Watershed Management

Prof. T. I. Eldho

Department of Civil Engineering

Indian Institute of Technology, Bombay

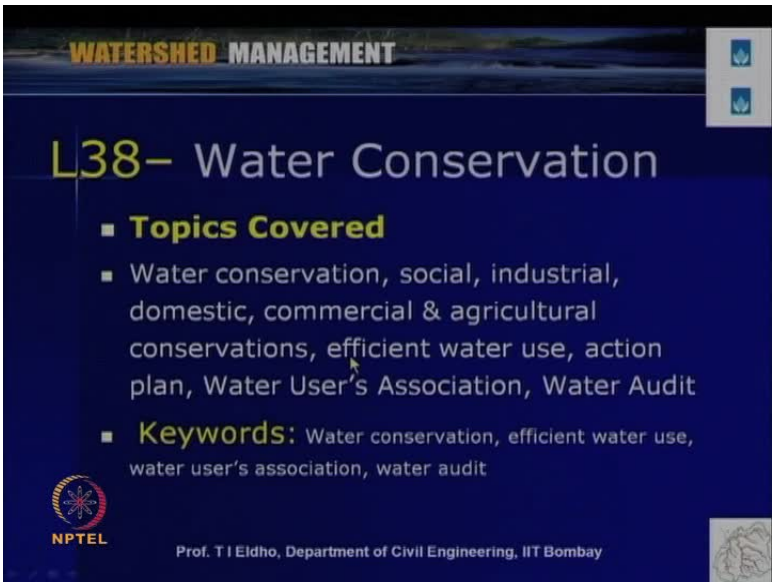
Module No. # 10

Lecture No. # 38

Water Conservation

And welcome back to the video course on watershed management. Today, in the last module of this video course module number ten on the topic of water conservation and recycling we will be discussing in this module mainly water conservation perspectives on recycle and re use waste water reclamation.

(Refer Slide Time: 00:45)

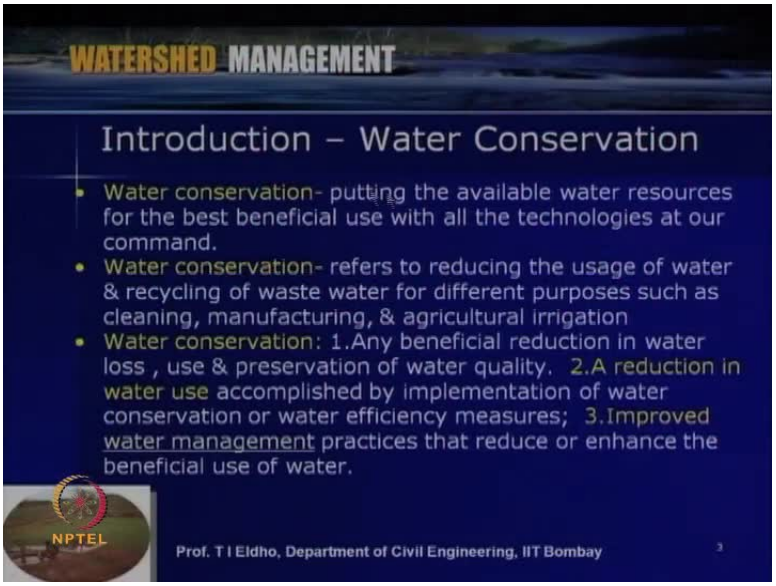


So, in today's lecture number thirty eight today we will be discussing about water conservation. Some of the important topics covered in today lecture include water conservation, social, industrial, domestic, commercial and agriculture conservations efficient water use, action plans, water user's association, water audit. Some of the key words for today's lecture include water conservation efficient water use water user's association and water audit.

As we were discussing earlier also when we discuss about the watershed management, we are mainly looking to the various aspects of water as a resource as an economical good as a social good. So, when we look into the watershed management in a holistic way so the water availability, water efficient water use all these issues come into picture. So, that way one of the important aspects in watershed management with respect to water is water conservation.

So, today we will be discussing more details on the aspects of water conservation so when we discuss about water conservation it can be with respect to various uses like a domestic uses then a agriculture uses industrial uses a commercial uses like that; so within this perspective only will be discussing about the water conservation.

(Refer Slide Time: 02:12)



Water conservation means putting the available water resources for the best beneficial use with all the technologies at our command so if an area is concerned, the depending up on the water availability some areas may be more water available will be available and some area less water will be available. So depending upon the area depending upon the conditions, water conservation we can define as the water resource utilization. The best beneficial way for say, best beneficial use with all the available technologies including modern technologies, for the best beneficial use…

So that way water conservation refers to the reducing the usage of water and recycling of waste water for different purposes such as cleaning, manufacturing, agricultural,

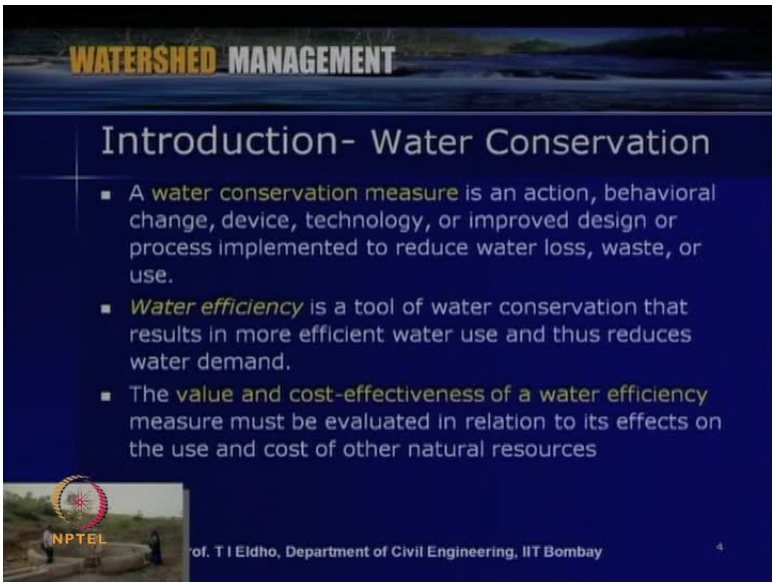
irrigation, etcetera. Various sectors of uses like agriculture sector or the domestic sector or industrial sector, we are looking to how much water we can reduce. But of course, with appropriate usage without wasting water by reducing the usage and then, how we can effectively reduce the waste water and how we can recycle the waste water.

So, that way when we look into water conservation, we are looking to any beneficial reduction in water loss, use and preservation of water quality. So, we are looking to the beneficial reduction. So, all our uses should be met; but, it should be in a reduced way; in a beneficial way and then a reduction in water use accomplished by implementation of water conservation or water efficiency measures.

When we look into water conservation we have to discuss about the efficient water usage so that way how efficiently say what kind of measures are we can adopt as far as water conservation is concerned, in an efficient way what we can do and third aspect is so how the improved water management practices so that we can reduce or enhance the beneficial use of water. For example, when we look into the agricultural water usage so as far as irrigation is concerned, there are number of methodologies as far as irrigation is concerned, we can simply fledge the form or with the agriculture land or we can say supply water through furrows or various small channels or we can apply the water through sprinkler irrigation or we can apply the water through drip irrigation.

So whatever the way we utilize the water for irrigation so the effect I mean that would be available to the plans or the crops may be the same but the water we can reduce by using the advance technologies like a sprinkler irrigation or drip irrigation. So that way we can serve large amount of water as far as that particular usage is concerned, so that is what you will say with in the contest of water conservation so that we can save water and that water can be utilized for other purposes.

(Refer Slide Time: 05:45)



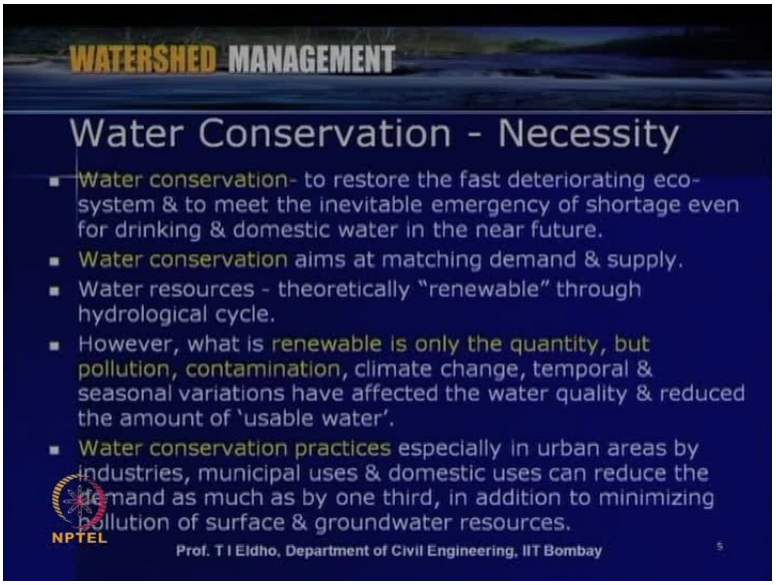
So that way a water conservation means a the conservation measures is an action it can be behavioral change or it can be a device or technology or improved design or process implemented to reduce water loss waste or use. So here there are some key words like a water loss so we have to reduce the water loss so we have to reduce the wastage and then water of the effective utilization or use is concerned, that also we reduce but of course by meeting the appropriate demand in an efficient way.

So that way we have to look into water efficiency so the water efficiency is a tool of water conservation that results in more efficient water use and thus reduces the water demand so as I mentioned when the water usage efficiency increases. So like when we are going from flooding type irrigation to the drip irrigation then we can see that large amount of water can be reduced as far as irrigation is concerned, or that the way we can reduce the demand of water so that way we will be increasing the water efficiency so that is what is we are looking for and that is in terms of water conservation.

So the value and cost effectiveness of a water efficiency measures must be evaluated in relation to its effects on the use and cost of other natural resources so even though this when we look into water conservation of course most of time we have to do a benefit cost analysis and then we have to see that the way which we are doing these I mean if water is available at a cheap rate and then we have to put large amount of money as a capital investment for such schemes like a drip irrigation.

Then the benefit cost ratio will be less so that way so sometimes we have to look into but in an effective way what we are talking is water conservation means we are trying to reduce the use as much as possible either then we have to increase the water efficiency.

(Refer Slide Time: 08:28)



So let us look into what are the necessities as far as water conservation is concerned, so as we discussed earlier now there is a many parts of the world the availability of fresh water is reducing and demand is increasing so that way we can see that if you can reduce the usage so or we can increase the water efficiency then that is the need of the our so that the available water we can use for various purposes in a more effective way so that way water conservation is one of the important or the important necessity of the our or necessity as far as watershed management is concerned.

