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

Lecture – 53
Wastewater Reuse and Recycling Opportunities

Hello everyone. So, this we are into the second class of this week, when we are basically discussing the Wastewater Reuse and Recycling Aspects. In the first class, we did talk about the basic concept of reuse and recycling, why we should think about recycling, why it is important to go for recycling. And in what way it can kind of provide a solution to some of the existing challenges in the water sector in terms of the deteriorating water quality of the existing resources, and the higher quantitative stress that is being imposed on the natural water resources, when we withdraw a lot of water. So, if we end up using wastewater as a resource, so how we can basically sort, how we can sort out these issues or how we can minimize some of these impacts that way.

So, this lecture we are going to talk about the various recycling and reuse opportunities. So, if we think of using wastewater as a resource that means we are actually trying to reclaim the water from the wastewater, so how to use that water and where to use that water ok.

So, as like from the time to time, we have had certain discussion over this that this depending on the degree of treatment or depending on the designated uses that we have in mind what kind of treatment process can be selected or if we are able to treat that water to a extent of kind of pure water, we can actually use it for any purpose. So, but still there are certain risk associated with this, certain features associated with reusing this into the different sectors. So that is what we are going to discuss in this class, the various reuse and recycling opportunities of the reclaimed water from the municipal or industrial effluents. So that is what we will be discussing.

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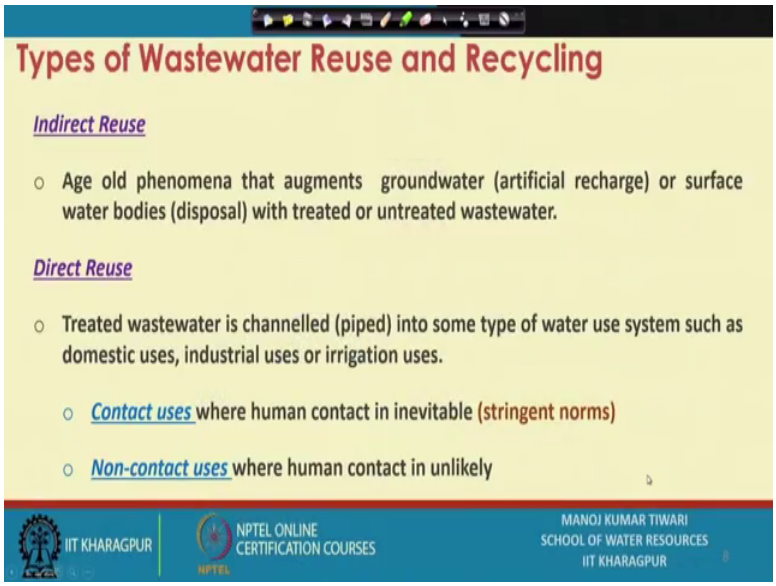

So, to begin with if we see the various types of wastewater reuse and recycling, we can categorize them into two distinct classes two different classes, so the one being that indirect reuse ok. So, indirect reuse is an age old phenomena ok, we have been using we have been kind of reusing wastewater or recycling wastewater since ages without probably acknowledging it ok.

So, how we indirectly use this? So, for say you are having say this is your Ganges river basin ok, this is your Kanpur city. Now, Kanpur city discharge its wastewater into the Ganges into the river Ganga. Now, what happens that when you come downstream, say this is for say Allahabad. So, now for meeting its water requirement, Allahabad city is withdrawing water from the Ganga ok. Now, the wastewater which has been dumped here has been mixed with the water has undergone properly self-purification or whatsoever. So that is quite obvious that if you see something which is being disposed or which is being mixed with the river water and as that water is flowing here.

So, when you are withdrawing water from this point for fulfilling the needs of the other city is not that part of the waste water which has come into the water, which has mixed in is being withdrawn here. So, of course there is a recycling of this waste water the water which is being used here is being which is being the waste water which is being disposed of here either treated, untreated, partially treated whatever form. So, if it is being

disposed off here and some other city is using that for upstream purpose, similarly after they say for say this Allahabad city is again putting its sewage into this zone.

And then once you go toward say Patna, so Patna again withdrawing water from the Ganga for its domestic consumption purpose say, so then that water disposed off at Allahabad will not come to Patna or say Varanasi that way. So, it is eventually there is indirect recycling, which is taking place. We have discussed it in the very first aspect that there is a cycle exist, which we call water cycle ok.

So, in the water cycle each component are kind of linked, the water that we gets like from sea, it gets to the atmosphere, then it comes in the form of rainfall, it goes off as a runoff or what we call if from urban areas, we call that storm water that way. So, storm water goes, then the water it consumed wastewater is generated that is again discharged in furniture.

So, everything is basically being taken from the nature and in some form or other form is being returned to the nature. So, in such scenarios, when things are being taken from the nature and this like this is again being returned to the nature; so what happens eventually that we are like in a kind of in this water cycle if we see, so we are recycling the waste water indirectly, so that is there.

Other thing is the like waste like the wastewater goes for the augmenting groundwater. So, in the form of artificial recharge or even the like if we see the naturally also, so what will happen that in natural systems. If you are having let us say your surface, and you are letting your water flow on the surface so surface disposal; what will happen that this will kind of infiltrate percolate, and will actually reach towards your groundwater right. So, this water is somehow reaching your groundwater.

And then at some other place or maybe somewhere you are pumping this ground water again for the purpose of using it for whatsoever reason may be for agricultural uses or may be for domestic uses, but this water could be pumped through well. So, again there is an indirect recycling that water which you have been which we have put on the surface has reached somehow to the groundwater or in the artificial recharge systems or natural recharge system, but eventually it has come to the groundwater. And then from groundwater, it is being used. So, there is indirect recycling or indirect reuse approach has always been existed.

