Urban Utilities Planning: Water Supply, Sanitation and Drainage
Prof. Debapratim Pandit
Department of Architecture and Regional Planning
Indian Institute of Technology, Kharagpur

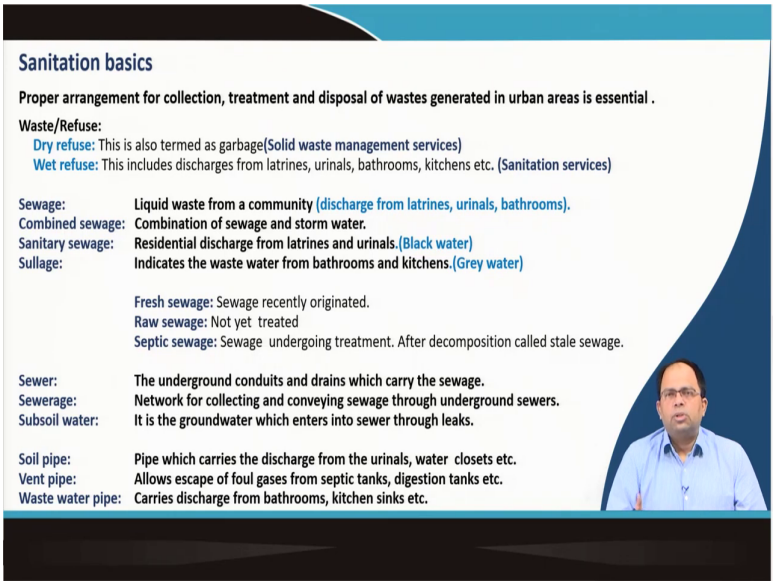
Module - 07
Sanitation and Drainage Fundamentals
Lecture - 31
Sanitation Basics Part I

In module 7, Sanitation and Drainage Fundamentals will be discussed and in this lecture Sanitation Basics Part 1 will be discussed.

(Refer Slide Time: 00:39)

The different concepts that will be covered in this lecture include sanitation basics, key issues of sanitation, the purpose of sewage collection, conveyance and disposal and finally, we will talk about sewerage and sewage treatment responsibilities.

(Refer Slide Time: 00:56)



Sanitation basics

Sanitation is the proper arrangement for collection, treatment and disposal of liquid wastes. This is an essential service that has to be provided in all urban areas. Usually sanitation deals with the liquid waste part, but sanitation can include both dry and wet refuse.

Dry refuse is dealt through solid waste management services. Wet refuse is the discharge from latrines, urinals, bathrooms, kitchens and other parts of the building and is covered in sanitation services.

In this course, only the liquid waste part will be discussed. Before going into the details of sanitation and the sewerage network design, there is need to understand some basic definitions.

Sewage refers to the liquid waste that is generated from a community. It is primarily the discharge from latrines, urinals, bathrooms or may be storm water from the roof and gardens. In addition, storm water which falls on the different parts of the urban area is included as a part of sewage. So, combined sewage is a combination of sewage and storm water.

Sanitary sewage refers to the discharge that comes from the latrines and urinals. Sometimes, it is also referred as black water. Sullage indicates waste water from bathrooms and kitchens which is sometimes referred to as grey water.

The reason why we treat sewage is to convey sewage or take away the sewage very quickly from home, treat it and then dispose it sine nobody want it to decompose inside the building. Thus, when sewage is categorized, it is as per fresh sewage which is the recently generated sewage. Raw sewage which is not yet treated and septic sewage which is sewage undergoing treatment and after decomposition it is called stale sewage. There is also a need to understand conveyance networks or the networks that carry sewage from the homes to the disposal point which can be a river or a land parcel.

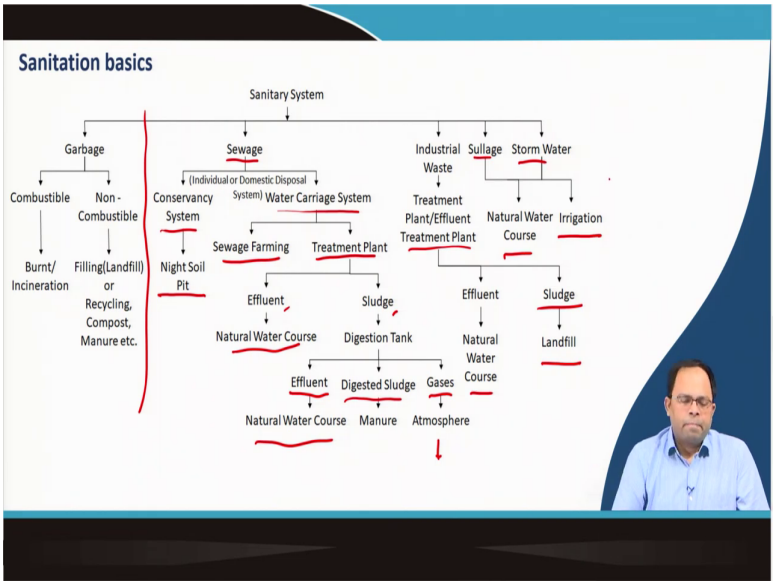
Sewer is basically the underground conduits and drains which carry the sewage and sewerage is the network for collecting and conveying sewage through underground sewers. Thus, sewer is the individual pipelines whereas; sewerage is the entire network of pipelines.

