Urban Utilities Planning: Water Supply, Sanitation and Drainage
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Module - 08
Water carriage system
Lecture - 40
Storm Water Drainage Planning Part III

Welcome back. In lecture 40, Storm Water Drainage Planning (Part 3) will be covered.

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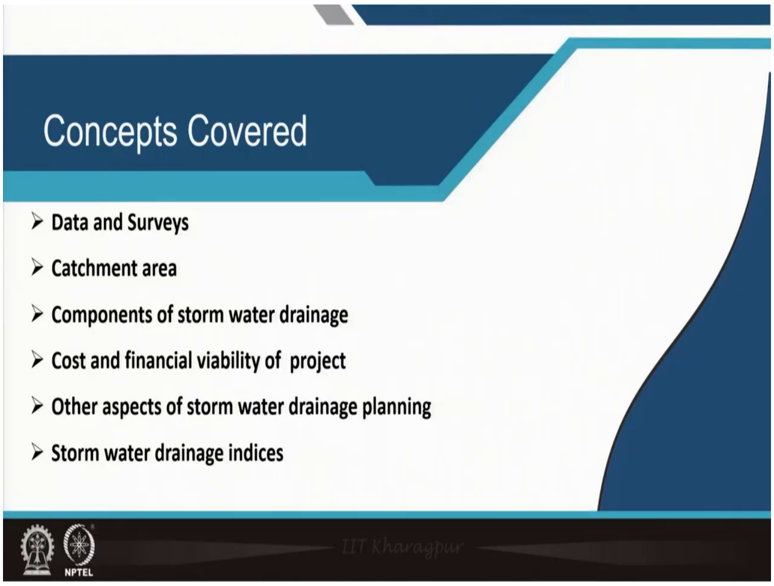

The different concepts that will be covered include:

- Data and surveys required for stormwater planning
- Catchment area
- Components of stormwater drainage
- Cost and financial viability of stormwater drainage planning projects
- Storm water drainage indices.

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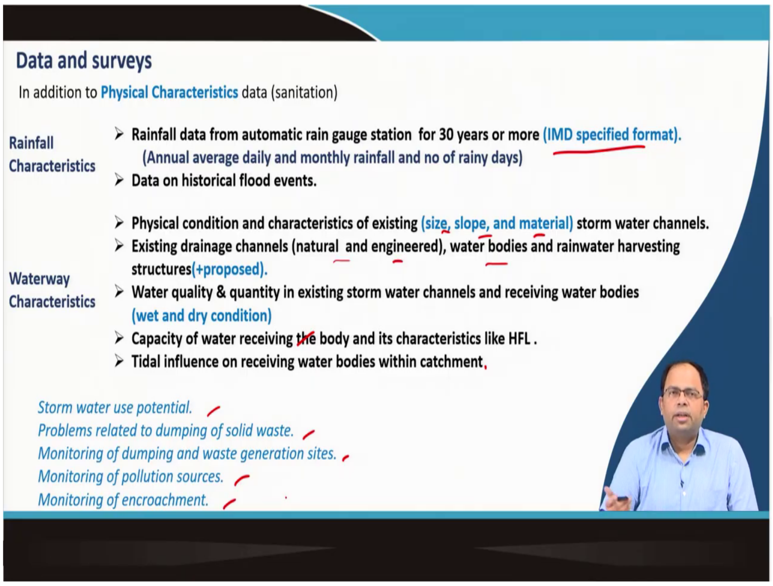

Data and surveys

For storm water drainage planning, in addition to Physical characteristics data (sanitation) other data is required:

Rainfall characteristics:

Rainfall data from automatic rain gauge stations for 30 years or more as per the IMD specified format. This includes the annual average daily monthly rainfall and number of rainy days.

Data on historical flood events

Waterway characteristics:

The physical condition and characteristics of existing storm water channels including its size, slope, material etc.

Existing drainage channels (both natural and engineered), water bodies and rainwater harvesting structures including the ones proposed because it determines the amount of water that can be carried in storm water drainage channels.

Water quality and quantity in existing storm water channels and receiving water bodies (wet and dry conditions).

The capacity of water receiving body and its characteristics like HFL characteristic

Tidal influence on receiving water bodies within the catchment.