What is more important and what is more newer phenomena is the direct reuse, because this indirect reuse has lot of complexity involved in this processes like we see the pollution of resources, then stress on that as we discussed actually in the previous class, all those factors will come in this indirect reuse or recycling aspect. So, what is better is the direct reuse ok. And under direct reuse, the treated water is channeled or piped into some type of water use system, which could be domestic use, industrial use or agricultural uses ok. And this uses again can be probably sub classified in terms of contact uses and non-contact uses.

So, contact uses are the one, where human contact is inevitable ok. So, if there is likelihood of human contact with that water which has been reclaimed from wastewater, so there the norms of reuse or norms of recycling are more stringent ok. We have to treat that water to a higher degree in order to protect the human health, which is one of the most kind of prime objective of the like civil society civilized systems ok. So, we are more bothered about human health and there would be risk, if the water or the reused water recycled water is undergoing some sort of contact uses, so that is why the norms are more stringent for these.

Then we have non-contact uses, where human contact is unlikely. So, there are relatively relaxed norm ok. Depending on the kind of reuse, we are going for again it is not always relaxed like particularly in the industry if it is going for industrial purpose, irrigation purpose, horticulture purpose, or non-content domestic uses purpose. So what kind of purpose it is going for the guideline or norm will depend on that thing.

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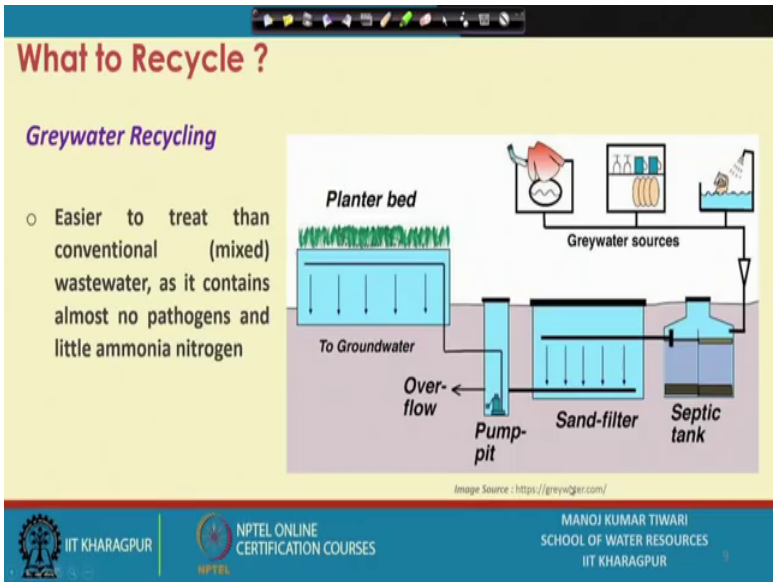

So, then we see what to recycle. So, wastewater when we are saying that wastewater recycling wastewater recycling, we go back to our basic discussions, which we had in the beginning of this course that wastewater are of different natures are of different characteristic. So, there are basically we can sub classify or sub component compartmentalize this wastewater.

So, there is a grey water component of the waste water, so we can make or we can come up with a strategy for recycling just grey water ok. So, there is there could be a kind of discussion, where we just see that grey water recycling is kind of more preferred or more favored as opposed to the sewage recycling or the whole of the wastewater recycling.

So, grey water as we discussed earlier that with the water which comes from the household uses apart from the toilet or those kind of thing. So we can get say the water coming from the washing clothes or washing machines, then washing utensils, then bathroom, water coming from shower. So, all those things are the sources of grey water. We can have water coming in from kitchen.

So, those are the sources of grey water. And we can adopt a suitable treatment to strategy, whatever could be strategy, it is not necessarily has to be this one only, but any strategy that we can actually adopt. So, we can adopt certain strategy to treat that water, and then use it for certain purpose, so that is what is called grey water recycling or grey water reuse.

Now, why we are focusing on the grey water instead of the whole of the wastewater, because it is easier to treat it, then conventional wastewater system or mixed wastewater system. The issue with the mixed wastewater system, because, when there are kind of toilet flush is also included, so there is a lot of solid mass comes in, there is lot of organic load comes in the form of fecal matter. And there is lot of pathogens comes in the form of those like pathogens, which survives on those fecal matters, so that is why that portion is kind of quite contaminated.

And we do not include that if we do not include in the kind of other component of the wastewater which are coming from say kitchen, from bathroom, from washrooms those places. So that the means if we do not add this black water component along with the grey water component. So that means, we the kind of water that we are having will be much more mild in terms of the pollution ok.

So, because it is have it does have milder pollutions, so it is easier to treat this grey water component. We can treat it at lower cost, there is not that great degree of pollution in this, there is only like relatively much milder pollution, so that is how the treatment cost decreases the kind of reuse applications could be more as opposed to the one, which is coming from the toilet.

So, since it contains almost no pathogens and very little ammonia nitrogen, very little organic loading rate. So it is kind of that way advisable or people are basically giving more emphasis on the treatment and recycling of the grey waters as opposed to the entire sewerage or entire wastewater systems for the easy reason.

And particularly if it is to be done on a decentralized scale, let us say for a household scale. So then it is far more preferred. Because, you can have a separate connection separate system for collecting this grey water, and then you water like put through a mild filter or some sort of things, and then you can use it for gardening, you can use it for some other purpose, car washing or other aspects of this, so that is what is the kind of aspect in the grey water recycling.