Subsoil water is basically the ground water which enters into the sewers or the sewage pipelines through the joints and other kinds of leaks that develop in the pipelines.

In buildings, there are soil pipe, vent pipe and waste water pipe.

The soil pipe is the one which carries the discharge from urinals, and water closets. Vent pipe is the one which allows escape of foul gases from septic tanks and digestion tanks. Waste water pipe is the one which carries discharges from bathrooms, and kitchen sinks.

(Refer Slide Time: 05:05)



Regarding the entire sanitation system, there are various components such as garbage (dry waste) and sewage(liquid waste). In addition, there is industrial waste, sullage, and storm water.

Garbage could be categorized as combustible, non-combustible and other categories as shown in the Figure. Regarding sewage, there are different kinds of sewage treatment or sewage conveyance system, i.e., conservancy system and water carriage system. Conservancy system are the old system that can be found in villages and other places where there is no network of sewer pipelines. The waste generated from conservancy system is treated in night soil pit. Pits are basically hole in the ground where the waste automatically gets treated.

Water carriage system carries the sewage or waste that is liquid waste that is generated via medium of water and through pipelines. This could be finally, taken to either sewage farming or to a sewage treatment plant. In sewage treatment plant, both the effluent as well as the sludge is treated.

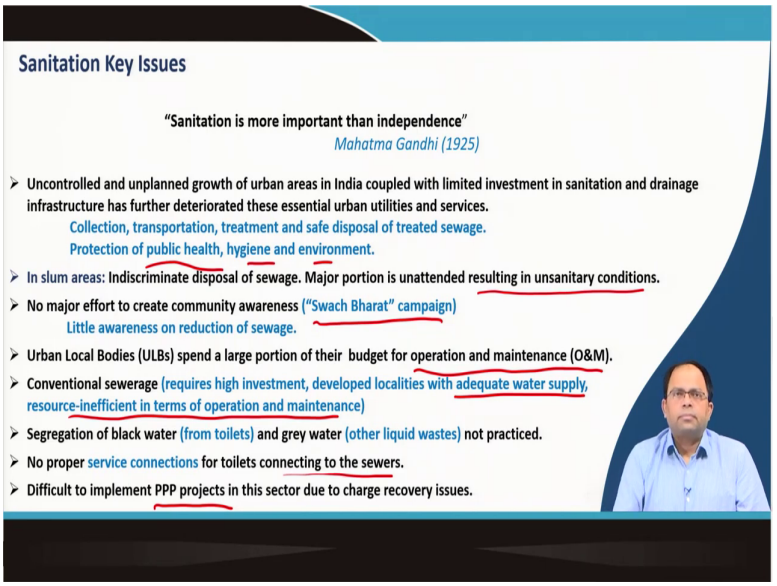
First, when the sewage is treated, it results in effluent and as well as sludge. Then, the effluent could be disposed in the natural water course whereas, sludge is further treated in digestion tanks where the sludge is left for a longer period from where effluent is obtained

again. It also generates digested sludge and gases. Gases get released to the atmosphere, while digested sludge can be used as manure and effluent goes to natural water course.

Regarding industrial waste which is primarily water, effluent treatment plant is within the premises of the industry because in urban areas industries cannot dispose or discharge effluents without treatment. Effluent after treatment is disposed in natural water course and the generated sludge is taken to landfill since industrial sludge cannot be used for sewage farming or preparation of manure.

Similarly, sullage which is the water that is generated from bathrooms, and kitchens along with storm water is part of sewage as well. It can be treated separately. It can also be taken and then disposed directly into the natural water course or can be used for irrigation. In case of advanced economies with adequate resources a storm water treatment plant can be set up.

(Refer Slide Time: 08:52)



Sanitation key issues

Mahatma Gandhi has said that 'sanitation is more important than independence'. Thus, sanitation is very important. It is linked with public health, well-being and it should be the first thing a society has to care for.

