Wastewater Treatment and Recycling
Prof. Manoj Kumar Tiwari
School of Water Resources
Indian Institute of Technology, Kharagpur

Lecture - 04
Wastewater Management: Concept of Treatment and Recycling

Hello friends, welcome back. This week we have started this course Wastewater Treatment and Recycling and earlier in the previous 3 lectures, we discussed basic about the course and then, what are the different sources and types of wastewater. So, we were discussing the various points and non-point sources of wastewater earlier. Now, we will talk about the concept of treatment and recycling which is the basic need of treatment, basic need of we briefly talked about it earlier in the very first lecture. But we are going to see some more prospective details of why we need treatment, and what is the significance and importance of recycling in the sense of wastewater management in this particular lecture.

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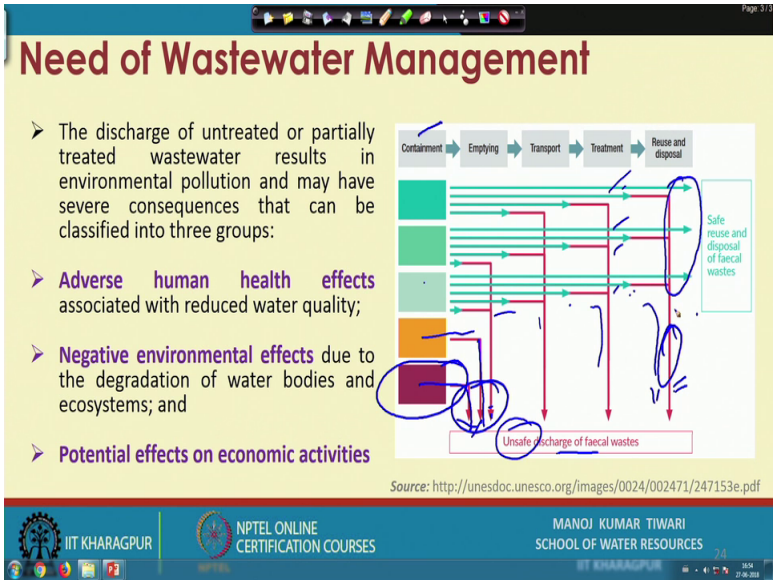

To begin with, first thing comes that why we need wastewater management, ok. We have been using water since ages. We have been sort of letting that flow, the used water or wastewater or sewage whatever we call it, we were letting the sewage flow in our natural systems either rivers, soils, anywhere and we have not been bothering earlier like since few centuries back. But with the progress of the time, with more and more population

increased and the development taking place in the form of a lot more urbanization where there is a huge population lives in a relatively smaller area, there after industrialization. So, all these things has sort of in a way concentrated the load in much more much more qualitatively as well as quantitatively concentrated form.

So, then the bulk of pollution getting released at one particular point, one particular location or one particular state has started creating several problems, multi-fold problems. The discharge of untreated or partially treated sewage typically results in environmental pollution and everybody agrees, everybody accepts that. It may have severe consequences that can be classified into three major categories. So, one is the adverse human health effect, which is primarily associated with the reduced water quality. Wherever we discharge that water, the wastewater, it actually the wastewater itself is of poor quality and then, whenever it meets a natural water system, it basically pollutes that as well.

So, large portion of water gets polluted and that results in sort of particularly because human relied let us say we are letting cities sewage, untreated sewage flow in a river. So, river water quality is also polluting. Now, many habitat, many small villages, many small towns significant degree of population may actually be surviving on that river, means that river is sort of fulfilling their water demands.

So, if the people are consuming that water and for say take an example of river Ganga, so river Ganga, the Kanpur cities sewage treated, sewage all that is treated, but let say first assume it is not treated with the required quality, or it is poorly treated water or partially treated water. If it meets to the river Ganga, the overall water quality in Ganga is likely to deteriorate. Now, by the time Ganga reaches means there are after Ganga passes through various small villages, few towns Fatehpur and then, eventually connects with Yamuna in Allahabad, so you may have for a size of city of Allahabad. You may again plan to pull water and then, put a treatment for supply, but what about those many small villages and towns across that. So, for them they might be relying directly on Ganga water which is contaminated with the sewage that has meet in Kanpur for say. So, in that case when the people are using such water which is amended with the waste water, also the quality has deteriorated. So, then they basically invite a lot of health risks, ok.

