Urban Utilities Planning: Water Supply, Sanitation and Drainage
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Module - 03
Collection of water
Lecture - 13
Groundwater Intakes and Issues

~~Welcome back, in~~ In lecture 13 we will talk about Groundwater Intakes and Issues. The different concepts that we will cover are groundwater use and issues, groundwater quality, groundwater management, and groundwater intakes.

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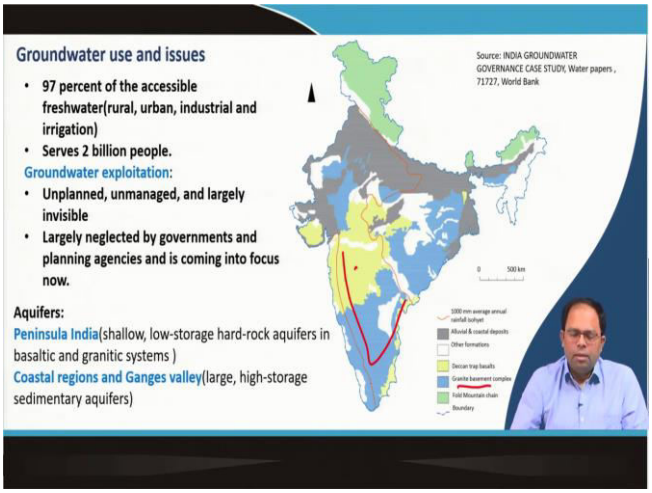

Around 97 percent of the total accessible fresh-water is ~~actually~~ groundwater and it is used for supplying rural areas, urban areas, industrial areas, and ~~also~~ for irrigation purposes. ~~So, mostly and it is so~~ ~~out~~ Out of all the different fresh-water sources, groundwater is the ~~biggest~~ most significant contributor~~,~~ ~~and and you can see it~~its ~~is almost all the entire~~major ~~contribut~~contribution ~~ion comes from mostly from groundwater~~ sources.

~~And a g~~Groundwater serves around ~~around~~ 2 billion people ~~all around~~ worldwide. ~~and usually t~~The groundwater exploitation ~~of groundwater~~ is unplanned, unmanaged, and largely invisible; that means we usually cannot~~are not able to see~~ monitor how the groundwater is ~~being~~ extracted ~~and so on~~.

And groundwater extraction is also largely neglected by governments and planning agencies. ~~St~~It~~ill, , but recently due to several problems, it~~ is currently coming into focus because of the water crises we are now facing ~~even~~ in India. ~~we are now g~~it~~roundwater is a big concern because of there are several issues that~~several issues that has ~~have been reasoned out of groundwater . and we will discuss them.~~

Now, if ~~I~~ we talk about India, groundwater is stored ~~it at~~in the different ~~parts of India~~regions of India ~~and~~ in ~~-~~different kinds of aquifers. For example, in peninsular India, we can see that the groundwater ~~in the peninsular part the this the groundwater~~ is stored in shallow, low-storage, hard-rock aquifers in basaltic and granitic systems. ~~so all~~rRefer to the blue ~~one~~areas in the maps~~., right.~~

And then In the coastal regions and the Ganges valley we see large, high-storage sedimentary aquifers- the (so, this one's grey one's on the map),s and in between, we have also theis basaltic ones- so both basalt this one is also basaltic sort ofin the peninsular region these which areis is this kind of shallow low storage aquifers.

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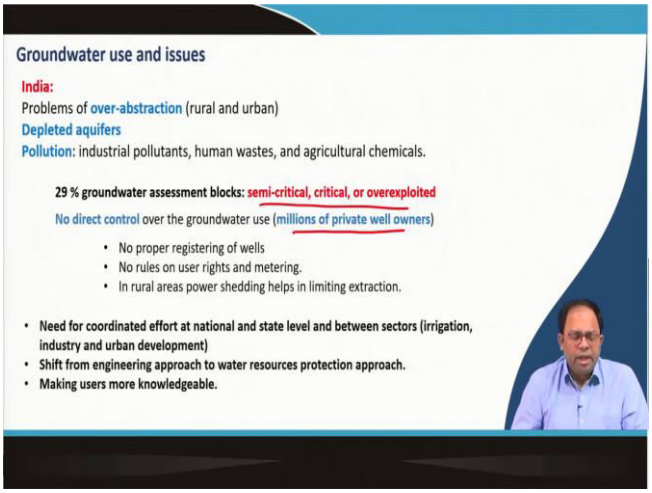

So,All these are the different kinds of aquifers that are there in India.

and what What we are seeing is tThere isis a huge over-abstractions in both rural and urban areas. that is A hHuge amount of water is being taken out-, and then, this is leading to depleted aquifers in several regions. and in In addition, to that lot of pollution is happening to the groundwater, and which is making this groundwater or this the aquifers inusable unusable because of industrial pollutants, human waste, and sometimes agricultural chemicals.