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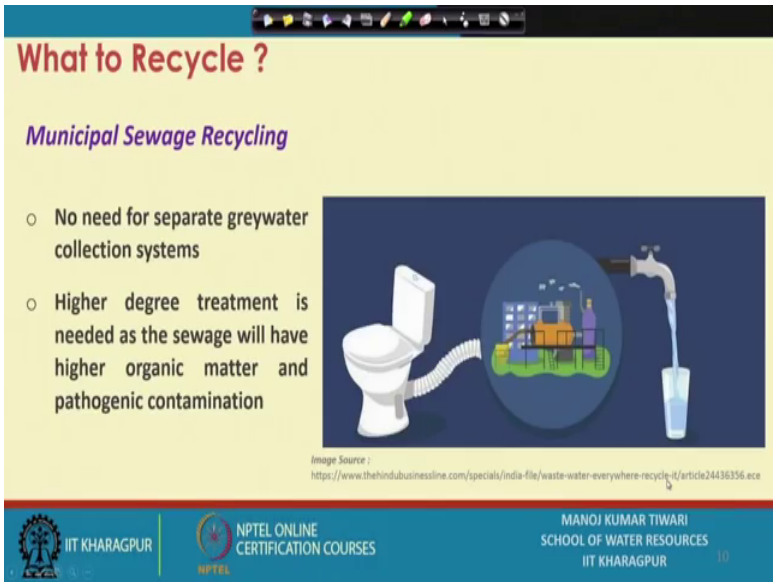

Then we can actually think of recycling the whole of the municipal sewage entire wastewater. So, the advantage here is that we do not need a separate grey water collection system, because if we just go for grey water recycling, we will have to have a separate grey water collection system. Whereas, particularly in India, if you see all of the waste that comes from the different places are eventually connected to the same sewerage line same sewerage system, so that way we do not have a separate collection of the grey water and black water components of the wastewater.

But, if we tend to just recycle the grey water, we will have to have those separate collection system, which is kind of again we have to put some investment for that there is some cost associated with this separate collection system. So, we can get rid of those cost, if we go for the whole of the municipal sewage recycling ok. However, the issue here is that we will need a higher degree of treatment, because there is a high organic matter and pathogenic contamination involved in the toilet water.

So, obviously the kind of treatment required will be much advanced as opposed to the grey water recycling, which can be done at a lower cost and with simple treatment procedures ok. So that is what is the like advantages and disadvantages associated with the whole of the water whole of the sewage recycling. We will save some cost on not having a separate collection systems, and not having a separate kind of transportation if

needed those kinds of systems, but at the same time, we will have to go for a higher degree of treatment as well.

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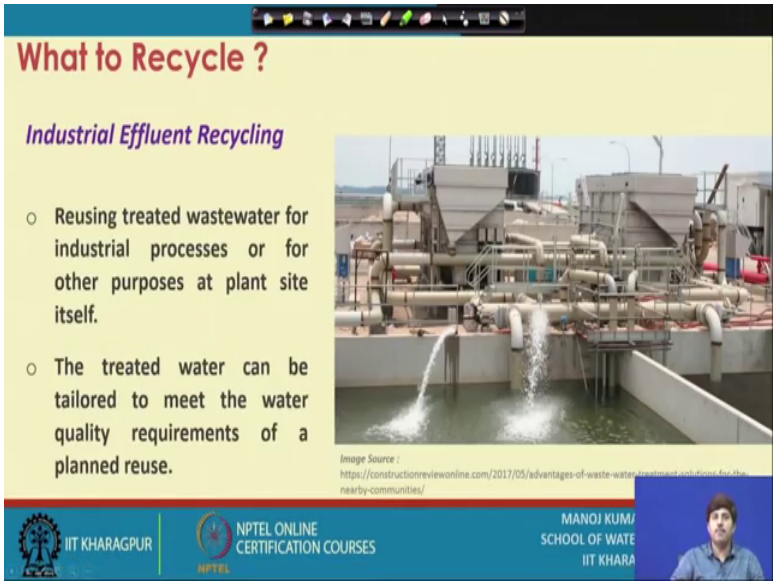

Then there is industrial effluent, which can be recycled. So, the industrial effluent recycle is reusing treated wastewater for industrial processes usually. So, within industry, it is far more preferred to use it for industrial processes or for other processes at plant site itself we can use. So, remember the last class, we are discussing the concept of zero liquid discharge.

So, industrial effluent recycling is more associated with the zero liquid discharge concept, where we can actually reuse or recycle the whole of the waste generated either for some industrial process within the industry or for other applications like say gardening, flowering and maybe like cleaning, washing, all those kind of purposes within the industry. So, not letting any effluent generate or any effluent come through come or come outside the boundary or outside the periphery of the industry.

So, this treated water can be kind of tailored to meet the water quality requirements for planned reuse. And this plant reuse as we said could be anything could be the industrial processes or could be the other aspects taking place within the industry ok. So that is one component.

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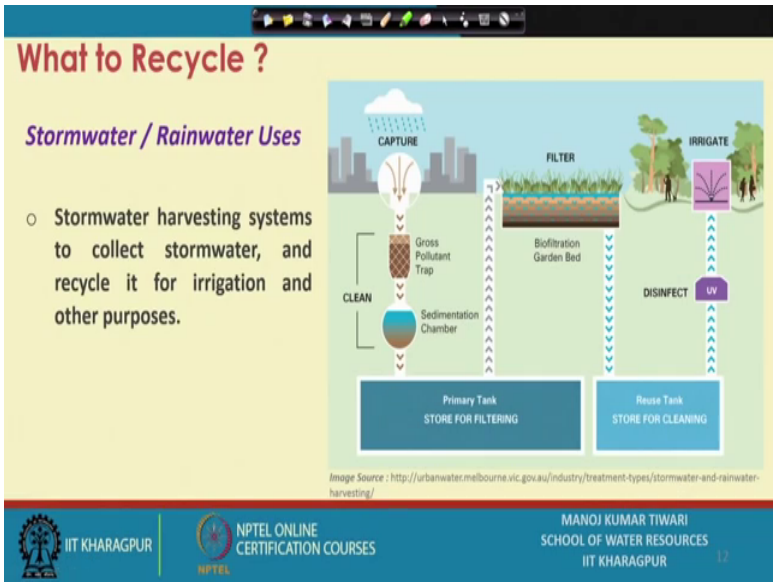

Then there is a storm water or rainwater uses ok. So, we can go for storm water or rainwater uses. This is not exactly a kind of reuse, because when we collect storm water or rainwater that is not a used water that comes naturally to us. But, since that is also if we do not use it, it is considered as a component of wastewater or it has to be treated as a wastewater.