When urban planning initially started, one of the primary concerns was to develop plans or to design our cities such that the grey water and black water is drained off from the point of origin to disposal points.

When, sewerage networks were not present, people used to dispose the waste in front of their houses which led to pandemics. When people became more aware, then sewerage networks or drainage networks came into being.

Regarding different sanitation issues that plagues India we have uncontrolled and unplanned growth in most of our urban areas, but the amount of investment for sanitation and drainage infrastructure was considerably less. The present utilities and services have deteriorated to a large extent as we have not kept pace with the growth.

Even though, new projects have come up, utilities and services are not at par with the kind of cities we want. Efficient collection, transportation, treatment and safe disposal of treated sewage is the target. Finally, the treated sewage should not harm any water body or disposal point.

Protection of public health/hygiene and environment/ecology are also the main concerns. One of the biggest challenges in urban areas in India is the presence of lot of slum areas and indiscriminate disposal of sewage. The major portion of this sewage that is generated in slum areas are unattended which results in unsanitary conditions in slums that leads to diseases like diarrhea as well as vector borne diseases and water borne diseases.

In India, there has been no major effort to create community awareness till the Swachh Bharat campaign which was taken up in the last 10 years. It was the first major initiative to build up community awareness. Sanitation and drainage require a lot of awareness to be created. It also requires users' participation and participation of communities. Else, proper drainage systems and sanitary systems would never be possible.

The other issue is that urban local bodies spend a large portion of their budget for operation and maintenance of infrastructure. It means that money required is not being generated. Another issue is the presence of conventional sewerage system where the pipelines connected

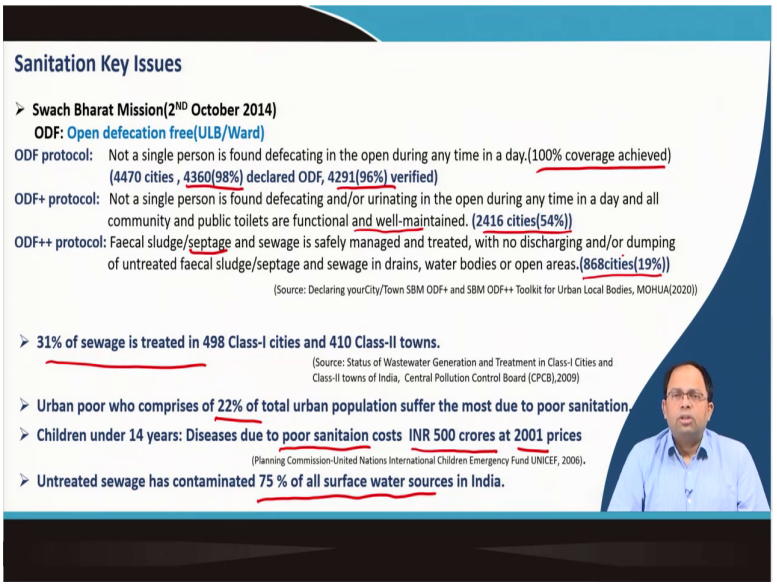
to the houses convey the sewage directly to the sewage treatment plant. This system requires high investment and are plagued by various issues like theft of infrastructure and pipelines.

Moreover, since it is underutilized this leads to chokage and blockage of these pipelines. It also requires adequate water supply which is lacking in many cities of India. There is resource inefficiency in terms of operation and maintenance as well.

Thus, some other form of sewerage system may be appropriate for India or maybe a mix of different kinds of sewerage system is appropriate. Also, segregation of black water and grey water is not practiced in India.

Sewage contains grey water as well as black water and even the storm water from roofs. In most cases there are no proper service connection for toilets connecting to sewers. This encourages people to break the sewage pipeline whenever they feel like to connect to the pipe. This leads to leakage and lot of other issues. In addition, it is difficult to implement PPP projects in this sector due to charge recovery issues. Thus, very few PPP projects exists.

(Refer Slide Time: 15:08)



On 2nd October 2014, the Swachh Bharat Mission was launched. This was the first mission that not only focused on awareness campaign but also focused on three kinds of protocol

known as ODF protocols. ODF is Open Defecation Free and particularly target ULBs and wards in urban areas.

ODF protocols include three protocols: ODF protocol, ODF+ protocol and ODF++ protocol. According to ODF protocol, not a single person should be found defecating in the open during any time in a day. We have achieved almost 100 percent coverage in this aspect. According to the last survey, out of 4470 cities in India, 4360 cities have been declared ODF and 4291 or 96 percent has been verified as ODF as well. It is not only the declaration by the ULB themselves; it has been verified by other sources as well.