So, Tthese are the dDifferent contaminants arethings that are leaching into the groundwater which is actually making it very very dangerous for future use either for for portable purposes or for other purposes. So, we Iin India, around 29 percent of the groundwater assessment blocks the are entire India is divided into different blocks for groundwater.

So, 29 percent of thesehis blocks are either semi-critical, critical, or overexploited. So, you one can understand the challenge that is in front of us. And there isWith no direct

control over ~~the~~ groundwater use~~, and because why there is no direct control? Because ,~~ there are millions ~~and millions~~ of private ~~you know~~ deep tube well owners or well owners who ~~actually~~ draw groundwater. However, ~~, but there is no;~~ there is no proper registration of these wells.

There ~~is~~ are no rules for user rights and metering. ~~systems, I~~i~~ and in~~n rural areas sometimes power shedding ~~actually~~ helps in limiting the amount of groundwater extraction because people will not be able to run the pumps~~., but Still, these are the only things the~~ which is the only option for the ~~government~~ can do; the at this point of time government can only turn off the power so that pumps will not be run~~.

O~~But o~~therwise, the extraction is ~~under~~ without any control, and even the number of extraction points ~~that is also not being~~is also not registered. ~~So, these different challenges~~are the different challenges that is are there and tThis is ~~both~~ happening both in rural as well as ~~areas and also~~ in urban areas ~~as well~~.

~~As we have seen that is why why thesere are challenges. when we discussed about ground when we will discuss i~~In the next ~~lecture~~ lesson you will learn about ~~about~~ groundwater flow, yield etc., and ~~how groundwater flows~~ you will see that if ~~there are many number of tube wells which~~ many tube wells are extracting water from ~~a~~ the same area without ~~giving~~ enough spacing then most of the tube wells will become redundant or will become defunct in a very short period ~~of time~~.

And, if there is ~~over~~ over-extraction ~~we will keep on you know we will start bringing~~it will result in ~~the~~ other kind of problems. ~~solutes which are there in the~~Along with groundwater we will start bringing up ~~those~~ other chemicals which are ~~very~~ very bad for human health. ~~So, we will look into those things.~~ So, there is a need for coordinated effort at the national and the state level and between sectors.

~~So, which are t~~The different sectors like irrigation sector, industry sector~~,~~ and urban development ~~so these are the different sectors we~~ should ~~be~~act in a coordinated way~~,~~ and determine how much amount of groundwater should be extracted and they should also develop measures to control that. ~~And T~~the second thing is ~~we should~~a need to shift from an engineering approach to the water resource protection approach.

~~So, usually~~ ~~when~~ When we talk about water supply and ~~even you know~~ groundwater resources, we think about how to extract groundwater, what should be the size of pumps, what should be the volume, what should be the yield ~~in this way~~, but we should think about from the conservation point of view, how much water is required from the demand point of view~~.~~ ~~,~~ how much water ~~has to be~~should be supplied or how much water should be extracted, how is the recharge happening~~,~~ and what is the quality of the groundwater?~~.~~

~~So, we have t~~To protect our water resources ~~so~~, we have to look into ~~some~~ other aspects as well and not just ~~for than~~ the engineering side. ~~So,~~ A~~a~~lso ~~we also~~ because people are not aware of the challenges or the problems that ~~is~~ are going to happen in the future because of these ~~issues of because of this~~ groundwater ~~-~~related issues we have to make them more knowledgeable otherwise, they will keep on extracting and that ~~is~~ will lead to a much ~~bad~~ worse situation in the future.

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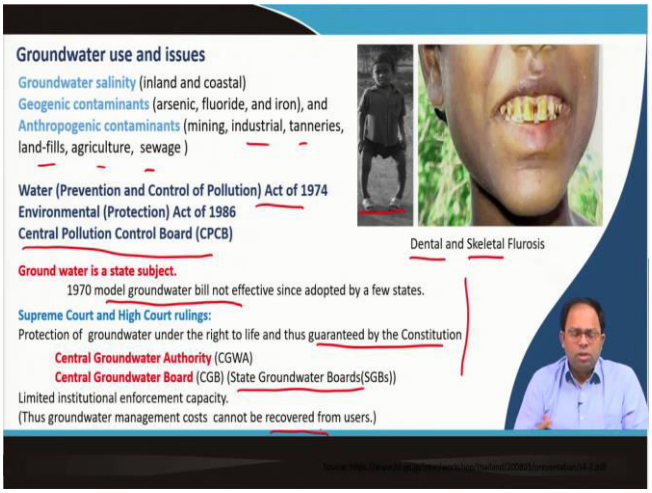

~~So, what are the different problems u~~Usually, we see that sometimes ~~ground~~ in inland and coastal regions groundwater is ~~you know~~ saline, ~~water enters into it or the s~~Sea water gets mixed with the groundwater which leads to groundwater salinity.

