Urban Utilities Planning: Water Supply, Sanitation and Drainage

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Module - 01
Urban Utilities Planning: Introduction
Lecture - 05
Water Sensitive Urban Planning

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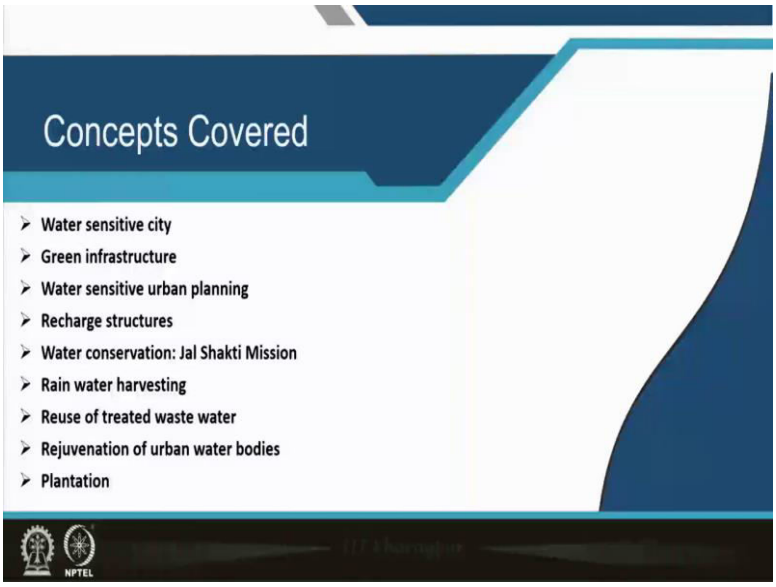

Welcome back! In lecture-5, theWater Sensitive Urban Planning will be discussed. The different concepts that will be covered are water sensitive city, green infrastructure, water sensitive urban planning, recharge structures, water conservation (Jal Shakti Mission), rainwater harvesting, reuse of treated wastewater, rejuvenation of urban water bodies, and plantation under Jal Shakti Mission.

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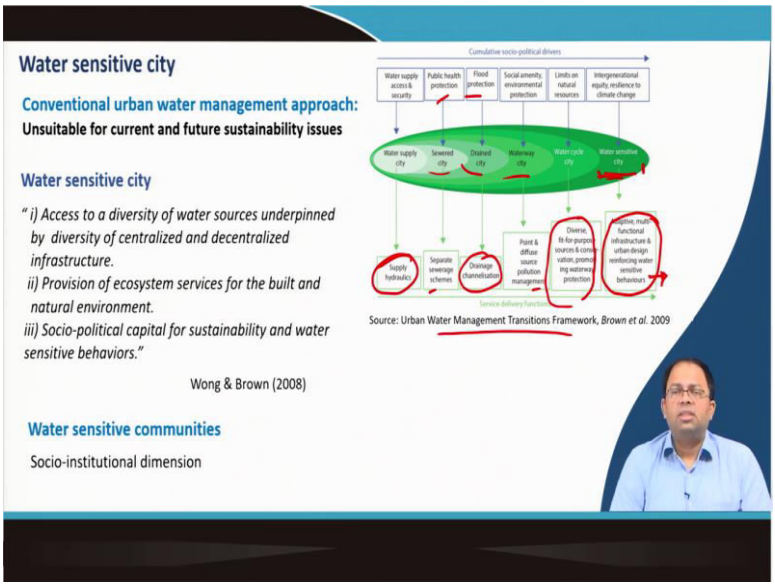

Water sensitive city

In this Lecture, another dimension of utilities planning will be discussed that deals with sustainability that andinvolves conservation of water will be discussed.

The term water sensitive city has been defined by Wong and Brown using three pertinent points. The first point deals with access to diversity of water sources underpinned by diversity of centralized and decentralized infrastructure. In other words,

there is a need to have a different kind of water sources based on centralized infrastructure and decentralized infrastructure. Centralized infrastructure is like a water treatment plant or water supply system at the urban level whereas decentralized infrastructure is like a water treatment plant at a local area that gathers waters from that particular area as well as provide water supply in the local region. For instance, rain water harvesting in a building that can be reused at local level.

The second point deals with provision of ecosystem services for the built and the natural environment. The third point deals with

the socio-political capital for sustainability and water sensitive behaviours. The socio-political capital involves people and their behaviour on water use and water reuse.

Similarly, water sensitive communities involves socio-institutional dimension. There exist various communities that are willing to save water or use it in a more sustainable or eco-friendly way.

The current approach to conventional urban water management is not sustainable. There is a need to improve sustainability, increase reuse of water, and reduce wastage, and reduce pollution.

The utilities and services for a particular urban area should be designed keeping these things in mind.

The evolution of urban water management framework involves

water supply city, sewered city, drainage city, waterway city, water cycle city, and water sensitive city.

The water supply city is only concerned about supplying water and are not concerned about drainage or sewerage. Some onsite treatment alternatives like septic tanks and some amount of drainage can be present.

Sewered city is concerned about public health. There is a focus on laying down sewers, conveyance of wastewater for treatment and final disposal. To deal with the system efficiently, there can be various types of sewerage schemes along with water supply schemes. Drainage cities arecity is concerned about effective drainage of storm water so that the floods can be avoided. It involves the designing of and channelization of drains to carry storm water.

Waterway cityies areis concerned with use of water for social amenities and along with environmental protection measures.

This involves point and diffuse source pollution management, for instance creating retarding basins, detention basins, etc.

Water cycle city deals with water reuse, reduction of the amount of water that goes into the drain to the final disposal point by performing infiltration, and recharging the groundwater.

