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BLUE-GREEN INFRASTRUCTURE: AN APPROACH FOR RESILIENCE IN URBAN WATERSHED MANAGEMENT

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Abstract : *Blue-green infrastructure is not an approach toward urban watershed and stormwater management as well as a tool for mitigating and adapting to climate change and boosting the city's overall resilience and livability. Green and Blue areas have played a significant role in the development of urban areas, not only physically but also socially and culturally, the study will concentrate on sustainable urban drainage system strategies and how they can be integrated with green areas for a more sustainable and resilient urban environment. various other factors influences the water shade management cycle as well as act as a primary parameter for developing BGI framework like stormwater, surface run off, and urban flood this paper examine the practices that have been practiced globally. It will conclude with an analysis of studies to show the significance of these practices and how the blue-green infrastructure framework should be implemented.*

Keywords: resilience, water shade management, storm water, surface water run-off, flood

1. INTRODUCTION

Urban Blue-green infrastructure is defined as "a network of nature-based features situated in built-up areas that form part of the urban landscape" (Amal Shehata, 2013). Blue-green infrastructure combines the watershed, blue) elements and green networks to manage storm water flows and water recharge, simultaneously intensify the green elements of the surroundings. Blue-green infrastructure has the capability to prevent and mitigate climate calamities, contribute toward environment augmentation and sustainable urban renewal, and lead to economic growth.

Resilience, on the other hand, refers to: 'the ability of a system (the city) to adapt and adjust to changing internal or external processes' (Ven, Voskamp & Van de, 2015).Thus, increasing adaptive capacity towards climate change, is acknowledged as a positive aspect of a city. The study aims to prepare a framework for the application of blue-green infrastructure strategies for watershed management in urban regions as an approach to resilience.

2. LITERATURE REVIEW

(S. P. Suryawanshi and Abhijeet Kamble, 2012) finds In India, where a lot of running water goes waste, it becomes very important to apply the technology of watershed management as watershed management can overcome annual problems of droughts and floods.

(Liao, Dang & Tan, 2017) elaborated that Blue-Green Infrastructure can intercept, retain, absorb, and dehydrate stormwater locally to reduce the runoff going to the storm drains to saturate the drainage network, thereby delaying the peak flow to mitigate downstream flood risk. BGI approach for water quality treatment, Multiple Ecosystem Services & constructed wetlands.

(Emily O'donnella, Colin Thornea, 2020) Finds that the Development of BGI is a key to creating flood-resilient cities and a Transformative change in practice, policy, and governance of flood and water management is necessary for the progress along the blue-green path to achieving urban flood resilience.

According to the article "a greener urbanscape" published in June 2021 talks about the incorporation of the blue-green economic framework as a counter to conventional infrastructure practices**.** For the development of cities and habitats, the fast-track sustainable development goals also recommend achieving various targets linked to green infrastructure, including those relating to water (SDG 6 and SDG 14), land (SDG 15), and climate change (SDG 13).SDG 1's green employment chances, SDG 2's food security, SDG 3's offsetting of the burden on the medical infrastructure, SDG 11's improvement of air quality for human habitation, SDG 9's assurance of resilience, and SDG 11's improvement of air quality all benefit from blue-green infrastructure (SDG 10). *(Drishti IAS).*

This article on **"**Time for a 'sponge cities' mission in India**"** which was published in The Hindu in Oct 2020 talks about how urban flooding is a man-made disaster and ways to deal with it. Kochi may be State's first 'sponge city' to be initiated on the already developed policy ideas on Wuhan city intervention. Which could be India's technical and aesthetic innovative concept so far.

2.1. ACTIVE, BEAUTIFUL, CLEAN WATERS PROGRAMME: SINGAPORE

The ABC (Active, Beautiful, Clean) Waters program 2005, interlinks water with the city and people, stormwater management, and the overall resilience and liveability of the city. The major objective of the

Figure 1.ABC programme, water as an environmental asset,
Source: (Centre For Liveable Cities,,2017)

ABC Waters program was "to transform waterways and water bodies into beautiful urban assets, integrating these drainage infrastructures with the built environment while bringing people closer to water"(Centre for liveable cities,,2017). The study revealed that ABC Waters design features are effective in reducing peak flow and runoff coefficient of the precinct during storm events. More than 100 potential locations are identified for the implementation of this program by 2030.

The incorporation of green infrastructure in urban areas further adds monetary value to a precinct as there is a willingness by the public to pay more for properties in precincts with green infrastructure. Inferences to the study are-

The socially evolving model rather than a water program. Treatment as well as enhancement of aesthetics by taking water as the main element. This model not only transforms the waterways but provides other ecosystem services such as the enhancement of biodiversity and improvements in runoff water quality. ABC Waters' design feature is a sustainable option for countries where the extensive use of such features has previously not been considered for storm water management.

