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Green Infrastructure Techniques for Sustainable Water Management and Urban Flooding

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Abstract*— Water as a global resource is presumed with this notion of 70% availability on earth's surface area, whereas the ground freshwater that supports life on earth is just the 3% only which can be regarded a resource. The tyranny of urban times is that the water systems that rejuvenates ecosystems thriving and feed the biodiversity have become stressed nowadays because of high demand factors of growing population and illegitimate or legitimate industrialization. Water systems e.g. Rivers, Aquifers , natural streams, wetlands and lakes etc. are drying up or becoming "too polluted" on the other hand the construction on flood plains have become a an urban trend. .More than half the world's wetlands have disappeared. As per the statistics, 75 % of water is used for Agriculture practices in most Asian countries and rest of the water is either wasted or exploited. The question that we need to cater today's urban issues is "what are anecdotes", what should be the new adopted concepts and technologies. By various intense research it can be concluded that for the current rising issues the answers lies in the history and ancient civilization, when people used to worship water rather than considering it as a necessity of life. The ancient techniques and conventional practices were always there but today they have just emerged with new concepts and terminologies e.g. Green Infrastructure, Grey Infrastructure, Blue infrastructure etc. This paper aims to discuss all these conventional practices along with an in-depth understand of roles of modern technologies to tackle water.

Keywords*— Sustainability; Green infrastrcuture; Water Management Urban Flooding; Techniques

1. INTRODUCTION

For the past four decades, the lack of potable water has become a severe issue all across the globe. Various studies have been undertaken to better understand the causes of this problem e.g. High-end development, agricultural use, high-end landscaping, expanding industries and manufacturing sectors, and, most importantly, increased demand etc. Water has many social, religious, and cultural values, according to archaeology and anthropology. Once upon a time, water was not only a necessity for the people, but it was also a sacred medium connecting them to divinity and their cultural and social values, and these associated values developed many ancient and traditional practices to connect with water and use it in a more sustainable way with all the sacred values intact. The conventional practices include restoration, preservation and rejuvenation of water bodies, these conventional practices included rain water harvesting systems, drip irrigation methods, wells, baolis, afforestation, reservoirs, wetlands and management ofs storm water as well. All these practices today have join forces to form green-grey infrastructure. Although storm water management deals with grey infrastructure but Reuse of treated grey water is now a viable option for the development of green areas, green urban spaces, agriculture and horticulture irrigation, and district cooling, among other things making it a distinct part of green infrastructure .

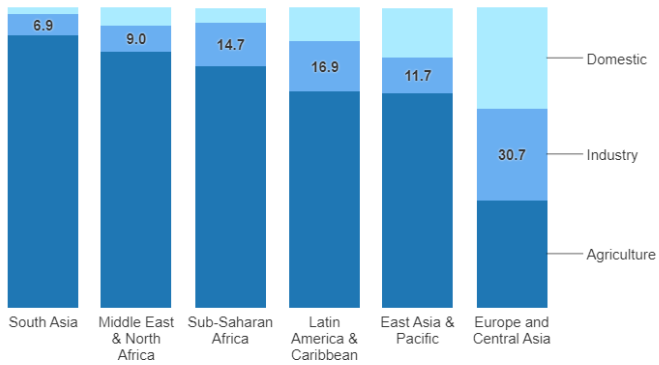

Fig. 1. Globally, 70% of Freshwater is used for Agriculture& Landscape

a.

2. HISTORICAL ASPECTS OF WATER MANAGEMENT IN ANCIENT CIVILIZATION

With time and civilization, population grew, villages became towns and cities, and agriculture and landscape practices touched new horizons. With the increased demand for food and water people started finding ways to preserve and restore their resources e.g Water, Food & habitat. People found ways to ensure water availability by collecting and storing rainwater, accessing hill and subterranean springs, developed water irrigation practices for their cultivations and water from snow and glacier melt. The administration was introduces to to construct reservoirs, ponds, lakes, irrigation canals, and other similar structures. Various Emperors and rulers not only constructed water bodies/systems, but also encouraged local groups and people to do so independently. The people of these villages were solely responsible for upkeep, construction, and conservation, and they were also in charge of ensuring an equitable distribution of water supplies as needed.

• The Indus Valley Civilisation (3000-1500 BC) built many reservoirs to collect monsoon runoff at Dholavira, a key site. It also featured a fantastic drainage system • Wells were most likely a Harappan invention. Every third dwelling in the Indus Valley Civilisation featured a well, according to a recent archaeological assessment.

• In the first century BC, the city of Sringaverapura, near Allahabad, developed a sophisticated water harvesting system that utilized the Ganga's flooding.