Water conservation is to restore the fast deteriorating ecosystem and to meet the inevitable emergency of shortage even for drinking and domestic water in the near future so we can see that as we are discussing some of the lectures the water demand is increasing and then water quality problems are increasing so to meet this shortage available fresh water. So we have to go for water conservation or we have to increase our water use efficiency so water conservation generally aims at matching the demand and supply so with respect to the demand and how much is available so we have to meet this and then when we are increasing the efficiency or when we are going for water conservation so we will be able to meet most of the needs in an effective way.

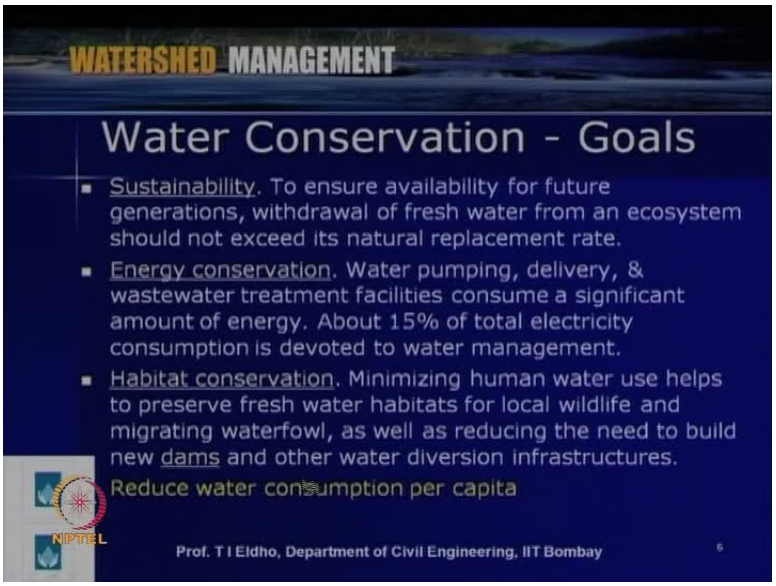
So water resources theoretically you can see that it is renewable through hydrological cycle but then of course there is problems like a the quality of the water like contamination however water is renewable is only the quantity but pollution contamination then problems like climate change then temporal and seasonal variations have affected the water quality and reduce the amount of usable water.

So we can see that in most parts of the world water is available but that available water is not usable water since most of the water source are polluted so the polluted water we cannot use in many cases like even for irrigation. So forget about the domestic or the drinking or other uses but even for irrigation many parts of the world water has become unusable so that way we have to see that how we can reduce the usage with respect to the available usable water.

So that way water conservation practices especially in urban areas by industries municipal uses and domestic uses can reduce the demand as much as by one third in addition to minimize in the pollution of surface and groundwater resources. So here two important point so here especially some of the analysis in many areas especially, in urban areas or in cities are shown that through or effective water conservation measures we can reduce the usage may be by one third in many of the industrial agricultural or domestic users. This is not only the reduction in the usage but, that way when we are using less water than the amount of waste water generate will be reduced.

So that way also we are minimizing the pollution of surface water and the available a groundwater resources. We can see that the necessity of water conservation is to meet the demand with respect to the available water and increase the water use efficiency and then due to the water stress in many parts of the world we have to look into the various options of water conservation. So, within this perspective let us look into the goals of water conservation so as far as water conservation goals are concerned, so as we discussed earlier also this is the issue of sustainability so the system as a watershed or the available water resources it should be sustainable.

(Refer Slide Time: 12:14)



We have to look into the sustainability issues when we look into the water conservation so sustainability means to ensure the availability for future generations that means here the water and then withdrawal a fresh water from an ecosystem should not exceeds its natural replacement rate.

So on an annual basis if you take the available water with an in ecosystem whether in as a surface water source or a groundwater resource so whatever we are utilizing on an annual basis so that should be replenished or replaced so we should not exceed what is replacing the usage. So that way we have to see so then we can say that the system is sustainable so the sustainability is very important as far as water conservation is concerned, then another aspect is energy conservation.

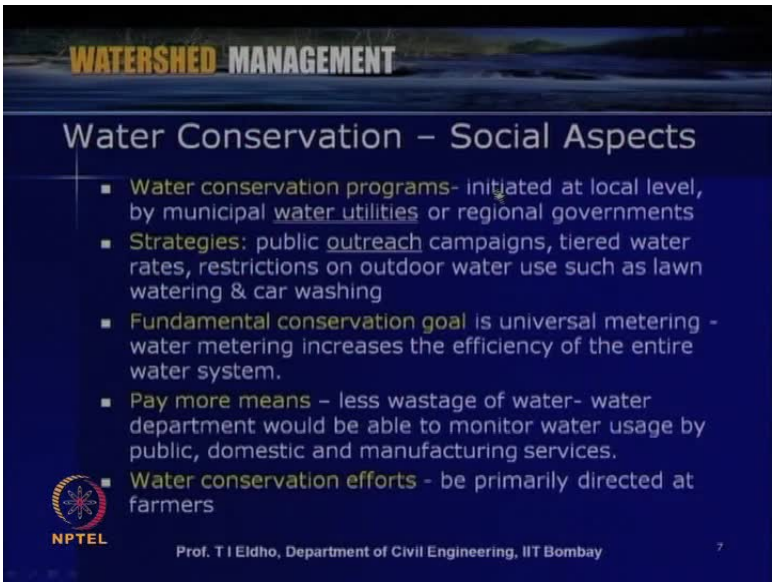
So when we look into water so we have to say the when the ground the water level is going down especially in aquifers we have to pump water from deeper wells so that way we have to use more energy so water pumping then water delivery and waste water treatment facilities all this consumes a significant amount of energy. So that way when we are conserving the water we are also conserving the energy so indirectly we are conserving the energy. So, an analysis throughout the world shows about 15 percent of total energy consumption what is presently consumed by the society or consumed by the world is for water management.

So it can be just like a pumping the water then distributing the water then the related issues like a waste water treatment waste water management so for all these we can see that about 15 percent of total electricity consumption is for the water related or water management. So that way when we are conserving the water we can see that we are also conserving the energy so we have becoming environment friendly we have become energy friendly and then third aspect is say habitat conservation. So when we are minimizing the human water use so that helps to preserve fresh water habitats for local wildlife for the ecosystem migrating waterfowl as well as reducing the need to build new dams and other water diversion infrastructure.

So most of time we can see that when we are using the when the uses is increasing a or the water demand is increasing we have to construct more dams more diversion canals so like that so that way when we are reducing the use or when we are conserving the water so we can reduce the number of dams when we can reduce the water dry diversion infrastructure so like that. That way what we are looking for water conservation is reduce the water consumption per capital so that way per capital demand is reduced or the consumption is reduce so that we can conserve more water and indirectly we can say or more energy conservation takes place and the habitat or the system become more sustainable so this are the some of the important goals as far as water conservation is considered.

Now, when we look into water conservation we have to see various aspects say just like social aspects agricultural aspects then ecological or environmental aspects or the commercial aspects like that. So, let us look into some of this important aspects with reference to the water conservation.

(Refer Slide Time: 15:48)



Most of the water conservation programs we can see that this water conservation programs are initiated at local level by municipal water utilities or regional governments so most of the water conservation programs are initiated by either water aborities or water boards or local governments like that. So that way we can see that the bodies or the aborities which are local level which are directly interacting with the people they can effectively go for water conservation or they can advise the people for water conservation. Some of the strategies which we can adopt for water conservation within the social perspectives like we have to go for public outreach campaigns so that the people should know that we have to conserve water so that to be much better than over use and then wastage all those things. So, that way a public outreach campaigns are important strategies then tiered water rates so we can see that now a days in a country like India we are in many parts of India we are distributing water on a bulk rate that means say for a household or a for society wise we give water on a bulk rate I mean per capita 150 liters per capital per day or something like that.

So that way then what happens is that the water the rate goes down the price water goes down and then the people who are using more water they have also paying less. So that way there is will be a tendency to waste the water so instead of these bulk payment or bulk rate for water we can put tiered water rates if you use per capital say if 50 liters per capital per day is this much rate and when its goes to 100 50 to 100 then the rate changes rate increases 100 to 200 the rate further increases like that.

and then we can see that some of the other strategies include like a restrictions on outdoor water use such as lawn watering and car washing so in many places many houses societies and then institutions we can see that they use so much of water for fresh water for lawn watering and then car washing or other kinds of washing.

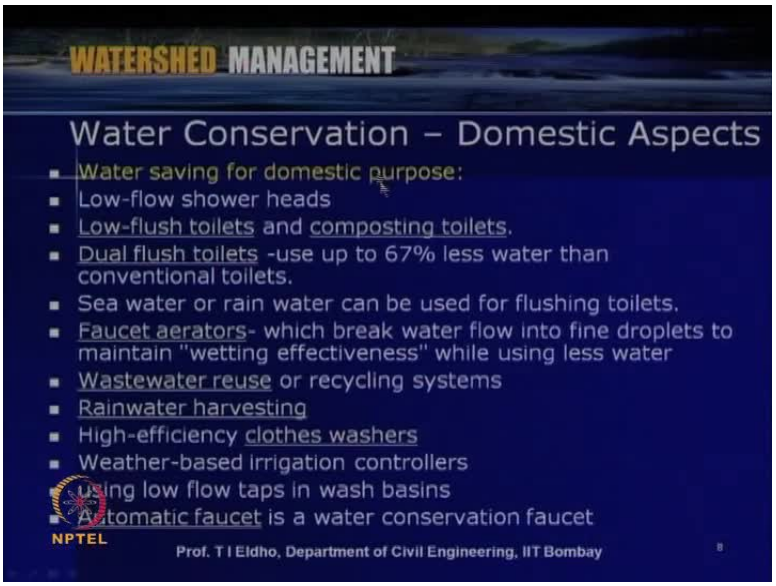
So that also they say if they can reduce then that will be a better strategy as far as water conservation is concerned, then fundamental conservation goal in all this is universal metering water metering increases the efficiency of the entire water systems. So when we are charging the consumers based up on the meter water I mean say if the consumers know they are using this much water and they have to pay according to the units what they are using then there will be a tendency for the people to reduce the usage of water.

So that way we can further conserve water or we can reduce the usage of water so fundamental conservation goal is a universal metering and then it is observes various study shown that water metering increases the efficiency of the entire water system that way we can see that the pay more means less wastage of water say when the society or when the people are paying more for water then there will be a tendency to reduce the wastage and then so that way we can conserve the water.

So water department would be able to monitor water usage by public domestic and manufacturing services and then accordingly they can say put the rates so those who are using more they have to pay more so like that we can give the principle for paying so that way we can conserve more water and then water conservation efforts we can see that the this are primarily directed at farmers since we as we discussed in a earlier lectures also farmers are using a major ( ) of water say in India say for about 75 to 80 percent or on an welled average it about 70 percent of fresh water usage is by farmers.

So that way when the farmers say comes to know that when they are using less water or effective way when they are using water we can see that there will more effective water conservation so that way when we look into social aspects we have to see the various issues like a pricing of water then public participation then public outreach with respect to water conservation and then those who are using more they have to pay more so like this various social issues we can consider and then we have we can go for this various kinds of water conservation a in this perspective.