~~So, T~~~~this is one problem particular in coastal areas t~~Then~~,~~ there are ~~contaminants~~ geogenic contaminants such as arsenic, fluoride, and iron which ~~actually~~ creates a lot of

problems as ~~you~~ shown ~~can see~~ in the images~~.~~ like ~~this one is for~~ dental and ~~this one is for dental and the other is for~~ skeletal fluorosis ~~this is because~~due to ~~of~~ fluoride.

~~So, t~~This ~~is what has happens~~ed in many places right ~~and,~~ a~~A~~nthropogenic contamination~~nts such as~~results from ~~mining that is based on~~ human behavior and ~~what~~ human activities~~, what is happening like~~ such as mining, industries, tanneries, land-fills, agriculture, sewage~~. these are actually contributinge to leach leaching of you know this kind of like in land fill sites i~~If there are no~~you do not do~~ proper liners then ~~there will be~~can be leach~~–~~ate coming out of the landfills ~~which~~ will gradually mix with the groundwater.

~~So, t~~These are all ~~creating~~ different kinds of ~~adding~~ added contaminants ~~to~~ of groundwater~~.~~

~~We are looking at. these kinds of So, this is the these are the problems. that we are looking at and T~~there are only a handful of laws ~~which~~ that can help us ~~like~~ for example, the Water Act of 1974 ~~which is~~for prevention and control of pollution and~~ then~~, Environmental Protection Act of 1986~~. and t~~The body that ~~is~~ usually ~~of you know~~ looks into this is the central pollution control board.

T~~So, t~~hey ~~are the ones who~~ are responsible for monitoring and determining what ~~has to be~~should be done. ~~So, this and these are the loss which can help us, but actually groundwater T~~there ~~is~~ are not ~~much~~ many regulations ~~in the groundwater~~, but recently some ~~amount of the~~ regulations have come up~~.~~ ~~and u~~Usually, groundwater is considered as a state subject; that means the state government is responsible for ~~that~~its extraction, management etc.~~.~~

~~And, but even i~~In the 1970s, the model groundwater bill ~~which~~ was passed ~~was~~ but not adopted by many states~~ so, that is a one core that is a big problem~~. ~~But~~ However recently, the supreme court and the high court ~~has~~ have given ~~certain~~ specific rulings where it says that ~~protection of~~ groundwater protection is under the right of life~~, he has to be protected under the right of life~~ and thus it is guaranteed by the constitution.

~~So, a~~Accordingly, the central underground water authority or the central groundwater board ~~along with~~and the state groundwater board should ~~actually~~ take measures to prevent groundwater exploitation, abstraction, or groundwater pollution~~ and so on~~. ~~So,~~

~~t~~These are the different laws and the rules or regulations that ~~actually~~ regulate groundwater and the different agencies that ~~actually~~ work with groundwater.

All the ~~But, all these~~ agencies ~~and all has got as we are discussing~~ ~~has~~ have limited institutional enforcement capacity, because of the nature of the~~is~~ particular ~~activities~~ activity; like ~~p v~~ there is no registration of wells, people extract ground-water as per their ~~own~~ wishes they do not consider the overall situation ~~in that~~of the particular aquifer, etc. ~~and so on.~~

G~~So, this kind of problems are there. So, there has to be cost that means,~~ groundwater management is costly and this cost ~~is~~has to be ~~has to be~~ recovered from the users; that means~~s,~~ if you extract groundwater you have to pay for it ~~as well as~~ and~~you know you have to~~ make sure that some amount of recharge is happening. ~~So, that this so this has to be done~~ ~~b~~But, this is yet to be enforced. ~~so, t~~These are certain things the government is going to look at in the coming years.

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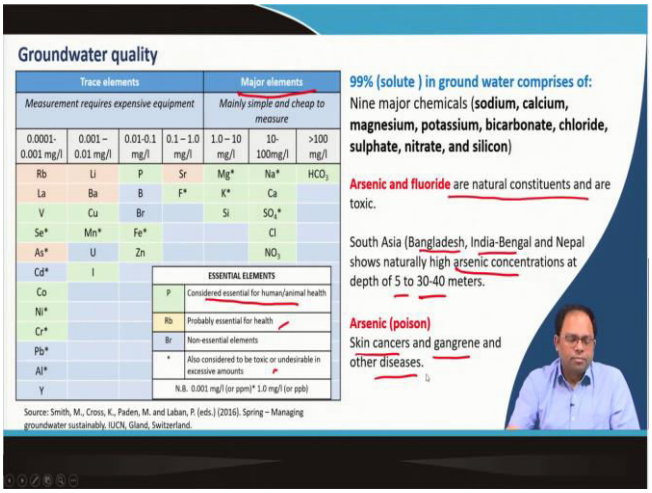

~~So, T~~talking about groundwater quality we see that around 99 percent of solutes that are available in groundwater ~~are in the major elements. These are~~comprises of sodium, calcium, magnesium, potassium, bicarbonate, chloride, ~~sulphate~~sulfate, nitrate, and silicon.