So, storm water, which is collected through storm water drains or channels. Many times even if let us say we have the combined sewage systems. It is mixed with the wastewater and then treated together, so that becomes quite challenging task, because of the large volume, and because of the milder pollution due to the dilution with the storm water.

But, eventually like the storm water can also be considered as a resource, and we can use this storm water, which essentially can be considered as a wastewater reuse, because anyway that is being disposed of as a form of the waste. So, if we are able to use that, so that way we can say that the using a component, which is considered as a waste right.

So, this storm water is basically the storm water harvesting systems are to be installed to collect storm water or rainwater and recycle it, usually for irrigation and other purposes ok. So, we can that way kind of capture the storm water coming in pass through a mile treatments systems and then store it in a tank. And then from there onwards, we can use it for the purpose ok, so that is how the storm water or rain water reuse concept can also be utilized for the purpose.

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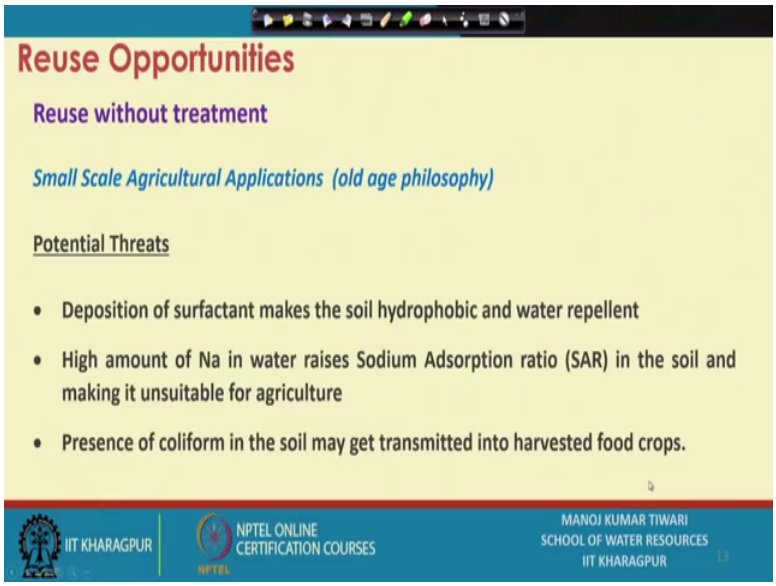

So, these are the different sectors for reuse ok. Like as we discussed that, we can reuse or recycle these different components, we can reuse as grey water or whole of the wastewater, industrial water, storm water systems, storm water that is being collected ok. Agricultural runoff can also be recycled, but since it comes at various different places, so the collection and those kinds of things are quite tacky and quite difficult.

So, if we see the opportunities of reuse like these are so far we discussed that what are the different components or what are the different types of wastewater, which we can think about reusing it. Now, if we see that (Refer Time: 19:35) where we can reuse, so reuse can be actually in the two forms two saves; one is reuse without treatment, and another one is when we go for certain treatment for reusing the wastewater.

So, reuse without treatment is obviously, like since we are not providing any treatment, so it is going to be a cost effective system ok, the cost of these systems is going to be low. And this reuse without treatment can be actually for two types of application usually; so one is the again quite old age philosophy, which is small scale agricultural application.

Now, I am sure many of us most of us have at some point of time, spent some time in the villages or have visited the villages. So, if you see what happens the water which comes out from your kitchen or water which comes out from your bathroom drain or the where you take bath ok, so that eventually is just channelized to some field, where you grow

some vegetables or crops or small those kind of things, so that is a form of wastewater, which is being generated, not treated at all, it is just generalized to flow through that field, where it is serving the purpose of kind of irrigation right.

So, at very like until unless you have a proper lined collection system, which is very rare in the villages even as of now ok. So, what happens that this wastewater which is generated is being used as a irrigation to smaller agricultural fields, so that is that reuse has been there since ages, and it is still there, whether people realize it or not, but that is what actually a kind of reuse of the wastewater, which is being produced ok.

Now, so what is the problem here, the problem here that there are certain potential threats of reusing water without treatment, there is a possibility of deposition of surfactant, because when we use soaps and those kinds of things, which contains lot of surfactants. So, if we are taking bath, we are like rubbing soap here and there, and then washing, so a lot of phosphate, lot of these surfactants goes away along with the water.

So, when these surfactant depositions takes place in the soil, the basically it can make the soil hydrophobic and water repellent, which is one of the issues; if there are high sodium in the water that can raise the sodium adsorption ratio of the soil, and making it unsuitable for agricultural purposes. And if there are coliforms present in this kind of water which is going there, so they may get transmitted to the harvested crop system as well. So, from water, it get can get transmitted to soil or from soil, it can get transmitted to the crop. And if we consume those crops, so that may have certain issues or certain health problems associated with that.

The other option of using wastewater without treatment is a relatively much newer philosophy ok, which is for the domestic application and using this for toilet flush ok. So, people think that particularly with the grey water, because the toilet flush which is coming may not be used again back for the toilet flush. But, in the apartment or many like a few places in the apartments the grey water system, where the separate grey water collection system has been installed, and then grey water is channelized to toilet flushes without any treatment ok.

So, the grey water can be that way used or part of the wastewater that can be used for the toilet flush system, which is kind of like new philosophy, which is not there in practice earlier ok. So, we can use it for only non-contact applications, there are certain potential

threats associated to this as well. So, the threats are there could be possibility of clogging in the pipes due to the deposition of suspended solids. So if, because the water which you are collecting may have certain suspended solids. And if you allow that to go to the toilet flush, so there might be some settlement some sedimentation over there, and if there is a lot of deposition. So, when you flush this, (Refer Time: 24:08) your pipe systems or like the drip drainage systems can actually get choked because of these suspended particles.