• In Kautilya's Arthasastra, written in the 3rd century BC, evidence of irrigation with water collecting may be found. According to the text, people were aware of rainfall patterns, soil kinds, and irrigation procedures. It also states that the state assisted in the development of irrigation works that were launched and controlled by residents of a newly settled community.

• Archaeological and historical evidence shows how Indians built dams, lakes, and irrigation systems during Chandragupta Maurya's reign (321-297 BD). A regular class of officers was assigned to supervise the rivers, measure the land, and oversee the sluices that allowed water out of the main canals.

• Bhoja, the king of Bhopal, built a massive lake by building an embankment over two hills. It was one of India's largest constructed lakes in the 11th century AD, with a surface area of approximately 65,000 hectares and 365 streams and springs feeding it. • West Bengal's system of overflow irrigation in the 17th century AD worked very successfully until the arrival of the British, as described by Kalhana, in prominent structures surviving around the Dal and Anchar lakes and the Nandi Canal. It not only improved the soil, but it also helped to combat malaria.

The other well documented practices included Maadaks/Johaad/Paimghara/Baoli/Jhaalara, Katta, sand bores, drip irrigation practices which is still very prominent in north-east India, rooftop rainwater harvesting which is still very prominent in south India, Ferro cement tanks & tech specs table etc. All these practices are simple and cost effectively and are being implemented majorly in rural areas on small scale for water management.

3. WATER MANAGEMENT, ROME:AQUEDUCTS

A. Aqueducts

The historical city of Rome had a convoluted water network that included small wells and cisterns around the city, but as the population grew, so did the demand for more consistent water supply and demand. This is when the idea of aqueducts was conceived. Although the aqueducts' water quality was not always perfect. Due to the inability to filter out clay particles, water sources with clay soils were frequently inadequate, and storms in the countryside might induce turbidity in the incoming water. Marcus Vitruvius, a famous civil engineer and architect, tried to look past the concept of an aqueduct from the perspective of plants, the proximity of probable water sources, the appearance of neighboring rocks, and so on.

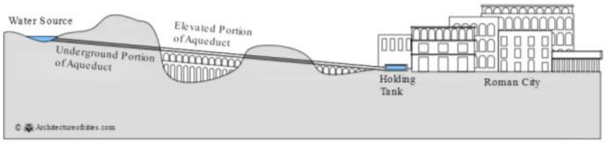

Fig. 2. Typical section through aqueduct

B. Construction: Tunnels, Trenches, and Pipes

Aqueduct construction procedures are based on an Old Persian technology known as the Qanat system, which needs the regular digging of shafts (putei) at horizontal intervals of approximately 230 feet.

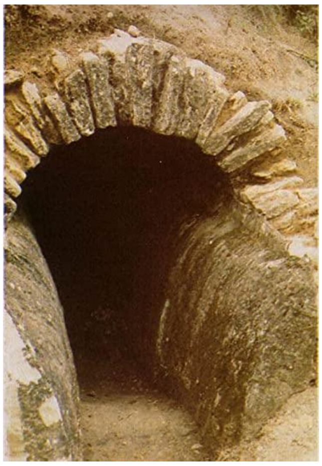

Fig. 3. Inside view of an aqueduct tunnel

4. WATER MANAGEMENT IN OTHER COUNTRIES TODAY

In the modern trend of urbanization, waste water reuse has become a key instrument for water resource planning and management. For example, grey water or waste water is widely used for agricultural practices in Australia and many parts of the United States, releasing high-quality water for potable use. Some countries, such as Jordan's Hashemite Kingdom and Saudi Arabia's Kingdom, have a national policy of reusing all treated wastewater effluents and have achieved significant progress in this regard. Since 1958, China's sewage use in agriculture has grown quickly, with sewage effluent now irrigating about 1.33 million hectares. Wastewater usage in agriculture is widely acknowledged as being justifiable on agronomic and economic grounds, although caution must be exercised to avoid detrimental health effects.

5. IMPORTANCE OF SUSTAINABLE WATER PRACTICES

Water is a crucial element for human survival on earth along with diverse ecosystem. Apparently, there has been a drastic loss of value of “water as a natural resource”, which requires intricate technical instruments and sustainable approaches towards water consumption and management. Sustainable water management (SWM) is an important component of sustainable development as it satisfies current water demand without impacting future supply e.g. use in agriculture, industry, lakes, recreational area , Soil water, rivers, and reservoirs etc. The development of complex settlement over the period of time is largely affected by the management of water as a sacred resource and its sustainable utilization from digging simple wells to development of irrigation systems at larger scales. The reality check is that the water sources are limited and reuse of water makes a major difference to fulfil all water needs. In some regions the scarcity of water is an issue, in some areas the urban flooding is an issue and to bring all the regions on the same page in terms of water availability we required sustainable water practices, these practices can be vary from macro scale strategies e.g. storm water runoff management, constructed wetlands and aquafers recharge to micro scale management e.g. Rain water harvesting, Bioswales, Green streets and green roofs etc.