The diverse, fit for purpose sources and conservation promotes waterway protection.

Water sensitive city is concerned about climate change, intergenerational equity, and sustainability. The service delivery functions involve

adaptive multifunctional infrastructure and urban design reinforcing water sensitive behaviour. Thus, the concern should be designing a city in such a way where a lot of water can be reused instead of generating it. In addition, the consumption should also be reduced and groundwater recharge should be promoted.

Thus, canal these aspects can be introduced in the city to make it more sustainable. However, the development of a water sensitive city is gradual as city transforms over time from focus on water supply to water sensitive behaviour. and

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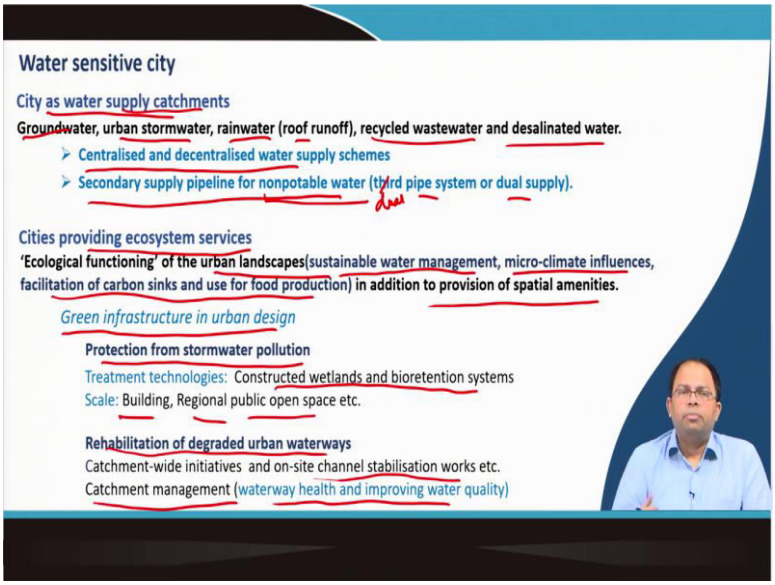

A city could be used as a water supply catchment forconsidering sources such as

groundwater, urban storm water, rainwater from roof, recycled wastewater and desalinated water in case of a seafront. These water sources are used to fulfill water demands in a city using

Tcentralized and decentralized water supply schemes. To ensure that the recycled wastewater, rainwater or urban storm water can be reused, secondary supply (dual supply) pipeline for non-potable water should be designed. Non-potable purposes involve

cleaning of streets, watering of lawns, etc. In a dual system, one supply is for

treated water from water treatment plant, and other supply is for recycled wastewater/urban storm water/rainwater from roofs.

Green infrastructure

Cities also provide ecosystem services that means in addition to provision of spatial amenities, ecological functioning of urban landscapes can be actually planned. Ecological functions include sustainable water management, influencing microclimate influencing, facilitation of carbon sinks and using it for food production. These functions correspond to the development of green infrastructure in the city. It can be achieved by various methods. For instance,

- **Protection from storm water pollution**: Wetlands and bio-retention systems (water treatment systems) can be designed at the building level or regional public open space. In case of decentralised system, storm water can be detained to enable infiltration. This water can be then conveyed to the water bodies. Thus, stormwater pollution is reduced.

- **Rehabilitation of degraded urban waterways that has been widened and depth has reduced**: The degradation of urban waterways deter the drainage of that particular area, thus storm water cannot be drained properly. To achieve this, catchment wide initiatives and on site channel stabilization (stabilization of banks of the channel) couldan be employed. This will reduce the chances of erosion and help in catchment management where the entire waterway's health and water quality in that waterway couldcan be monitored as well as improved upon.

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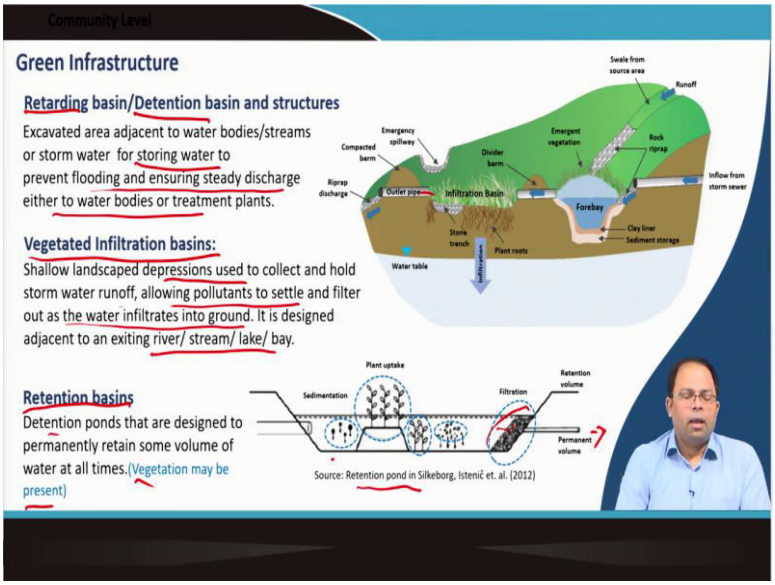

- **Retarding or detention basin**: The

detention basin or retarding basin detain or retard water to go to the drainage channel directly. In case of a rainfall event, when the water flows over the land surface,

- the entire pollution from this particular urban area is also carried along with it from the surface which then goes into into the water body through the drains. This direct flow into the water bodies and can be prevented by designing retarding/ basins at the local level, city level, and regional level. In thisese structures, the water can be held for some time then can be gradually released as per the capacity of treatment plants or water bodies. These are excavated areas that are designed adjacent to water bodies to prevent flooding and ensure steady discharge either to water bodies or treatment plants. plants. Detention basins, on the other hand, retain some amount of water permanently.