There is severe consequences could happen in terms of health effects, ok. So, that is one aspect. Then, there is negative environmental effects due to sort of degradation of water bodies and ecosystem. So, when such water meets and pollutes natural system, obviously there will be environmental effects of that and there could be potential economic effects as well, ok.

So, these are the three broad categories; there could be human health impacts, environmental effects as well as economic effects. So, these are the three broad categories in which these effects can be categorized. Now, if you see this diagram over here, you get a contaminant that how typically happens that many different municipalities or different governing agencies, governing bodies do different type of governance. You take a small village where nothing is there. People directly use water and that contaminated water directly gets discharged, ok. Then, at some places it might be basically getting collected or channelized to a collective system and thereafter, it is emptied. In some cases, it might actually receive some degree of transport, some degree of collection and even some degree of treatment also at times, but if that is not adequate and in whatever stage, it is getting discharged until unless it is completely treated and it is properly reused or disposed of. Whatever stage we are discontinuing it, the level of risk could be different, but there is a risk associated with it, ok.

These are probably the most dangerous or most risky options. Here you have achieved some partial degree of treatment. So, the red line that you see here has much less threat as compared to this red line, but this one also is not totally safe. So, there is some degree of risk involved in this as well. If it is a unsafe discharge because it has not been adequately or it has not been properly treated, so those kind of issues comes in there now as we were discussing 3 broad categories or 3 broad groups of the adverse impacts.

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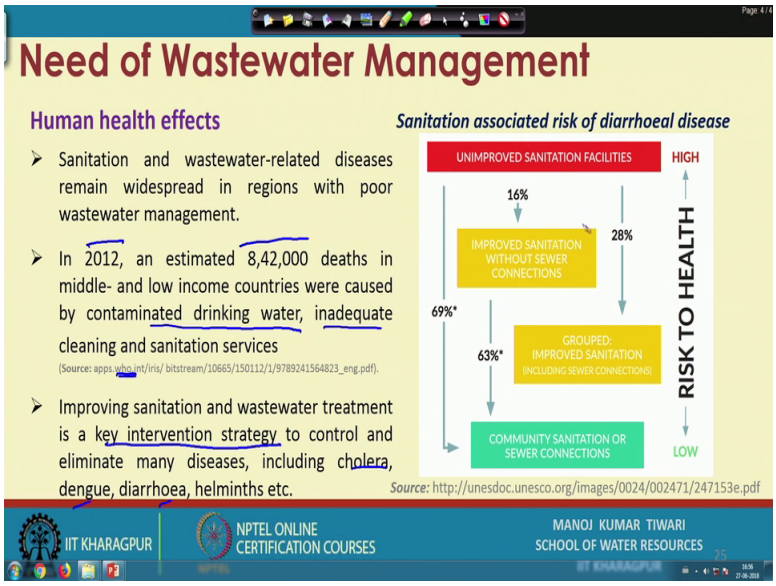

So, if we see first human health impact, so in human health impact, the sanitation or wastewater related diseases, they sort of remain widespread in the region where there is a poor wastewater management practices are adopted. So, if the wastewater management practices are not good, if there is no proper sewer line, if the waste is not channelized in a proper fashion to a treatment facility, then there is always chance of human exposure to that waste water and such exposure impose as a great degree of risk for the human health, ok.

If we see the WHO report, World Health Organization report, they in their report claimed in 2012, claimed that around 8 and half lakh of deaths in middle and low income countries have been caused due to the contaminated drinking water in that particular year, ok. So, it is either due to contaminated drinking water or inadequate cleaning and sanitation services. So, this includes let us say not proper hand washing facility, not proper toilet facility, not proper sewer connections. Whatsoever if this cleaning and sanitation services are inadequate and the drinking water sources are not good enough that attracts a great degree of health risk. The idea is that improving sanitation and wastewater treatment is normally accepted as a key intervention strategy. So, people believe that if we sort of provide a proper sanitation and wastewater treatment facility we can eliminate so many water borne diseases or so many water base diseases, this could include cholera, dengue, diarrhoea. There are many more actually.