5.1 Importance of Blue- Green Infrastructure for Sustaianble water practices Water management helps to establish the future in compliance with existing policies, need and regulations. Storm water management also plays an important part in water management as it is a technical aspects to manage surface runoff. The practices not used not just in rural areas but also in urban peripheries where run-off cannot infiltrate because the impermeable surfaces.

5.1.1 Reduced Localized urban Flooding:

With climate change, heavy rains have become a very frequent scenarios over decades which has increased the risks of overflow of sewer systems and urban flooding. Water management as a part of green infrastructure helps to reduce/manage urban flood risks by separating rain water from sewers and waterways by different infiltration techniques.

5.1.2 Smog and heat mitigation

The average air temperature of a city is directly proportional to the density and is comparatively warmer as compared to the surrounding low density areas. As a thumb rule, Air quality gets reduced by higher temperatures increasing ground-level ozone, where a colourless Pandora of gases surrounds the earth surface or can be termed as fog/Secondary pollution. Rise in temperature increases the secondary pollution on earth surface e.g. in Los Angeles increment of 1 degree of temperature increased the ground level ozone by 3%. To mitigate the effects of smog and heat mitigation, E.g. Green roofs, green streets etc. absorbs and mitigate the fog/ Secondary Pollution from the environment through the vegetation thus improving the environmental quality. The processes like evapotranspiration and evaporation by Vegetation or Plants absorbs pollutants and reduces air temperatures.

5.1.3 Health benefits

Green-Blue infrastructure reduces pollution, temperature and water pollutants, thus enhancing the environmental condition. Green-Blue infrastructure creates green and natural spaces by managing to create large scale public benefits, Greener areas also promote physical activity and can boost mental health while improving neighbourhood liveability. The air and water borne diseases are can be expunged by the proper execution of Blue-green infrastructure.

5.1.4 Reduced costs

Water management improves the quality of water drawn from rivers and lakes for drinking, which reduces the costs associated with purification and treatment—in some cases by more than 25 percent e.g. green roofs can cut heating and cooling costs, leading to energy savings of as much as 15 percent. Deep irrigation system, bio sensors helps to reduce cost and pressure on water treatment plant

5.1.5 Quality-of-life improvements

Green infrastructure creates job and employment opportunities s in several ways such as in the design, construction, and maintenance of green sites, but also indirectly. Green infrastructure also increases local property values: In Philadelphia, being near a green infrastructure feature correlated with an increase in property value of 10 percent or more. New research suggests green infrastructure may even help reduce crime: Pleasant, verdant areas encourage people to gather outdoors (increasing safety); open spaces with grass and tall trees are especially effective. Improved Landscape & irrigation quality

6. GREEN INFRASTRUCTURE (GI) FOR SUSTAINABLE USE IN LANDSCAPE AND WATER MANAGEMENT

6.1 Introduction: Green Infrastrcuture

Green Infrastructure provides an insight to the natural water system with infrastructure qualities e.g. water purification, storage, urban flood management, irrigation practices and water supply chain etc. Green infrastructure provides more resilient services for 21st century challenges and solutions due to its ever adaptive and regenerative potential along with environmental, low –cost /Cost-effective benefits. The green infrastructure projects helps to strengthen community and empowers them by inclusive participation. On a technical ground, Green infrastructure prevents runoff by capturing rain where it falls, allowing it to filter into the earth (where it can replenish groundwater supplies), return to the atmosphere through evapotranspiration (when water evaporates directly from the land or plants), or be reused for another purpose, such as landscaping. A project in rural Somalia witnessed an approach where “Sand Damps” were built instead of expensive groundwater wells, these cost effective dams were used to capture and store sand, the sand used accumulate water and eventually recharge the shallow aquifers. (Integrating green and grey, 2019). In 2019, Congress enacted the Water Infrastructure Improvement Act, which defines green infrastructure as "the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, storm water harvest and reuse, or landscaping to store, infiltrate, or evapotranspiration storm water and reduce flows to sewer systems or to surface waters”. Over the past years green infrastructure is being prioritized over grey infrastructure. At the landscape or watershed scale, Green infrastructural elements can vary on different scales e.g. a rain barrel up against a house to a row of trees or greening an alleyway, from acres of open park space to planting rain gardens or artificial wetlands. Green

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infrastructure as a collective entity provides cleaner environment with significant value for the community, diverse habitat and livable green spaces.