ODF+ protocol includes the ODF basic protocol. In addition, all community and public toilet should be functional and well maintained. Thus, not only people should not be found defecating or urinating in the open during any time in the day, but community and public toilet should be functional and well maintained. Thus, the role of community toilets and public toilets are very important. Around 54 percent of the cities that is 2416 cities are following ODF+ protocol.

ODF++ protocol talks about the treatment of faecal sludge and septage; which is basically the sludge that is generated in septic tanks that has to be taken out at certain intervals for further treatment.

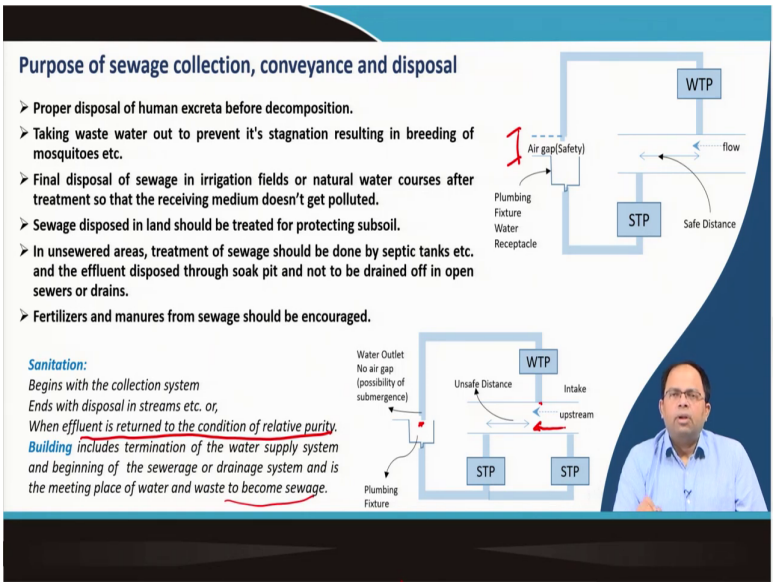
Thus, faecal sludge or septage and sewage is safely managed and treated without discharging or dumping of untreated faecal sludge or septage and sewage in drains, water bodies or open areas. It means that we need to achieve proper treatment of all kinds of waste in urban areas and we should not dispose it without treatment. Only 19 percent of cities in India have been able to achieve ODF++protocol. Thus, considerable efforts are required to achieve this kind of standards.

Around 31 percent of sewage is treated in 498 class – I cities and 410 class – II towns. Among class – I and class – II towns, primarily urban poor suffers the most due to poor sanitation who constitute around 22 percent of the total population.

Medical treatment of children under 14 years in fighting diseases primarily resulting from poor sanitation costs around 500 crores of rupees at 2001 prices which is a huge amount of

money. Untreated sewage has contaminated about 75 percent of all surface water sources in India. This is a big concern that we should be very careful about. Sewage mixing with open water bodies makes it undrinkable or unusable for purposes such as bathing.

(Refer Slide Time: 19:10)



Purpose of sewage collection, conveyance and disposal

There are certain things that need to be achieved whenever any kind of sanitary system is designed. Firstly, there is a need for proper disposal of human excreta before it decomposes. This is our primary goal because as soon as it decomposes, not only it creates problems regarding aesthetics and odor, it also invites lot of disease causing bacteria and pathogens that will spread in that area and can lead to contamination of drinking water which will lead to further diseases.

Waste water must be taken out to prevent its stagnation resulting in breeding of mosquitoes. The vector borne diseases such as dengue, and malaria results from stagnating water due to improper drainage.

The final disposal of sewage in irrigation fields or natural water courses should be done only after treatment, so that the receiving medium does not get polluted. Thus, sewage has to be treated to an extent. Since, we are not able to treat most of the portion of sewage, it

automatically pollutes the water bodies. Sewage disposed in land should be treated for protecting subsoil as the treated sewage is used for sewage farming purposes.