(Refer Slide Time: 21:26)

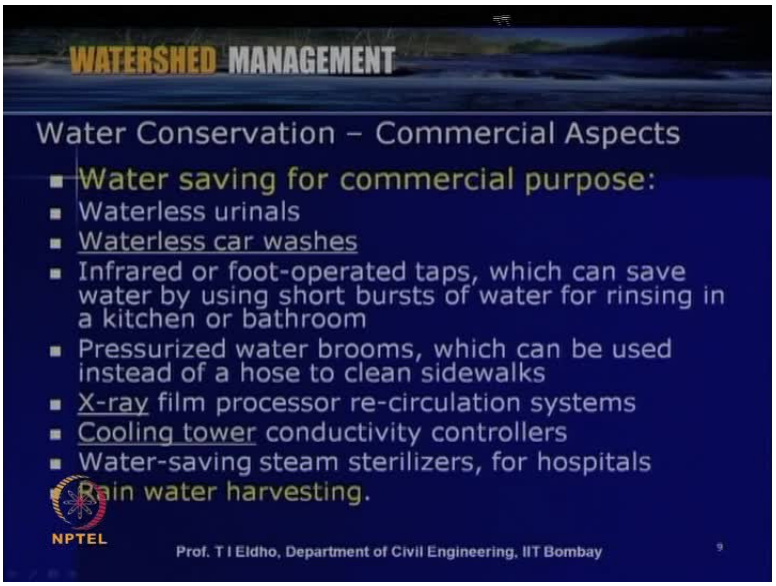


Then, when we look into domestic aspects we can see that water is needed for various purposes say like a cooking bathing then washing etcetera so water saving for domestic purposes we can see that like a various schemes like a say we can go for low flow shower heads then low flush toilets and composting toilets. Dual flush toilets use up to 67 percent less water than conventional toilets then sea water or rain water can be used for flushing toilets then faucet aerators which break water flow into the fine droplets to maintain wetting effectiveness while using less water then waste water reuse or recycling systems which will be discussing further a in a later lectures.

And where rain water harvesting then high efficiency clothes washers then weather based irrigation controls controllers then using low flow taps in wash basins then automatic faucets in a is a water conservation faucet so like that when we look into domestic aspects so how much we can reduce say per capital or per person on a domestic ways is for cooking or for washing or for say normal usage like a toilet usage or the brushing usage or shaving so like that how much water can be reduced say as far as domestic usage is concerned.

So that way we can see that if you if you reduce the usage through various means then we can see that say we can go for better water conservation then next one is say when we look into commercial aspects so like a commercial buildings or the various commercial complexes they can reduce the use of water.

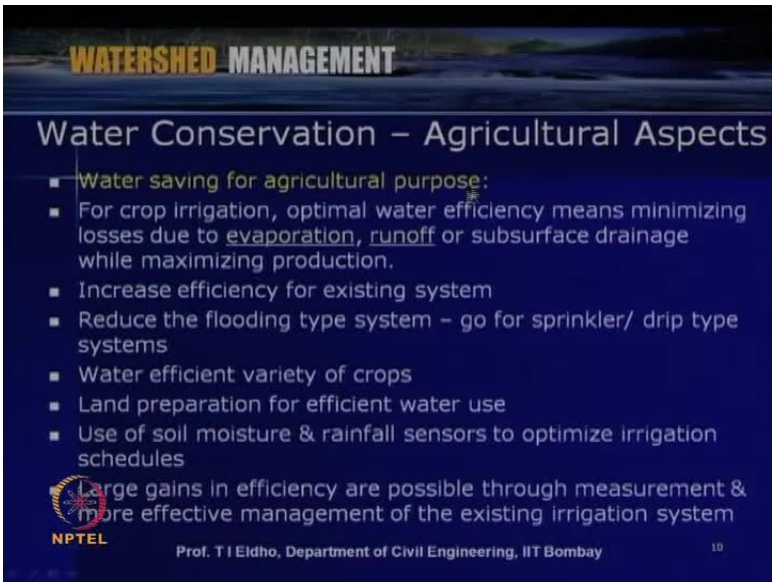
(Refer Slide Time: 23:12)



Water saving for commercial purposes like various usage like a say water will be used for toilet blocks urinals or washing cars or automobiles so like that some of the aspects which we can consider are listed here like a waterless urinals then waterless car washes. Then infrared or foot operated taps which can save water by using short bursts of water for rinsing in a kitchen or bathroom then pressurized water brooms which can be used instead of a hose to clean sidewalks.

Then, x ray film processor recirculation systems then cooling tower conductivity controllers water saving steam sterilizers for hospitals then rain water harvesting so like this when we look into commercial aspects so there are various ways we can conserve the water so first aspect which we they say water can be conserved by rain water harvesting. Wherever water is coming they can store or they can recharge in that location as far as commercial buildings are concerned, and then for various commercial uses they can reduce the usage of water so that is about the water conservation with respect to commercial aspects.

(Refer Slide Time: 24:43)



Now when we look into agriculture aspects as I mentioned agriculture sector is the one of the major user of water so water saving for agriculture purposes include say for crop irrigation optimal water efficiency means minimizing losses due to evaporation runoff or subsurface drainage while maximizing the production. So, the motor should be reduce the usage of water but increase the yield of the crops so by reducing the use by various means we can reducing the usage I mean by scientific tanning or scientific usage of water and then say by using a very efficient seeds less use the water say if you are using the crops which use less water so like that various aspects we can consider when we look into agricultural aspects.

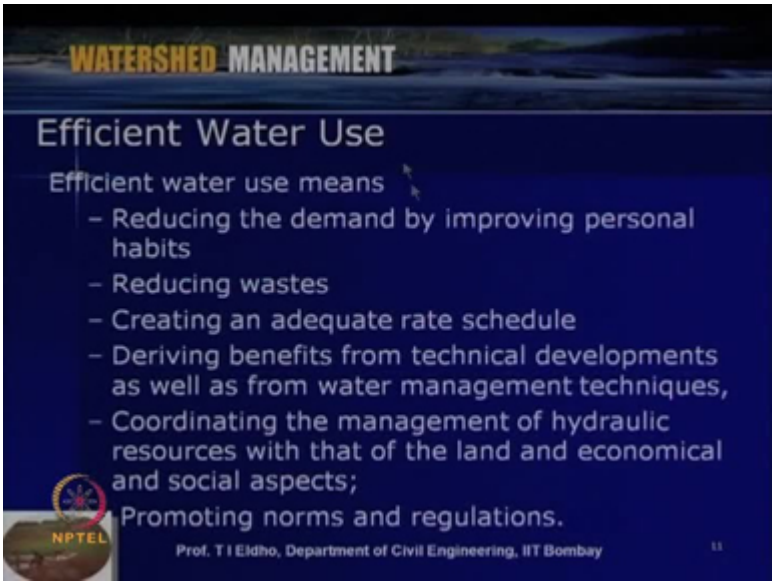
So then increase efficiency for existing systems so whatever the say for example if you are using say if you are irrigating through flooding whether we can go for furrow systems or for say whole systems like that then reduce the flooding type systems or go for sprinkler or drip type very effective irrigation system. Then water efficient variety of crops whether we can utilize or land preparation for efficient water use so we can prepare the land in advance and then so that the moisture will be conserve with in the soil so that less water utilization is required that way we can conserve the water.

Then use of soil moisture and rainfall sensors to optimize irrigation schedules so instead of over irrigating say now a days we can go for scientific farming so that see we can have sensors with respect to the optimum irrigation schedules so according to when the

plant needs water then we can irrigate or there is water stress so for the crops so at that time we can irrigate and then we can save water and that way we can have large gains in efficiency these are possible through measurements and more effective management of the existing irrigation system so what it we can observe most of the irrigation systems so the farmers are using water without metering or without measuring so they do not know how much water they are using for that particular crops.

So that way if we can go for some type of measurement so we can educate the farmer they are over using the water so if that can be reduce they may get better yield also and we can stop problems like water logging and then say water quality issues so all this things are possible so that way when we look into agriculture aspects say we can go for various means of water conservation.

(Refer Slide Time: 27:46)



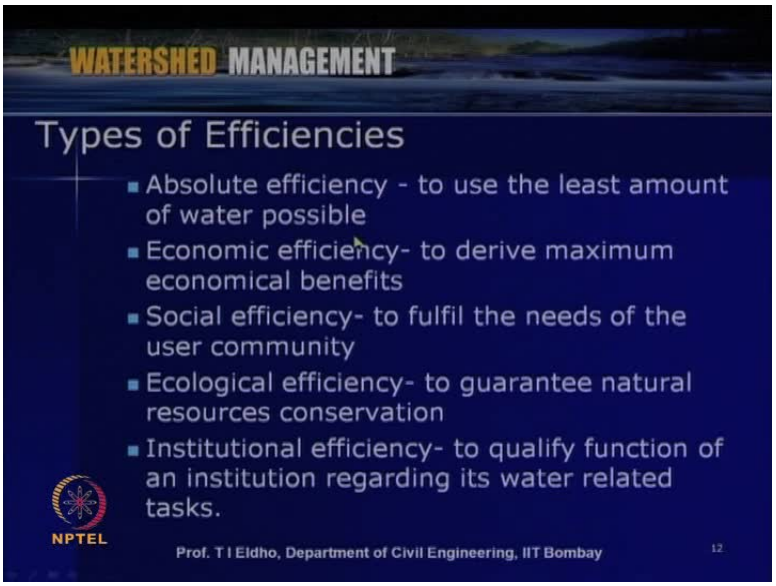
So that way when we look into water conservation so as I mentioned we are looking for efficient use of water so efficient water use means so what we discussed with respect to what we are discuss so for we can put into various points like this so we can reduce the demand by improving say if it is domestic sector by improving personal habits we can reduce the wastes by various means then we can create an adequate rate schedule.

So those who are using more water they have to pay more so like that we can come up with some rate schedule so that there will be possibility of reduction in water use then deriving the benefits from technical developments as well as from water management

techniques so we can go for various management techniques to reduce the use of water then various technical developments like effective flushing system effective taping systems so like that.

Then, coordinating the management of hydraulic resources with that of land and economical and social aspects so we can coordinate with respect to the hydraulic aspects then with respect to land management with respect to the crop management like that and then say also we can promote the norms and regulations we can come up with the norms and regulations and then educate the people a so that say there will be more efficient use of water so that way we can conserve the water.

(Refer Slide Time: 29:05)



When we look into the efficient utilization of water efficient use of water we have to consider various types of efficiencies as far as water use is concerned. So, some of the important efficiency norms what we can adopt as far as water use is concerned, are listed here so first one is the absolute efficiency so this is related to use the least amount of water as far as possible.