SERVICE	GRAY INFRASTRUCTURE COMPONENTS	EXAMPLES OF GREEN INFRASTRUCTURE COMPONENTS AND THEIR FUNCTION
Water supply and sanitation	Reservoirs, treatment plants, pipe network	**Watersheds:** Improve source water quality and thereby reduce treatment requirements **Wetlands:** Filter wastewater effluent and thereby reduce wastewater treatment requirements
Hydropower	Reservoirs and power plants	**Watersheds:** Reduce sediment inflows and extend life of reservoirs and power plants
Coastal flood protection	Embankments, groynes, sluice gates	**Mangrove forests:** Decrease wave energy and storm surges and thereby reduce embankment requirements
Urban flood management	Storm drains, pumps, outfalls	**Urban flood retention areas:** Store stormwater and thereby reduce drain and pump requirements
River flood management	Embankments, sluice gates, pump stations	**River floodplains:** Store flood waters and thereby reduce embankment requirements
Agriculture irrigation and drainage	Barrages/dams, irrigation and drainage canals	**Agricultural soils:** Increase soil water storage capacity and reduce irrigation requirements

6.2 Elements of Green Infrsatructure

6.2.1 Green roof / Eco Roof

Green roofs (or eco-roofs) are structure roofs that are fully or partially covered with masses of vegetation. Vegetation generally consists of plants or trees, depending on the weather conditions of the area, and the growing medium (sand, soil, gravel, etc.). Vegetation layers are planted on well-managed waterproof membranes, and additional layers of root barriers, drainage nets and irrigation systems can also be part of the rooftop greening setting. **(Foster et al. 2011)**. Green roofs can be classified into extensive type and intensive type. The extensive green roof has a soil depth ranging from 5cms to 15 cms with more of aesthetical purpose whereas the intensive green roof has soil depth exceeding 15Cms with more resilient Vegetation with deeper roots. Rooftop greening acts as an integral part of regulating the flow of water in the city, reducing storm runoff and thereby preventing flood-induced sewer overload. As the roof vegetation grows, it can store large amounts of water. It is later released during the evaporation process from the greens or the evaporation process of the plant itself. In this way, rooftop greening helps to mitigate public sewers and prevent floods during heavy rains. The annual roof storm water runoff can be reduced by the help of green roof system with retention capacity of around 90.The effective Costs varies as per the geographic location, roof typology and availability of local labor and material and respective cost.

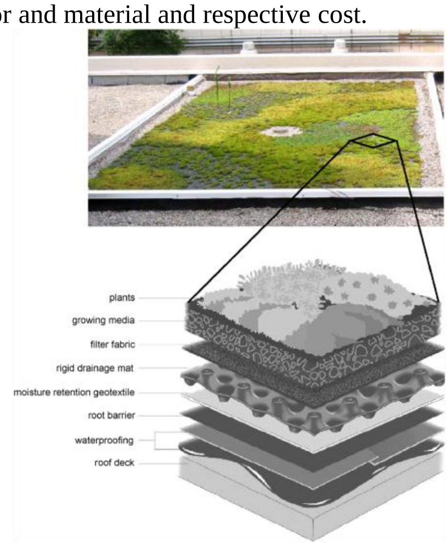

Fig. 4. Typical Layers for a green roof

6.2.2 Downspout disconnection:

Downspout disconnection is the exercise of connecting rooftop runoff or neighborhood drains to a completely pervious surface, that includes rain barrels, lawns and cisterns etc. which stores the water for other time utilization. 1,300 gallons of water can be saved by Rain barrels. Downspout disconnection helps to reduce the stress from the municipal systems for management. In the city of Portland, Oregon more than 26000 housing properties adopted the downspout disconnection system to save 1.2 billion gallons of water from the sewer system each year also acting as a combined backup sewer system at city and neighborhood level between 1993 to 2011.