But, Tthere sSome of this these materials are is considered essential for human and animal health. the green ones, the blue, the yellow ones are probably essential for health it may be it may not be and the bBlue ones the bluish ones are nonessential elements, and the star marked ones that are given a toxic or undesirable in excessive amounts (refer slide), right.

So, these are the ones like LLead and, then chromium, then you know iron, then fluoride, then arsenic these are the ones which are very very toxic and which are undesirable for normal water supply all.

So, we see that aArsenic and fluoride are natural toxic constituents which are toxic but very rare., because of high abstraction, particularly in South Asia we see in Bangladesh, India in Bengal of in India, and in Nepal, we show wWe see naturally high arsenic concentrations at a depth of 5 to 30-40 meters in South Asia such as in Bangladesh, Bengal in India, and in Nepal. In case of high abstraction in these places, , and here if we have to extract a lot of groundwater then we will end up and we are ending up with a lot of arsenic and fluoride over arsenic concentrations in our groundwater, and that is leadingleads to lot offurther problems.

So one of the mThe main problems with arsenic is itsis it causes skin cancers and gangrene and many other diseases and this is this is a big point of concern for South East Asia or you know orand particularly for Bangladesh and Bengal this particular region.

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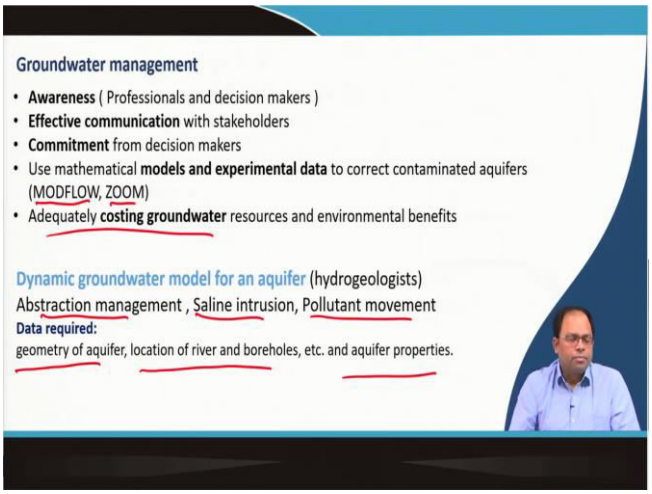

~~So, h~~How do we manage ground-water? First of all, we have to increase awareness both among the professionals the ~~decision-~~decision-makers as well as the users. ~~-of course, w~~We have to increase communication with the stakeholders that means, we have to make people aware ~~about-~~of what is happening, what are the problems, what it will ~~it~~ cause in the future ~~-what it may result in and, so on.~~

We want commitment from the ~~decision-~~decision-makers ~~that-which means, taking a decisiondecision,~~ to put ~~the~~ cost ~~for-~~on groundwater. ~~these are very which may actually you know g~~Governments may be ~~-are~~ unwilling to do that because ~~of~~ they will lose popularity because of ~~that~~ these are not popular measures ~~right~~.

~~So, plus there has to be~~~~This~~Groundwater management also requires mathematical models and experiments.~~,~~ ~~experimental-~~Experimental data is ~~that has to be~~ collected from ~~this~~ contaminated aquifers. ~~and some of the s~~Software's ~~s~~ like MODFLOW, ZOOM ~~that~~ could be used for further modeling. ~~some of the models that could be used or MODFLOW, ZOOM. So, this~~These are ~~-could be~~ used for determining what kind of pollution, what kind of contamination is happening in those aquifers ~~and so on~~.

~~And w~~We need to ~~also~~ adequately ~~cause~~ calculate groundwater resources and environmental benefits and ~~or rather~~ the cost of groundwater extraction and accordingly, we have to put a price on ground-water ~~-and we have to charge that price~~for charging users. ~~So, that is that~~This ~~will~~ prevents excessive use of groundwater and people will ~~will~~ try to manage or reduce groundwater use or ~~try to~~ reuse already extracted ground ~~whatever~~ water. ~~is being used.~~

~~So, even though as u~~Urban planners ~~we~~ are not required to do extensive ~~not; we are not into~~ groundwater modeling ~~that much~~ but, we should ~~know~~ understand the work ~~of~~~~that~~ undertaken by hydro-geologists~~,~~ such as ~~-do~~ modeling of ground-water~~s~~ ~~for~~ in aquifer~~s~~~~.~~. ~~they create dynamic models where theyto can manage abstractions they can model for saline intrusion, how much salinity is entering in a certain area, and about pollutant movement, that means, if there is contamination how it will spread inside the entire aquifer.~~

~~So, these are the people who actually do this kind of modeling~~'~~s but, w~~We ~~can~~ use this data to~~that and we can take that when we~~ decide the use of ~~about~~ groundwater ~~use~~ for certain urban areas or even for rural areas. ~~And t~~To do this ~~kind of~~ work we generally

require geometry of the aquifer, location of rivers and boreholes ~~and so on~~ and ~~the~~ different aquifer properties.