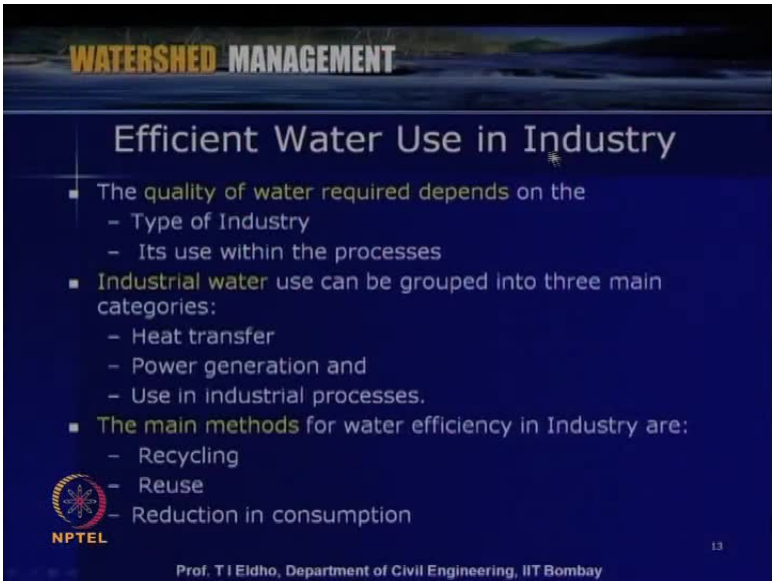
In terms of the use of water so we want to reduce the use as much as possible that is what we are looking in absolute efficiency then economic efficiency means to derive the maximum economical benefits so if it is say crop production with a less use of water how maximum crops can be produce or if it is industrial production with less use of water or how maximum industry productions are possible.

Then social efficiency to fulfill the needs of the user community so it is not like we are not cutting the supply and conserving the water but we are supplying the water but we are educating the society we are looking the social aspects and then we are trying to achieve say, by providing normal supply but through the participation of the uses we can reduce the use of water or we can conserve the water so that way we can look into social efficiency then ecological efficiency means to guarantee natural resources conservation.

As we discussed earlier say the nature the ecology need minimum use of water so the how effectively that we can supply and we can reduce the usage so that is so called ecological efficiency. Then when we look into institutional wise the institutional efficiency to qualify the function of an institution regarding its water related tasks so when we look into various industries or various establishments we have to see that how much water they are conserving how they can reduce the use of water now a days it is one of the norm or so called corporate social responsibility by the industries.

So like a water conservation water harvesting or water reuse or water recycling so like that so with respect to that institutional efficiency we can have we can look into various aspects of that.

(Refer Slide Time: 31:54)



Then now we will say with respect to what we are considered so for is water conservation with respect to the various uses or the water efficiency so with in this perspective now let us look how we can use the water efficiently say for various sectors

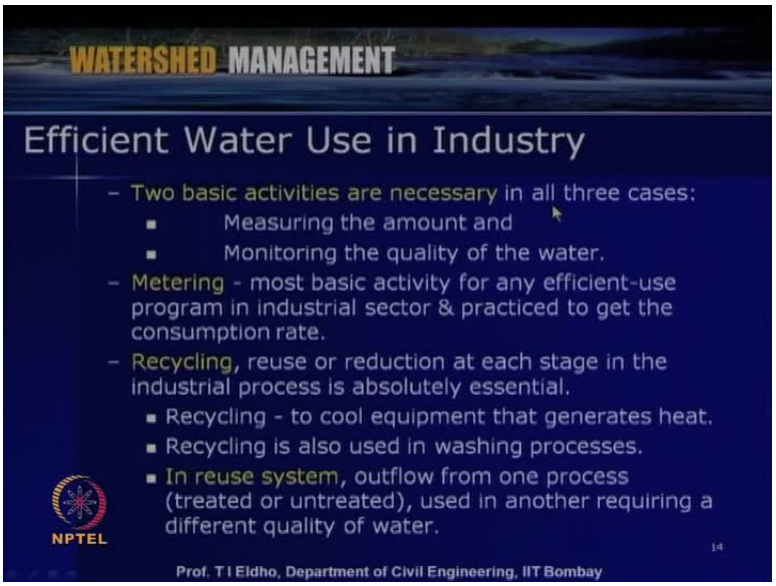
so first let us look into industry so efficient water use industry so general the quality of water required depends on the type of industry.

So some industry need a highly purified water very good quality but some industry that may not be needed so like that type industry accordingly we can see then it is use within the processes so from one process to another process within the same industry the quality of water requirement may vary say for example for washing purpose the quality may not be needed so good or say cooling purpose even we can go for say less quality water.

Then industrial water use can be grouped into three main categories if you generally look in to various industry usage like heat transfer like in thermal power plants or cooling systems then power generation and then so power generation means through especially say steam turbines like that and then use in industrial processes so various process like a paint industry or a say the manufacturing industry or the pharmaceutical industry like that so the main methods for water efficiency in industry are like recycling with respect to the waste water we can treat this waste water and then recycle and then reuse so for example the water coming from say some washing can be used for other purposes or the water used for cooling purpose we can use further for other purposes.

Then third aspect is reduction in consumption so when we look into the water efficiency in industry 3 aspects are there 1 is reduction in consumption then how much water we can recycle and then how much water we can reuse so that way we have look into efficient water use in industry so the aspects of water recycling and reuse will be discussing the next lecture.

(Refer Slide Time: 34:15)



Now, further aspects when we look into efficient water use industries are concerned, so 2 basic activities are necessary in all these 3 cases like the recycling reuse and reduction in consumption. The 2 basic activities are like a we have to measure the amount of water which we are using and we have to monitor the quality of the water so as I mentioned if we know this much water is used for this purpose so we have to measure effective measurement or metering should be there so and then also once we use particular amount of water for some particular processes.

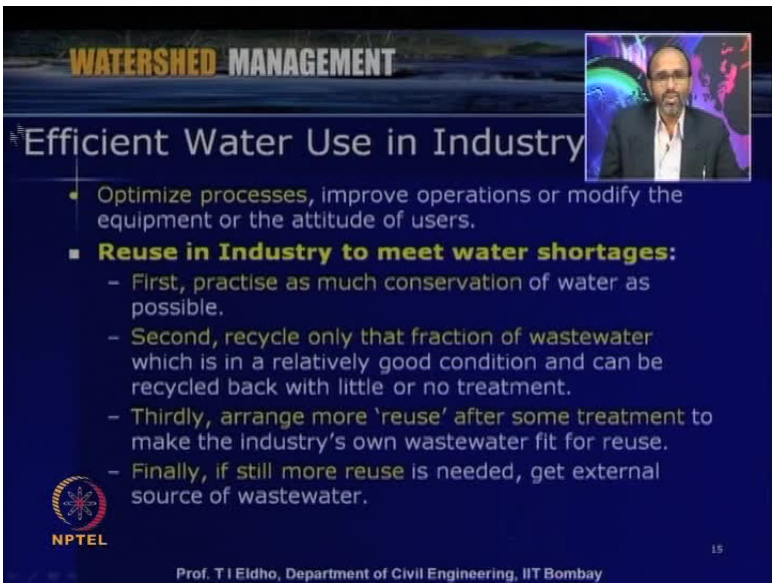
Then the water coming out of that process how much it is polluted or the quality of that water and whether we can directly use that water for other purposes like that so that way we have to look into the metering so most basic activity for any efficient use program in industrial sector and practiced to get the consumption rate.

So that way we when we are having water metering and then if the industry say we can make them know that this much water is used and that we can reduce so that way the reduction or water conservation is possible.

Then recycling is concerned, so as I mentioned whether the water used for one process we can use for another purpose and then reuse or reduction at each stage the industrial process is absolutely essential when we look into the efficient water using industry then recycling to say for example recycling to cool equipment that generate heat so the water used for cooling purpose we can use for other purposes.

Then recycling is also used in washing processes so wherever say 1 process to another process we can use and in the reuse systems outflow from 1 process say treated or untreated used in another requiring a different quality water so reuse means in recycle we are treating and we can we are reusing it or we are using it again but reuse means whatever once it is used for 1 process wherever we can use for treated in a treated where untreated way for another purpose.

(Refer Slide Time: 36:23)



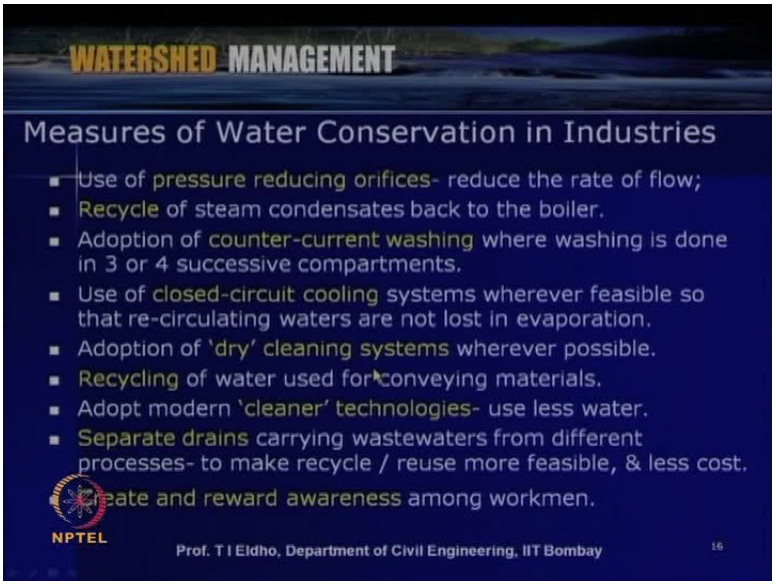
So that way when we look into efficient water use industry we have to see we have to optimizes various processes as far as industrial process are concerned, then we have to improve the operations or modify the equipment or the attitude of users so if you can educate the workers if you can educated the staff to use less water in an effective way then we can optimize the use of water and we can even optimize the processes the industrial process.

So that way when we look into reuse in industry to meet water shortages we have to see first practice as much as conservation of water as possible so whatever the way we can reduce the use of water so that is we have to practice first that means practice as much conservation of water as possible and then second aspect is recycle only that fraction of waste water which is in relatively good condition and can be recycled back with little or no treatment.

Recycle means instead of treating the water and then reusing water what we are trying to recycle it for other purpose say with little or no treatment so that is the second aspects then third arrange more reuse after some treatment to make the industry own waste water fit for reuse. So, for reuse is concerned, by give some primary treatment or secondary treatment whether we can reuse the water for in the next cycle so finally if still more reuse is needed get external source of waste water.

So if the industry considered if they are not getting sufficient water then they can go for waste water treatment plan and they can treat their own waste water and then reuse that waste water. The treated waste water or in some industries like in Mumbai or R C F Rashtriya Chemical Fertilize company in Chembur they are buying the waste water for the municipal corporation and then they are treating that waste water and that treated water they are using for in their industrial purpose so that way we they can look into still more reuse if it is needed get external source of waste water so that is also a possible.