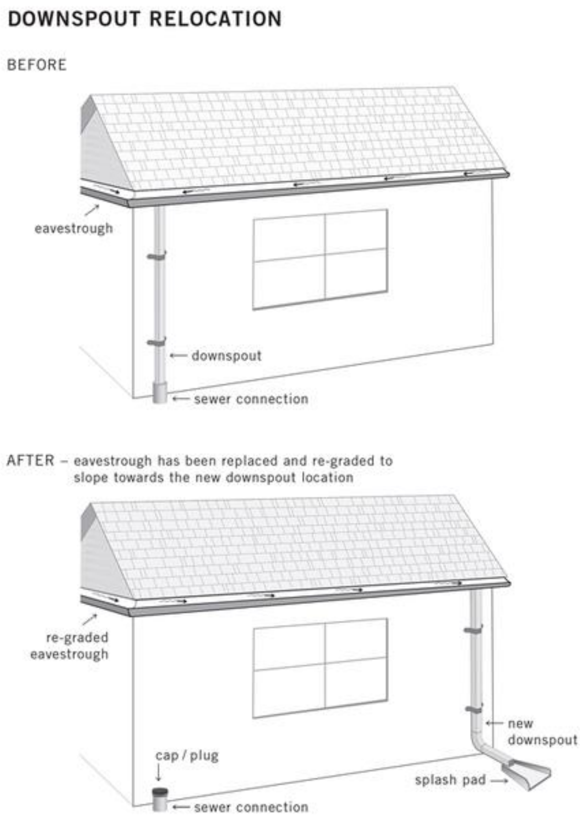

Fig. 5. The components of a downspout assembly, Disconnect from sewer and used in vegetation

6.2.3 Rainwater harvesting:

Rain water harvesting system exhibits 21% to 75% potential to cater the annual water need. Rainwater harvesting provides ways to meet demands of different sectors (e.g. industries, agriculture and commercial etc.). Water harvesting systems comprises practicing at various scales e.g. Backyard rain barrel, ground level pits, commercial building cisterns, aquifers and nets capturing fog/dew etc.

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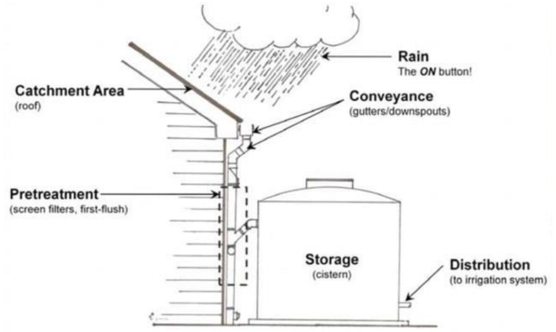


Fig. 6. Sectional Details of Rain water Harvesting

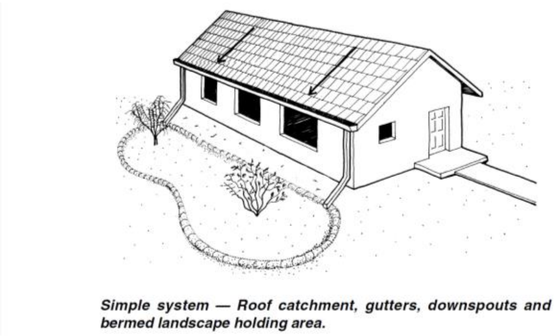


Fig. 7. RWH in Landscape Practices

6.2.4 *Rain gardens/ Bio retention cells:*

Rain gardens are shallow cavities for planting vegetation that further collect storm water runoff from streets, roofs and sidewalks etc. . Rain gardens are effective and popular control strategy against urban runoff and mitigate flooding. These depressed gardens consist of vegetation that acts as a buffer for urban runoff. These gardens relive the pressure of urban drainage system by storing runoff. Bio retention cells have engineered soil for filtration process while pre-buried perforated pipelines help in the purification of water making it an effective technique to prevent pollution due to urban runoff. This study, conducted in the Ward of Nagakyo, Kyoto in Japan to evaluated hydrological systems in terms of water quality filtration and purification impacts of rain garden systems. The SWMM model was used for the stimulation process and significant results were obtained regarding the effectiveness of Bio retention cells. Finding evaluated that Bio retention cells exhibited. A positive runoff control effect, these gardens also exhibited significant reduction in the contaminant ratios. The overall observations evaluated that the rain gardens can be considered as good technique in reducing urban flooding risks and reducing the pressure of short-term rainstorms. This technique should be given more attention in cities across worldwide.

Fig. 8. Glimpse of a typical Rain garden/Bio retension Cell

6.2.5 *Bioswales:*

Bioswales is a network that hosts large outflows from impermeable surfaces. Bioswale absorbs and suppresses spills. It slows the release of rainwater into the sewer and filters out water pollutants. It can filter about 90% of metals, fats and oils, and about 70% of sediments. And about 30% phosphorus from the spill.

- Linear channels for native plants and grasses
- Massive spills from impermeable surfaces
- Absorb and contain spills from small storms
- Filters and slows the release of rainwater into drains and surface waters
- Helps manage urban floods and water pollution.

