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Shreya Shetty is a collaborative consultant from Bangalore, accredited with MA in Urban Design from Newcastle University, UK and B. Architecture from VNIT, Nagpur, India. She is a LEED Green Associate.

With the zeal for human centric approach, her professional experience has been around sustainable and social approaches in the sector of mobility, transportation and public realm with keen interest in universal design, accessibility and inclusivity. She is a strong advocate of collaborative and participatory approaches and is actively involved in fixing on ground spatial aspect through the means of policy, planning and design

## Green roads: Significant role of water to develop climate resilience

### *Abstract*

Road and water are known to have adverse effects on each other. Water is known to be responsible for the pot holes and the degeneration of the roads. The roads are known to cause major problems such as waterlogging, floods, erosion and increase the heat island effect. These diminish the transport functions and impact the climate detrimentally.

An environmental approach needs to be adopted at all stages such as planning, design and construction of the roads. Transportation functionality and ecological sustainability need to work in cohesion. More recently concepts such as ‘Green highways’ and ‘Green roads’ have been explored to benefit the transportation sector, urban health and the ecosystem. This paper explores the significant role of water to develop climate resilience through varied techniques and approaches.

### **Keywords**

Integrated road and water management, climate resilience, green infrastructure, nature based solutions

### **1. Introduction**

Road transportation is the most viable modes of transportation in India as it has high penetration level with door-to-door delivery in both freight and passengers. As per the Economic Survey of 2021-22, the road network of India consists of National Highway, state highway, district roads, urban roads, rural roads and project roads of over 63.7 (provisional) lakh km of roads as on 31 March 2019, which is the second largest in the world (Government of India, 2021-2022).

The investment in the road infrastructure worldwide is enormous. India has the second-largest road network in the world, spanning a total of 5.89 million kilometres (kms). Private sector has emerged as a key player in the development of road infrastructure in India (India Brand Equity foundation, n.d.). There has been a constant increase in the road construction as shown in the Figure 2.



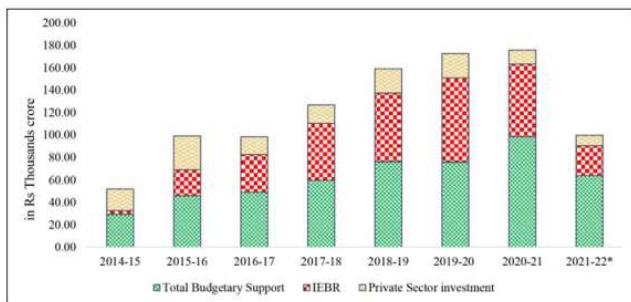


Figure 1 Investment in Road Sector

**Source:** Survey calculations based on data from M/o RTH. For year 2021-22-As on 30.9.2021

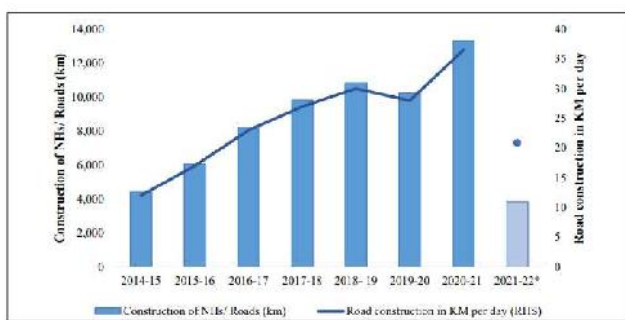


Figure 2 Road Construction

**Source:** Survey calculations based on data from M/o RTH. For year 2021-22-As on 30.9.2021

Road network will further develop and an integrated water management development with the road network will reduce the impact on climate resilience.

