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RECOMMENDED STRATEGIES FOR URBAN STORM MANAGEMENT: *LESSONS FROM FOREIGN COUNTRIES*

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Abstract : As the urban population grows and water is needed for various purposes in urban localities, the cities faces water crisis and management. Including three elements such as freshwater, waste water treatment, and stormwater to manage. Urban stormwater is surface runoffs resulting from precipitation or snowmelt processes. This article explains the practices in these three countries, and uses one of the practices in these countries as an example. It is aimed to consider & analyze the application of sustainable infrastructure and water supply equipment in the city to manage stormwater value, quality, water security and ensure minimum damage to nature resulting from later city development. Indian states are yet to solve the problem of integrating rainfall management into their plannings. Ideas from these countries can be followed for better stormwater management in Indian context. ***Keywords: Storm water control, Water - Sensitive Planning, Sustainable Infrastructure***

I. INTRODUCTION

When it rain or snow water flows from the land surface, heading downhill is called stormwater runoff. Storm water management is necessary to maintain the nature's water cycle. Stormwater management aims to reduce the impact of urban runoff during snowmelt, heavy rains in the urban areas and thus supports the city's development. Water at the aquifers and water bodies need to be well protected. Harmful chemicals may damage the quality of stormwater; thus, it is important to control the risk of floods and related economic and human losses. Stormwater management can improve urban sustainability, and rainwater can be used as an asset derived from groundwater or to recharge groundwater to make cities sustainable. It is must to analyze storm water management efforts as a pre-requisite for plans, and international locations should encourage these efforts to prevent water scarcity. Indian states face storm-water quality & quantity control issues. According to a 2013 study by the World Resources Institute (WRI), our country is the 13th most water – stress country in the world, and the 2018 NITI Aayog stated that the country endures the pathetic water crisis (2018 NITI Aayog). Our country can acquire knowledge from other countries who have came near to best approach to water management.

II. METHODOLOGY

This study selected 3 countries with good Approaches towards storm water management, such as, the USA's Low Impact Development, Singapore's Active Beautiful Clean Program, & China's Sponge Cities Concept. These countries were chosen due to their integration of stormwater in urban planning. To understand each country's approach for stormwater management, we looked at the guidelines issued by environmental organizations, stormwater manuals, water resources guidelines in the field and conducted a study using a city as an example. Methods of managing the quantity and quality of stormwater, water security and reducing environmental damage following urban development is considered fixed constraints for all countries. Finally, strategies are suggested for Indian cities to include better flood management plans.

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III. LITERATURE STUDY

UNITED STATES OF AMERICA

The concept of stormwater management was introduced in United States in 1972. There are many stormwater management offices in various cities of the country. EPA hold the authority to develop and implement storm water management policies; The USEPA Stormwater Management Practices (USEPA 2020) Methodology, Smarter Growth Plan, Natural Pollutant Discharge Elimination System (NPDES) Stormwater Plan, Ground water safety Strategy, Ground-water Action Plan review the nation's regulatory framework. Non – point urban pollution & development of urban planning strategies. A watershed approach that considers storm water, soil, & hydrogeology waters is included EPA's Watershed Management System.

WASHINGTON CITY: The metropolis covers an area of 176 km² & receive 664 mm of rainfall per year (weather, US 2020). The city depends on the Potomac River (DC Water,2020) to provide water to a population of approximately 700,000 (U.S. Census Bureau 2019). Since there are many rivers in the region, rainwater from West Virginia and Pennsylvania fill the river. In Washington DC. Well (Washington, DC Water 2020). The soils and hydrology of the area indicate that much of the land is fitted for reclamation (Johnston 1964) and integrated sewers are present in some areas of the city. It has implemented green building measures as part of the Anacostia River Cleanup efforts to determine storm water quality and quantify storm-water management as outlined in the land

use plan (Washington Planning Office 2020). The situation is similar in India. Most Indian cities combined water and rainwater and faced urban flooding.