As study conducted, it has shown that how let us say risk of diarrhoea diseases or risk of diarrhoea reduces with the proper sanitation facility. So, you see that this is unimproved sanitation facility, the risk is quite high. Now, you do the improvement, around 16 percent improvement, the risk further reduces to 28 percent, risk further reduces by around 70 percent reduction. The community sanitation or sewer connection if we connect, the risk is very low for such diseases. So, that is how the like human health aspect can be considered one of the triggering factor or one of the important factor which sort of emphasizes that there is a severe need for wastewater management or good wastewater management practices.

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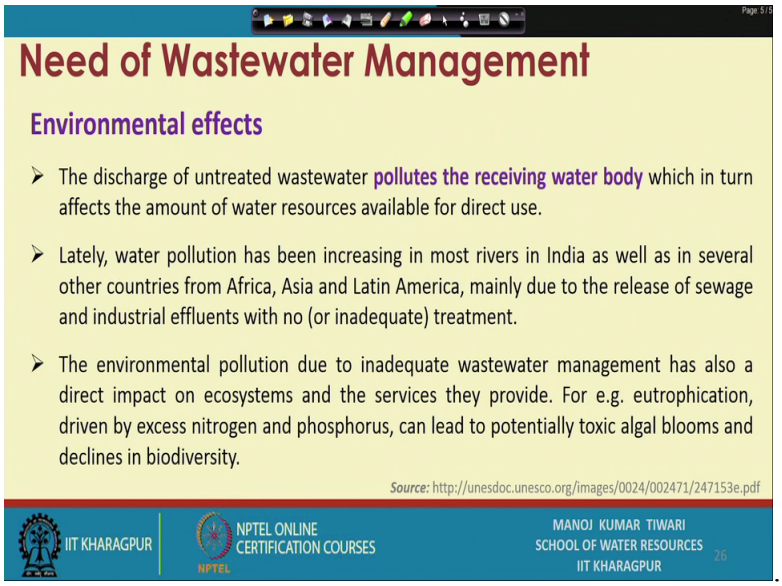

The environmental effects as we were discussing earlier, so if we start discharging say polluted water in the receiving body, the body which receives polluted water will in turn get polluted and then, your entire resource, water resource which is available for direct use it we are not, when we are considering the environmental effect of the natural effect on the nature, we are not just bothered about the human consumption, but all other. We have so many other ecosystems, aquatic ecosystem, terrestrial ecosystems also depends on last degree of surface water bodies. So, all those ecosystems you are having contaminated water in a river. So, your fishes are likely to get contaminated, your animal surviving on that river for drinking purposes and all that are likely to get exposed to the such water. So, it posses risk of a great degree for the environmental damage as well, ok.

So, the water which is available for direct use if that gets contaminated, then we are of course exposing our ecosystem to a contaminated water. Lately water pollution has been increasing in most of the rivers in India ok. We have seen the state of Ganga, Yamuna, all major rivers how polluted they are and it is not only in India, it is there in several other countries also. So, other countries from Africa, Asia, Latin America only if you like discount for some developed countries, the status is not very like good in many other countries are most of the, most part of the world, ok.

So, the issues are similar, the problems are very much similar. So, this pollution of rivers are mainly attributed towards the release of sewage and industrial effluent with no or

inadequate treatment. So, that is one of the major reasons why these our natural body natural rivers have been considered, have been sort of slowly and steadily getting polluted.

There is an interesting case study of Thames river in Britain, in England. So, how at one point of time, it was basically completely lost its pristine stage it was like a very dirty drain kind of thing and they slowly and steadily then started managing their sewage. They built quite a few sewage treatment plants and industrial waste effluent treatment plants, then channelize the treated water into that which started improving condition. Later on with further urbanization the condition once again started deteriorating in the around 70s or 60s and then, they further tried to revamp that. So, they moved these treatment plants or these things out of the city. So, quite a few of efforts has been made in order to restore that river, so, those kind of examples are there even in the developed world as well.

So, environmental pollution due to an inadequate wastewater treatment has also direct impact on ecosystem and these services it provide, for say we can take an example of lake which is receiving some effluent or some wastewater which is rich in nitrogen and phosphorus. So, that will obviously lead their algal bloom or eutrophication which is kind of potentially toxic for the biodiversity of that particular lake. So, this kind of environmental effects are very prominent and are often seen.