- **Vegetated infiltration basins**: These are shallow landscaped depressions in the urban landscape used to collect and hold stormwater runoff that allows pollutants to settle and filter out as water infiltrates into the ground. These are designed adjacent to the existing rivers, streams, lakes and bays as similar to the detention basin.

- **Retention basins:** These are a type of detention ponds where infiltration of the storm water happens and that are designed to permanently retain some volume of water is permanently retained at all times for future use. Vegetation can also be provided in these structures.

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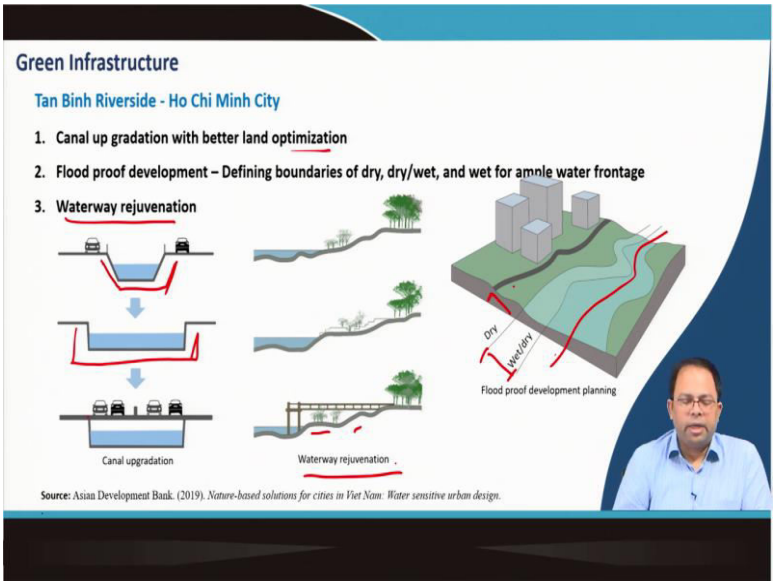

Tanh Binh Riverside – Ho Chi Minh City

- **Canal upgradation:** The profile of the canal is made wider to ensure more catchment of theprevent water withoutto spilling along the banks. Eventually, it can be covered so that

the space couldan be utilised for some purposewith better land optimization. **This is an effective strategy to rejuvenate or refurbish the water channels in urban areas.**

- **Waterway rejuvenationFlood proof development**: It involves defining proper boundaries of dry, dry/wet, and wet for the water bodies so that access of people can be controlled by designing suitable structures. It also ensures flood protection. as well as a site for recreation and other activities.

- **Waterway rejuvenation**: It involves redevelopment of waterfront in a way that provides protection from floods as well as a site for recreation and other activities.

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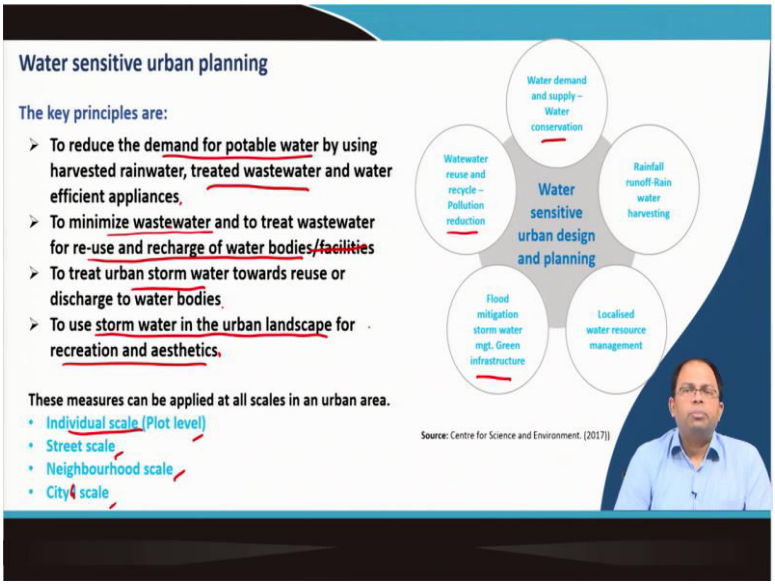

Water sensitive urban planning

The key principles of water sensitive urban planning involves

- Reduction of the demand for potable water by using harvested rainwater or localised water resource management, treated wastewater and water efficient appliances.

- Minimization of wastewater and treatment of wastewater for reuse and recharge of water bodies.

- Treatment of urban storm water towards reuse or discharge to water bodies through provision of green infrastructure and flood mitigation.

- Usage of storm water in the urban landscape for recreation and aesthetics.

To implement these principles, there is a need to understandunderstand the basics of volume of water generated from a rainfall, volume of runoff and the volume of water for recharge, and management strategies.

These measures can be applied at all scales in an urban area such as individual scale (plot scale), street scale, neighbourhood scale and city scale.