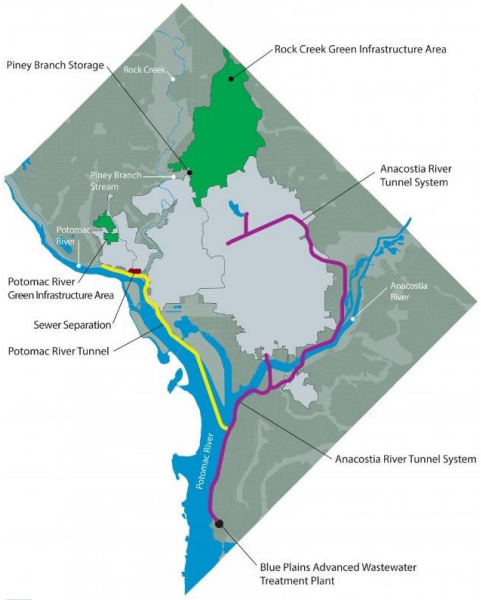


FIG.1: shows the map of Washington DC Green Infrastructure planning in areas with combined sewer system

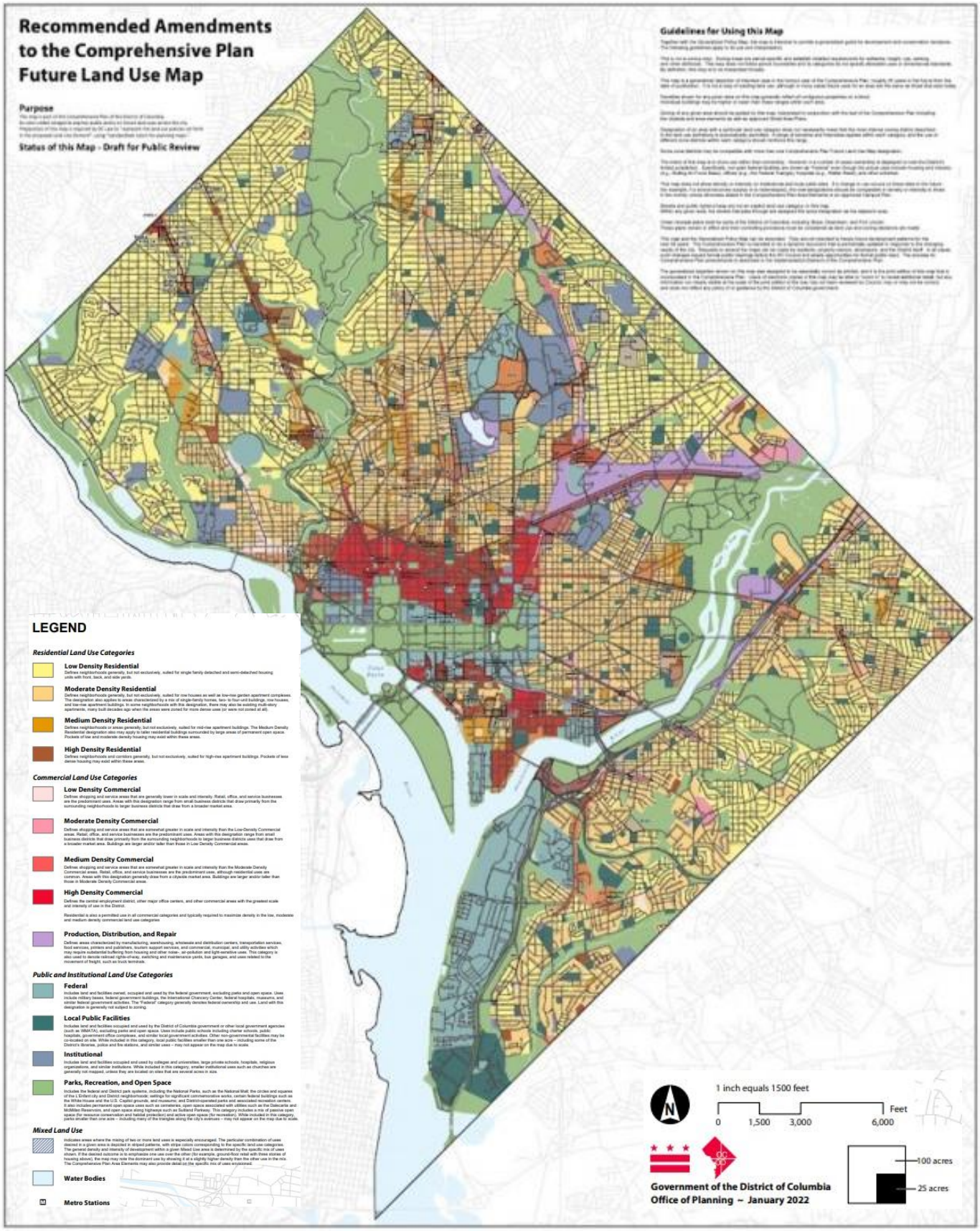
Stormwater management strategies & urban planning tools adopted in the United States:

