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Integration of Urban Storm Water within Transport Planning-A Case of New Delhi, India

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***Abstract*: "Water is the primary source of our ecosystem" and due to the increasing urbanization and industrialization, the amount of water demand has increased steadily, and the available water resources have declined. The Integrated urban water management has been observed as a piecemeal solution to conserve urban water. The paper targets are to explain the integration of water within transport planning. To promote sustainability, the paper will also explain the effectiveness of green infrastructure for urban storm water management which includes rain gardens, permeable pavements and street designing.**

***Keywords*: Urban storm water management, Bioswales, permeable paving, rain gardens, parking lot designs, kerb extensions and street profile.**

1. Introduction

"Water crisis looms over India". Most of the Indian cities are water stressed, with no city having 24*7 water supply. About 30% of people in India live in metropolitans' cities that are expected to double in population by 2050. With a growing economy and changing lifestyles the pressure on already strained water resources is increasing. The major three metropolitan cities like New Delhi, Mumbai and Kolkata have not kept pace with rapid urbanization which result in poor sanitation and storm water management further resulted in failure to cities to meet rapid demand of water supply and treatment of sewage.

In this paper, the author would like to explain the problems that country's facing for scarcity of water supply. Lack of infrastructure development and tremendously increased urbanisation result in complexity of storm water management in India. India's most used source for centralised water supply system are surface water and ground water resources. There are 14 major rivers, among them Ganga-Brahmaputra-Meghna is the largest. On the other hand, contribution of ground water resources is important as majority of inhabitants in rural areas depend on ground water. With the increase in the impervious areas, storm water runoff increases, endangering precarious conditions to ground and surface waters.

In order to conserve water resources, the government of India has initiated a new framework and approach to integrate urban storm water management in country's capital New Delhi. In infrastructure development roads networks, highways and streets contributes major land use pattern. In fact, they also play a vital role in storm water management, if roads and streets are designed satisfactorily. The paper would also like to discuss the proposed solutions to integrate urban storm water with transport planning.

2. Intricacy of urban storm water management

The enormous urbanization in India has brought about creating colossal amount of tempest water which is squandered. This water can be gathered or can be utilized for reviving the groundwater. The other imperative element is that absence of ecological contemplations in city arranging and development has prompted hindering of normal seepage arrangement of the urban areas. Overseeing urban tempest water in a creating nation India postures enormous difficulties and the results of its disregard are extreme. Subsequently, choice making to decide favoured methods for maintainable tempest water administration is turning out to be more intricate.

A. Unlimited Metropolitan Elongation

The quick development of the city erratically hinders the determination of stream cut off points for future occupation because of the trouble to gauge porousness soil rates. Living arrangements situated on stream bank and water bodies with direct sewage releases to the water body are much of the time watched. This heedless urban development has a tendency to bring challenges to estimate the genuine figures ashore utilize design and occupation in future. The tempest water administration enormously relies on upon the area use design in hydrological demonstrating which acquires awesome instabilities expectation of tempest water streams.

B. Shortfall of Infrastructure planning

Indeed, India's lack of infrastructure planning and many years of underinvestment have left the nation with dire deficits in such critical areas as railways, streets, water supply, drainage systems and power supply systems. Current situations in rural areas are becoming outrageous because of poor sanitation and water supply which surpass the development in urban areas due to migration of rural population to urban areas. For example, nation's capital New Delhi has planned infrastructure, but nearby villages or towns migrate to the city for better facilities and living standards.

3. Towards a new approach-integration of urban storm water

Considering the expanding water emergency in India, the government has made integration of urban storm water with landscape planning, urban planning, and transport planning making obligatory in metropolitan urban areas. Huge township projects are been developed with the storm water capacity and waste water treatment plants. New Delhi, India's capital did reconciliation of urban storm water with city's road and street layout. As there are huge road network in Delhi, incrementing the chance of conserving the huge amount of storm water per year. This storm water is gathered into the all-around planned seepage systems and afterward released into the landscapes zones or on the field of watering system. They achieved this by using of pervious paving and infiltration techniques along the road side. Also with the proper design of street profile and inclusion of kerb extension and rain gardens help the city to store huge amount of storm water. Parking regions additionally assumes a critical part in rationing storm water since it has the greater part of the storm water overflow.