(Refer Slide Time: 38:52)



So that way when we look into the various conservation measures as far as industries are concerned, so here again I have a say summarize the various measures say like use of pressure reducing orifices so wherever more water usage is there we can use pressure reducing orifices so that the rate of flow water will be reduced.

Then recycle of steam condensates back to the boiler so especially in thermal power plants or the cooling systems so whatever the steam condensates so that can be put a

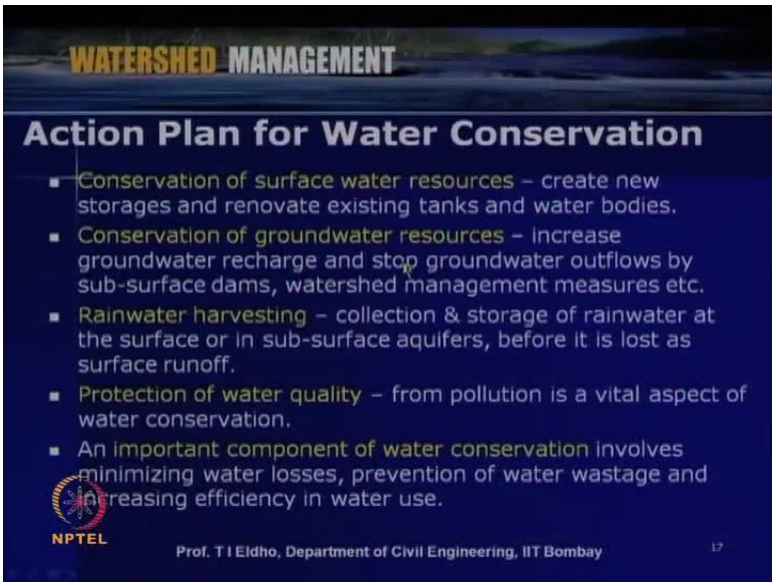
send back to the boiler so that much water can be saved then adoption of counter current washing their washing is done in 3 or 4 successive compartments.

So for the industrial processes where the washing is done in 3 or 4 successive compartments whether we can use counter current washing when use of closed circuit cooling system wherever feasible so that re-circulating water are not closed in evaporation so we can see that whenever we are looking for cooling systems so say once the water evaporated that the same water can be instead of losing that water whether we can convey back and then condense tank reuse.

Then whether we can go for dry cleaning systems instead of cleaning using the water then recycling of water used for conveying materials so whether directly while conveying the materials say whether we can recycle then adopt modern cleaner technologies use where we can use less water. So compare to a traditional technologies we can go for cleaner technologies as far as industrial processes are concerned, where the water demand will be less and then we can go for a better water conservation then separate drains carrying waste waters from different processes to make recyclable recycle or reuse more feasible and less cost. So if we have got 2 types of, or separate drains carrying the waste water so that we can give appropriate treatment to that waste water and then, immediately we can either recycle it or reuse as far as the waste water is concerned.

Then most important aspect is the awareness campaign or create an reward awareness among workmen so that the people will be knowing about the water conservation principles as far as the particular industry is concerned, and then they will be educated so that we can create and reward awareness among workmen.

(Refer Slide Time: 41:47)



So, that is about the measures of water conservation industries now let us look action plan for water conservation so we the various action plans are possible some of the important action plans are listed here like conservation of surface water resources so we can create new storages we can have more ponds more lakes or more reservoirs and then we can renovate the existing tanks and reservoirs so that we can DE-silt we can remove the silt so that more storage will be possible so like that so that way we can conserve the surface water resources.

Then conservation of groundwater resources so here we can go for rainwater harvesting or we can recharge the water to the aquifer systems so conservation of groundwater resources increases groundwater recharge and stop groundwater outflows by subsurface dams as we discussed in the previous lecture then watershed management measures so as we have seen in many of the earlier lectures various watershed management measures are very helpful for water conservation as an action plan. Then, rain water harvesting so that is one of the important aspects in many of the water conservation schemes. So, like collection and storage of rain water and the surface or in sub-surface aquifer systems before it is lost as surface runoff.

Then, protection of water quality; so water quality is a major issue so we have to look into from pollution is a vital aspect of water conservation and an important component of water conservation involves minimizing water losses so like evaporation losses or any

kind of losses then prevention of water wastage and increasing efficiency in water use so most important aspect is efficiency in water use so reduce the wastage and increase the efficiency.

(Refer Slide Time: 43:28)

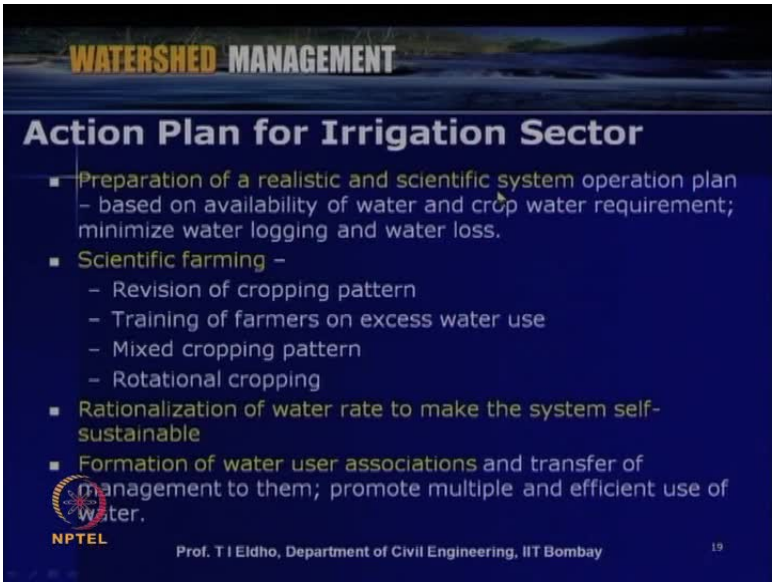
Now, let us look the various action plans for various sector so if you consider irrigation sector when we look into water conservation so as I mentioned the irrigation sector is the sector where more water is used so if you can improve the usage of water or we can come up with a various scientific or better performing irrigation measures like a drip irrigation or various schemes then we can go for water conservation better water conservation.

So performance improvement of irrigation systems and water utilization like a proper and timely system maintenance then rehabilitation and restoration of damaged or silted systems like a small channels or canals then reduce seepage losses by lining the channels or canals then restoration or provision of appropriate control structures. Then renovation and modernization of existing irrigation systems then provision of adequate water measuring structures so as I mentioned so we if you have some water measuring structures so that the farmers will be knowing how much water they are using so that the water usage can be reduce.

Then, another important aspect is conjunctive use of surface and groundwater so whenever for example more surface water is available so we can allow this water to

recharge to the aquifer systems and then whenever surface water is less available then we can use this groundwater for particular use so in the area so where there is threat of water logging this conjunctive use is important. Then we can adopt efficient irrigation systems such as sprinkler drip and other schemes wherever efficient water use is possible so that way this are some of the action plans for irrigation sector.

(Refer Slide Time: 45:26)



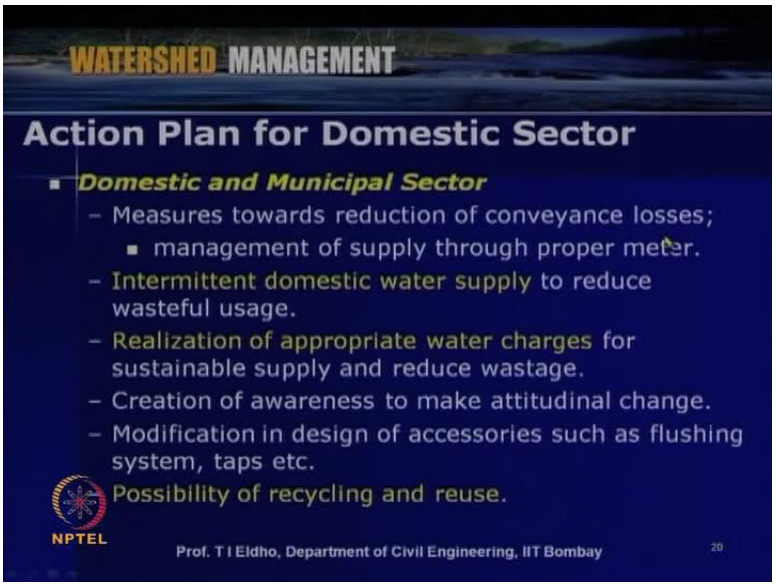
Then also further we can prepare realistic and scientific system operation plan based on availability of water and crop water requirements so we can scientifically understand scientifically study the crop water requirement accordingly we can supply the water and then minimize water logging and water loss. Then as I mentioned earlier we can go for scientific farming so where the crops will be growing with a less water is or we can use less water intensive crops so revision of cropping pattern then training of farmers on excess water use then mixed cropping pattern then say rotational cropping so all these schemes are very important a water conservation measures as far as irrigation sector or agriculture sector is concerned.

Then rationalization of water rate to make the system self sustainable so if you give the water free of cost then there will be a tendency for the farmers to use more water that use of more water may decrease the crop production and then it may lead to water flow logging and other related problems.

Then of course, say the water which is available for other purpose by using more water the water conservation will not be possible so that way we have to rationalize the water rate in an effective way so that system is sustainable and then another important aspect is formation of water users association and transfer of management to them.

So wherever on a local basis we can for water users association and then we can transfer the effective the utilization or the storage or the supply of the water to the users association so that there will be better water utilization and water conservation and then we can promote multiple and efficient use of water whether irrigation to various crops are concerned.

(Refer Slide Time: 47:44)



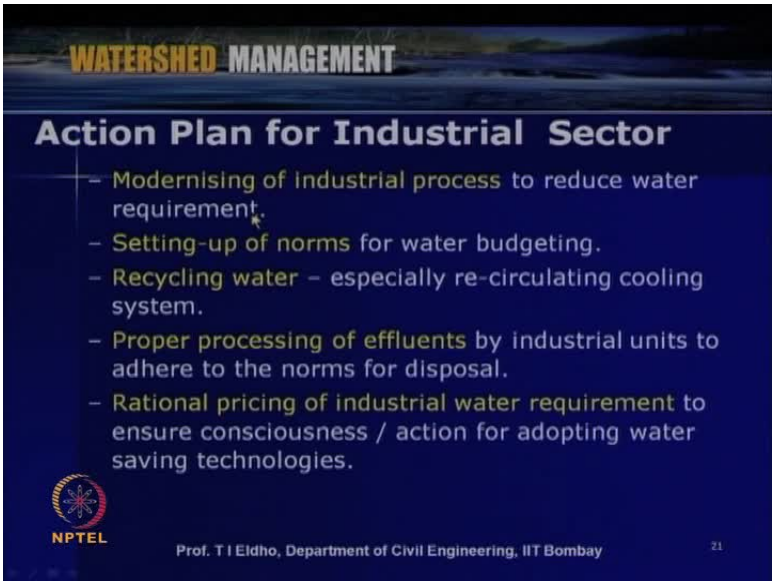
Now, when we look into action plan for domestic sector so domestic and municipal sector as we already discuss say if you can reduce the use of water through various means then a we can go for better water conservation.