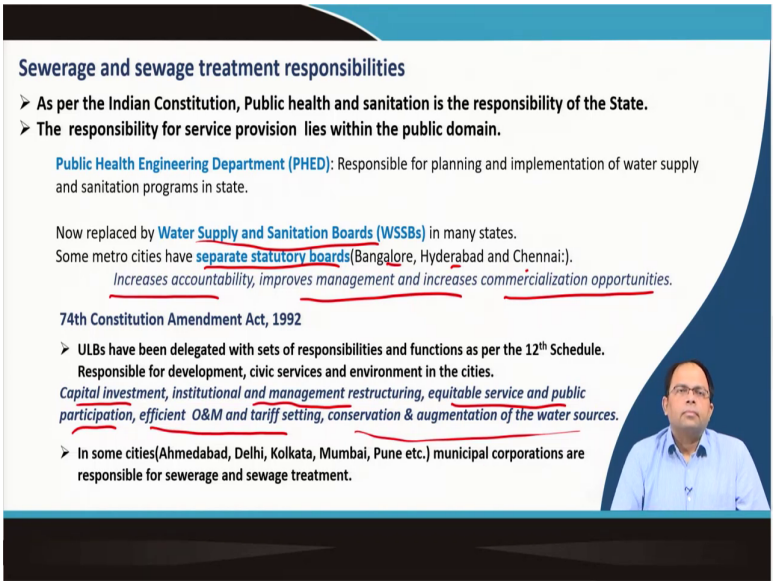
In unsewered areas, treatment of sewage should be done by septic tanks and effluent disposed through soak pit and not to be drained off in open sewers or drain. The effluent that is generated in septic tanks contains a lot of pathogens, thus, cannot be drained directly into the open drains or sewers. Thus, it has to be first treated or it has to be disposed off via soak pit. Fertilizers and manures from sewage should be encouraged for use in urban areas.

Sanitation begins with the collection system and ends with its disposal in streams and water bodies or land in case of sewage farming. We should target that the effluent is returned to the condition of relative purity; which means that once it mixes with the disposal body, the purity of water of the waterbody still remains the same.

Buildings in an urban area are both the termination of the water supply system and the beginning of the sewerage or drainage system. It is the meeting place of water and waste to become sewage. As seen in this image, this is a plumbing fixture where the water supply ends and the sewage system or the waste system begins. This waste system goes to the STP where it is disposed off. There can be multiple STPs and water treatment plant in an urban area. Thus, there should be careful consideration of safe distance between STP and WTP since impure water can enter the WTP which may be difficult to treat. Thus, we should create adequate gap between our STP and WTP so that there are no such issues. Its better to not have STPs upstream.

Within house an air gap should be maintained between the water supply and the waste system. In cases when the air gap is not there, there may be chance of pressure differences and there may be chance that waste may get into the water supply system. Thus, one should be careful about this.

(Refer Slide Time: 23:22)



Sewerage and sewage treatment responsibilites

As per the Indian constitution, public health and sanitation is the responsibility of the state governments.

The entire responsibility of service provision lies within the public domain; that means, government should provide these kinds of services and this is provided through Public Health Engineering Department and they are responsible for both planning and implementation of water supply and sanitation programs in the state. The public health and engineering department can be a state body or a central body. The organization is primarily involved in new infrastructure development, but gradually many states are also getting involved. Water Supply and Sanitation Boards are taking up many of the responsibilities of Public Health Engineering Department and are involved in both construction as well as maintenance.

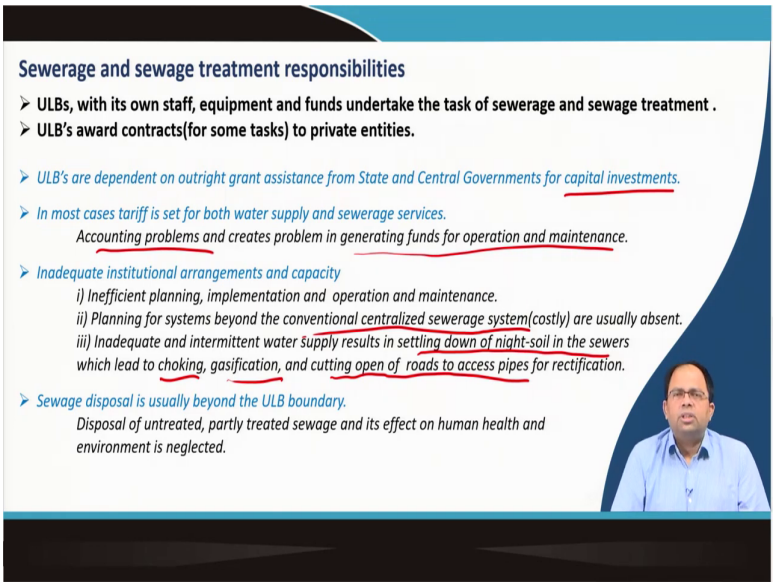
In metro cities, there are state boards. Big metro cities can have their own separate statutory boards as in cities like Bangalore, Hyderabad and Chennai. These statutory boards, can create some special purpose vehicles in such a way that these are independent to a certain extent.

Being independent increases accountability, improves management and increases commercialization opportunities. In PPP projects, some amount of commercialization has happened even for government entities through creation of these special purpose vehicles.