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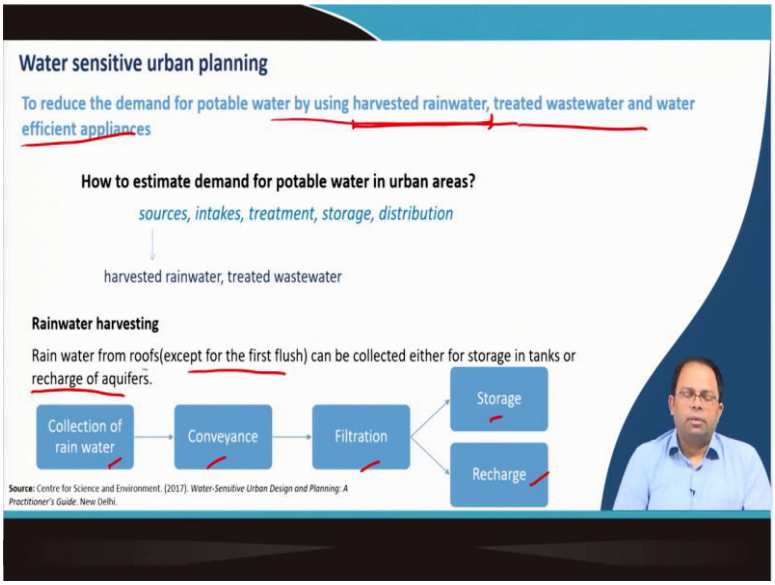

Regarding water sensitive urban planning, demand for potable water can be reduced by using harvested rainwater, treated wastewater and water efficient appliances.

Harvested rainwater is rainwater collected from the roofs. The first flush can not be collected because it might contain different pollutants/impurities that are collected from the roof with the first rainfall of the season.

Rainfalls after that can be collected and stored either in tanks or it can be used to recharge the aquifers in that particular area. The collected rainwater is then conveyed using pipes, filtered if required and then stored it for reuse/groundwater recharge.

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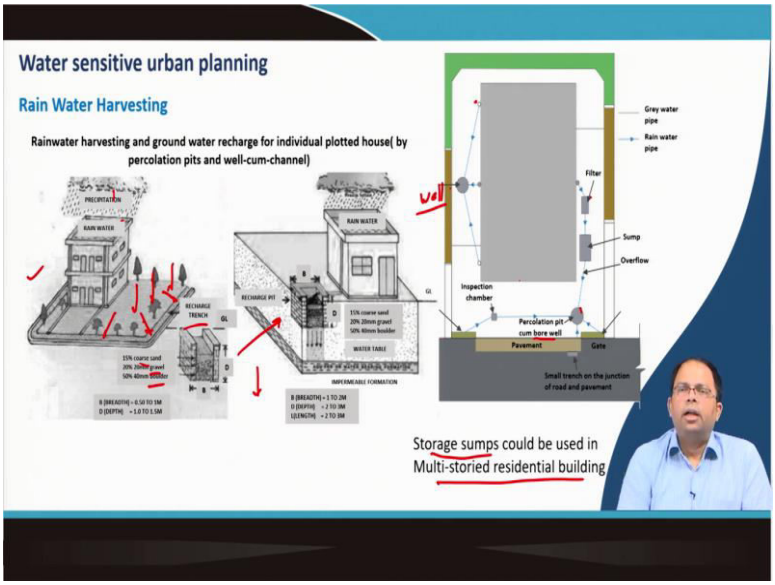

Rainwater harvesting

When precipitation happens, rainwater from roof and lawn isare conveyed using rainwater pipes tor a recharge trench in the ground where it is stored and then gradually goes into the Earth. Water can be conveyed into recharge pit also. In this system, layers of sand, boulders and gravel are put so that the water can gradually filter and go into the ground. Apart from groundwater recharge, this water can be reused for various non-potable purposes.

In case of multi-storied residential building, if there are not enough open lawns, storage sumps can be created where the water can be stored (after filtration) in future. The excess water from the sumps can go to percolation pit/borehole or reused for non-potable purposes such as cleaning, fire-fighting, etc.

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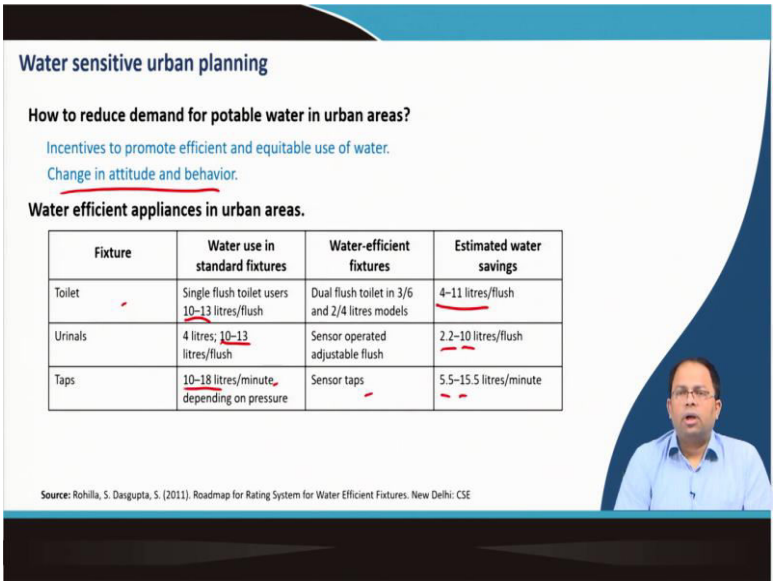

To reduce demand for potable water in urban areas, water efficient appliances should be used and incentives should be provided to promote the usage of water efficient appliances. In addition, there is a need to changes attitude and behaviour. Urban planners are responsible for creation of awareness as well as changing the attitude and behaviour towards sustainable practices.

Water efficient appliances, toilets that use water efficient fixtures(reduce the use the amount of water per flush to 4-11 litres from 10- 13 litres for standard fixtures.), Wwater-efficient urinals (help to save 2.2-10 litre/flush instead of 10-13 litre/flushes) help to save water. Similarly,

Similarly, tThe taps with sensors help to save 5.5-15.5 litres per minute instead of 10-18 litres per minute.