The availability of such data may not be very important in the case of a sewer pipeline, however, if it is an open canal or a channel, a detailed understanding of these data is necessary. Apart from this, there is a need to understand factors such as:

- The storm water use potential – refers to whether the storm water can be used in the urban landscape.
- Problems related to dumping of solid waste – The locations where dumping is done, the amount of waste dumped, the causes of dumping etc.
- Monitoring of dumping and waste generation sites,
- Monitoring of pollution sources
- Monitoring of encroachment.

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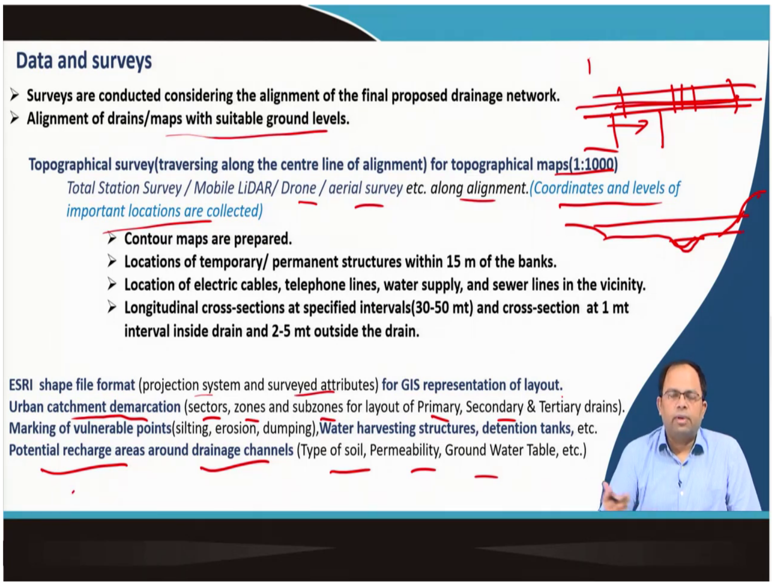

Surveys are to be conducted considering the alignment of the final proposed drainage network. For example, if an engineered channel is proposed, then, relevant surveys have to be done including the detailed surveys for the surroundings. Alignment of drains with suitable ground levels has to be done.

Topographical survey (traversing along the centre line of the alignment) for generating topographical maps (in a scale of 1:1000). The surrounding areas on either side of the drainage channel have to be surveyed. This can be done using a Total Station, Mobile LiDAR, Drones, or based on aerial surveys.

Coordinates and levels of important locations are collected and contour maps are prepared based on that.

Location of temporary and permanent structures within 15 meters of the bank is collected.

Location of electric cables, telephone lines, water supply, sewer lines in the vicinity has to be collected.

Longitudinal cross-sections at specified intervals (every 30 to 50 meters) and cross-section at 1-meter interval inside the drain and every 2.5 meters outside the drain. The profile may change from one point to another and hence has to be noted.

ESRI shapefile formats (projection systems and surveyed attributes) for GIS representation of layouts.

Urban catchments demarcation (Sectors, zones and sub-zones for the layout of primary (the major drains) secondary and tertiary drains.

Marking of vulnerable points (silting, erosion, dumping), Water harvesting structures, detention tanks, etc.

Potential recharge areas and drainage channels (types of soil permeability, groundwater table around different zones etc. needs to be understood to design an integrated system of green infrastructure, the urban landscape where storm water can be used etc.)

Components of storm water drainage

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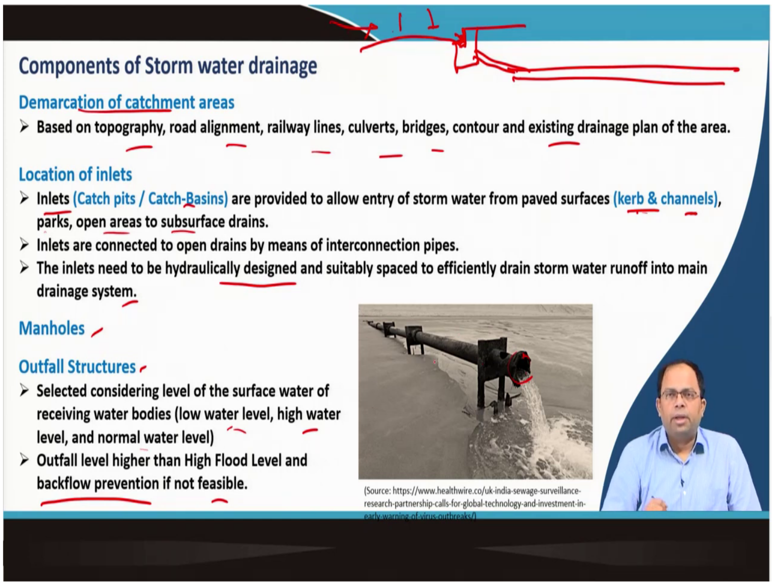

Demarcation of catchment areas – has to be done based on the topography, road alignment, railway lines, culvert, bridges, contours and existing drainage plan of the area.