After the 74th Constitution Amendment Act in 1992, ULBs have been delegated with set of responsibilities and functions as per the 12th schedule. They are responsible for development, civic services and environment in cities which means that the entire responsibility of providing sewerage and sanitation services come downs to ULBs. They are responsible for the capital investment part, institutional and management restructuring part, equitable service and public participation part, efficient operation maintenance, tariff setting, conservation and augmentation of water resources in urban areas.

Thus, all the responsibilities of a sustainable sewerage and sanitation system is now the responsibility of ULBs. In many cities like Ahmedabad, Delhi, Kolkata, Mumbai, Pune municipal corporations have taken up the job of sewerage and sewage treatment.

(Refer Slide Time: 26:30)



As ULBs are now involved in various tasks, ULBs has its own staff, equipment and funds who are supposed to do these tasks. But everything is not possible to be done by the ULBs because they may neither have the technical knowhow or neither have the manpower capacity. Thus, they sometimes award contracts to private entities as well.

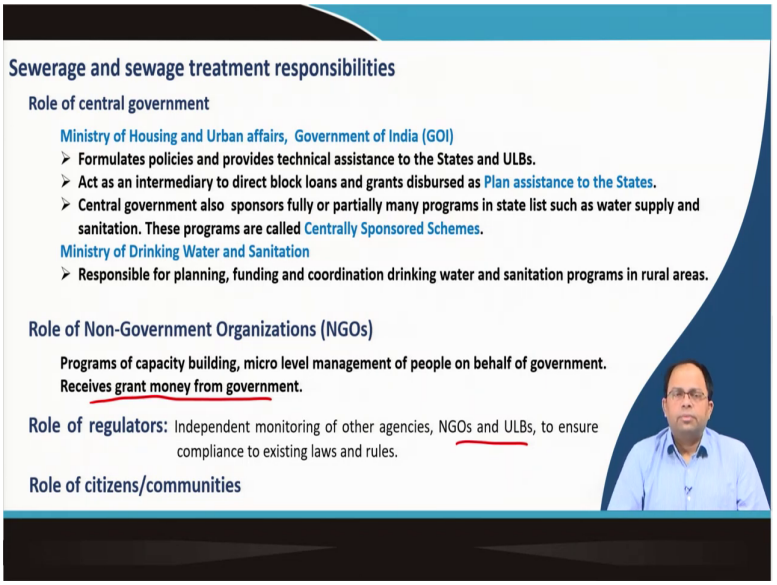
ULBs are unable generate funds within through user charges. ULBs thus depend on the grants from state and central government for capital investments since, these are huge investments.

In most cases, ULBs set tariff both for water supply and sewerage services together. This leads to some accounting problems and in generating funds for operation and maintenance. If there is more expenditure of funds for one task, others tasks might suffer.

ULBs have perennial issues of inadequate institutional arrangements and capacity. This is one of major problems in ULBs and primarily results in inefficient planning, implementation and O&M services. Usually ULBs plan mostly for conventional centralized sewerage system like sewer networks, which is a costly system. Inadequate and intermittent water supply also results in settling down of night soils in sewers. This is another big issue because we do not have 24 hour water supply system in Indian cities and in most cases water supply is for a few hours in the morning and evening. This leads to choking, and gasification. H_2S gas is one of the biggest problems in sewer design. So, we need to cut open the roads to access pipes for rectification which leads to another set of problems. These are some of the issues regularly faxed by many ULBs.

In addition, another big issue is that the disposal of sewage is usually beyond the ULB boundary. ULBs undertake some treatment but whenever the sewage load is high, particularly during the rainy season, the waste is disposed without treatment or with partial treatment. This causes a lot of health and environment problems in the disposal area but because it is not the responsibility of the ULB, they may ignore it. These are some of the issues that we are facing in Indian cities.

(Refer Slide Time: 29:46)



Regarding the role of the Central Government, the Ministry of Housing and Urban affairs and the Ministry of Drinking and Water Sanitation are primary responsible for sewerage and sewage treatment. While Ministry of Drinking Water and Sanitation is primarily in charge of rural areas, Housing and Urban Affairs is in charge of the urban areas. Their job is to formulate both policies and to provide technical assistance to state and ULBs via preparation of manuals and sometimes through funding as well. They sometimes act as an intermediary to direct or to determine who should get the loan or a grant while money is being disbursed through planned assistance to states.