So measure towards reduction of say like conveyance losses say when we are supplying water through pipe lines whether there is any leakage so we can if you can identify at the earliest and then reduce the conveyance loss then we can conserve the water then management of supply through proper meter so that people knows how much water they are using then intermittent domestic water supply to reduce wasteful usage so instead of continuous supply if intermittent water supply is there then the rates may be reduce.

Then realization of appropriate water charges for sustainable water supply and reduce wastage so as I mentioned earlier so we have to see the sustainability and then we if we can increase the water charges so there will be the supply will be sustainable and wastage will be reduced and then creation of awareness to make attitudinal change so we have to see that the people who are using more water for say various purposes whether we can change their attitude so that they use less water and that way we can conserve the water.

Then modification design of accessories such as flushing tanks taping taps etcetera then on a domestic side whether we can recycle the water and whether we can reuse the water say for example water coming from kitchen sinks we can use for gardening or the water coming from the flushing system with some treatment whether we can use for other purposes.

(Refer Slide Time: 49:16)

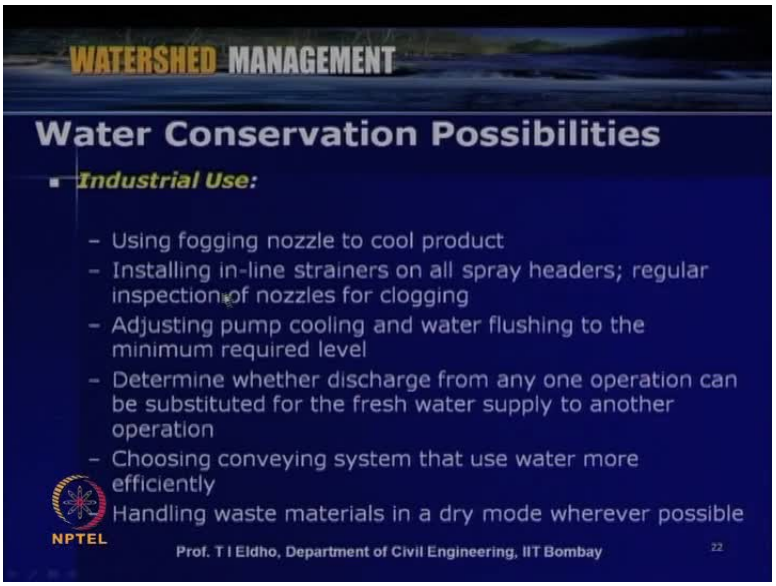


Then industrial sector is concerned, like a whether we can modernizing the industrial process to reduce the water requirement as we all discuss then whether we can setting up norms for water budgeting so where the they can have the water budgeting so that say the industries can reduce the use of water so that better water conservation is possible.

As we discussed recycling of water is very important especially in re-circulating cooling systems then proper processing of effluents by industrial units to adhere to the norms for disposal then rational pricing of industrial water requirement to ensure consciousness and action for adopting a water saving technologies.

So now in the most of the industries our main industry main purpose is or main objective is to achieve serological discharge that means sero waste water coming from the industry so that we have to keep on reusing or recycle the waste water through various means so and then use the very water efficient technologies in the various industrial processes.

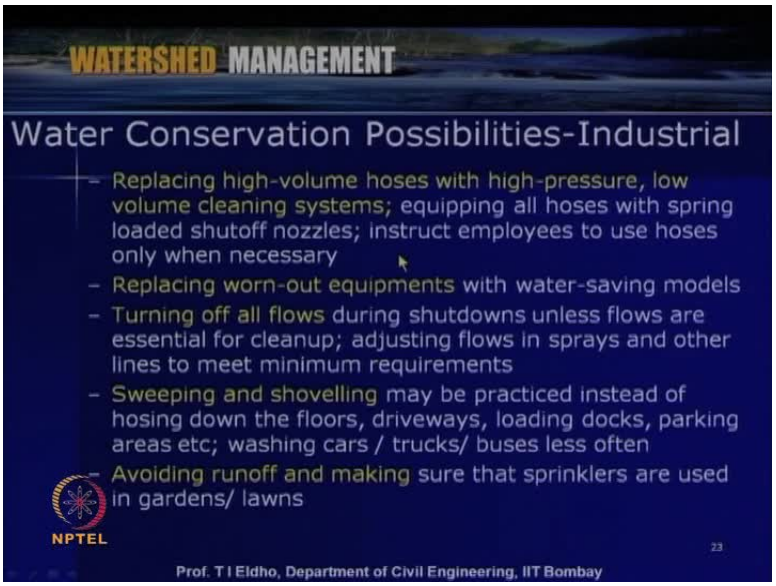
(Refer Slide Time: 50:30)



So that way when we look into industrial use the water conservation possibility is include some of the possibilities I have listed here like using fogging nozzle to cool products instead of water then installing in line strainers on all spray headers regular inspection of nozzles for clogging then adjusting pump cooling and water flushing to the minimum required level then determine the whether discharge from any one operation can be substituted for the fresh water supply to another re operation.

Then choosing conveying system that use water more efficiently then handling waste material in a dry mode wherever possible so these are some of the way the water conservation possible in various industries.

(Refer Slide Time: 51:10)

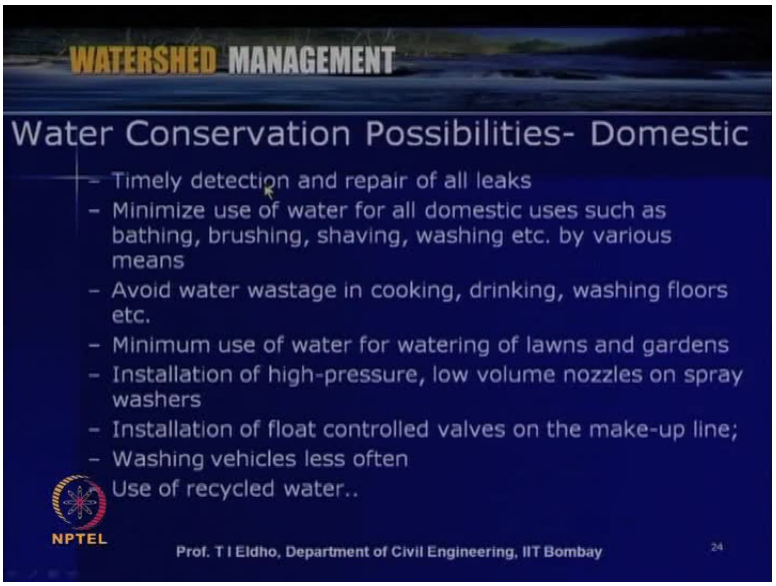


Then further replacing high volume hoses with a high pressure low volume cleaning systems then equipping all hoses with spring loaded shutoff nozzles then instruct employees to use hoses only whenever necessary.

Then replacing worn-out equipments with water saving models then turning off all flows during shutdown unless flows are essential for cleanup then adjusting flows in sprays and other lines to meet minimum requirements.

Then sweeping and shoveling may be practiced instead of hosing down the floors then driveways loading docks parking areas etcetera in loading washing cars trucks buses less often so that we can conserve the water then avoiding runoff and making sure that sprinklers are used in gardens lawns so this way we can use a various possibilities depending up on the industry depending up on the processes depending up on the rates so there are various possibilities as far as the water conservation in industries are concerned.

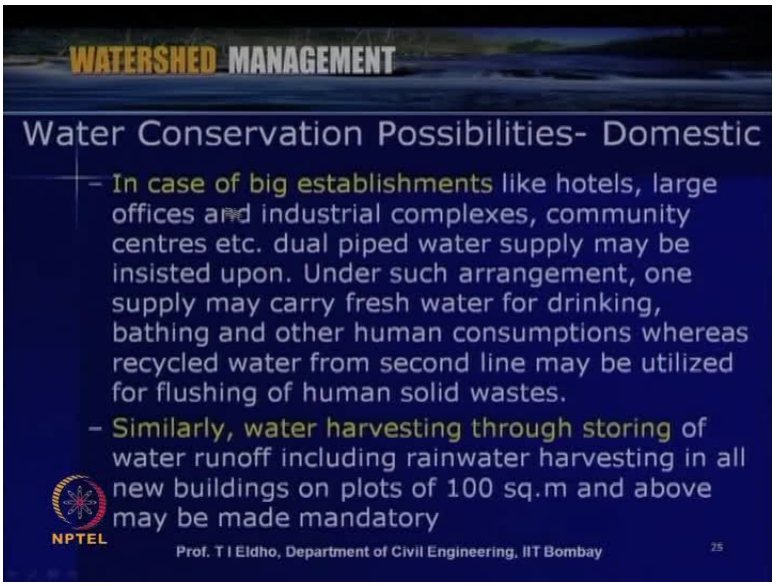
(Refer Slide Time: 52:29)



As far as domestic purpose is concerned, water conservation possibility is include timely detection and repair of all leaks so leak is a major issue about 20 to 30 percent water is a lost in leaking so that way whether we can detect it and repair. Then, minimize use of water for all domestic uses such as bathing brushing shaving washing etcetera by various means as we already discussed and then avoid water wastage in cooking drinking washing floors etcetera.

Then minimum use of water for watering of lawns and gardens then installation of high pressure low volume nozzles on spray washers then installation of float controlled valves on the make-up line then washing a vehicles less often then use of recycled water like that. So this way we can see that as far as domestic sector is concerned, there are various conservation possibilities so depending up on the situation depending up on the location depending up on the nature of the people we can adopt various schemes as far as water conservation is considered.

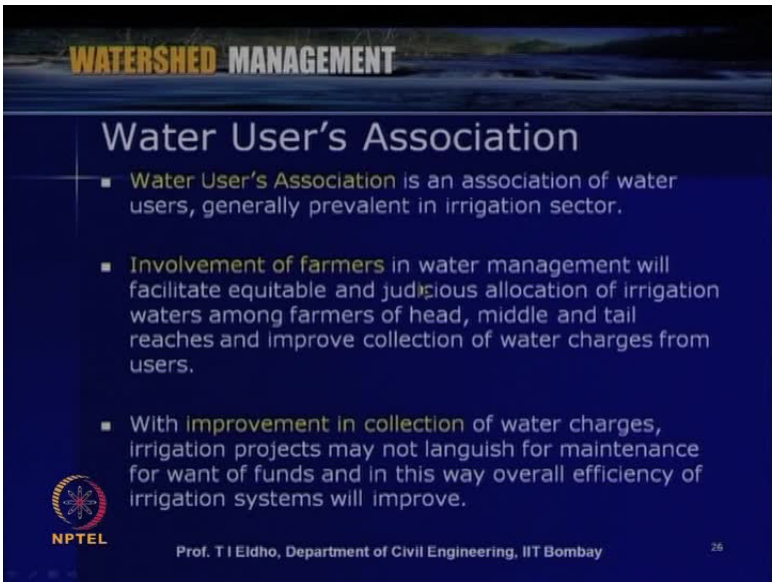
(Refer Slide Time: 53:34)



Then also in case of big establishment like hotels large offices and industrial complexes community centers etcetera, we can go for dual piped water supply. So, under such arrangements one supply can carry fresh water for drinking bathing and human consumptions whereas recycled water for second line so we can have a dual system so one is for fresh water another for waste water so that can be used for various purposes.