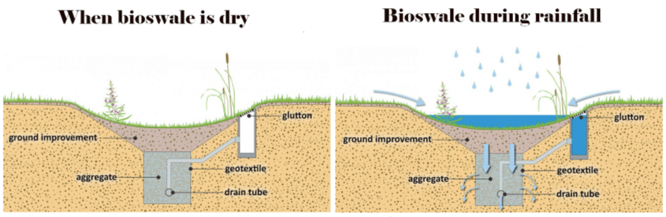


Fig. 9. Sectional Detail of a rain garden

6.2.6 *Mangrove Forests/ Tree canopies:*

Trees play an important role in stormwater management systems. The top of the tree blocks the rain before it hits the ground. By providing a surface (branches and leaves) where raindrops land and evaporate, mature deciduous trees can hold up to 700 gallons of rain per year, and mature evergreens can hold up to 4,000 gallons per year. The tree root system also plays a major role in managing spills. In addition to absorbing the water released by transpiration, the roots create waterways and open spaces in the soil, improving the water absorption capacity of the soil.

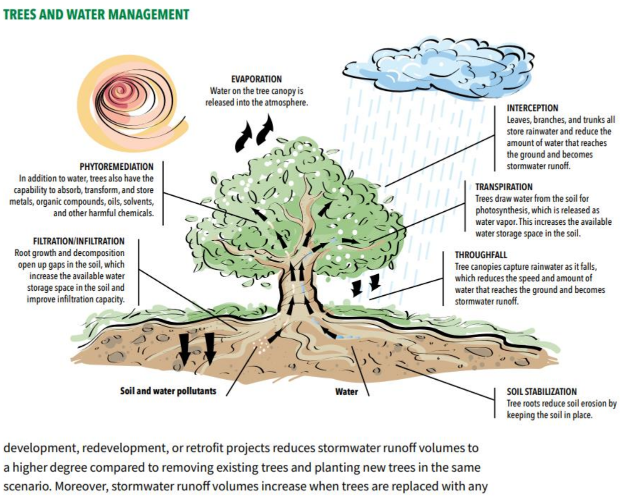


Fig. 10. Working of mangrove Forest

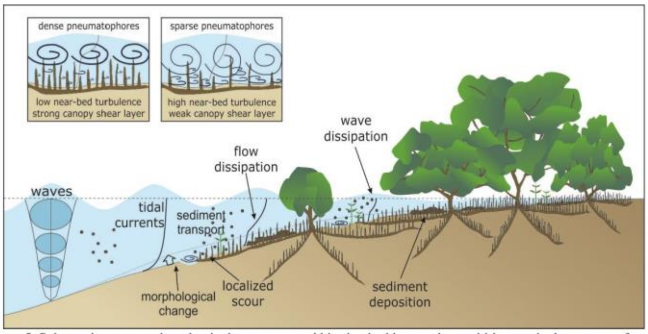


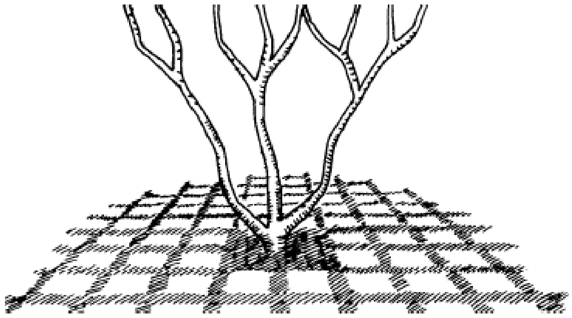
Figure 5. Schematic representing physical processes and biophysical interactions within a typical mangrove forest.

	CU-Soil	Stalite	Soil Alone
Total Porosity	26%	32%	34%
Porosity as Macropores (as % of Total Porosity)	31%	39%	2.20%
Infiltration Rate	>60 cm/hr	>60 cm/hr	1.24 cm/hr
Plant Available Moisture	7%	9.80%	n/a

Table 1 . Comparison of physical properties of CU-Soil, Carolina Stalite and a silt-loam soil. Note: The Stalite specifications usually call for sandy loam but plant available moisture with Stalite was tested using the same interstitial silty clay loam as was used with the CU-Soil.
Table based on information from Haffner, E.C. 2008.

6.2.7 Permeable pavement:

A pavement system used for sidewalks, parking lots, or driveways with some degree of porosity or permeability. Permeable sidewalks allow precipitation to penetrate through the lower layers of soil that filter pollutants before entering the aquifer. A pervious pathway is up to 50 percent less expensive than traditional pathway, which require less maintenance.