Location of inlets - Inlets (catch pits or catch basins) are provided to allow entry of storm water from paved surfaces (kerbs and channels) and also from parks, open areas etc. to surface drains. Consider a kerb adjacent to a roadway; the water from the surrounding areas and the parking areas near the road, the runoff from the road and the footpath surface etc. is collected at the entry points/inlets on the edge of the road and consists of a chamber constructed below it for water collection. The water from the chamber is conveyed to the underground sewer lines (under the roadway) as represented in the above image.

Inlets are connected to open drains using interconnected pipes.

The inlets need to be hydraulically designed and suitably spaced to efficiently drain storm water runoff into the main drainage system.

Manholes – Manholes are to be provided in association with both the sewer lines as well as the storm water drainage lines.

Outfall structures – are the structures which let out water into the receiving water body. These are selected considering the level of surface water of the receiving water body (low water level, high water level and normal water level) to make sure that flooding doesn't occur during the high water level period.

<u>Outfall level higher than high flood level and backflow prevention if not feasible</u> - It is not always necessary and feasible to locate the outfall structure above the high water level because the backflow of water can be prevented by installing backflow prevention devices. High water level occurs rarely and may be very high. Installing the outfall structure above that may not be feasible. These devices are flaps that could be opened or closed. If the water reaches the high water level in the receiving body, the flap can be closed to prevent the backflow. However it is not possible to drain the water from the city to the receiving water body during this time. So, adequate storage has to be provided.

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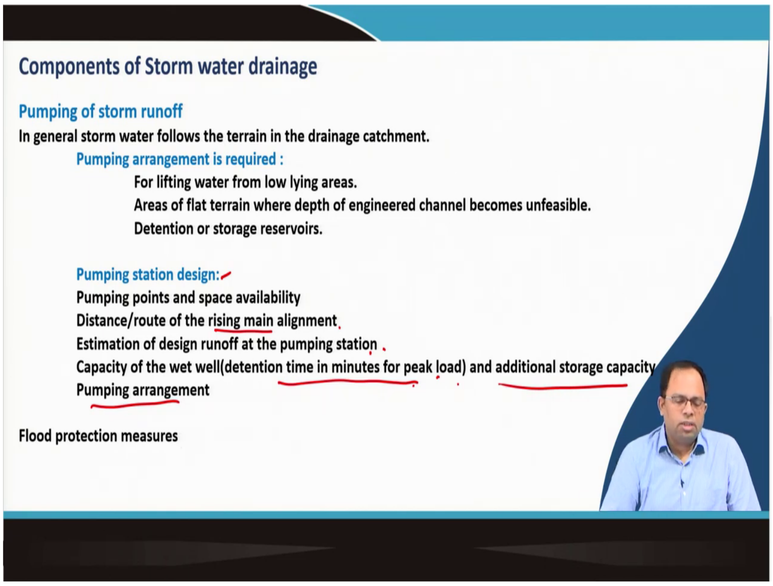

Pumping of storm runoff

In general, storm water follows the terrain in the drainage catchment, but pumping arrangement is required for lifting water from low lying areas or areas of flat terrain where the depth of engineered channel becomes unfeasible (it has to be raised to achieve adequate slope). In that case, detention or storage reservoirs are required and pumps are employed to pump the water from those detention basins to the drainage channels.

Pumping station designs depends on:

- Pumping points and space availability
- Distance or route of the rising main alignment.
- Estimation of design runoff of the pumping station
- The capacity of the wet well or the sump (detention time in minutes for peak load)
- Additional storage capacity for that pump house in case of emergency or repairs
- Pumping arrangement: the capacity, horsepower of the pump etc. should be determined.