Further, there is if your water contains little of organic matter, so there is a possibility of formation of biofilm inside the pipes and kind of sanitary-wares which are there which are being used. So, a biofilm formation can takes place, which can cause corrosion on their surface by generation of various organic acids, and it can also generate your bad smelling sulfide gasses odours ok. So that kind of problem may also be there.

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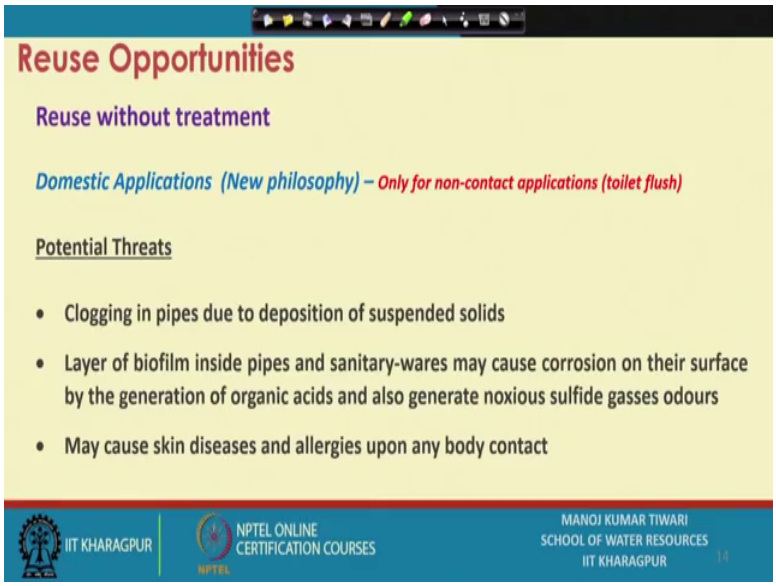

And if by mistake, it comes into the contact, there might be possibility of skin diseases and allergies, if it somehow comes into the body contact. So that is why for contact this thing, it is totally like prohibited. For non-contact uses, people has started using it earlier, but again that has not been encouraged too much, so it is preferable that even if you are using it for toilet flushing, one has to provide a milder degree of treatment at least before going for the flushing. So, this kind of reuse option, so that is the reuse opportunities, which are kind of without treatment ok.

There are reuse opportunities major reuse opportunities with treatment. So, when we say that reuse and recycling of the wastewater, one of the inherent component that lies is that we reuse it with treatment ok. So, with treatment reuse options if we see, there are basically reuse in the irrigation sector, so landscape, agriculture and aquaculture those kind of thing. There is reuse in the non-contact domestic application, the contact domestic application, the industrial application. So, we can actually if we are able to purify that water ok, so since that water or wastewater has been converted to pure water through the proper treatment technologies.

So, depending on the degree of treatment that we provide, we can select the specific reuse option. And if we can treat it to the purist label, it can be used even for the drinking purpose conceptually, because if you have removed all the contaminants, if you process it fully, and then put through a RO system, which ensures kind of removal of all the contaminants from the water, so why this water cannot be used for drinking purpose ok.

Keeping aside the social obligations; so if you keep aside the social obligations, when you reclaim the pure water from a wastewater, why you cannot use that water for whatsoever purpose, and it has there has been cases. So, like in the Singapore, the new water system actually the like treats the sewage to a level of RO system. And then the reclaimed water is augmented is basically mixed with the domestic water supplies and people are using it. So, absolutely there is no problem, there is no health concern, there is no risk.

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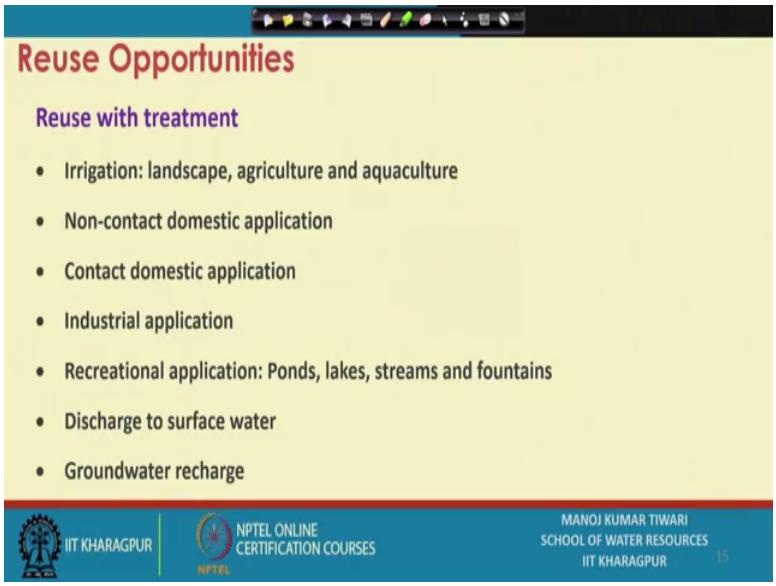

So, if you are able to treat it to that level, if you are able to achieve the water quality which like can be supplied to the domestic household, so why not it can be done, so that way we can go for contact application, non-contact application. It can be reused for various industrial processes, recreational processes; including pond, lake, stream, fountains those kind of thing. It can be used for groundwater recharge or augmenting the surface water systems.