## 2 Road construction

Road construction depends on different environments and use of the roads. Water impacts not only the structural component but also the road safety, in trafficked roadways. Hence special considerations need to be adopted during soil analysis in relation to soil moisture content and surface flowing water. Impervious surfaces are used most commonly in road construction, parking lots, pavements etc, which increases the moisture content, in turn affecting the lifecycle of the

road and the pavements. Furthermore, reducing resilience and causing distress such as potholes, cracks etc. natural river flow pattern significantly.

Water is one of the main causes of pavement distresses, therefore if keeping these structures in good condition and properly sealed, it results in a durable pavement, safe and saving over the years. (Global Road Technology International Holdings (HK) Limited, 2021)

## 3 Integrated road and water management

Water is our valuable resource. The key environmental challenges today are water management. Hence the relation of road and water is highly crucial. The surface water and the ground water are highly impacted by road construction. The way roads are constructed and maintained can affect the hydrology and landscape of the area.

Harvesting surface runoff water to recharge the groundwater, would further help in increasing the moisture of the soil.

Integrated road and water management would benefit flood conditions and protect the nature

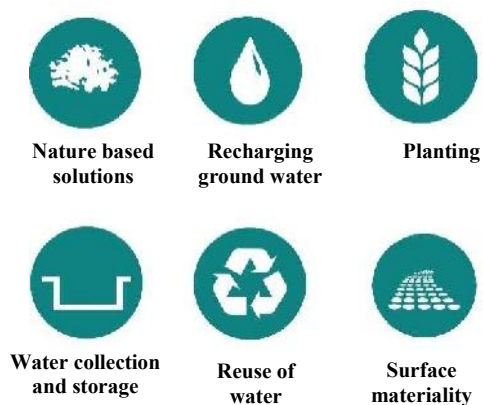


Figure 3 Elements of water management

**Source:** Author



Figure 4 Water management in urban landscape

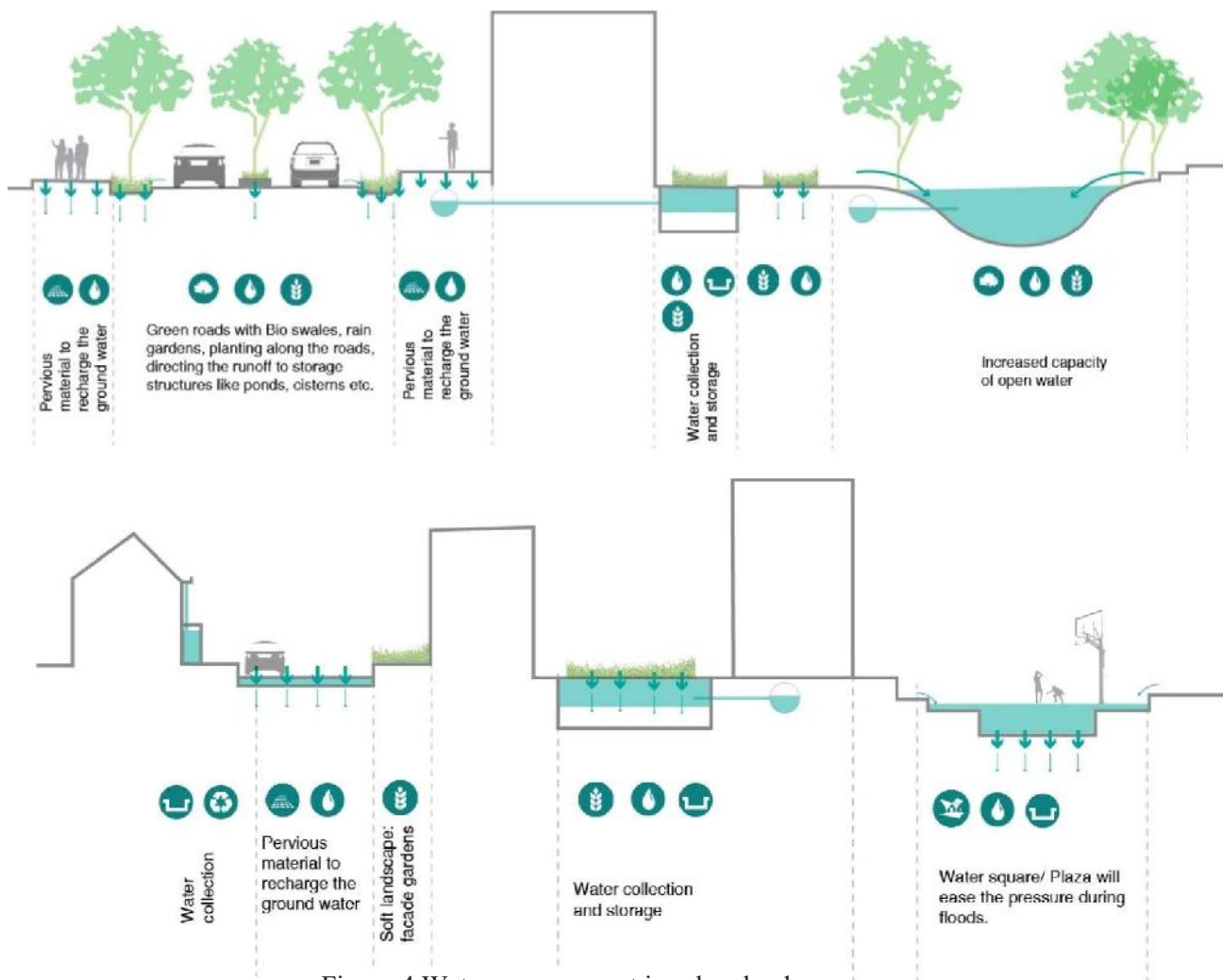