Methods

A. New Delhi, India – A Case study

New Delhi is the capital and a union domain of India has a range of 42.7 square kilometres (16.5 square miles). It has a populace of 11,007,837 and thickness of 5,855/square km and metro of 21,753,486. New Delhi shapes a little part of the Delhi metropolitan territory. Since the city is situated on the Indo-Gangetic Plain, there is a rise of 216 m (709 feet). The city lies on the floodplains of the Yamuna River, voyages an aggregate length of 1,376 km (855 miles) and has a waste arrangement of 366,223 square kilometres (141,399 square mi).

The atmosphere of New Delhi is a storm affected damp subtropical atmosphere with high variety in the middle of summer and winter as far as both temperature and precipitation. The temperature differs from 46 °C (115 °F) in summers to around 0 °C (32 °F) in winters. The yearly mean temperature is around 25 °C (77 °F). The normal yearly precipitation is 784 millimetres (30.9 inches), a large portion of which is amid the rainstorm in July and August.

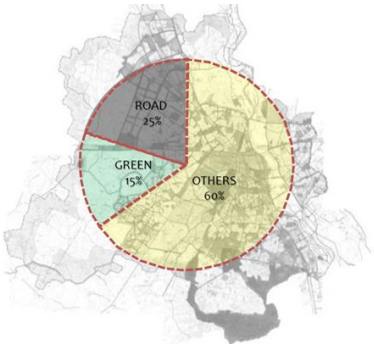

Fig. l. Land use pattern New Delhi

The population in New Delhi has tremendously increased three folds in the last 3 decades, thus resulting to paved areas leading to increased storm water runoff. Land use pattern in New Delhi is 25% for roads, 15% for green areas and 60% for other including residential, commercial and industrial areas. Earlier, lack of permeable surfaces the runoff getting diverted into the sewers or storm water drains that convey the water into the River Yamuna. Later on, Delhi development authority (DDA) has proposed the Delhi masterplan 2020, where roads and impervious areas associated with transport activities (i.e. car parks, driveways etc.) can constitute up to 70% of the urban catchment. The specific contribution of highways and freeways to decreased storm water runoff is likely to be small due to the linear form of the pervious area.

There are 19 drainage basins; large natural drains; storm water drains alongside roads; and combined sewer-cum-storm water drains. Most of the water collected through different drainage systems and further treated into storm water treatment plants and gets discharged into the river Yamuna.

B. Proposed Solutions.

1) Porous paving option

In New Delhi, porous pavements are commonly used in open car parks and driveways to allow water to infiltrate below the paving and then into the soil and ground water below. With infiltration, groundwater is recharged, and streams are replenished with cool, clean groundwater in a more natural way.

2) Bio swale option

A bioswale is a modified swale that uses bioretention media to improve water quality, reduce the runoff volume, and modulate the peak runoff rate while also providing conveyance of excess runoff. Bioswale has been used in between walking streets and driveways which is a part of infrastructure within transportation.

3) Infiltration trench

In the city, Infiltration trenches has been used to temporarily hold storm water runoff within a sub-surface trench prior to infiltration into the surrounding soil.

As shown in figure the storm water runoff is diverted into the trench and is stored until it can be infiltrated into the soil, usually over a period of several days.

4) Rain gardens

Rain gardens are shallow landscape areas that can collect, slow, filter and absorb a huge amount of storm water, delaying discharge into the watershed system. Example Connaught place at Delhi, famous commercial hub has a huge rain garden in the form of round bout in the centre. Figure shows the proposed rain garden at greater Noida.