Pumping is very important particularly for cities like Kolkata; During rainfall, the pumps are run continuously at the pumping stations which are located all along the storm water drainage channels to pump the water from one level to another. In the absence of such pumping arrangements, urban areas may get submerged.

Flood protection measures - Walls could be built along the river or the water channels to prevent spillover of flood water or to handle additional flow in a particular storm water channel.

Cost and financial viability of project

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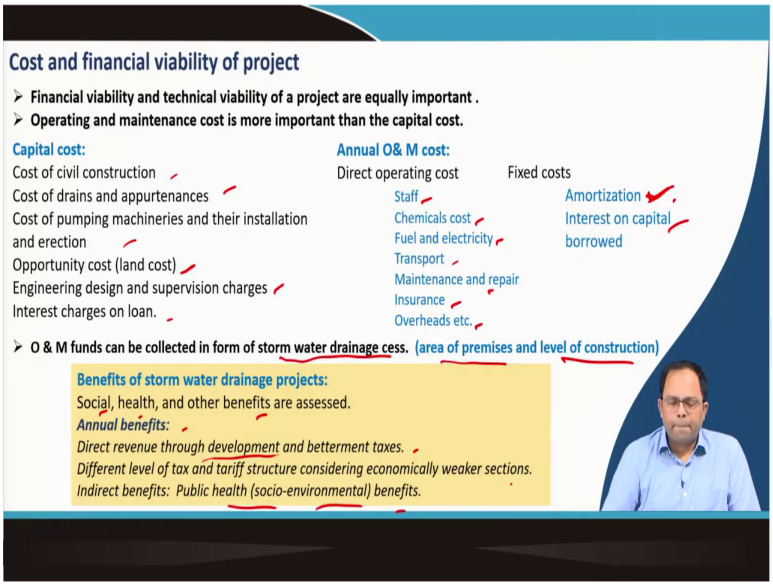

The financial viability and the technical viability of the project are equally important. The operation and maintenance cost is more important than the initial capital cost because the operation prevails for long period such as 25 or 30 years.

Capital costs

Capital cost involves the cost of civil construction, cost of drains and appurtenances, cost of pumping machinery and the installation and erection, opportunity cost or land cost (because the land is utilized for pumping arrangement and not for any other productive cause), engineering design and supervision charges, interest charges on loans if loans are availed for construction.

Annual operation and maintenance cost

It consists of the direct operating cost and the fixed cost.

Direct operating cost involves staff cost, chemical cost (for chemicals required in the chemical unit), fuel and electricity cost, transport cost, maintenance and repair cost, insurance, overheads etc. Fixed cost involves amortization, interest on capital borrowed etc. In the Indian condition, the capital cost is difficult to be charged to the people however money is charged for the operation and maintenance in the form of storm water drainage cess. This amount may vary from place to place. It can be a part of the property tax itself.

These projects can achieve various social benefits, health benefits and other benefits. The annual benefits involve the direct revenue through development and betterment taxes, that is, land can be sold at a better price as an effect of having a proper storm water drainage system.

Different levels of tax and tariff structure considering economically weaker sections can be considered.

The indirect benefits involve the public health and socio-environmental benefits.

Other aspects of storm water drainage planning

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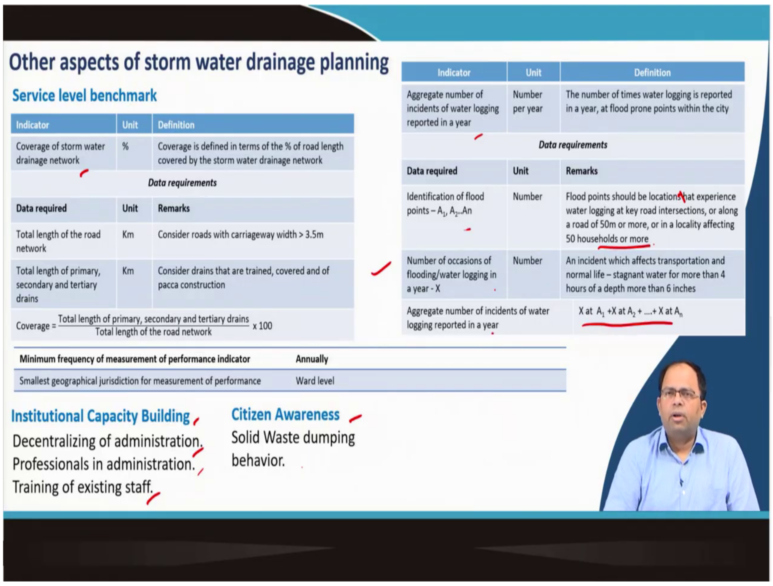