Figure 4 Water management in urban landscape

Source: Author (Adapted from varied sources)

#### 4 Green infrastructure techniques and approaches

Two approaches can be adapted which would vary based on the application in different geographies such as semiarid areas, coastal areas and floodplains, high- and medium-altitude areas and desert areas.

##### 4.1 Innovation/modification for optimization of road design

Each road elements such as bridges, drifts, paved roads, unpaved roads, roadside slopes, drainage structures, borrow pits and roadside

vegetation can have three levels of road resilience namely protective, adaptive and proactive.

- Harvesting water from optimization of side drains, culverts etc. as infiltration ponds, trenches, borrow pits, Planting along the sides of the roads with safety measures to avoid accidents due to the outgrowth of the trees and their roots.
- Pollutants found in the runoff water from the streets such as oil, dust can be filtered out by using the following:



- Green infrastructure solutions such as permeable materials and naturebased solutions such as rain gardens, bioswales
- The traditional stormwater infrastructure would require reconfiguration. The green infrastructure methods are also reliable and cost effective. The natural methods will help restore and protect the natural water cycle.
- Changing road alignments to recharge areas
- Optimizing design of junctions for storage of water and recharging the ground water by means of recharge pits etc.

dams etc), spread over land (bunds, terraces, pits, borrow pits etc), shallow aquifer recharge (trenches, recharge structures, tube recharges etc)