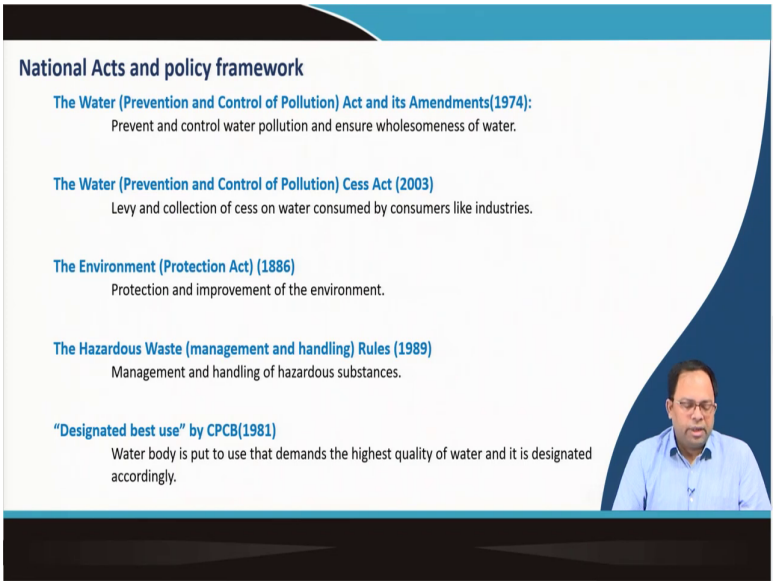
Central Government also sponsors fully or partially many programs in state list such as water supply and sanitation. Sometimes, they directly invest and these are called centrally sponsored schemes. This is how the central government actually plays a role in the sewerage and sewage treatment.

In addition, we have Non-Governmental Organizations that are primarily responsible for capacity building. They also do micro level management of people on behalf of government like running a community based service or drain cleaning services and similar services where there is a need to deal with many people or laborers who will actually work on the system.

NGOs actually take charge of this task for which sometimes they also receive grant money from the government. Then there are regulators including monitoring agencies such as NGOs, and ULBs to ensure compliance to existing laws and rules, and sometimes even the service level benchmarks as well.

And finally, we have citizens and communities who have the role of monitoring, complaining and making sure that the problems are identified. They can designate the areas that needs to be improved via grievance cells.

(Refer Slide Time: 32:11)



National Acts and policy framework

Different National Acts and policy frameworks are discussed below. The Water Act and its Amendment in 1974 prevents and control pollution to ensure wholesomeness of water. This is the first act that is connected with sewerage and sewage treatment.

The water (Prevention and Control of Pollution) Cess Act (2003) talks about levy and collection of cess on water consumed by consumers like industries. The Environmental Protection Act of 1886 looks into improvement of the environment and its protection. The Hazardous Waste (management handling) Rules (1989) looks into the management and handling of hazardous substances related primarily with solid waste management.

In the ‘designated best use’ by CPCB (1981), water body is put to use that demands the highest quality of water and it is designated accordingly. This is directly related with restoration of water bodies or use of water bodies.

(Refer Slide Time: 33:20)

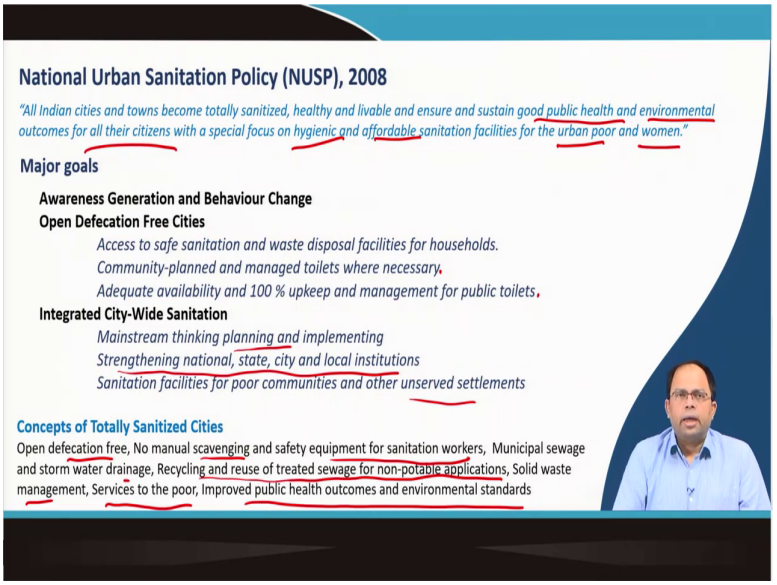
The General Standards for Discharge of Environmental Pollutants under the Environmental Protection Rules (1989) talks about specific standards for emission and effluent discharge, general standards for discharge of environmental pollutants, ambient air quality standards.