Similarly, water harvesting we can make it compulsory in various domestic housing colonies or various domestic systems. Water runoff including rain water harvesting in all new buildings on plots of 100 square meters and above, may be made mandatory.

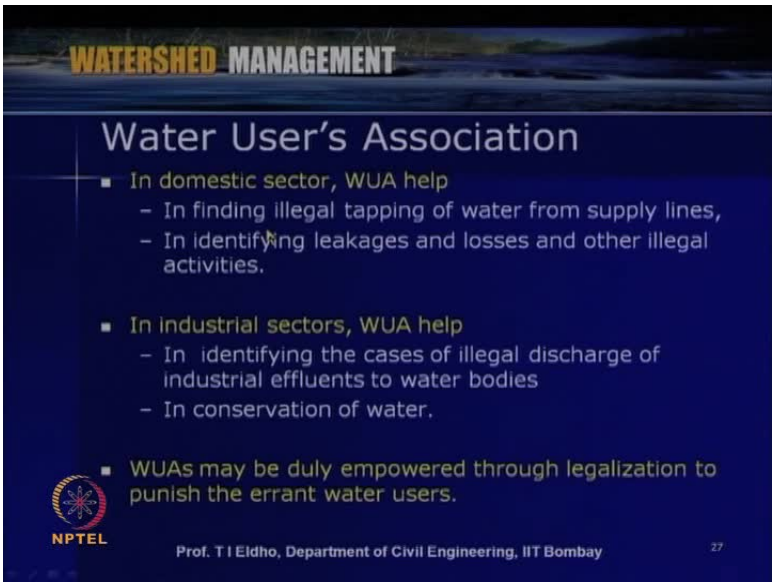
(Refer Slide Time: 54:14)



As I mentioned, another option is of course we have to educate the people so we can have association called water user's association in many areas it has been found very effective if the formation of water user's association and if you can enters the water user's association the water distribution and water storage and other various aspects then it has been found to be very effective so water user's association is an association of water users generally prevalent in irrigation sector.

Then, involvement of farmers in water management will facilitate equitable and judicious allocation of irrigation waters among the farmers of head middle and tail reaches say like in a canal system or wherever it is and an improve collection of water charges from users. Then with improvement in collection of water charges irrigation projects may not languish for maintenance for what want of funds and in this way overall efficiency of irrigation system will improve.

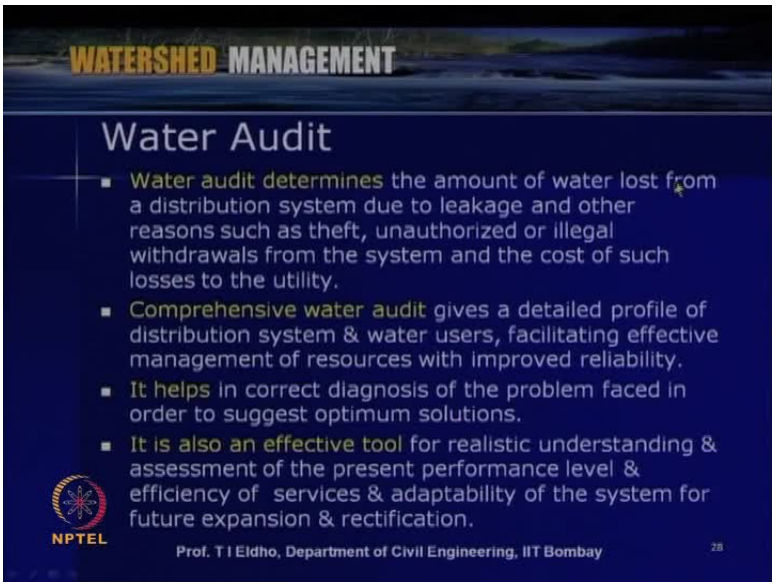
(Refer Slide Time: 55:25)



So that way, water users of association can play a major role as far as the efficient water use or water conservation is concerned, then in domestic sector we can see the water user's association can help in finding illegal tapping of water from supply lines. Then they can identify the leakages and losses and other illegal activities so that way water user's association will be the effective then industrial sectors water user association help in identifying the cases of illegal discharge of industrial effluents to water bodies then in conservation of water water user's association can help then water user's association may be duly empowered through legalization to punish the errant water users.

Wherever say, an industry or domestic or the agriculture sector we can give appropriate powers to the water user's association so that they can punish the errant users so that the say effective utilization is possible.

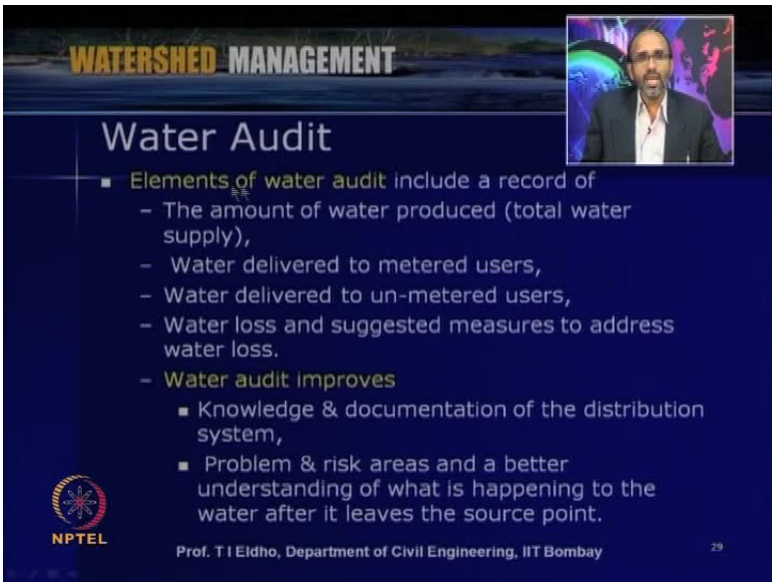
(Refer Slide Time: 56:26)



Then another important aspect in the water conservation is considered is water audit. So, water audit generally determines the amount of water lost from a distribution system due to leakage and other reasons such as theft unauthorized or illegal withdrawals from the system and the cost of such losses to the utility. So, when a water distribution system is there that assess how much water is distributed, how much water is reached to the consumers, how much water is used by the consumers, how much water is lost in the processes, so that a water audit will show so this is has been found to be very effective water conservation measure.

So then, comprehensive water audit gives a detailed profile of distribution system and water users then facilitating effective management of resources with improved reliability so we can increase our reliability and then we can reduce the leakage or release the wastage by going for a water audit so the water audit helps in correct diagnosis of the problem faced in order to suggest optimum solutions. Then water audit is also an effective tool for realistic understanding and assessment of the present performances levels and efficiency of services and adaptability of the system for future expansion and the rectification. So that way this water audit is very important so that we achieve water conservation very effective water conservation through water auditing.

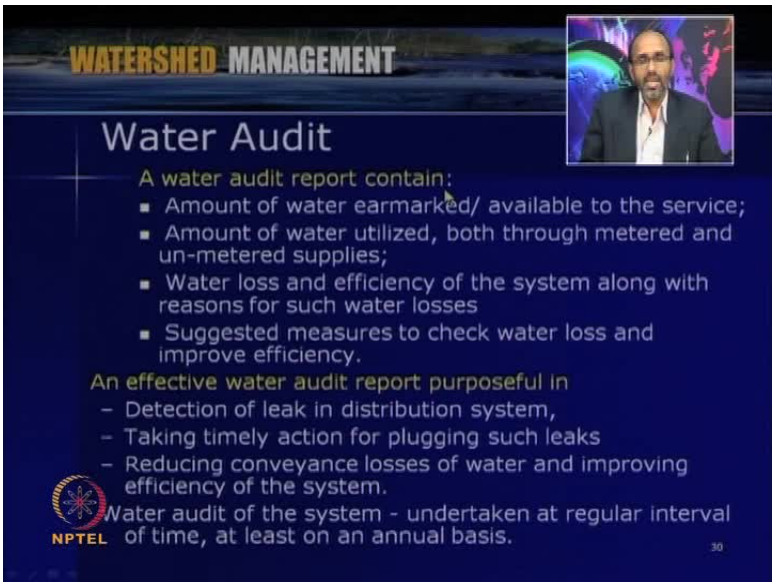
(Refer Slide Time: 57:53)



Some of the important elements of water audit include a record of the amount of water produced like a total water supplied which is may be obtain through pipelines or from reservoirs or from the aquifer systems then water delivered to metered users so that is directly we can get. Then water delivered to unmetered users through various means we can calculate then water loss and suggested measures to address water loss then water audit also improves knowledge and documentation of the distribution systems then problems and risk areas and a better understanding of what is happening to the water after it leaves the source point.

So if you consider a major source from where the treated water we are supplying and then it goes through the city or the areas considered then how much water is obtain to the metered users or unmetered users and then how much is the loss and how we can improve so all this say an effective water conservation will be possible through an appropriate water audit.

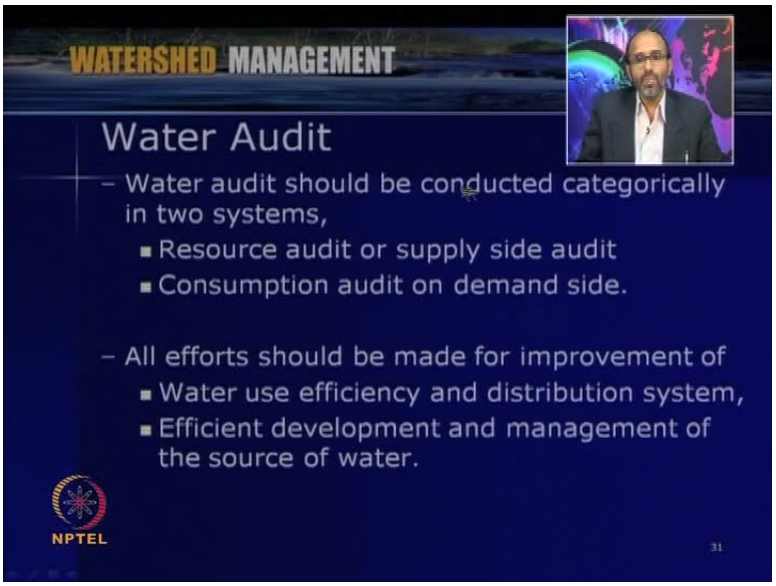
(Refer Slide Time: 59:00)



Water audit report then contain amount of water earmarked available to the service amount of water utilized both through metered and unmetered supplies then water loss and efficiency of the system along with a reasons for such water losses. Then suggested measures to check water loss and improve efficiency so overall theme is to improve the efficiency the water use efficiency so by water auditing so an effective water audit report so we can say by studying the various aspects we can come up with an effective water audit report so the an effective water audit report may contain detection of leak in distribution systems.