1.Minimal damage to nature: EPA guidelines for protecting water body, rivers, and forests in master plans and ensuring adequate buffer zones near streams to prevent damage, at least after urban development. EPA has developed guidelines for local agencies on stormwater quality and quantity control (USEPA, 2020) (Energy & Environment Department, 2020).

2.Storm-water quality: Epa recommends that urban planning be appropriately designed to minimize impacts to the watershed area because the natural environment has valuable resources that can't be sustained by basic green infra - structure BMPs (USEPA 2006). The EPA recommends the acceptance of buffer zones along rivers and storms drains to prevent pollution, but the extent is not specified. Land use planning can be used to identify conflict zones, allocate areas of potential commercial and other contamination, and investigate water quality, water research etc., site topography and collaboration. Additionally, in the city, the Washington Land Use Plan has allocated areas for green buildings to monitor stormwater quality (Washington, DC Department of the Environment,2020).

3.Stormwater Quantity: Storm-water drains ought to be designed taking into account regional hydrology, topography, natural streams & water bodies. (US Environmental Protection Agency, 2008). Encouraging the population to hold loans for future business and new construction to protect them from rain, reducing runoff water could be another way to control rain, (Washington D.C. Department of Environment, 2020). For example, large inland works are expected to store 1.24 inches to 0.81 inches of rain on site, respectively (Watershed Conservation Center, 2020). This means compliant discharge with runoff management is required to reduce stormwater runoff through city ordinances or zoning zoning codes. Garbage management & separate drainage systems ensures that rainwater is not blocked.

4.Water Safety: USEPA recommends that master plans protect standing water areas and maintain sustainable layer for rainwater harvest (USEPA, 1985). Local zoning and zoning oversize have been permitted in a few areas to control residential or commercial development in the backcountry through ground water conservation strategies. Required decision ought to be incorporated at the beginning of urban land use planning.


Recommended Amendments to the Comprehensive Plan Future Land Use Map
Purpose
Status of this Map - Draft for Public Review
Guidelines for Using this Map
LEGEND
Residential Land Use Categories
Low Density Residential
Moderate Density Residential
Medium Density Residential
High Density Residential
Commercial Land Use Categories
Low Density Commercial
Moderate Density Commercial
Medium Density Commercial
High Density Commercial
Production, Distribution, and Repair
Public and Institutional Land Use Categories
Federal
Local Public Facilities
Institutional
Parks, Recreation, and Open Space
Mixed Land Use
Water Bodies
Metro Stations
1 inch equals 1500 feet
0 1,500 3,000 6,000 Feet
100 acres
25 acres
Government of the District of Columbia
Office of Planning -- January 2022