~~So, if this kind of~~With ~~this particular type of~~ data ~~is there we can actually do dynamic groundwater modeling. here we can see t~~The flow of water inside the ~~groundwater inside the~~ aquifer, ~~the~~ going up and down of water levels; how the salinity is encroaching, how ~~pollutions~~ contaminants ~~is~~ are ~~you know~~ spreading inside ~~that~~ a particular aquifer and ~~other~~all ~~these the~~ aspects can be modeled.~~things could be modeled, right.~~

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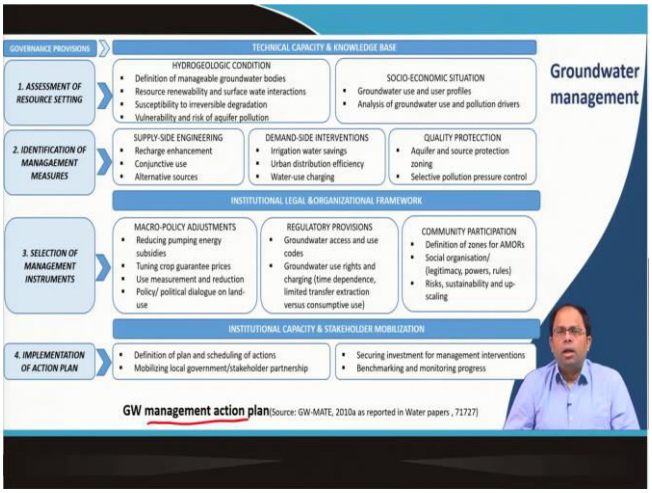

~~Some of So, some of the typical way typical what to say the~~A ~~s that are available~~ for groundwater management, ~~I am showing as~~is shown in the example ~~you an example from the GW mate report, and you can see that there are been several approaches, to this like for example, we first need to assess of the particular situation~~.

~~So, w~~We ~~need~~ first need to understand the hydro-geologic condition of that particular aquifer and also ~~we~~ need to understand the ~~socio~~ socio-economic ~~situation~~ condition for ~~that~~ this particular region. ~~Now, why socio~~ The is helps ~~socio economic situation required because, we need~~ to understand who are the people using groundwater, ~~are those~~Are these poor people or ~~you know~~ people who are using it for commercial purposes and we also need to understand that what is leading to pollution of the groundwater in this particular zone.

So, that is why we need to understand the socioeconomic situation at the same time wWe also need to understand the hydro-geologic conditions-, such as what are the how resource renewability,— i.e., how the groundwater is being renewed, what is the interaction with surface waters, and you know other problems that is are happening with that particular aquifer.

Then, based on that this we have to identify different management measures, for exampleconsidering, such as we have to looking from the supply side, we have to look from the demand side, and we have to also look from the quality side right. So, iOn the supply supply-side, what it means is recharge if we have can have some alternative sources of water if we can organize some recharge of some amount of water, if we can organize recharge of some amount of groundwater, could be recharged.

On the So, this is from the supply side, demand side, if we can save some amount of irrigation water that means, we reduce some amount of irrigation water requirement then we can improve the distribution of water in the urban area or we can use some water charges. and so on so, tThis comes from the demand side interventions. For And qQuality concerns, of course, wWe also have to protect the quality and reduce pollution pressure. this the pollution Pollution needs to beiscan be controlled and we canby zoninge the different aquifers and so on.

So, in this way we can go for quality protection and fFinally, to we have to determine you know different aspects like we have to determine the policies that we have to set for an urban area, like there could be regulatory provisions. wWe can make certain rules, to we can make the community participate or we can also do some macro policy adjustment.

Now, wWhat are is macro policy adjustment? We can reduce the pumping subsidy that means, we can reduce the money for electricity for pumping because some governments do subsidize that and we can also let go for of you know some crop guarantee prices are there that actually alsowhich sometimes determines what kind of crops should be grown. So, thatThis actually may play an important role and we can change the type of cropping pattern. and so on, right.

The And whereas, regulatory frameworks can talk about who is allowed to access groundwater and what kind of how much amount he is allowed and what could be the

user rights ~~in case of~~ in terms of time dependence and how much amount of extraction at what periods ~~and so on~~.

~~And then, t~~~~T~~~~hese are the different things that we can actually look into, and f~~Finally, we have to implement these action plans~~, and~~ by ~~you know~~ securing, ~~investment~~investing, ~~or~~ mobilizing resources~~,~~ and ~~and you know preparing actual plans of implementations and~~ schedules ~~of those~~for implementing th~~o~~ose plans.