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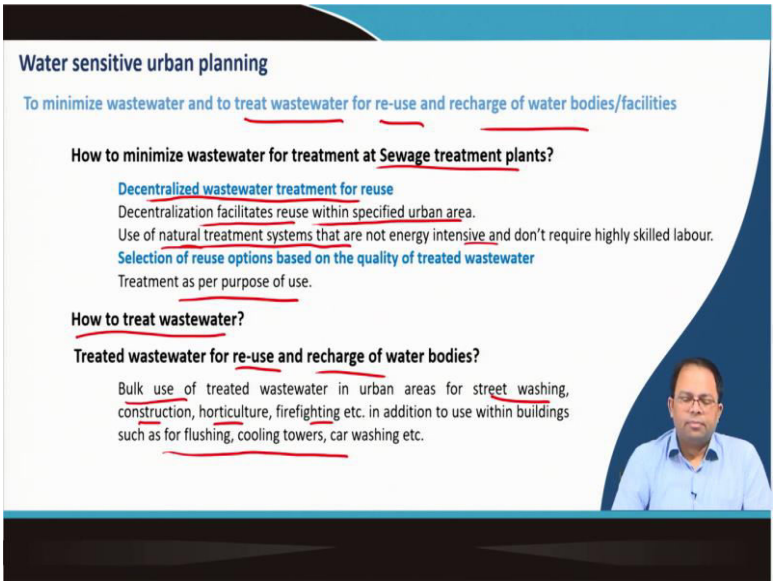

Another objective of water sensitive planning is to minimize wastewater and treat it for reuse and recharge of water bodies. The minimization of wastewater at sewage treatment plant can be done in a decentralized way using decentralization facilities within specified urban area, and use of natural treatment systems that are not energy intensive and do not require highly skilled labour. In addition, the reuse options can be selected based on the quality of treated water. Shallow filtration beds can be created for stormwater storage that ensures natural filtration.

Treated wastewater can be used for recharge of water bodies and in urban areas for street washing, construction, horticulture, and fire-fighting in urban areas. It can be also used for flushing, cooling towers, car washing, etc.

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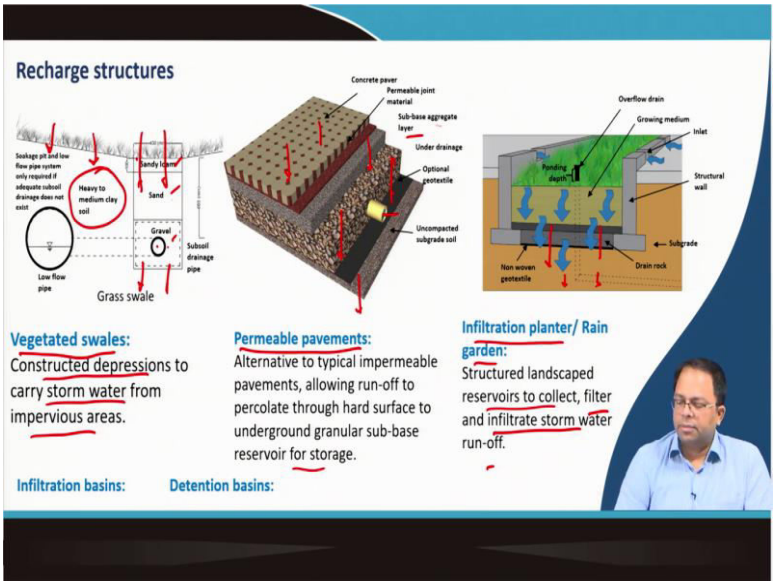

Recharge structures

Recharge structures include vegetated swales, permeable pavements and infiltration planter/rain gardens.

Vegetated swale is a constructed depression or permeable green area to carry storm water from impervious areas/areas with heavy to medium clayey soil.

A pit is constructed where sandy loamy soil, sand, and gravel is put that allows water to infiltrate into the ground .. Under drainage pipes can also be laid so that the excess water can be drained properly.

Permeable pavement, an alternative to a typical impermeable pavement,

allows runoff to percolate through the hard surface to underground granular sub base reservoir for storage. Over the uncompacted subgrade soil, a layer of geotextile is laid which filters the percolating water.. Over the geotextile,

sub base aggregate layer is laid through which the water passes via pores. Under drainage pipe is also provided so that the excess water can be drained out. The permeable concrete pavers are laid over the sub base aggregate layer.

Infiltration planters or rain gardens are structured landscape reservoirs to collect, filter and infiltrate storm water runoff. A geotextile layer is also provided to ensure the filtration of percolating water.

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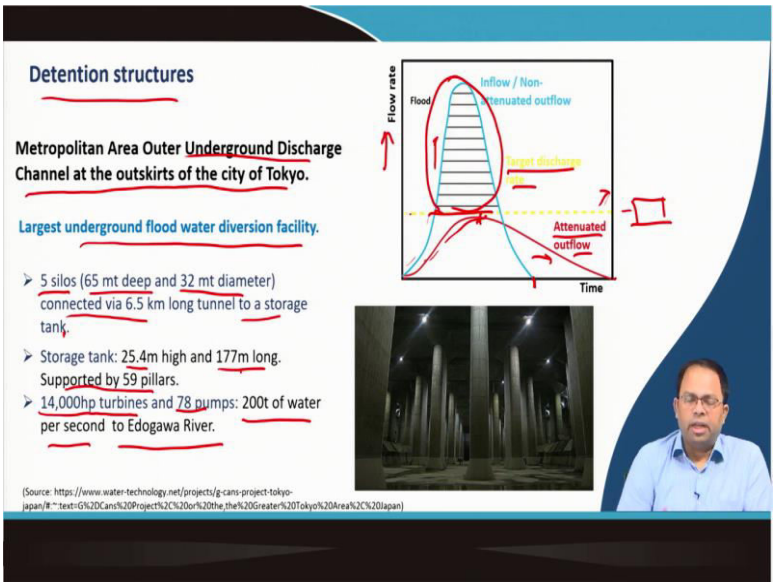

Detention structures

When rainwater is sent to treatment plants, it can exceed the rate up to which treatment plant is able to treats the water. Drains are also not designed to capture the huge inflow. This is non-attenuated flow. Thus, floods happen.