SINGAPORE

The country covers a land of 724 km2 and has an annual rainfall of 2430mm, (Singapore land management Authority,2019).The country is a densely populated city with a population of 5.7 million (Government of Singapore2020). Since land is scarce, the country provides its citizens with tall buildings. Since there are no underground water resources in the island country, collecting water is the best solution to face water scarcity. The Public Utilities Commission is a stormwater management agency. Singapore relies on Malaysia (raw water) to Collect purify and desalinate stormwater to fulfil its water needs. Singapore has positively managed rainfall and reused it as drinking water on a large scale. The Public Utilities Board (PUB) aims to create comprehensive water solutions (URA, 2019) through which the city uses its water (PUB, 2014) through Source-Path – Receiver quantitative and qualitative analysis. This model is suitable for island cities that do not have a water source (URA, 2019). Indian states can acquire knowledge from Singapore's model to conserve stormwater. Indian states can get measurable water from rainwater. Stormwater management tightly incorporates storage and canals into the urban landscape to benefit urban communities and biodiversity.

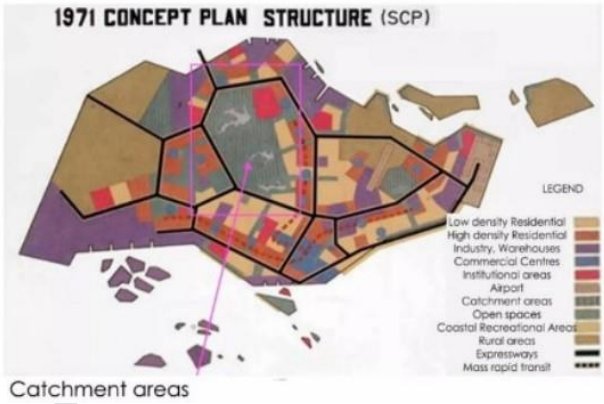


Figure 02: showing the map of Singapore with protected catchments preserved in the Master plan from 1971. (Source: Author based on info - (URA, 2019)

Strategies incorporated in Singapore for better storm-water management:

1.Minimal damage to nature: Singapore implements strategic watershed-based planning, including protected areas and reservoirs, by defining watershed areas in the master plan, taking into account hydrological and geo-graphical factors, including daily rainfall.

2.Storm-water quality: This could be accomplished by way of separate storm-water and sewage systems and required waste-water treatment. For example, Singapore has separate collection and treatment for sewage and rainwater and uses protection of utilities, conveyors and receiving facilities to reduce pollution in the city. Good solutions for parks and urban green spaces can be used for good development through the construction of laws, urban roads and waterways. Follow the “field-path- receiver concept” for better and more effective stormwater treatment. It refers to the path where rainwater is collected (water path), the place where the water is discharged and the area (receptors) where the flood may reach (PUB, 2014). It allows the waste management system to separate rainwater. Managing land use for non- polluting industries, establishing conservation measures for rainwater harvesting, and implementing water conservation measures that limit development can reduce water pollution.

3.Stormwater Quantity: Plan infrastructure according to the topography and greening sections of the area. plans should take into account streams and rivers and not affect peak water levels. Singapore mostly uses natural rivers and man- made rivers, local canals, widening & deepening canals & canals and providing buffers to prevent flooding and inundation. It also controls the maximum flood level through a "mitigation" strategy that uses a closed area before it is released into the public water supply.

4.Water Security: Singapore’s 1971 Concept Master Plan and 2008 master Plan protect rivers to capture rainwater marked for land use (URA, 2019). Designated protected catchments help lessen effect of impacts.

CHINA

China explained a sponge city idea in 2013. It is rainwater that can be collected, absorbed and treated for reuse; It has benefits such as reducing floods, improving groundwater and water scarcity. (China Ministry of Ecology and Environment, 2017). Qunli Rainwater Wet-land Park is the most essential measures of China's sponge city layout. The country's limitation is likely to be that of the United States, which uses natural methods to improve the quality of rainfall. There are pipes that collect storm-water in the wetland and filter the water in the ponds and then drop it off at the park. These activities include collecting, purifying, storing and recycling rainwater. The ecosystem of the wetland has been restored by growing native plants in the ponds.

