, promotes biodiversity, and controls soil erosion. It helps to make a sensitive connection between the environment and the urban people. It is significant for the healthy lifestyle of people who are living in urban areas.

Source:https://www.gstimes.in/urban-forest-in-india-and-miyawaki-method/

- **Urban agriculture**- Urban agriculture is an evolving idea in urban areas. It is also known as urban gardening. This type of agriculture can be done on the vacant places left in the houses or on the roofs. It consists of all the process which comes from reaping seeds, growing, refining, handling, and at last distributing foods across the cities. There are some other forms of urban agriculture which include mixed agriculture or animal husbandry and horticulture which is a study or practice of growing flowers, fruit, and vegetables. Aquaculture and beekeeping are also included in urban agriculture to promote biodiversity and reproduction systems. These techniques also generate income for the dwellers.

Source:https://www.organicauthority.com/what-is-urban-gardening-hot-trend/

- **Green pockets**- A peaceful, extremely green, and beautiful place is frequently located near residential areas, offices, and schools for the public to get relaxed and calm surroundings which are called as green pockets. It has countless benefits for human beings. It is helpful during taking rest from stressful and busy schedules of people and generate emotional and mental health. The green pocket concept also supports to control of air pollution and increases the beauty of surrounding places along with the value of the property.

Source:https://merchantsquare.co.uk/see-and-do/floating-pocket-park

Blue Techniques:

- **Sponge City**- As the name suggests sponge absorbs water which is useful for the city based on the technique of collecting or absorbing rainwater. Such type of cities are called sponge cities. The collected water is free of soil, sand, pebbles, and rocks due to the natural filtration process. This method also shoots up the groundwater level which would support to creation peri-urban well and can be extracted whenever needed.

Source: https://www.worldfuturecouncil.org/sponge-cities-what-is-it-all-about/

- **Bioswales-** Bioswales are a technique to manage or direct stormwater to the right place in urban areas. It is also said to run off storms through a good transportation system. This model of blue infrastructure emphasizes the time period of conveyance of water as well as removing pollutants from water. Bioswales are used to store stormwater before plunging into the watershed and follow the procedure to make it clean and pollution free.

Source:https://blog.landscapeprofessionals.org/effective-stormwater-management-installing-bioswales/

- **Rainwater Harvesting-** Water is a vital natural resource and is required to be utilized properly. It is important to conserve this resource and make it useful to the people. But as the population increases, the demand for clean and free water also increases. Hence, it is necessary to reload groundwater to complete the demand. In this process, water is not allowed to run off to the ground. It is one of the techniques of blue infrastructure that collects rainwater and later use them for agricultural purpose.

Source: https://www.villagesquare.in/rainwater-harvesting-best-way-forward-irrigation/

V. Blue-Green Infrastructure in India

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Industrialization is a prime force source to accelerate the economy of the country, but on the same ground conservation and sustainability of natural resources have the same importance. It is required to maintain both elements to generate economic value along with proper containment of natural resources. To make this possible honorable Prime Minister of India launched Atal Mission for Rejuvenation and Urban Transformation (AMRUT) on 25th June 2015 in selected 500 cities and towns across the country for sustaining and proper utilization of natural resources.

The main focus of this mission is to develop the basic infrastructure of cities and towns that are selected for this mission. The criteria on which AMRUT is emphasized are water supply mainly sewerage and septage management, proper system of drainage for the stormwater, developing green spaces like gardens and parks; and non-motorized transport in the cities and towns. The Urban Reforms and Capacity Building have been prepared and also included in the Mission.

Ministry of Housing and Urban Affairs has approved State Annual Action Plans (SAAPs) of all the States/Union Territories (UTs) amounting to ₹77,640 crore for the entire Mission period, which includes committed Central Assistance (CA) of ₹35,990 crore. So far, States/UTs have taken up 5,873 projects worth ₹82,222 crores, of which 4,676 projects worth ₹32,793 crores have been completed, and another 1,197 projects worth ₹49,430 crores have been grounded which are at various stages of implementation. Further, overall works worth around ₹66,313 crore have been physically completed and expenditure of ₹59,615 crore has been incurred.

Source:https://pib.gov.in/PressReleasePage.aspx?PRID=1885837#:~:text=The%20Mission%20focuses%20on%20development,and%20non%2Dmotorized%20urban%20transport

Till date, 134 lakh water tap connections and 102 lakh sewer connections have been allotted through the AMRUT scheme (including household which is covered through Faecal Sludge and Septage Management - FSSM) has been provided to targeted 139 lakh water connections and 145 lakh sewer connections respectively.

Recently, the second phase of the mission AMRUT has been developed under AMRUT 2.0, which was launched on 1st October 2021 to attain all the targets which are left to be achieved in phase-1 of the AMRUT scheme. The central administration or nodal agency for this scheme is the Ministry of Housing and Urban Affairs (MoHUA).

This scheme ensures that every household has availability of water taps inside the houses with proper water supply and also focuses on systematic sewage connections of the households. As per the aim of the scheme, AMRUT 2.0 is to provide a 100% range of water supply to all households in the selected cities around 4,700 ULBs (Urban Local Bodies). This scheme also promotes public-private partnership (PPP) through startups and young entrepreneurs along with the thought of Atmanirbhar Bharat.