So, this kind of groundwater management or action plans ~~could be~~can be under~~-~~taken to control groundwater ~~you know~~ extraction, or groundwater management ~~to do groundwater management~~ for a particular urban area.

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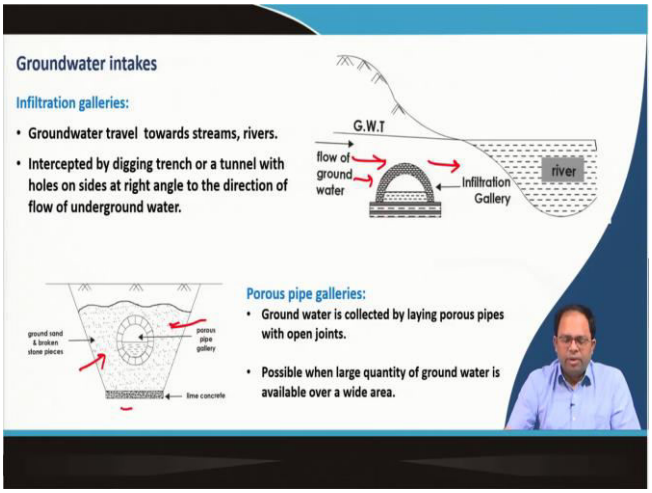

~~Now, now that we have talked about~~After groundwater management, ~~let us see~~we will discuss what kind of groundwater intakes are there~~-~~, ~~that means, in this case~~ how can we extract water from the ground ~~or how we take out the water from the ground, what are the different ways?~~.

Some of the ways are: ~~like~~ ~~we can~~ construction of infiltration galleries. ~~these are like infiltration galleries are there, in the as you can see in this particular image this is a~~These structures are ~~which is~~ constructed below ground and the purpose of constructing these galleries is to trap the groundwater which is trave~~l~~lling toward streams and rivers~~,~~ ~~right.~~

So, tThe flow of groundwater is happens and its flowing towards the river, via sub surface flows. along with and while it, goes there it is you know thisthen it comes tothisThe infiltration galleries galleryare is placed on the way and thesethen to the are like tranches or tunnels with holes on sides at a right angle to the direction of flow of groundwater. The groundwater enters these tunnels/galleries through openings and

And because of this the holes groundwater will enter and will baree stored inside. and then, this theThe tunnels could can be linked to certain porous pipes or certain pipes and all or to certain wells through which where we can transfer the water right.

This So, this is just trapping the water which that is flowing along and then using it for other purposes. So, sSimilarly, to in to thisthe infiltration galleries gallery, which are is large tunnels, we can just lay down simple pipes porous pipes, and this these porous pipes (refer as you can see in this image) could be laid inside a layer of sand and broken stone pieces and which is compacted to some extent there is with a base of lime concrete within that we can be laid withy the pipes.

And aAutomatically if we put it iIn an area where it has geots awith lot of groundwater water, will see through this particularwater will seep through the sand and will enter into theis porous pipe and then based on the way the pipe has been let laid, the groundwater could be transported to a point from where it could be extracted and then pumped, to be and then sent send to somewhere for treatment or for directives or delivery.

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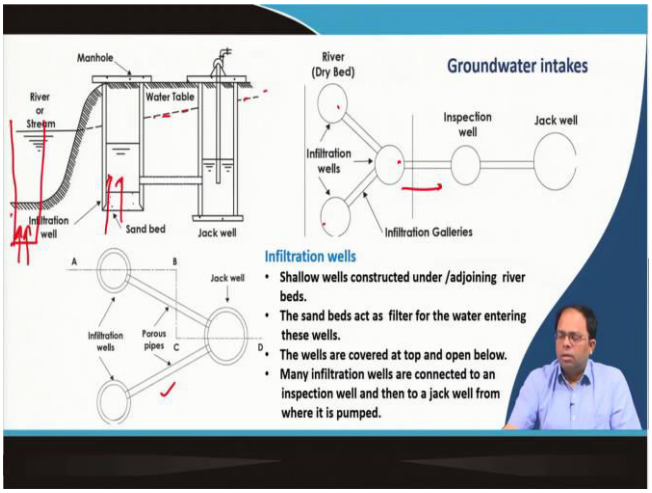

~~So, i~~In addition to ~~this~~ these infiltration galleries, ~~we can also have~~there are infiltration wells which are shallow wells constructed ~~both under or~~ adjoining river beds. ~~So, either i~~It ~~could be~~ be ~~we can constructed this wells over here under the river beds over here or we can construct around at the adjacent to the river beds so the~~The bottom of the well is under the river and open ~~bottom is open~~. ~~So, over here there is a~~Water enters the well via the sand bed ~~and we see that water will enter into, this~~it ~~because of~~ the water table is higher ~~., this is the water table over here.~~