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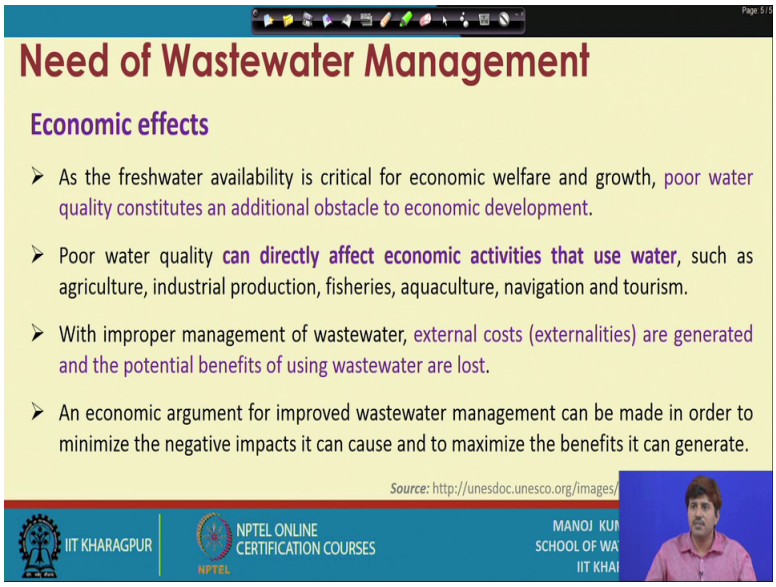

There are economic effects as well. So, economic effects are mostly indirect effect though, ok. Human health effects if we are relying on contaminated water, one can see it directly and even the environmental effects. Most of the environmental effects can be seen directly, some are indirect effect as well, but there are lot of indirect economic effects as well.

Consider that you, for say you are adding untreated or inadequately treated water to a river. The water is getting polluted, then in downstream some cities relying for their drinking water facility on that river so if they are withdrawing that water, they have to provide certain degree of treatment in order to get that water usable. If rivers are in pristine stage, a very little or nominal treatment could do, but if you are contaminating the river with say severe pollutants or industrial pollutants or some other kind of things which are unacceptable for portable uses of the water. Then the downstream city or downstream municipality have to arrange for that degree of treatment which may incur huge cost, ok. So, this becomes a burden because somebody is polluting water in the river in upstream, the downstream regions or downstream areas suffer.

So, we all understand that fresh water availability is very critical for economic welfare and growth, and if you are getting poor water quality, it constitutes additional obstacles for the economic development. So, there would lot, you cannot use let say dirty water or a polluted water for many industrial process, you cannot not use for municipal supplies. So, you will have to provide treatment, you will have to incur sort of you have to made certain expenses in order to make that water fit for the purpose, whatsoever purpose it is being used. So, there comes a cost associated with that.

Further the poor water quality can directly affect economic activities that use water it can sort of affect agriculture. We can see a loss of agricultural productivity, ok if we are irrigating a field with not so good quality of water or there is some contaminant in water which you try to irrigate a field with saline water, it will quickly get infertile, ok.

So, those kind of losses are there, we can get to see a loss of agricultural productivity, we can see economic effects or bad effects on industrial production, fisheries aquaculture, navigation, tourism. So, these are the activities, some of the activities which directly use water and there sort of economic status or this thing is going to be changed if the quality of water that is being used is not adequate, is not pure, ok. We have seen news coming in

that our food grains or vegetables are polluted with this particular contaminant, that contaminant sometimes pesticides or sometimes these things.

So, how it is coming? Because we are not irrigating properly, we are irrigating with not so good quality of water or we are cropping in a soil which is already contaminated. So, in such cases if we like, if such cases arises, that will obviously lead adverse effect on to the productivity, on to the acceptability of those goods, ok. Many times you see if like if there are issues with the quality of any of these food grains or food materials, many for say other materials, other products are also, ok. Many countries will put a ban that, ban on the sort of import of these goods, ok.

So, you are doing a fishery, a fish culture on a much larger scale and then, irrigating with certain water which is not of good quality, putting for fish culture, putting using some water which is not of that good quality. So, and your fish is up taking some contaminant in it you probably will not be able to export that fish to the western countries or to the developed world because they have their own quality control and if they figure out that, it is being grown on such contaminated water, they may actually refuse to take. So, that could incur a huge economic loss, ok. For tourism purpose, we have lot of our water bodies, they take lot of tourist, but if the quality of water deteriorates probably that will, that business is completely going to die down.