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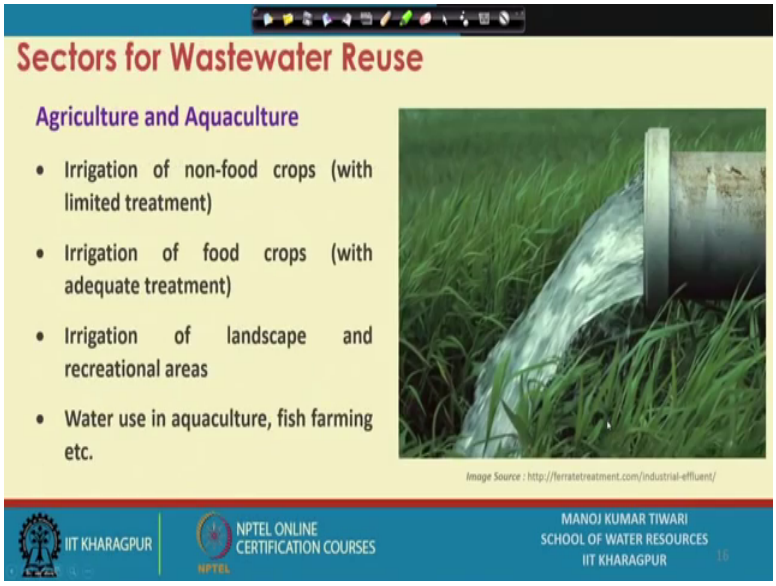

So, if we see that the various sectors for wastewater reuse, so there is agriculture and aquaculture sector, as we were just seeing among the various reuse possibilities. So, under this agriculture or aquaculture sector, of course agricultural sector water is used for irrigations, so it is going to be used for irrigation.

Now, we can use this for irrigating non-food crops with limited amount of treatment, because those crops are not being used for food purpose anyway. So, if we are let us say producing flowers or fibers kind of systems or crops, which are being utilized for industrial fiber production, those kind of thing or flowers or other things, which are basically not getting consumed. So, those are non-food crops.

So, for using at non-food crops, we may actually imply the wastewater with limited amount of treatment. But if we are actually going to irrigate the food crops, we must ensure that adequate degree of treatment has been provided to the water. Because, when we apply it on to the food crops, there is if there are let us say heavy metal or toxicants or those kinds of things present in the water. So they might get up taken from the roots of the plants, and eventually can transport to the part, which is being consumed by the humans.

So, if that way like it has come into our food, those toxicants from the wastewater can actually find way to enter in our food chain system, and that way affecting human health to a great degree. So that is why we must ensure that those kind of things are removed beforehand, and adequate degree of treatment has been provided for has been provided to ensure that risks are just very minimum. We can use it for irrigation of landscape and recreational areas as well. And we can use it in the aquaculture, fish farming those kind of thing as well.

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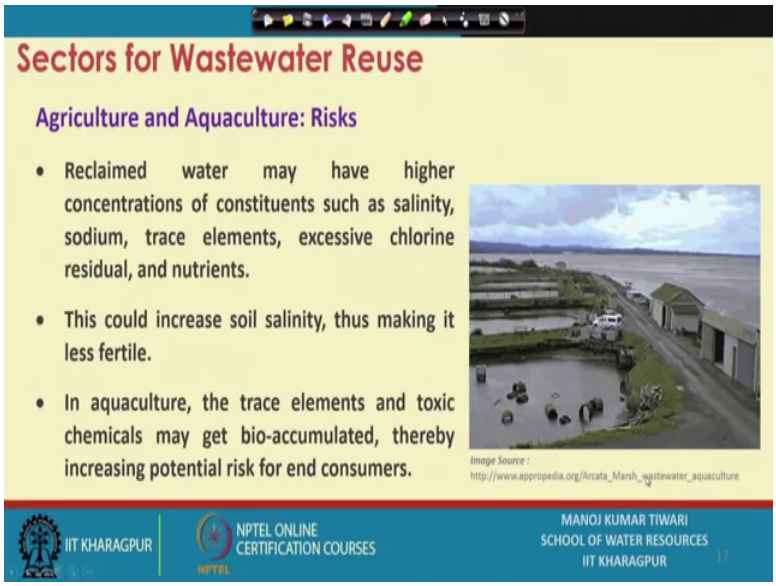

So, if you see what are the various risk involved in the agriculture and aquaculture reuse of the wastewater. So, the reclaimed water may have higher concentration of various constituents such as salinity, sodium, trace elements, then there might be chlorine residual, because we chlorinate the water, we disinfect the water before supplying it to the households. So that there might be residual chlorine, there might be higher degree of nutrients. So, nutrients is not that a problem for the agricultural systems and mores ever, but if it is excessive of again that is not desirable. But, if these kinds of contaminants come into the soil system through irrigation means, so they can increase the soil salinity, and thus making the soil less fertile.

In aquaculture also, if there are these trace elements and toxic chemicals which are there, make it bio accumulate ok, and thereby increasing the potential risk of the end consumers of these aquaculture products. So, if you are going for say fish farming in a contaminated water. So what will happen that if there are some toxicants and those kind of things are present, they may be consumed by the fishes, they may retain in the body of fishes or they can get adsorbed on the body. So, when that fish is being consumed by someone, so those toxicants can get transferred to the person consuming those. So, the end consumers may get affected by these contaminants ok, so that is the major risk associated with this.

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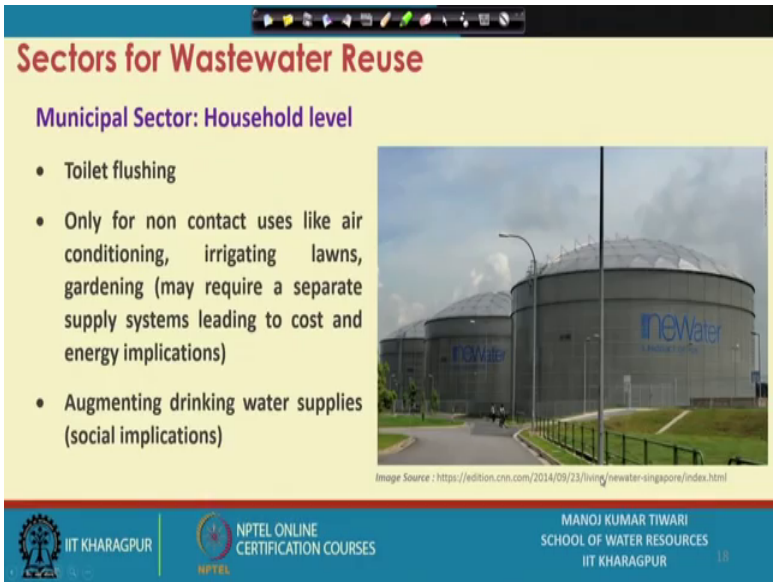