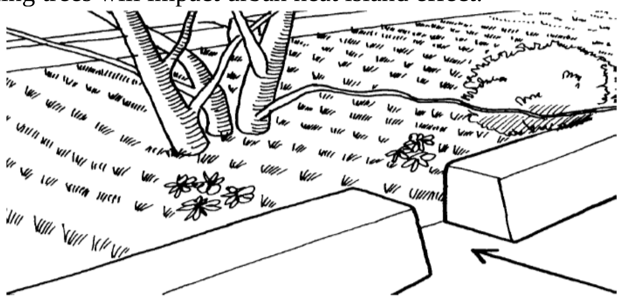


Pervious paving block with grass.

Fig. 13. Types of Pervious Pavements

6.2.8 Green parking lots:

Green parking lots often consists green elements e.g. vegetation areas at perimeter, permeable pavement and shading trees will impact urban heat island effect.



Parking lot curb cutout directing water into planted area.

Fig. 15. View of green parking lot along with high end Landscape

6.2.9 Green Streets & Alleys:

Green streets manage stormwater by combining various green infrastructure practices. When a typical road uses a variety of techniques to direct the outflow to a storm drain, green streets capture, absorb and filter precipitation where it lands, such as

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permeable pavement, bioswale, and planter boxes, reducing runoff to reach waterways and improving quality. Green roads can remove 90% of stormwater pollutants. As an example, in the Watts district of Los Angeles, the Green Street Project aims to reduce billions of gallons of urban stormwater spills that flow into local rivers and beaches each year. Green roads improve air quality, create shade, create walkways for safe pedestrians and cyclists, and beautify the neighborhood. If the green road integrates other elements, for example

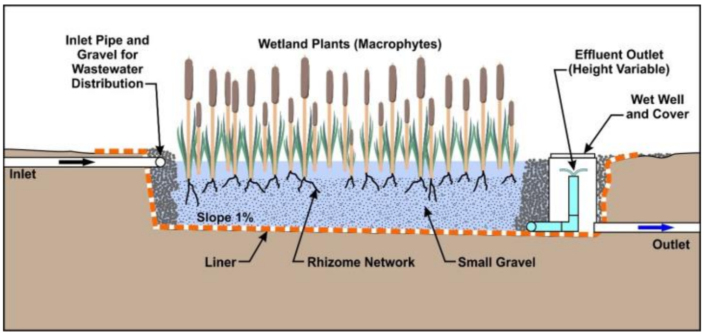
energy efficient lighting, recycled or locally sourced materials, and more space for walking, driving, biking, or using public transportation , Called Full Street**.**

Fig. 16. Detail of a green Street/Green Alley

6.2.10 Constructed Wetlands:

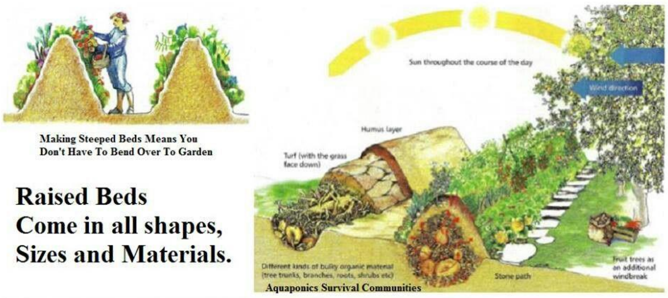
Constructed and natural wetlands helps to capture storm water, reduce nutrient loads, and create diverse wildlife habitat. Various researches have been conducted to understand nutrient retention capabilities across various wetlands of different types and sizes. These studies determined that the nutrient removal potential lost is not good in larger wetlands given as compared to smaller wetlands given the same total area. A wetland size-frequency distribution was used to upscale the k-τ relationships. Results obtained from this study concluded that small area wetlands play a comparatively larger roles in landscape scale nutrient processing which is approximately 50% as compared to larger scale wet lands.