For the implementation of this initiative by 2030, more than 100 suitable venues were identified. As more people are willing to pay more for properties in precincts with green infrastructure, the incorporation of green infrastructure in urban areas increases a precinct's monetary value. The study's conclusions point to a socially evolving paradigm as opposed to a water program. By using water as a primary component, aesthetics can be

improved as well as treated. In addition to changing the rivers, this strategy also offers additional ecosystem services, such as boosting biodiversity and raising runoff water quality. A sustainable alternative to nations where substantial usage of such elements for storm water management has not previously been explored is ABC Waters' design feature.

2.2. SPONGE CITY CONCEPT, WUHAN CHINA

Sponge-City program was launched in 2014 with a primary goal to, "Create a city with a water system which operates like a Sponge to absorb, store, infiltrate and purify rainwater and release it for reuse when needed. As the first stage of development, 16 cities were chosen as pilot city projects, where these principles were applied and tested. Wuhan city was also chosen as one of the 16 pilot projects. (Zhang et al, 2019)). The sponge city principles involve preserving the city's natural habitat, environmental restoration, low-impact construction& efficient utilization and management.

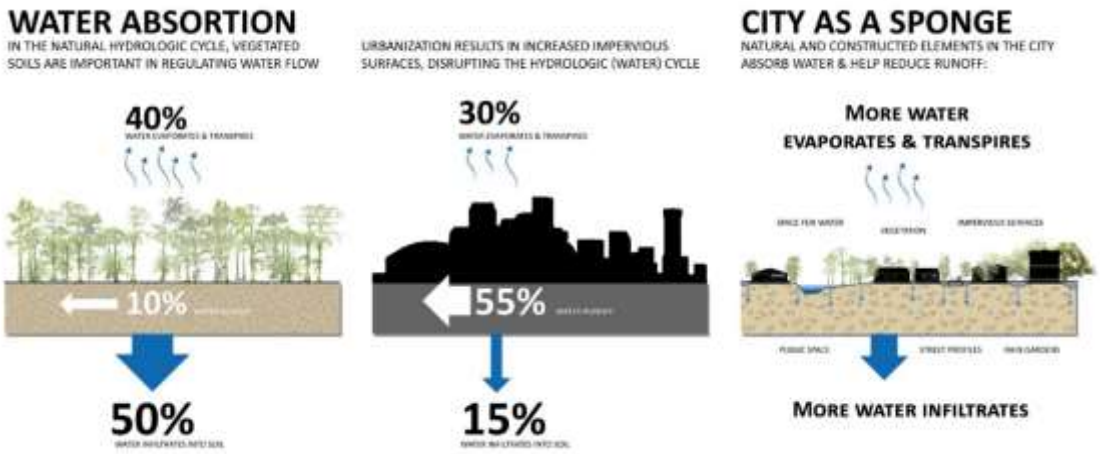

Figure 2. image showing water absorption in natural land & city as a sponge
(Agency, US Environment Protection, 1993)

The program's advantages for the city include the city's water logging issue being resolved using this method. This strategy gives resilience to the city, which is vulnerable to flooding,. Urban wetlands and trenches were developed to purify run-off water. Following that, this water will be utilized to clean homes, irrigate gardens and urban farms, and flush toilets. Sponge cities, which also raise air humidity and lower public health problems, control urban microclimates. The strategy framework includes the following steps mentioned below in figure2.