Then, there are many other such activities. So, with improper management of waste water, there would be external cost because if you are not properly managing this wastewater, there are likely to be externalities or external cost, which will be sort of generated, for say I was giving an example of the treatment of water for domestic supply. So, if upstream water is contaminated, downstream has to incur more cost for the treatment purpose.

Similarly, like you want to promote tourism and if your inflow water quality is not good, you will have to treat and then, let it flow in the pond, channel whatsoever you are making. So, there are going to be economic externalities in the form of external cost, which will be generated, at the same time, the potential benefits of using wastewater or reusing wastewater are lost. So, because we are letting our water flow, our wastewater flow in some bodies, we are not utilizing or we are not using that a resource because even if it is a waste water as we discussed in the earlier lecture that even it is a waste

water, it is a form of water. Only there are certain contaminants in it and if those contaminants are removed, it can still be used as a resource so we are letting that resource also flow. So, we are not using that resource for beneficial purpose.

So, we are losing some sort of potential benefit out of letting that water flow that is also an economic damage. So, at one place, we are incurring more cost for purification and these kind of thing and in one place, we are letting a resource flow we are not using it for sort of targeted or good purpose. So, these kind of issues sort of generate a lot of economic effects. So, the economic argument for improved waste water management are fairly simple, ok, it can simply be made that we need to minimize the negative impact, it can cause and maximize the benefit, it can generate. If we are started using, if we are started reusing wastewater, ok. So, we are getting a resource, there is some additional, some value of that. Of course, we will have to incur treatment cost and all that, but that anyway is coming through other means, through externalities and all that.

If we are leaving the pollutants to the environment, we are facing environmental cost indirect, your financial cost, economic cost, then risking human health. So, there are lot many things, lot many risks, which is leading to economic effect, ok. A village is let say fed with poor quality of water, people will often fall sick, as we discussed in the health effects. So, if they are often falling sick, they will have to bear their medical expenses, right. So, that is also, there is an economic burden associated with health risk also there is an economic burden associated with the environmental effects also. So, all things eventually like are connected, ok.

Here a bad environment will lead to bad health will lead to more cost of the treatment or medical facilities, ok. So, all these things are connected and overall holistically if we seeso this appears as a fair proposition that the wastewater should be treated, should be reused as a resource, so that its adverse health effect, adverse effect on the human health, adverse effect on the environment and adverse economic effects could be saved.

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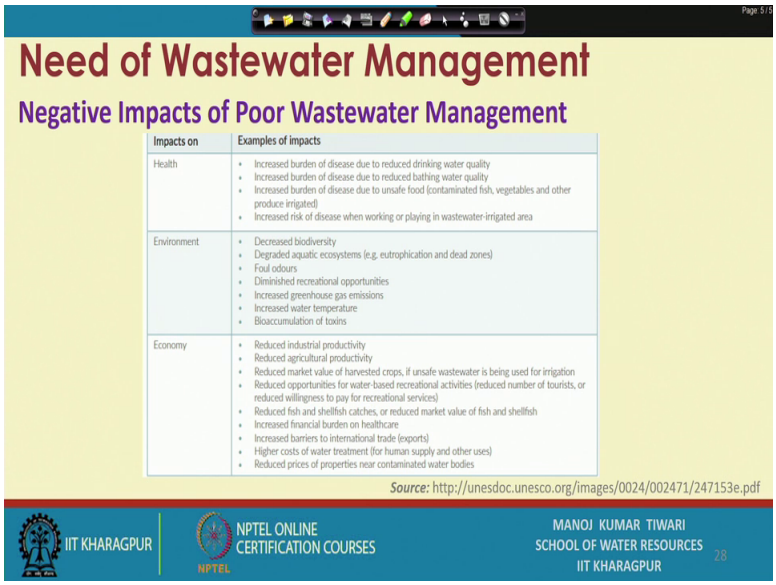

So, these are some of the examples of impact whatsoever we have been discussing, ok. So, impacts on health if we see there is increased burden of diseases, there is impact on environment in the form of decreased biodiversity, degraded aquatic ecosystems so, fall orders and all that coming in and if you see there is a long list and their quite a few points mentioned in the impact on economy as well, ok.