Then there are municipal sector. So, we can reuse it for household level the for toilet flushing or we can reuse it only for non-contact uses like air conditioning, irrigating lawns, gardenings etcetera. This may require a separate system, which may lead to the cost and energy implications as we discussed, because, if you want to reuse for other purpose reuse water for just all these purpose. So you will have to have a dual supply line. One supply line, which goes to your kitchen for cooking food and drinking purpose; and the other supply line, which goes for maybe other non-contact uses ok; so that having dual supply system will have its own energy implications, its own cost implications those kind of thing will be there.

Then there is a like possibility of augmenting drinking water supplies, where it can actually go directly to the drinking water system. So, as we were just discussing that new water of the Singapore is one such system, which kind of purifies water reclaim total water and augment drinking water supplies with that ok, so that is there, which is if we are able to treat that water to (Refer Time: 32:49) level, we can we will not have we will not need a dual supply system or a kind of two pipelines supply system. We can actually just augment the treated water or reclaim the water with the water worth that we are pumping anyway; so that we are reducing the total water demand or reducing the total water abstraction from the fresh water resources.

But, this may have certain social implications ok, which we will discuss in the later classes that in like people may not be readily able to accept the recycled wastewater coming in their drinking water or kitchen kind of places ok. So, if you know that the water that you are flushing from your toilet is going to be come back again to your kitchen and your kind of likely to cook food in that or drink that. So there might be certain social reservations.

And this kind of reservations has been seen in many part of the world, not only in the developing countries or not only in the India, but in many other developed nations also. So, acceptance of the public for the reuse of the water for drinking purpose is one of the major challenges in today's time, when we think about the reusing of the entire sewage or entire wastewater for the domestic supplies.

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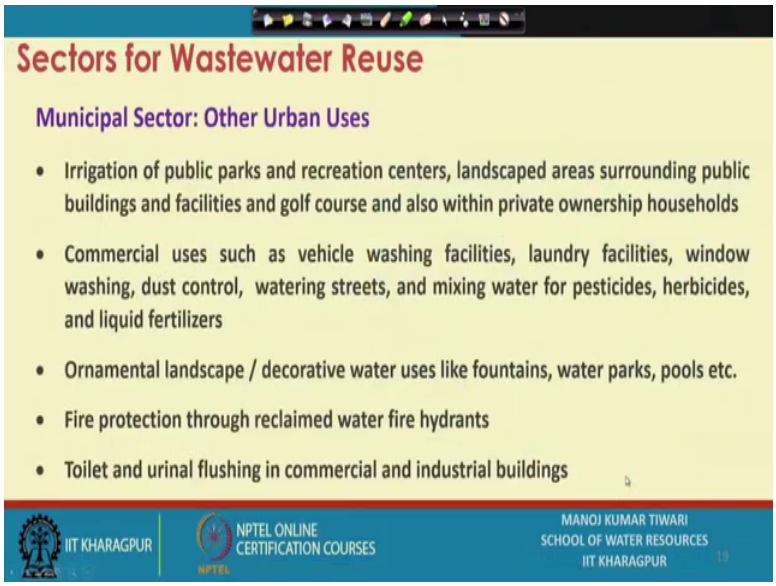

Then there are other various urban uses in the municipal sector ok, which could include the irrigation of public parks and recreational centers, landscaping area surrounded the public building and facilities irrigating golf courses ok; so all those things. There are various commercial uses like vehicle washing facilities, laundry facilities, your window washing, dust control, watering streets, mixing water for the pesticides, herbicides, liquid fertilizer those kind of thing.

There are various ornamental and landscape or decorative water uses like fountains, water parks, pools etcetera. There is fire protection through the fire hydrants, so that

needs quite some water which like this reclaimed water can be used for that purpose. There is toilet and urinal flushing in commercial and industrial building is another sector, where this water can be reused. So, there is a lot of potential of using water in the municipal sector as well apart from just the domestic supplies.

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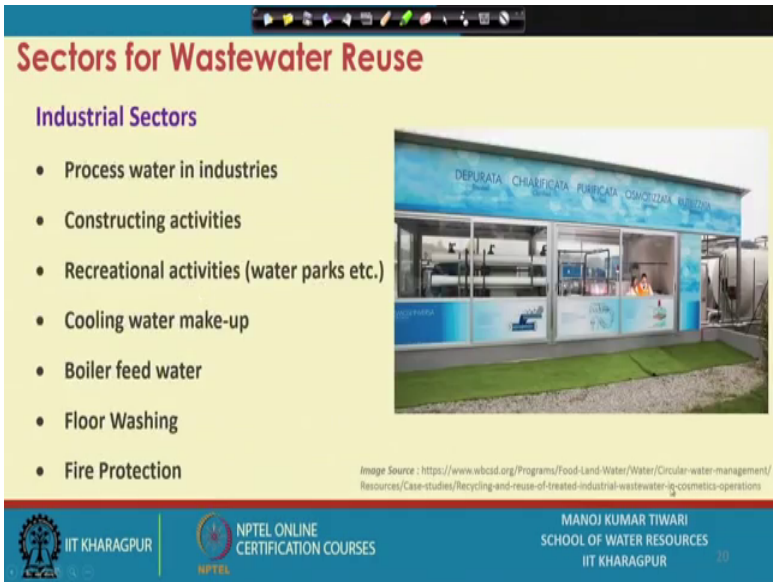

Then there are industrial sector for wastewater reuse. So, there are various reuse opportunities within the industry as well, which could actually include the process water within the industry. So, like industrial process particularly the industries which kind of generate certain type of product ok. So, the production units or manufacturing units, so they need water at different stages in the production or manufacturing of almost each and every item, you need water at certain stages.