Thus, instead of all the water being released in a short period of time, it needs to released gradually in a longer period of time. This is called attenuated flow. The excess water can be stored in detention structures if natural basins like retention basins or detention basins cannot fulfil the purpose.

This picture shows the metropolitan area outer underground discharge channel at the outskirts of the city of Tokyo. This is a very famous discharge

structure. It is the largest underground flood water diversion facility that stores the floodwater and gradually releases it so that neither the water supply nor the treatment plants and the water channel is overwhelmed.

There are five silos or chambers which are 65 meter deep and 32 meter in diameter. These are connected via 6.5 kilometres of long tunnel. These are all connected to a storage tank which is around 25.4 meter high and 177 meter long and supported by 59 pillars. This is drained once filled by using 78 pumps and 14000 horsepower turbines. 200 tons of water is released per second in the Edogawa River.

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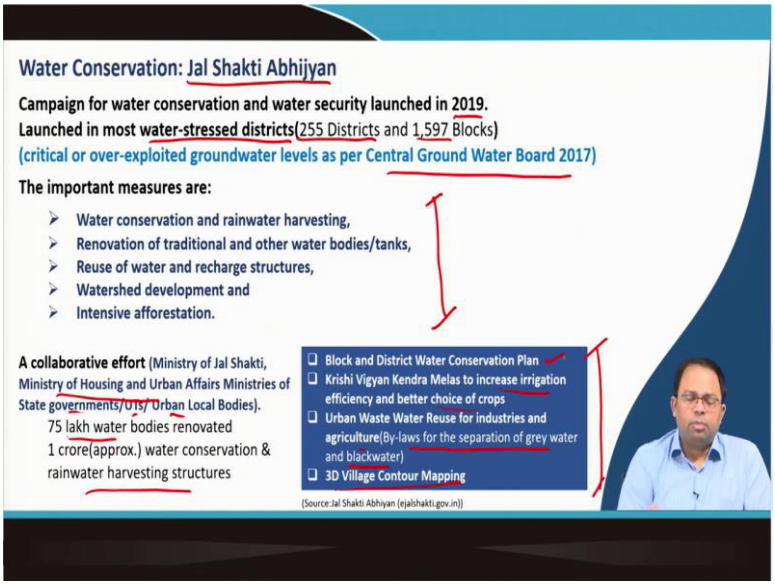

Water conservation: Jal Shakti Abhiyan

Jal Shakti Abhiyan is the program which has been launched by the government for water conservation and water security. This campaign has been launched in 2019 in the most water stressed districts of India (255 districts and around 1597 blocks) as per the Central Groundwater Board, 2017 report. The important measures in this campaign are include

water conservation and rainwater harvesting, renovation of traditional and other water bodies and tanks, reuse of water and recharge structures, watershed development, and intensive afforestation.

A collaborative effort by the Ministry of Jal Shakti, Ministry of Housing and Urban Affairs, ieMinistries of State Governments, urban territories, urban local bodies have renovated around 75 lakh water bodies and introduced 1 crore water conservation and rainwater harvesting structures.

In this project, block and district water conservation plans are prepared. Krishi Vigyan Kendra Melas are organized to increase efficiency of irrigation, and help to choose better crops for that particular area. It also implementedconsiders

urban waste water reuse for industries and agriculture. By-laws are introduced for separation of grey water and black water in an urban area. Then, 3D village contour mapping is also done to understand the flood possibilities and other drainage requirements for different rural areas.

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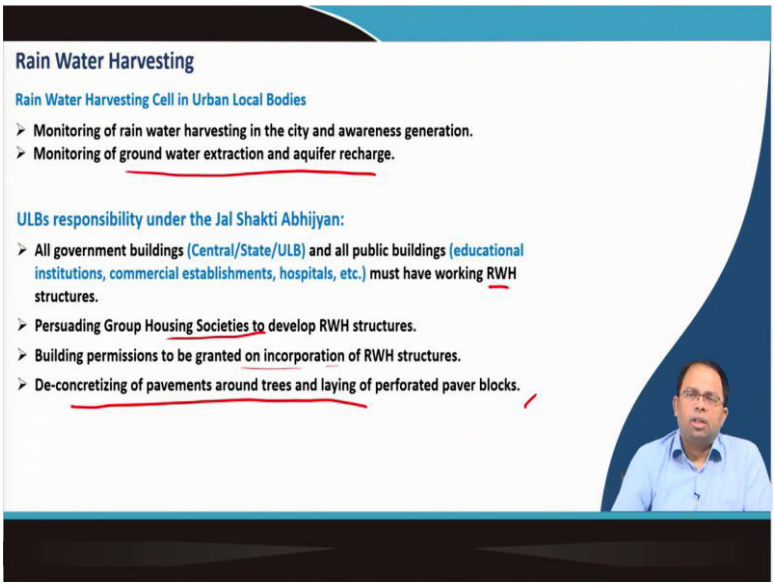