Coastal Regulation Zone Notification (2011) looks into livelihood protection, coastal area ecology, and economic activities generation. This act also ensures restriction on sewage outfall in coastal areas which is one of the crucial points.

Prohibition of Employment as Manual Scavengers and their Rehabilitation Act (2013) prohibits not only manual cleaning of sewers and septic tanks, it also talks about elimination of insanitary latrines to at least twin pit pour flush latrines and rehabilitation of manual scavengers in alternative occupations.

The National Urban Sanitation Policy of 2008 is also a crucial Act which is primarily the directive for proper sanitation services in urban areas.

(Refer Slide Time: 34:37)



National Urban Sanitation Policy (NUSP), 2008

The National Urban Sanitation Policy says that all Indian cities and towns should become totally sanitized, healthy and livable and ensure and sustain good public health and environmental outcomes for all their citizens with a special focus on hygienic and affordable sanitation facilities for the urban poor and women. These are the vulnerable groups one should take care of. The services should be affordable and should be hygienic for all citizens and good for public health as well as environment. This is the goal of our National Urban Sanitation Policy.

Regarding detail goals, first, we need to create awareness and ensure behavior changes. This task is difficult since considerable effort is required to create awareness. A large share of people are used to throwing garbage in the places where it is not intended such as drains. Thus, this kind of awareness campaign must be run for a long duration of time. In addition, some amount of fine or penalty has to be imposed for defaulters to actually change the behavior.

Once this is achieved or simultaneously, there should be efforts to make the cities open defecation free. The Swachh Bharat Campaign has been able to achieve this to a large extent. Access to safe sanitation and waste disposal facilities for households must be ensured;

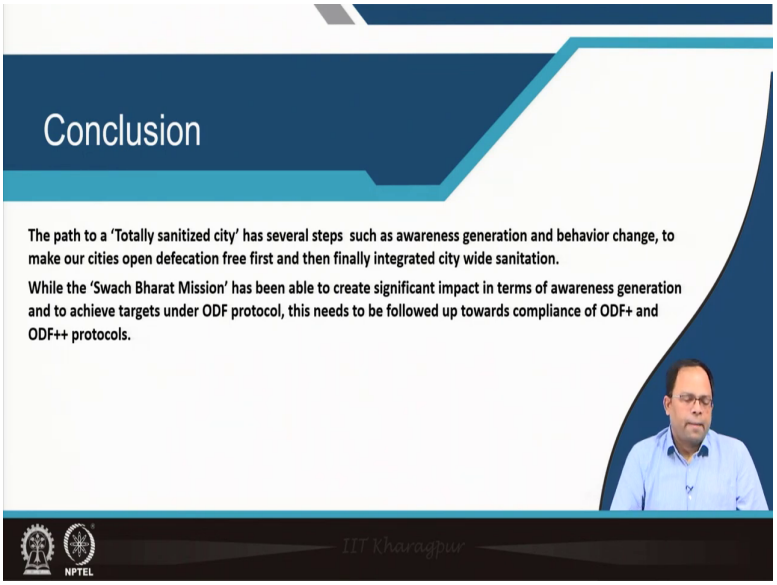
community planned and managed toilets should be planned wherever necessary and adequate availability and 100 percent upkeep and management of public toilets should also be ensured. In the last subtask, India is still lacking, but eventually would be able to achieve.

Integrated city-wide sanitation is the final step where not only open defecation is taken care of, planning the entire sewerage networks or the kind of treatment systems are also implemented in a particular urban area. Also, strengthening the different institutions, i.e., state, city and local institutions are also ensured by building up capacities in those and sanitation facilities for poor communities and other unserved settlements.

This will lead to the concept of fully sanitized cities where we not only plan for sewage treatment, but also for recharge, and reuse of treated sewage for non-potable purposes, services to the poor, and improved public health outcomes and environment standards. All these major goals will lead to the concept of totally sanitized cities which are open defecation free, without manual scavenging and with access to safety equipment for sanitation workers. Cleaning of sewers, drain, bigger channels should be done mechanically and through equipment.

Thus, this is the concept of totally sanitized cities that we should target.

(Refer Slide Time: 37:46)



Conclusion

To conclude, the path to a 'Totally sanitized city' has several steps such as awareness generation and behavior change, making the cities open defecation free first and then finally, integrated city wide sanitation policies and programs which would be able to take care of all the different aspects that were already discussed in this Lecture.

While the Swachh Bharat Mission has been able to create significant impact in terms of awareness generation and to achieve targets under ODF protocol, this needs to be followed up towards compliance of ODF+and ODF++ protocols.

(Refer Slide Time: 38:23)

References

These are the references you can study.