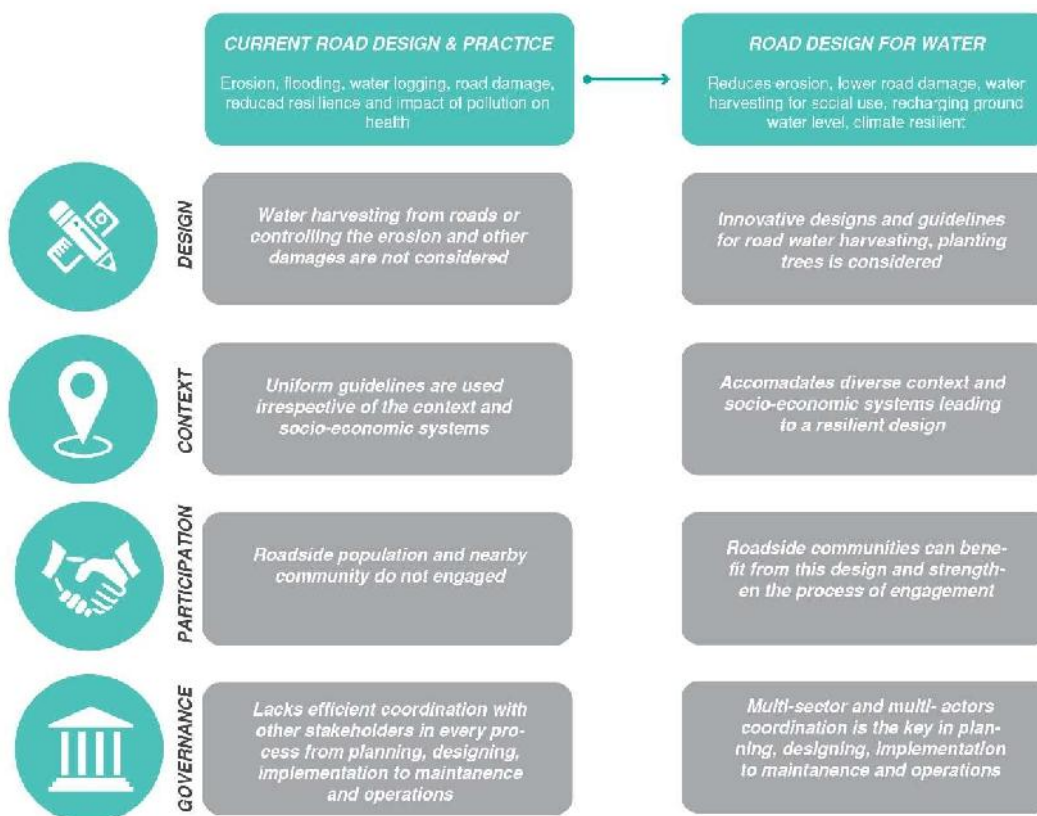
## 5 Implementation

1. Political will and commitment
2. Capacity building and development at different levels of systems and work
3. Revised planning and design
4. Participation and coordination of varied stakeholders
5. Allocation plan
6. Investment plan
7. Operation and maintenance
8. Monitoring and Audit

### 4.2 Using roads for water management:

- Directing road water runoff to storage structures like ponds, cisterns earth

Figure 5 Need for shift from current road design towards road design for water



Source: Author (Adapted from roads for water<sup>7</sup>)



## 6. Climate Resilience and Impact

The extreme events of climate are leading to prioritizing the preservation of road assets leading to change in road specification, increasing the expense of the design and hence adapting to methods like “road-hardening” by higher capacity drains or changes in materials. This may withstand the impact of severe climate but hinders the management of water resource, leading to floods, increasing the heat island effect etc.

Green road approach manages road water more efficiently, benefits the environment and preserves the transport functions of the roads, making it more sustainable than the protective and basic resilience.

As per the Green roads for water Guidelines for Road Infrastructure in Support of Water Management and Climate Resilience (Frank van Steenberg, 2021), green roads have substantial benefit for instance, in coastal Bangladesh (wet climate), hydrological modeling of Polder 26 showed that improved drainage could potentially produce up to US\$3.1 million in net benefits through increased agricultural activity. Green Roads would reduce the depth and duration of waterlogging by 10 days in low-lying areas.

## 7. Conclusion

Green Highways policy, 2016 was launched in New Delhi with the aim to promote greening of highway corridors with participation of the roadside community, NGOs, government institutions, farmers and private sectors. However, other roads and streets are also in need to adopt to water and environmental sensitive design.

The following are important aspect

- Governance for green roads for water

- Coordination between the varied stakeholders
- Capacity building and sensitization at different levels of planning, designing, implementation and maintenance
- Revised schedule of rates

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