Rainwater harvesting

Rainwater harvesting cell has been created in urban local bodies, where not only monitoring of rainwater harvesting in the city is done but also monitoring of groundwater extraction and aquifer recharge is also undertaken. Regarding this, tThe responsibilities of ULBs under Jal Shakti Abhiyan to improve the water sensitivity of that or the water reuse include:

- Making mandatory the working rainwater harvesting structures in all government buildings and public buildings
- Persuading group housing societies to develop rain water harvesting structures
- Building permissions to be granted only with incorporation of rainwater harvesting structures
- De-concretizing of pavements around trees and laying of perforated paver blocks

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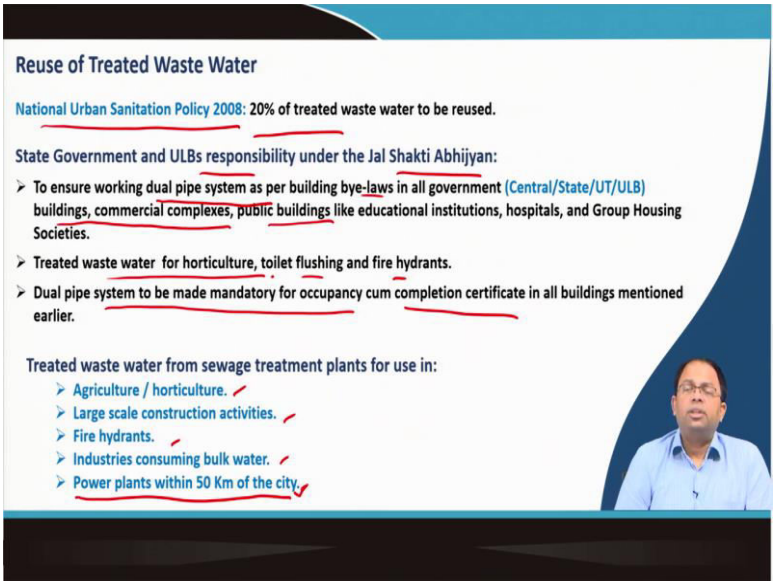

Reuse of treated waste water

According to National Urban Sanitation Policy, 2008; 20 percent of wastewater should be reused. Thus, state governments and ULBs have been made responsible under Jal Shakti Abhijyan to achieve this. The responsibilities are:

- Ensuring working dual pipe systems as per building bye-laws in all government buildings, commercial complexes, public buildings like educational institutions, hospitals and Group Housing Societies. Dual pipe systems are for not only for the standard water supply pipes, but also for water supply through secondary sources like harvested rain waters or treated water. This water may not used for portable purpose,purpose; they could be used for other purposes.

- Usage of treated water for horticultureal, toilet flushing, fire hydrants, etc.

- Dual pipe system is to be made mandatory for occupancy cum completion certificate in all necessary buildings. Whenever the completion certificate is given for a building, it is checked that dual pipes are led for that particular building.

The treated wastewater could be used in agriculture/ horticulture, construction activities, fire hydrants, industries consuming bulk water, and power plants within 50 kilometer of the city. The usage of treated water in appropriate way can reduce the water requirement for urban areas.

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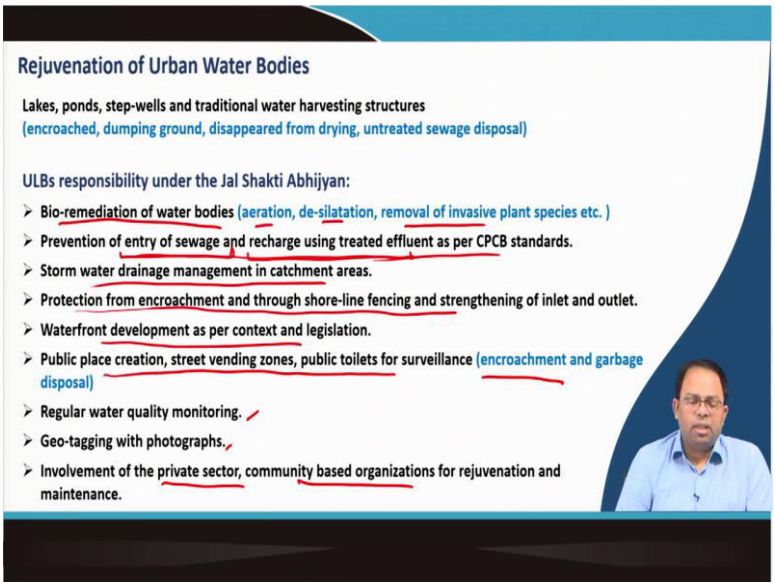

Rejuvenation of urban water bodies

The existing lakes, ponds, step-wells and traditional water harvesting structures which have been encroached upon, converted into a dumping ground, or disappeared fromdue to drying or from untreated sewage disposal should be rehabilitated or put to .reuse. Under Jal Shakti Abhiyan, ULBs have been made responsible for the following tasks:

- Bioremediation of water bodies which include aeration, de-silatationsiltation, and removal of invasive plant species
- Prevention of entry of sewage and recharge using treated effluent as per CPCB standards
- Storm water drainage management in catchment areas
- Protection from encroachment and through shore line fencing and strengthening of inlet and outlet
- Waterfront development as per context and legislation
- Public place creation, street vending zones, public toilets for surveillance
- Regular water quality monitoring

- Geo-tagging with photographs
- Involvement of private sector and community based organizations for rejuvenation and maintenance of water bodies