~~So, w~~Water ~~will enter into this~~ these ~~particular chambers or this~~ these ~~particular wells~~ and ~~then we~~ can be extracted~~.~~. ~~this water and we can use this water for some other purposes. So, these are s~~Shallow wells ~~are constructed under adjoining or adjoining river beds and the sand beds act as~~ a ~~filter for the water entering this~~ these ~~wells; the wells are covered at~~ the ~~top and open below so the water enters from below.~~

~~And m~~~~m~~M~~a~~ny infiltration wells ~~are~~ can be connected to an inspection well ~~and~~ which is then ~~this inspection where is~~are ~~connected to a jack well from where it could~~ can be pumped. ~~So, as you can see in this~~Refer to the image. ~~there are several in infiltration wells. So, this is 1, 2, 3 this could be put inside the river bed or it could be put in the bank. It could be connected by infiltration galleries as well or through porous pipes like in the given case over here.~~

~~This connects to an inspection well and then finally this connects to a jack well, ok.~~ To ~~So, this is how we can~~ extract groundwater ~~in a by just capturing their flow by capturing~~ the flowing groundwater below the surface ~~we can actually extract also groundwater~~needs to be captured.

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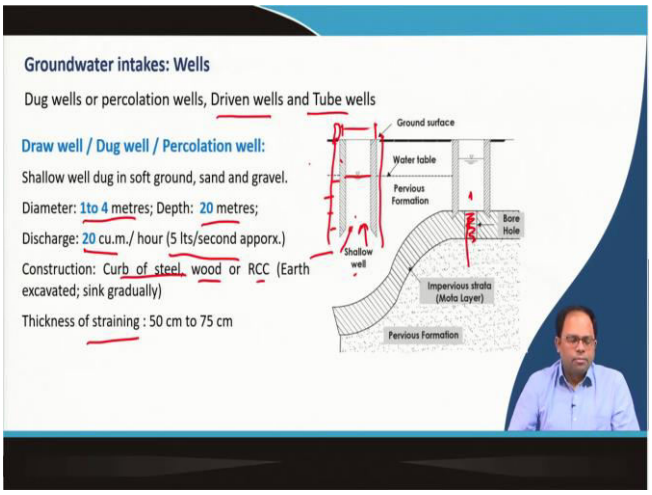

~~Then, the we can also have standard wells are like . So, this is like in many we have seeseen wells in many of i~~In rural areas people construct wells in their houses and if the water table is high you ~~will always~~ get water throughout the year~~, . but s~~Sometimes water table goes down particularly during the summer season ~~then the well you will not get water, during the rainy season you will get water and so on, right~~. The image shows that

~~So, as you can see in~~~~Refer the image,~~a ~~. So,~~ well is a opening in the ground and ~~the and from if you create a~~the opening in the ground, ~~automatically~~ water will automatically come inside from the surroundings ~~and it will come from below and it will come into the sand, at the~~so that the water level in the well would be at the same height as the water table.

Sometimes, because of impervious layers, we do not get ~~water~~ too much water and in that case, we need to ~~you know~~ punch through the impervious layer, ~~by a bore hole,~~ and then, water ~~will be able to~~ enters ~~into~~ the well from bottom aquifers~~, ok~~.

So, these are the different kinds of dug wells or percolation wells that are constructed in many rural areas~~.~~. ~~and we I~~Instead of ~~this~~ these dug wells or percolation wells we can also have ~~this~~ driven wells or tube wells; that means, ~~where~~ we ~~really construct or~~where ~~we~~ put a pipe inside the ground and can ~~we can~~ extract groundwater from multiple aquifers ~~right~~.

So, both these kind ofthe systems are there, and just toTo be elaborate more on this dug well or percolation well, it's a shallow well dug in the soft ground of sand and gravel usually.. And and its diameter varies from 1 to 4 meters and depth two then extends of to around 20 meters. so, we do not go beyond that and dDischarge is around 20 cubic meter per hour which comes to around 5 liters per second approximately.

So, when we you can understand that if you draw water from the well you will the well, water will start flowing inside the well and it you will gets the some flow of around@ 5 liters per second, which is pretty good..

And construction is hHow is it is constructed?

Usually, we have a curb of steel, wood, or RCC it's a(circular ring) you can say and we put it is put on in the ground and then we bysoil is removed keep digging from inside. and we keep and through and we replace and gGradually, when the more we dig the this particular ring will go down and gradually it sinks and we put another ring on top of it and another ring and we keep on diggingthis goes on till the desired depth is achieved..

So, there are people who goundertake this digging work es underground. and they keep digging, itThis is and they you know risky of courseas, sometimes the walls collapse.s and a lot of other issues happen and, but usually, its a manual process and we keep on dDigging is continued till and with and at and then we reach the groundwater level and then we keep on digging a little bit more and then, we can actually have a well.