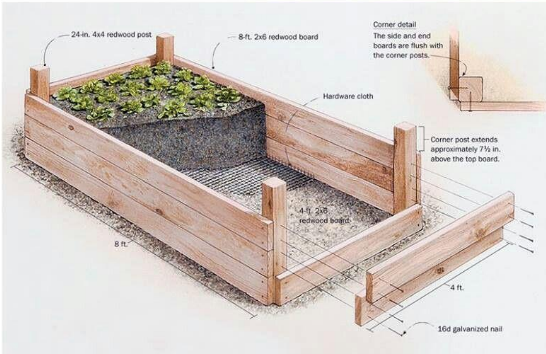
Wetland Restoration is the approach to revitalize existing wetlands whereas the artificial landscape is the approach of building manmade wetland for the purpose of simulating the hydrological processes. They usually transforms into shallow depressions with diverse and dense vegetation cover acting as biological waste water treatment "technologies" (CWP 2007). Wetlands play a role in managing nutrient pollution in wastewater, domestic wastewater, reclaimed water, urban sewage, industrial wastewater, and sludge. Artificial wetlands reduce flow rates, remove nutrients and sediments, and mitigate runoff from farmland and livestock fields. Artificial wetlands are estimated to be able to reduce the influx of runoff by infiltration and evaporation by 5-10 percent. Therefore, artificial wetlands also contribute to the recharge of groundwater. Like natural wetlands, vegetation and sediments provide a growth medium for microorganisms and filters, depositing pollutants that adhere to the sediments. These attributes are optimized when designing artificial wetlands. Natural wetlands plays vital role in biodiversity preservation as well as community and recreational benefits and generating new income for communities. Oman has the world's largest commercial constructed wetland to treat water rather than disposing it in deep acquirers. The wetland of Oman consist 360 hectares of area to treat 95,000 cubic metre waste water each day. Furthermore, they are a home to hundreds of fish species and migratory birds.

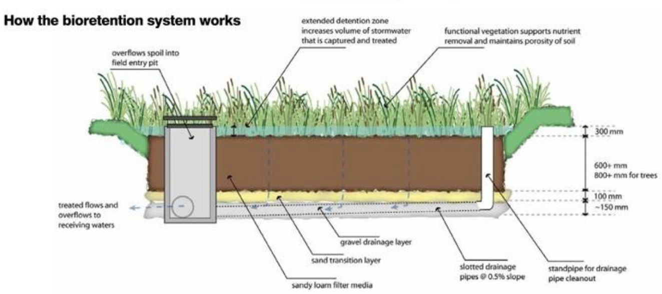


6.2.11 Planter Boxes/Rain Gardens/Bio Retention Cells:

Planter boxes also known as urban rain gardens collects & absorbs runoff from Alleys, streets, roads, sidewalks, green landscape and parking lots. Planter boxes also play aesthetical roles as an element of a greener environment.







6.2.12 Drainage water management (DMW):

Drainage water management (DMW) is the most suitable technique used for managing the timing and the amount of water discharged from agricultural landscape, it improves both water quality and production benefits. This can be achieved by reducing unnecessary tile drainage, minimizing the amount of nitrate that leaves farm fields. Another advantage of DWM systems is that it can retain water in fields that could be used later for crop production.

6.2.13 Graph Spectral Techniques to Water Distribution Network Management

Traditionally designed Water Distribution Networks (WDN) were based on mathematical models, now a days, it is difficult to manage the old water system because of several issues such as water losses in the WDN. Urban water management is difficult because of complexity of WDN such as network connectivity or asset location. Mathematical tools are not efficient to analyze and manage WDN due to complex network. Graph Spectral Techniques (GSTs) is one the important method to handle complex network designed with traditional methods like urban water system, also useful for continuity check.

6.2.14 Machine Learning and Data Analytic Techniques in digital Water Metering:

Water scarcity is the leading global risk because of its degrading quality and insufficiency. Various factors are responsible for water scarcity including improper water distribution among different regions, industrialization, increasing population, bad water management and drought. Due to these reason, challenges are faced but many metropolitan water utilities. These challenges increased the demand of smart technology-based, water distribution system for the sustainable supply including water demand management (WDM), it has fiber major strategies. The main goal of WDM is to supply water with sustainability. Digital water meters (DWMs), along with machine learning (ML techniques play a vital role for giving reliable information for the identification and implementation of these strategies. The identification of novel methods are needed to apply ML and DA techniques Digital or intelligent water meters (DWM) can be serve as an important component during water scarcity and low pressure during peak usage times. You have the option of sending information about water consumption electronically and using it for water management. The use of large amounts of data generated by DWM has been facilitated by recent advances in machine learning (ML) and data analysis (DA) technologies.

7 CONCLUSION

Proper management strategies are required for highly diversified hydrogeological settings and variations in groundwater availability & Effective management of water. Water management helps to frame long term goals and short term goals for sustainable water conservation. Sustainably designed landscape conserves water, decreases the rate and volume of runoff water from rain, irrigation & snowmelt and helps reduce the amount of pollutants in surface water. Green Infrastructure provides key instrument to tackle water management and its sustainable utilization in landscape. Grey infrastructure can be integrated with green infrastructure for a sustainable water management but green infrastructure has the potential to tackle the urban issues in coming years when combined with modern technologies e.g. Data analytics and machine sensory approach. The ideologies of water management in sustainable landscape helps to replenish groundwater reserves and Conserve waters a natural resource in urban times.

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