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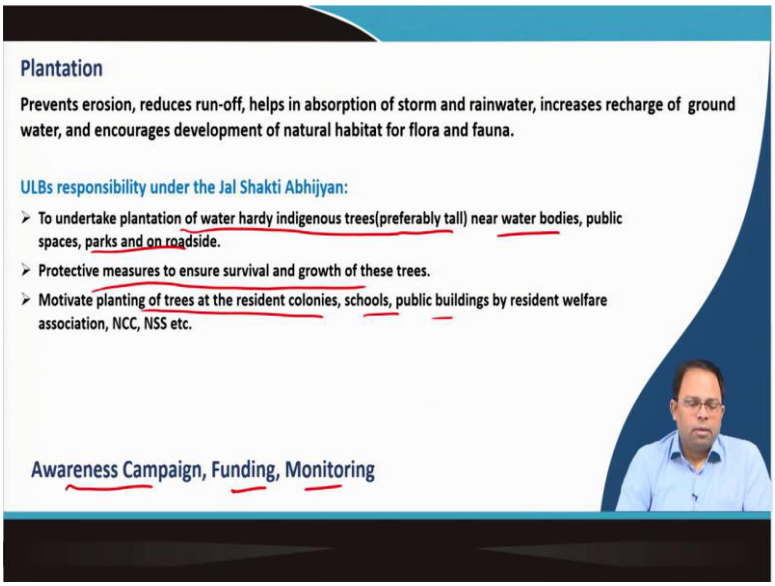

Plantation

Plantation is also a part of Jal Shakti Abhiyan because these prevents erosion, reduces runoff, helps in the absorption of storm and rain water, increases recharge of ground water, and also encourages development of natural habitat for flora and fauna.

ULBs have been made responsible to undertake plantation of water hardy indigenous trees (preferably tall) near water bodies, public spaces, parks and roadside. They are also responsible to undertake protective measures to ensure the survival of these trees. In addition, they motivate planting of trees at residential colonies, schools, public buildings and so on. This program is making various changes to water-stressed districts. This also requires

awareness campaign, funding, and monitoring that needs to be considered while designing these kinds of programs for an urban area.

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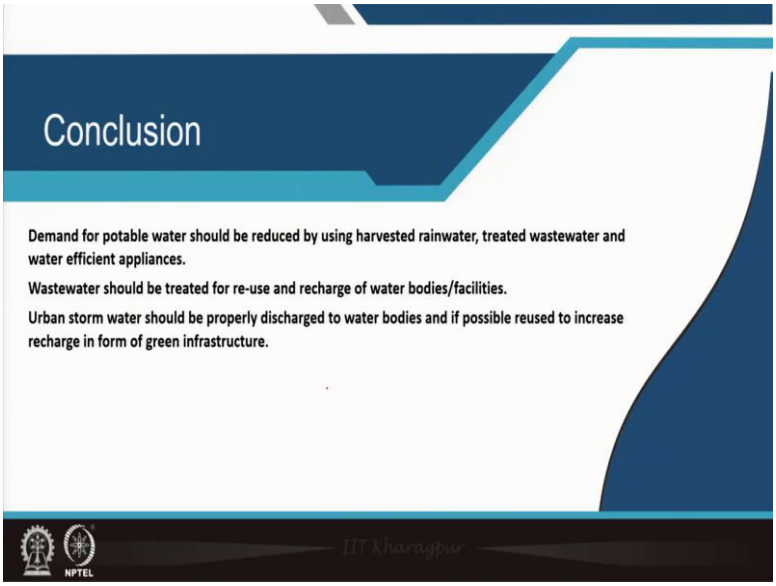

Conclusion

This lecture provides an overview of water sensitive urban planning.

Demand for potable water should be reduced by using harvested rain water, treated wastewater and water efficient appliances for all urban areas. Wastewater should be treated for re-use and recharge of water bodies and facilities.

Urban storm water should be properly discharged to water bodies and if possible reused to increase recharge in form of green infrastructure. These concepts provides an understanding about how we should look into utilities planning for urban areas in Indian urban areas for future.

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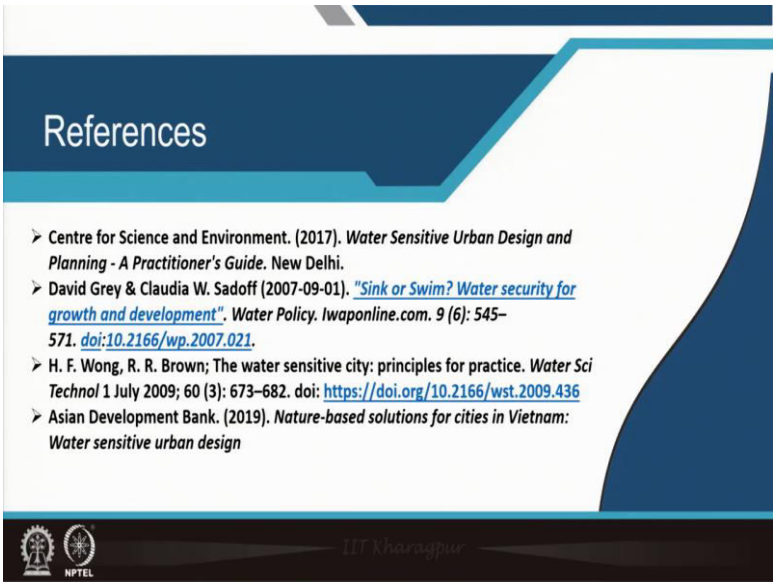

These are the references.