So, reduced industrial productivity, agricultural productivity, fish and shellfish catches, financial burden on healthcare, increased barrier on international trades as we are discussing that, the export and these kind of things can also be affected. The higher cost of water treatment is the point that we were discussing, so more or less points that we have discussed, some of them are listed over here.

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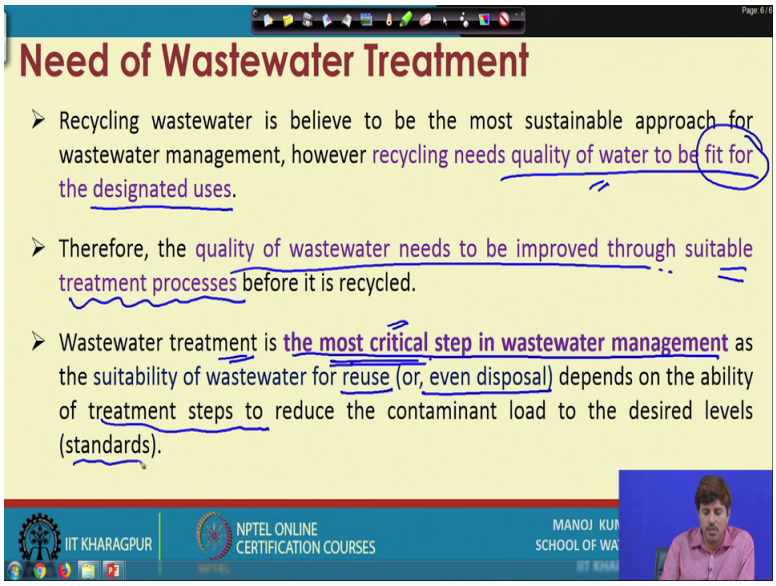

So, the idea is by now we realize that wastewater management with an idea or with an intention of recycling is good in a way that it gives multifold benefits, and the risk associated in terms of human health or in terms of environment or financial losses are huge.

So, that is why one should think about the reuse and recycling of wastewater as a fair proposition. Now, for the purpose of recycling waste water, we say that it is like now people believe that it is the most sustainable approach for wastewater management, however if we want to recycle waste water, we need the quality of water to be fit for the designated use or for the purpose for which we are using the water. If we are recycling water, we are obviously going to use that water. Now, for using that water, the quality of water has to be fit for the particular use.

Now, how the quality of water would be fit? We are talking about a wastewater thing. So, the quality of wastewater is often everyone know that quality of wastewater is quite poor, and the quality of water which is used for certain purpose even if its agriculture or irrigation or household activities or industrial activities are generally they are cleaner water and we are talking about wastewater using for those purposes. So, what is essential that this quality of wastewater needs to be improved and how it can be improved? It can be improved through this suitable treatment processes.

So, we must employ suitable treatment process to the water or to the wastewater before we get it recycled. Before the water is recycled, it should be properly treated with the suitable treatment process, so that the quality of water or quality of treated water which is produced is fit for the designated use. So, therefore, this wastewater treatment becomes the most critical step in wastewater management. Why it is most critical? Because we are talking about wastewater management and we see that the prime thing or the best option that appeared of the wastewater management. We have different option of a wastewater management, we can let it discharge to the river or we can use it for a certain designated purpose and that we see that reuse or recycling is probably the best approach for wastewater management. And for recycling or reuse purpose we have to ensure that the quality of water or the quality of treated wastewater is good enough for the recycling application and that can only be ensured with the good and adequate degree of treatment.

So, that is why this treatment process becomes the most critical step because this is what it can actually produce the quality of water which can be reused or even for safe disposal also, because this ensures that the water is suitable for either reuse purpose or even disposal. Even if you want to let say for disposal also, we should not dispose the contaminated or untreated or partially treated sewage.

So, this depends on the ability of what are the various treatment steps that reduce the contaminant load to the desired level or what we typically call the prescribed standard, because there are standards for disposal there is standard for reuse. So, if you want to reuse or recycle of water, it should meet the prescribed standards, means the quality of water should meet the prescribed standard. And how you can ensure that quality of water can be produced out of a waste water? It can only be produced by providing suitable adequate treatment steps, and that is why the wastewater treatment is very crucial and very important aspect of the wastewater management, ok.