Service level benchmarking is done for drainage as well. So, two primary indicators are used. One is coverage of storm water drainage network which is given in percentage and the other is the aggregate number of incidents of waterlogging reported per year. Coverage (%) of storm water drainage is determined by:

Total length of primary, secondary and tertiary drains / Total length of the road network. The aggregate number of incidents of water logging is determined based on the flood points where floods usually occur such as at the key road intersections or along roads of 50 meter or in a locality affecting 50 households or more. Aggregate number of incidents of water logging reported per year is determined by multiplying the number of events into flood points and then we get an aggregate number of incidents of water logging reported per year.

Other important aspects involve Institutional capacity building and citizen awareness. Citizens should be made aware of the solid waste dumping behaviour. Institutional capacity should also be built for better stormwater drainage by training of existing staff, decentralization of administration etc.

Storm water drainage indices

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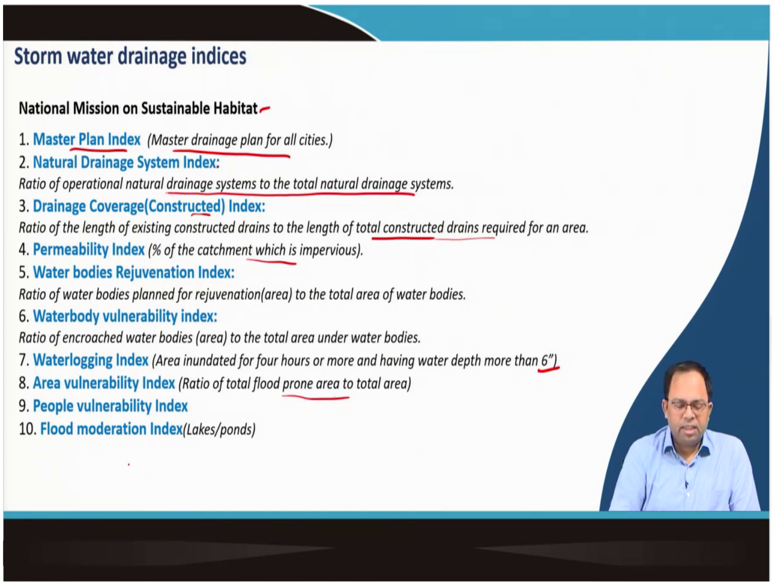

The National Mission on Sustainable Habitat has given several indicators to determine storm water drainage status for a particular urban area; these are very important for urban planners. Understanding detailed engineering design is important to measure the specific quantity of storm water that is drained or the amount of water that leads to creating floods or the extent of the flood that can be caused etc.

1. **Master Plan Index (***Master drainage plan for all cities.)*

2. **Natural Drainage System Index:**

The ratio of operational natural drainage systems to the total natural drainage systems.

3. **Drainage Coverage (Constructed) Index:**

The ratio of the length of existing constructed drains to the length of total constructed drains required for an area.

Engineering design has to be considered to understand the length of drain has to be constructed to serve a particular area. If all the roads have constructed drains, then, that can also be considered.

4. **Permeability Index** *(% of the catchment which is impervious).* Imperviousness is a significant contributor to flooding.

5. **Water bodies Rejuvenation Index:**

The ratio of water bodies planned for rejuvenation (area) to the total area of water bodies.

6. **Waterbody vulnerability index:**

The ratio of encroached water bodies (area) to the total area under water bodies.

7. **Waterlogging Index** *(Area inundated for four hours or more and having water depth more than 6”).* This indicates where an area is flooded or not.

8. **Area vulnerability Index** *(Ratio of total flood-prone area to total area)*

9. **People vulnerability Index**

10. **Flood moderation Index** *(Lakes/ponds)*

11. **Drainage cleaning Index:** *3 times a year. (Before monsoon, after a first heavy shower, after monsoon).* This indicates the time at which cleaning of the drain has to be done.