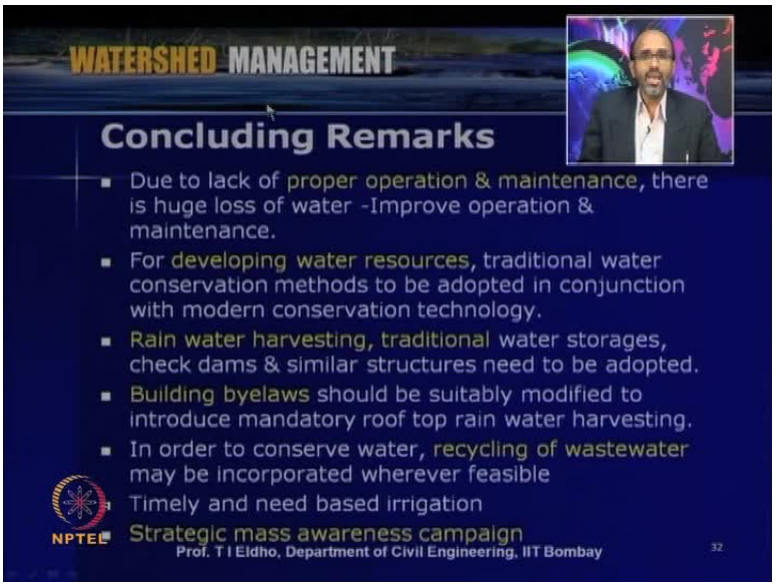
Taking timely action for plugging such leaks reducing the conveyance losses of water and improving the efficiency of the system then water audit of the system like undertaken at regular interval of time for example at least an annual basis is very essential so that we can go for a better water conservation.

(Refer Slide Time: 59:59)



Finally, water audit also should be conducted categorically in 2 systems like the resource audit or supply side audit and then consumption audit or demand side. So, this should be water audit should be supply side as well as demand side and then all efforts should be made for improvement of water use efficiency and distribution systems so that we can achieve water conservation and then efficient development and management of the source of water. So that way, water audit is very important system in any water conservation plans so in a very effective water audit report will be very useful as far as water conservation is concerned.

(Refer Slide Time: 01:00:38)

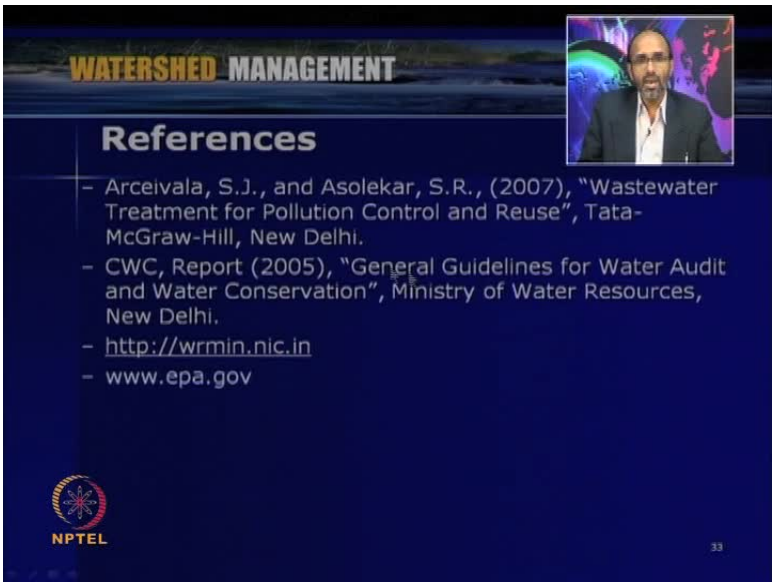


Now, finally to conclude this lecture some important remarks so due to lack of proper operation and maintenance there is huge loss of water as we can observe in many sector agricultural industrial or domestic sector so we have to go for improved operation and maintenance schemes. Then for developing water resources traditional water conservation methods to be adopted in conjunction with modern conservation technologies so it is not only modern technology we have to marry the ancient wisdom or the traditional system with modern technology and then come up with very effective water conservation measures.

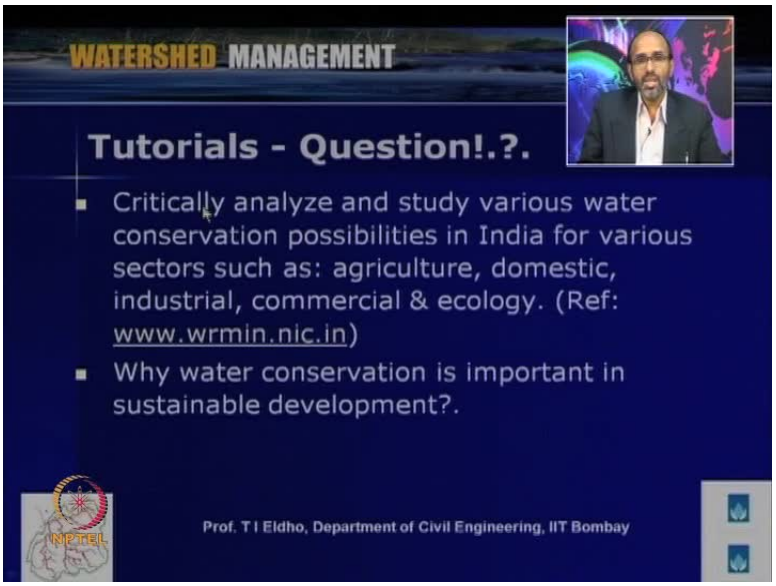
Then one of the important aspect in water conservation is rain water harvesting traditional water storages check dams and similar structures that we have to consider then we can have building byelaws we can suitably modify to introduce mandatory roof top rain water harvesting or the water the groundwater recharge schemes and then in order to conserve water we can go for recycling and reuse so depending upon the type then timely and need based irrigation so instead of going for simply irrigating the farms we can go for we can identify what is should be intervolved whether that probes are water stress then we can go for timely and need based irrigation.

So overall say, we have to go for a strategic mass awareness campaign the people should know the importance of water conservation and how the a supply can be improved through water conservation and then the demand can be made so that way the people participation is very important aspect as far as water conservation is concerned.

(Refer Slide Time: 01: 02:21)

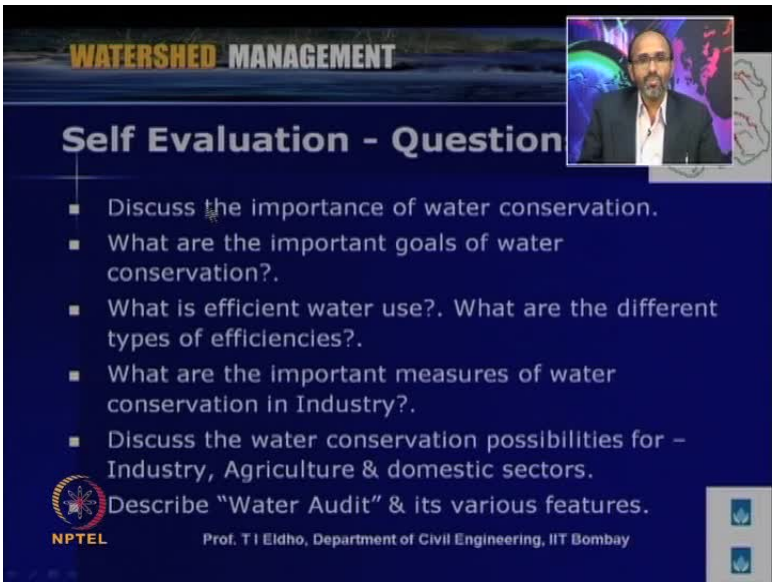


(Refer Slide Time: 01:02:27)



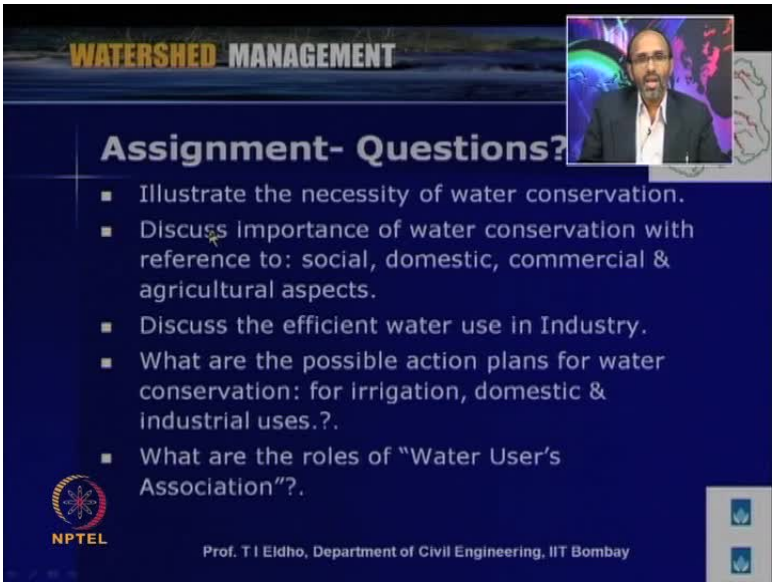
So, before closing this lecture some of the important references used in today's lecture I listed here. Then, a tutorial question critically analyze and study various water conservation possibilities in India for various sectors such as agriculture, domestic, industrial, commercial and ecological sectors.

(Refer Slide Time: 01:02:44)



Why water conservation is important in sustainable development? Then, few self-evaluation questions: discuss the importance of water conservation what are the important goals of water conservation? What is an efficient water use? What are the different types of efficiencies? What are the important measures of water conservation industry? Discuss the water conservation possibilities for industry agriculture and domestic sectors. Then, describe water audit and its various features.

(Refer Slide Time: 01:03:13)



Some more assignment questions illustrate the necessity of water conservation discuss importance of water conservation with reference to social domestic commercial and agricultural aspects. Then discuss the efficient water use in industry; what are the possible action plans for water conservation for irrigation domestic and industrial uses? What are the roles of water user's association?

So, in today's lecture what we are discussing is water conservation. What are the goals of water conservation? What is the necessity of water conservation and for various sectors like agricultural, industrial or domestic sector? How we can achieve what are the ways we can go for water conservation? So, in the next lecture we will discussing about water recycling and reuse in this module; thank you.