Stormwater management ideas adopted in China and urban planning tools used:
1.Minimal destruction to nature: use green zones, wetlands and urban gardens and keep in mind topography and soil conditions to manage stormwater efficiently and effectively. A land use plan that allocates green areas to rainwater in master plans.

2.Stormwater quality: This project includes the collection, treatment, storage and recycling of rainwater. Secure the space, path and receivers in the open area with the right solutions. Land Use Classification of wetlands in land use planning for collection,

maintenance, storage & recycling. It is a developing country with national programs to improve waste-water and solid waste management. There is no specific guidance on emission standards. The National Songhua River Basin Pollution Control Master Plan (SRBPCMP) (Asian Development Bank, 2008) examines waste disposal and sewage, and infrastructure planning should also examine waste and stormwater.

3.Stormwater quantity: Increment in the stormwater volume is mentioned in state plans. The national target is for 80% of City areas to collect 70% of their rain-water from urban sponge content by 2030. 10% of the green area in Qunli city has solved the flood problem (ADB,2008), Used the existing green spaces and prepared rainwater to manage the amount. The country's plan highlights the need to increase capacity to improve drainage system to manage rainfall.

4. Water Scarcity: The sponge city idea focuses to recover groundwater through purification of rainwater. Qunli Wetland now has 500,000 cubic meters of flood filter and storage.

IV. INFERENCES

1. Minimal destruction to natural bodies: in all 3 countries, stormwater governance is executed through irrigation or waterways, including topography, hydrogeology & ground conditions. USEPA & Singapore's Public utility Board(PUB) lowers the effect of development by nominal destruction to forests, land & securing the water & rivers from inadequate facilities, EPA supports Singapore by protecting rivers and protecting areas suitable for restoration, shows how the impact on nature can be reduced. While the US standard is BMP, Indian cities can obtain development commitments by setting standards is Master Plans to support urban infrastructure development.

2.Stormwater quality: In these countries, methods have been implemented to improve wastewater, create a separation system between rainwater and sewage, and inspect the waste in the city to improve rainfall. Emission standards vary from country to country. In our country, municipal solid waste administration by local bodies is required to ensure good rainfall and this has improved significantly after the Swachh Bharat Abhiyan. But the country needs to relocate wastewater treatment. The distribution of green areas in urban planning will differ depending on the goals, models and technologies used to achieve the same goal. Nature-based areas, trails and receiving solutions can be planned in a strategic plan.

3.Stormwater quantity: these research supports the protection and use of waterways and bodies of water and those who build gutters to collect all rainwater. India may ignore the potential of urban sponges that could help solve the problem of urban climate and blight. Discharging waste and sewage into waterways is not recommended as it lowers the carrying capacity of water. India should encourage stormwater harvesting in large- scale projects and reduce the burden on existing stormwater by building rainwater catchments or encouraging rainwater reuse in the region by creating laws or municipal ordinances.

4.Water security: After the geological evaluation, it is most appropriate to protect areas with increased strength in the stormwater harvesting plan and review the development according to USEPA rules. In the strategic plan, construction will take place over several years and the sensitive area will be restored or protected. This approach requires the cooperation of many departments, including the water department and the building department. China's sponge city can learn from India how to use green spaces and wetland restoration. Stormwater storage can be used in places where water is not available, such as Singapore. Singapore's model can be accepted on islands and coastal areas where supplies are not available.

V. CONCLUSION

If there is a problem with stormwater management at the first stage of strategic planning, these ideas can be used. These countries are looking at sustainable infrastructure or natural measures rather than the process of building tunnels & rivers. This approach will vary due to differences in topography, hydrogeology,
Soil conditions and existing infrastructure. Economic efficiency & environmental sustainability can be achieved through such strategies. India needs to incorporate such ideas into urban planning through grazing weapons and visions like master plans, urban plans and legal frameworks.

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