Overall you will see several steps in the wastewater management. Wastewater is collected, channelized, bought to a treatment plant, it is treated, then either disposed or recycled.

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So, all those things are there, but the treatment is essentially the one of the most critical or the most critical step.So, if we see the effective wastewater management cycle, the there are various variety of options. The prevention or reduction of the pollutant at the source is the first step, or the first process if we can prevent the waste water from getting generated or reduce, the pollution at the source itself. This reduction means in terms of pollution load as well as volume of the waste water produce. So, if let say we are producing 100 units of wastewater, if we can reduce that quantity to 20 unit or 30 unit, we are saving a lot of water or lot of polluted water from being produced, ok.

Similarly, if we can reduce the contaminant load, then there after the removal of contaminant from the wastewater streams which is actually the treatment step, then the use of wastewater so water reuse or water recycling becomes the next step and there is a recovery of useful by product, ok. So, from sludge and from water if we can recover certain useful by products, that is also very important, and that should be in a effective wastewater management cycle, right.

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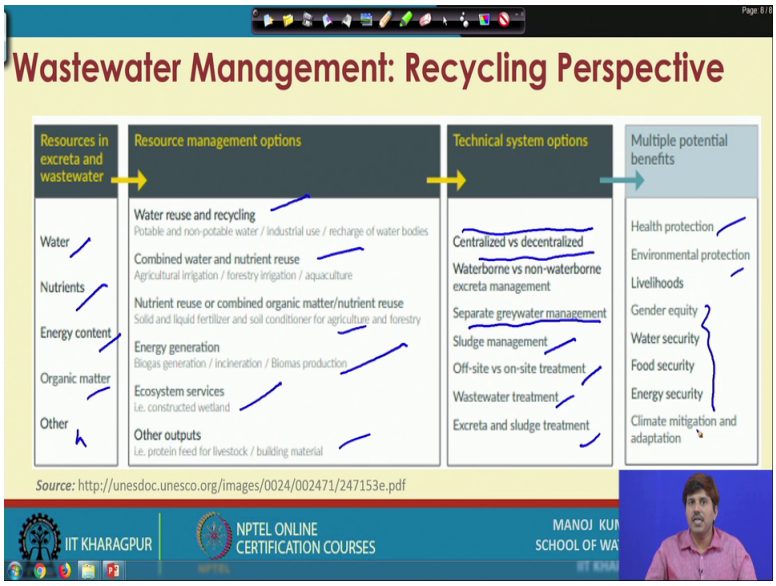

So, how we can basically convert from waste to resource wastewater? So, around 80 percent is pure water which can be treated and used for variety of purposes, ok. The sludge can be used for biogas production or bio solids production, ok. So, there is basically reduction in the pollution or solid solution and through anaerobic digester, we can produce energy out of it. We will discuss these thing in detail once we move further in the course, and we can of course recover certain materials like phosphorus and this kind of thing also can be recovered out of waste water. So, that way we can go for the recovery of useful by products, we can go for the reusable quality treated effluent production through treatment and of course, if we can prevent so that is one of the ideal cases.

So, if we see the recycling prospective of wastewater management, most majority of things we have already discussed. So, resources in the excreta and wastewater are what are the resources, there is water, there is nutrient, there is some energy content in the form of organic matters and there are other things, the resource management option is water reuse and recycling combined water and nutrient reuse.

So, if you are let say going for agricultural irrigation and all that we can use nutrients also together we anyway sort of apply fertilizers for that purpose, then nutrient reuse or combined organic matter and nutrient reuse, we can use for energy generation, ecosystem services and get in some other outputs. The technical system options are there, whether

we should go for centralize or decentralized, water born or non-water born excreta management. Then, whether we should go for separate grey water management we discussed what is grey water. So, the one which is coming from kitchen and laundry and washing, what about sludge management of site or onsite treatment, where we should provide what degree of treatment, what kind of treatment is to be given. And if we see the benefits, there are health protection, environmental protection, there are water security, food security, some energy things, climate mitigation and adaptation. All these are sort of potential benefits can be obtained, if the wastewater is managed nicely considering the recycling and reuse of material, energy, water, everything.

So, we conclude this lecture here and in the last lecture of this week, we will talk about the, what are the major issues and challenges particularly in the wastewater management sector.

Thank you.