Analysis and interpretation

To analyze the awareness among the people regarding the concept of BGI, heterogeneous group has been selected as population parameter which consists of students, academicians and local public. With the help of 5 point Likert scale questionnaire method, 55 responses were received over the survey of Blue-Green infrastructure. Hence the sample size of the survey is 55. It is evident that the sample size is small to depict the result of a particular study but it is a considerable sample to analyze the knowledge of demography in the field of environmental sustainability. 21 questions regarding sustainability and Blue-Green Infrastructure has been framed.

The questions asked in the questionnaire to analyze the knowledge and awareness of the concept and Goal behind the Blue-Green Infrastructure in India are as follows:

- Is sustainable development is necessary for Socio-Economic development?
- Does sustainable development consists of Preserving nature for the future?
- Does sustainable development demands that we humans reduce all sorts of waste?
- Is sustainable development essential for Improving people's health and opportunities for a quality life?
- To achieve sustainable development, people must have access to good education.
- Do poverty in India is responsible for the unlimited and improper use of Natural resources.
- In India, do the companies should also take the responsibility to reduce the use of packaging and disposable articles.
- In India, do the people who pollute land, air or water should pay for the damage they cause to the environment.
- Can Blue-Green Infrastructure can be defined as an umbrella of nature-based solutions that have a direct impact on climate change, urban resilience, health, and wellness."
- Does dimensions and Management of infrastructure systems can store and collect rainwater by creating a concept of a sponge city.
- Does Blue-green infrastructure reduces overheating in urban areas
- Does Conservation of Blue-Green Infrastructure is reducing the risk of flooding
- Is Blue- Green Infrastructure helpful in Increasing connectivity for people and nature
- Is Blue- Green Infrastructure sustaining tourism
- Is Blue- Green Infrastructure responsible for Increasing the number of jobs in an area
- Are people in India accepting the concept of Urban forestry including planting, supervision, conservation, and maintenance of vegetation in the areas of urban dwellings.
- Are People in India accepting the concept of Urban agriculture including gardening and vegetation on the terraces and the vacant places outside the houses.
- Has COVID the pandemic had an impact on the perception of the benefits of green infrastructure on people's health and well-being?
- Is Blue -Green Infrastructure protecting the environment through Clean Air and the Maintenance of Forests and Pure Vegetation.
- Is there a need to replenish the groundwater and use alternate methods to harvest water.
- In India, are existing Blue-green resources essential and will there always be a need for a sustainable future.

Interpretation:

Questions	Strongly Agree (%)	Agree (%)	Strongly Disagree (%)	Disagree (%)	Don't Know (%)	Total(N) (%)
Q1	47%	51%	2%	0%	0%	100%
Q2	58%	38%	2%	0%	2%	100%
Q3	47%	51%	0%	0%	2%	100%
Q4	49%	45%	2%	0%	4%	100%
Q5	51%	44%	4%	0%	2%	100%
Q6	33%	45%	18%	2%	2%	100%
Q7	44%	55%	2%	0%	0%	100%
Q8	53%	45%	0%	2%	0%	100%
Q9	40%	47%	0%	0%	13%	100%
Q10	35%	56%	0%	2%	7%	100%
Q11	35%	55%	0%	0%	11%	100%
Q12	33%	51%	2%	0%	15%	100%
Q13	35%	58%	2%	0%	5%	100%
Q14	33%	44%	0%	4%	20%	100%
Q15	24%	55%	2%	0%	20%	100%
Q16	35%	51%	5%	0%	9%	100%
Q17	31%	60%	2%	0%	7%	100%
Q18	42%	45%	4%	0%	9%	100%
Q19	38%	56%	0%	0%	5%	100%
Q20	44%	51%	0%	0%	5%	100%
Q21	42%	49%	0%	0%	9%	100%

VI. Statistical Inferences

- As per the table and graph it is evident that the term '*Strongly Agrees'* has been answered by maximum people than the term *'Agree'*. '*Don't know'* is the answer to many questions rather than the option *'Disagree'* and *'Strongly disagree'*. That shows the psychological behaviors of the respondents as they accept being clueless about the thing as compared to the fact that they have disagreements on the same topic.
- The results are very obvious that the people can easily connect with the topic of sustainability but they cannot relate to the theory and techniques to conserve the Blue and Green Resources of the environment.
- The questionnaire contained the responses to be recorded about the role of BGI in increasing tourism and job creation opportunities. Most people know about the concept but are not sure about the process and outcome of BGI techniques for job creation.
- Maximum answers have been found in the *'Agree'* Statement as compared to *'Strongly Agree'* which means that many people realize the importance of the BGI conservation concept but don't have complete knowledge of the utility and plans to sustain the blue and green environment.
- There are some respondents who opt for *'Don't know'* which shows the lack of knowledge towards the environmentally positive approach.

VII. Suggestions:

- Government of India should implement a national vision for sustainability and should continuously determine guiding principles for such projects.
- Annual blue-green audits should be started for all cities to create realistic policies according to the demographic data, poverty, and social challenges.
- The water waste from RO purifiers may be put to reuse where ever possible.
- In a country like ours the major wastage of water is through the flush tanks installed in washrooms. This wasted water can be treated separately and can be reused again in the flush tank which would conserve the water immensely. This can be done through compact Sewage Treatment Plants which are already in the market. Government can publicize the domestic treatment of this waste of water and can also incentivize it so that the public may be more aware and determined towards the usage as well as treatment of the water.

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