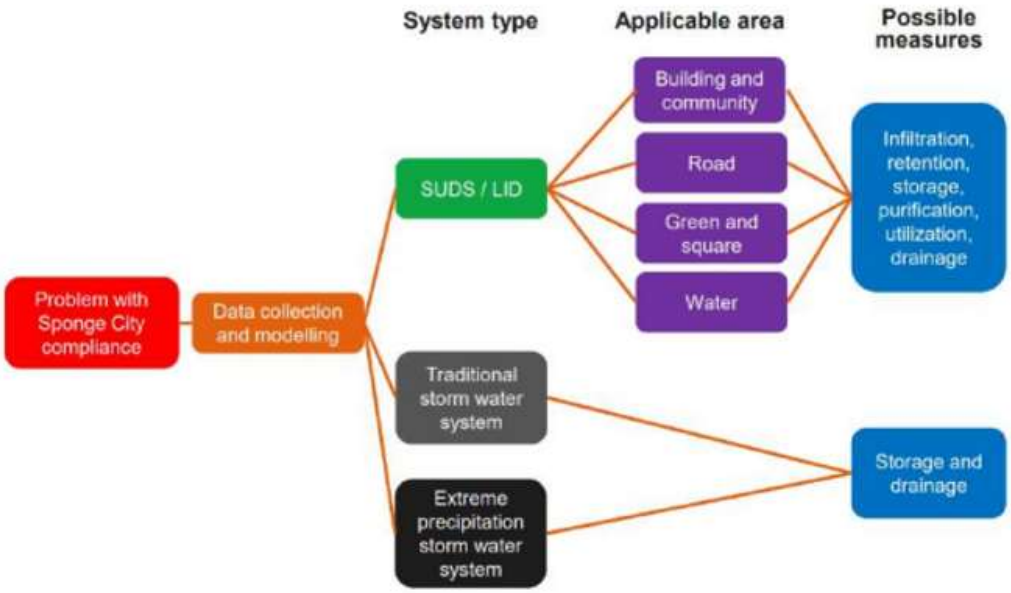

Figure 3. strategy framework for sponge city, Wuhan

(Wuhan Sponge City Planning and Design Guideline, 2019)

2.2.1. TOTAL WATERMARK- CITY AS A CATCHMENT MELBOURNE, AUSTRALIA

City as Catchment: The idea of creating a city as a catchment is the core of the "water sensitive city" movement. While acknowledging the significance of the natural catchment, it concentrates on reducing the impact of storm water discharges on receiving waters by working with the artificial city catchment, which includes its roads, rooftops, and impermeable surfaces. The integrated water cycle management method is used by the City of Melbourne. This is, according to Melbourne City Council, the coordinated management of all water cycle elements, including groundwater, wastewater, rainwater, storm water, and use of water, in order to secure a number of benefits for the larger catchment. The major objectives which are covered under the catchment city are flood, alternative use of water, unsealed soil and quality of water, open spaces, and canopy cover.

One of the main projects of the city as a catchment programme is Elizabeth street catchment integrated water cycle management plan having a a total area of 308ha (Total watermark – city as a catchment, 2014)he project caters delineation of drainage lines, defining storage needs of different areas of the project and establishing future goals. Action plan accomplishes the major tasks such as Protection of receiving waters, Demand management, Storm water quality improvement, Storm water harvesting as well as Greywater/wastewater harvesting.

A method to lower the risk of flooding is included in this plan. It also discusses methods for using alternative water sources to irrigate both current and future parks and open areas. This includes water use, groundwater management, rainwater, storm water, and wastewater, and all other components of the water cycle that the City of Melbourne may have control over.

MAJOR PARAMETERS INVOLVED IN ANALYSIS OF STUDIES

S.NO	LITERATURE/CASE STUDY	AREA(SQ.KM)	AGENCY	PARAMETERS
1.	ABC WATER PROGRAMME SINGAPORE	718	Public Utilities Board Ministry of Environment and Water Resources, Government of Singapore.	• Storm water run-off • Surface run off • Green spaces (primary potential)
2.	SPONGE CITY, WUHAN CHINA	8569	Ministry of Housing and Urban-Rural Development, Ministry of Water Resources, Ministry of Finance, private sector, and city Municipalities	• Flood reduction • Storm water management
3.	TOTAL WATERMARK, CITY AS A CATCHMENT-MELBOURNE, AUSTRALIA	1400	Catchment Management Authority municipality	• Storm water harvesting • Rainwater harvesting • Ground regeneration • Soil penetration

Table 1. Analysis of studies showing major parameter

3. CONCLUSION

Form the above mentioned studies analysis it can be concluded that the major parameters which are analyzed in the study are accomplished and improved with the use of blue green infrastructure approach. BGI approach in various ways can be a resilient to many problems i.e., water logging, flood and mitigating heat islands as well. Also, combined sewers are more affected by flooding than separate sewers and that blue-green infrastructure can reduce urban, flooding. Overall, Blue-green infrastructure elements are being introduced in sporadic ways for climate adaptation and mitigation in cities across the world and at the federal level. So, India requires a comprehensive plan that recognizes how important the environment is to the economic and social stability of its cities and how current blue-green resources must be planned carefully for a sustainable future. Taking into account the new invention and technologies adopting in all around world with the intervention of policy measures.

4. RECOMMENDATION

- The analyses and benefits provided by the green-blue infrastructure are taken into consideration, and the conclusion supports the viability of designing such infrastructure for the future green-blue places. But before developing the green-blue infrastructure, it's crucial to gather both primary and secondary information about the location to understand how the area functions.
- Through horizontal and vertical management directions, the expertise of politicians and agencies, and other methods, it is strongly advised to provide value in terms of management and governance knowledge.
- It is advised to look into the prospects for effective administration. A challenge for a novel process like BGI is ensuring good maintenance with continuity over a longer period of time. Because of this, maintenance plays a crucial role in the operation of BGI. Citizen participation can even help with maintenance.

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