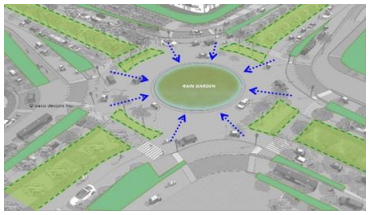

Fig. 2. Proposed rain garden at Greater Noida

5) Kerb extensions

They are only used for small residential roads where half of the streets are covered with parking, and storm water goes into drain.

Water enters green areas through kerb cuts and those green areas are connected through the sub surface pipes.

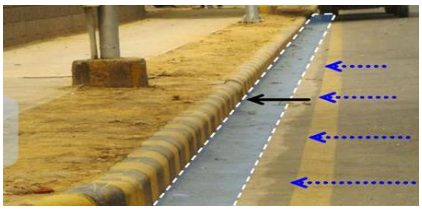

Fig. 3. Existing street with no kerb extension

Fig. 4. Proposed street with kerb extension

6) Parking lot designs

Parking lots are often designed with oversized parking numbers and travel aisles. In a day, it is important to consider a number of car parks and often many of the park lots are left empty mostly in commercial, shopping areas and metro station in New Delhi. At Connaught place the parking has been designed in such a way that overall area fully utilized by reducing the oversized dimensions of parking bay and adding following storm water techniques to the rest of the surface. Providing green patch between two car park lots to infiltrate rain water into the green areas. Providing swale/planters with parking lots. Provision of kerb to use in parking lots.

Angled parking lot so that water goes to nearby swale/planters. Providing parking lots with pervious paving.

Fig. 5. Existing street with impervious paving

Fig. 6. Proposed street with pervious paving

7) Street profile option

The streets were designed in such a way that the rain water enters from the bell mouth to the draining pipe and then to the water bodies. The street profile or designing of streets and roads determines how storm water runoff flows of a street if a slope is towards median or towards road edge. Street size vary as per the location or usage. Every street has a limitation based on whether a newly built, or it is a part of a retrofit project. When building new streets, the storm water facility on a street is compulsory and it also depends on the profile or typology because the street profile can be designed in a variety of ways.

- 6 mt wide road – permeable paving and green gutters.
- 9 mt wide road – permeable paving, flow through and infiltration planter and green gutters.
- 12 mt wide road – further in addition of vegetated and gravel filter.
- 18, 24, 30, 40, 45 and 60 mt wide road – swales and rain gardens are included.

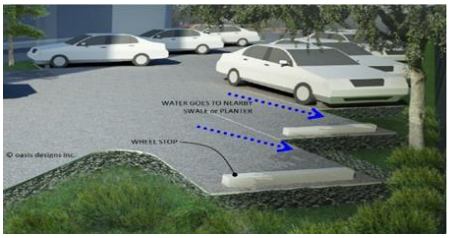

Fig. 7. Proposed parking lot

Fig. 8. Existing street with no bioswale

Fig. 9. Proposed bioswale for the same street

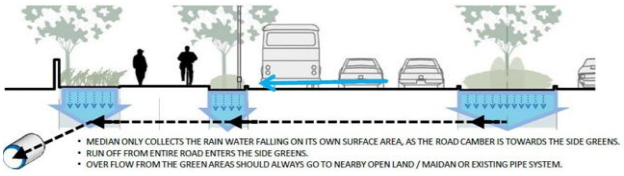

Fig. 10. Part road section – proposed for new sites

4. Conclusion

This paper presented storm water management concept with respect to transport planning. The adoption of a sustainable approach for the urban storm water management faces many challenges especially in developing countries like India, mainly due to absence of proper data, uncontrolled urban expansion, and lack of knowledge. In case of India's capital city New Delhi water crisis grows as the demand of water supply increases. The proper design of road network could prevent flooding, improves the volume of only water source Yamuna River, increasing opportunities for recreation, and restoring ecosystems and water quality as well. India's street system are entirely amazing and biggest, practically every state have association with one another. On the off chance that these streets system are attractively outlined with appropriate offices of storm water administration then country could satisfy the interest of water supply.

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