So, we can use water for those particular at those particular stages, there might be the different requirements ok. So, for say if you are going for a coolant water, so there is not too much like not very high degree of treatment is needed for coolant water ok, you can use just mildly treated water for a coolant purpose.

But, if you are going to use water in your boiler, so you do not want to go for scale forming or anything else. So, you have to reduce the (Refer Time: 36:29) completely ok, almost you will prefer to use demineralized water. So, if you want to have reduced the (Refer Time: 36:36) completely, so you will have to provide that degree of treatment or

like ion exchange or those kind of systems are generally used for treating water to that degree, when it is going for the boiler applications or those kind of applications ok.

There are constructing activities ok. So, the construction activities particularly like building construction, road construction, highway construction, then your bridge constructions. So, there is a lot of water requirement in these construction activities. So, in these construction activities also like these reclaimed water or recycled wastewater can be used.

There are recreational activities like Water Park on those things. So, they are also a kind of industry, where water can be used. There is cooling water makeup. There is boiler feed water as we are discussing. There could be requirement for floor washing purpose. There could be requirement for fire protection purpose, so that way there are like it can be used at different spaces within the industrial sector as well.

Apart from this, there is a because let us say you are coming up with a plant, so there will obviously, be some housing colonies for the officers, workers living in there. So that reclaimed water could actually be used for gardening for planting within the industrial periphery, or maybe for non-contact uses or supply to the to the community living within the plant boundary. So, those kinds of reuse options could also be there ok. So, there are like variety of reuse possibilities with the industrial effluent as well.

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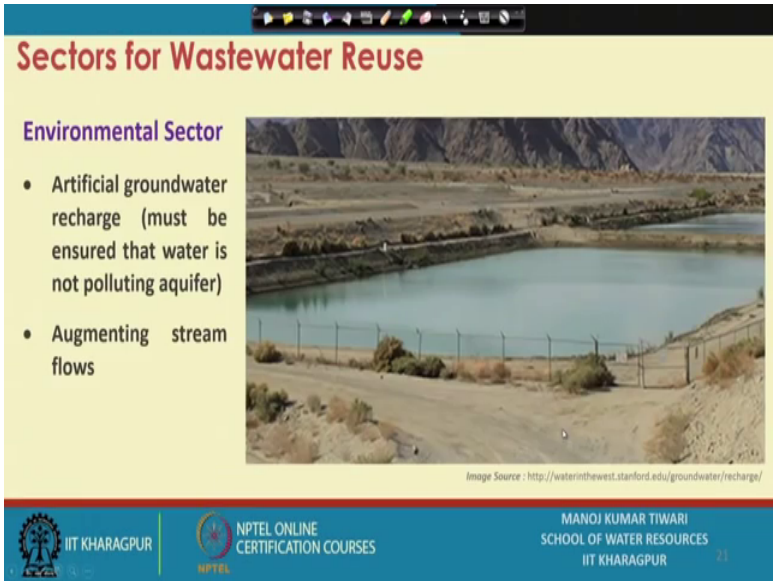

Then there is environmental sector, where this reclaimed water or where this treated wastewater can be reused. So, one of the major reuse potential in the environmental sector is the artificial groundwater recharge, where water is used to recharging the groundwater. So where there is say great degree of where there is a great degree of kind of groundwater depletion ground water table is getting lowered, and your aquifer is not having enough water, so there these kind of systems are adopted in order to maintain the aquifer levels in order to maintain the groundwater tables. So, we can make artificial recharge basins or artificial recharge galleries through which the water percolates through a kind of filter bed, and eventually reaches to the subsurface level.

So, here again the filter bed that is being used is has a responsibility to treat that water to purify that water before it gets mixed to the ground waters ok, so that again must be kind of ensure. So, (Refer Time: 39:40) we ensure that water is not eventually polluting the aquifer water, which is kind of a big issue, because you are let us say putting water inside the groundwater systems. And if you are end up polluting your groundwater, if this water is getting filtered in a proper way, by the time it reaches to the subsurface, it is fine. But, if it is not happening that way, so your groundwater may get certain pollutants, which are there in the wastewater.

And then once you pump that groundwater at other place or for using purpose, you get exposed to those pollutants as well. So, there is a lot of artificial groundwater recharge projects being taken up across the world, but the in like there has to be proper assurance of the quality of the water, which is reaching to the aquifer level ok, so that is one of the important factors which must be seen. And it can be used for augmenting stream flow as well obviously, so the stream like if it is properly treated, we can put it to basically surface stream as well ok, which can be for recreational purpose or for other purpose could be use or utilized.

So, these are the kind of reuse in the environmental sectors, so that way so, like what we discussed in this class if we just want to quickly summarize it, so there is the wastewater generation at different levels, which could be recycled. So, for say grey water, total sewage water, industrial effluent or the storm water, so they could be recycled.

And this recycled water could be used for different applications, which again are from the different sector. So, could be used for agricultural sector applications in the form of

irrigating food or non-food crops, then could be used in the municipal sectors, urban sector applications, industrial sector applications, and the environmental sector applications, each have their own pros and cons, there are risk associated with each of the reuse options. So, one must evaluate these options properly before going for a decision making that ok. I am going to reuse this component or this part or this much volume of the wastewater and purify it following these methods, and then reuse it for these certain applications or these purposes. So, there has to be kind of a decision making involved, and that should be based on the sound knowledge of what are the risk, what are the implications, particularly health and environmental risks of the various reuse options that reclaimed water can be applied at.

So, with this we will conclude this lecture here. And in the next class, then we will discuss what are the kind degree of treatment or the regulatory requirements or those things are that exist for reusing the wastewater.

Thank you. And see you in the next class.