12. **Complaint Redressal Index**

13. **Climate Change stress index** *(20% increase in calculated discharge for designing future storm water drain)*

14. **Storm water discharge quality index:**

Ratio of the measured value of (TSS)/ (BOD) to the prescribed limits

15. **Sewage Mixing Index:** *Ratio of the volume of sewage in storm water.*

16. **Preparedness Index/ Early Warning Index** ***(****Real time rainfall intensity)*

17. **Rainfall Intensity Index:**

Ratio of the observed rainfall intensity to the rainfall intensity which will cause flooding

18. **System Robustness Index:**

Ratio of rate of incoming storm flow to rate of pumping.

19. **Tidal Index:** *Ratio of tidal level for which the present protection is adequate to the maximum tidal level observed.*

20. **Rain water Harvesting/Artificial Groundwater Recharge Index:** *Ratio of the rainwater volume stored/harvested to the measured rainfall volume.*
(2 to 5% of area reserved for water bodies: recharge)

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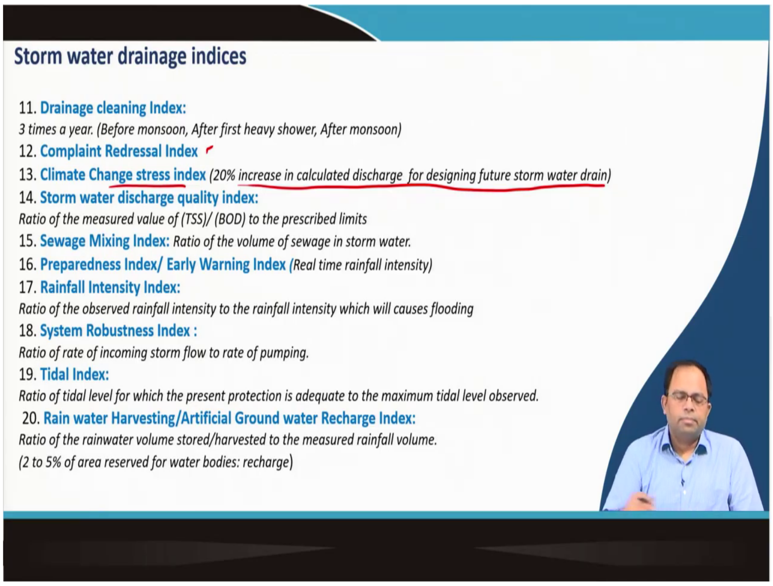

These indices present a good way to measure the effectiveness of storm water drainage for a particular area and can be considered by the urban planners to evaluate the status of storm water drainage in particular zones of the city.

Conclusion

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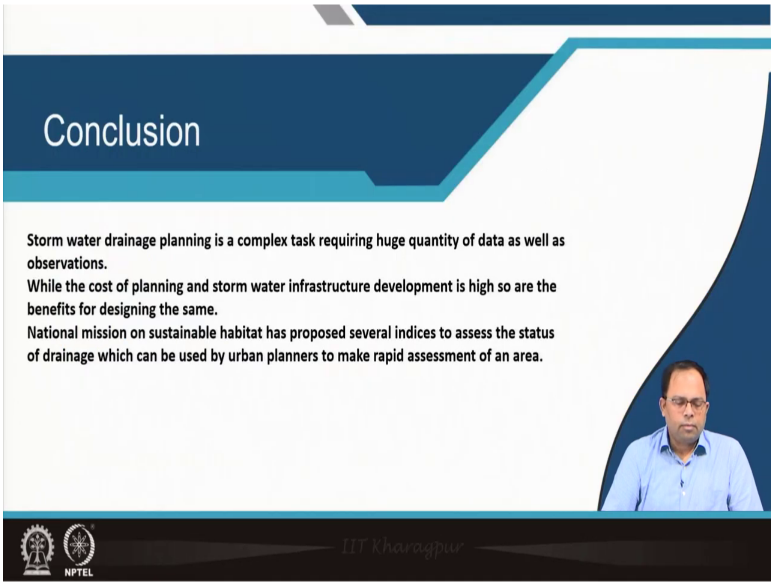

Storm water drainage planning is a complex task requiring a huge quantity of data as well as observations. While the cost of planning and storm water infrastructure development is high so are the benefits for designing the same. National mission on sustainable habitat has proposed several indices to assess the status of drainage which can be used by urban planners to make a rapid assessment of an area

References

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