And once we do that sSometimes before we put this particularthe circular this curb or wood or RCC whatever we put there we can sometimes have a straining is providedas well; that meansi.e., at the we have one layer of 50 centimeters to 75 centimeters of the layer we can puta sand layer s around the curb just to ensure that water can flow from the surroundings into this particular well right.

So, we keep a protection layer of aThis straining layer which preventsallows only clear water to come inside the well. So, this straining helps acts in as acts as a filter to allow water to get inside from the surrounding soil. through if it passes through the sand. The and this kind of layer automatically it gets filtered and then it enters into the well, ok.

~~So, that means when I amwhile creating a hole I am we creating it a little bit bigger than the actual this concrete or steel curb, and then, we keep on the more the we keep on pushing this particular curb down and at the sides we keep on filling with sand, and may be some gravel and that actually access straining.~~

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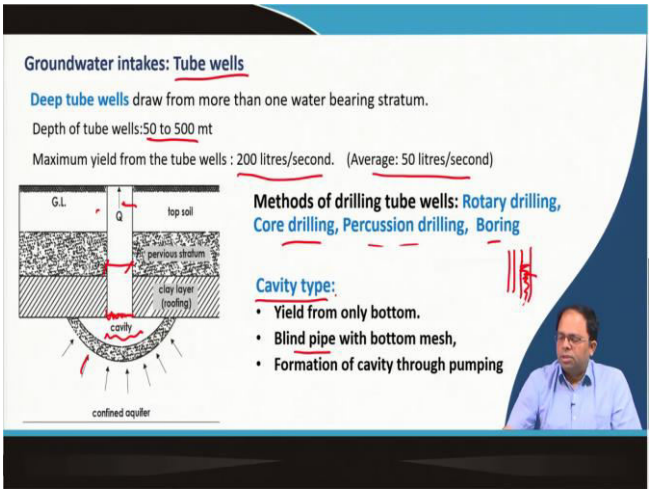
Formatiert: Vom nächsten Absatz trennen



~~So, in addition to tube wells which are dug and we can have sorry i~~In addition to wells which we have dug, we can also have tube wells and tube wells drawing water from more than one ~~water~~ water-bearing stratum ~~as refer the image. you can see in this particular image it shows only one stratum in the is particular case, but in other cases over here.~~

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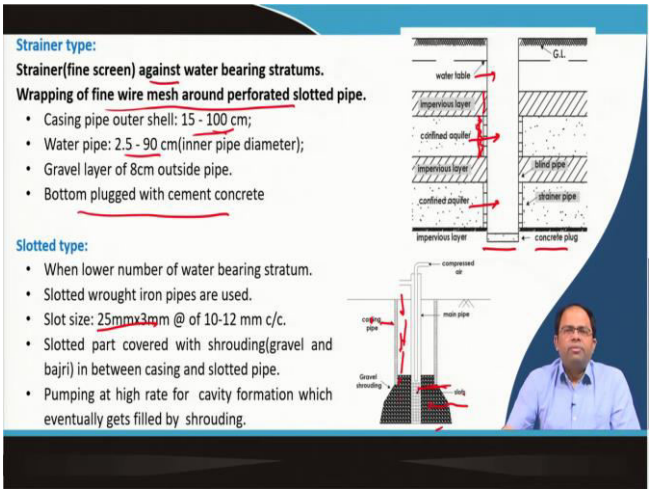
Formatiert: Vom nächsten Absatz trennen



~~You can see that m~~Multiple ~~water~~ water-bearing strat~~um~~a~~s~~ are ~~being~~ shown in the image~~to draw water~~. ~~and you can see that we are drawing water from here; we are drawing water from here and so on, right. So, usually, tube wells are draws water from the main stratum, but depends on what kind of tube well it is of course.~~

~~So, over here it is only one stratum suppose.~~ Depth of tube well ~~could~~ can be 50 to 500 meters~~, .~~ ~~but of course, 500 meters is very large very high depth and m~~Maximum yield from the tube wells is around 200 liters per second whereas, in case of normal wells it was 5 liters per second and average is around 50 liters per second, depends on what kind of tube well you are using.

And how are tube wells constructed? We usually use rotary drilling, core drilling, percussion drilling, boring, ~~and~~ to ~~actually~~ put a pipe in the ground. ~~and u~~Usually, it's not one pipe. ~~there~~ There are two pipes; one is a casing pipe and then there is the actual pipe through which the water comes out. So, ~~the case~~ in between the casing pipe and ~~that this~~the water pipe ~~there~~ we usually put ~~sometimes like~~ sand and gravel to ensure only filtered water gets inside ~~right~~.

~~So, this refer to the image, even though this image is little bit you know this is done in this way for explanation purposes, but this is basically a pipe and t~~The diameter of the pipe ~~is limited to~~ depend~~ing~~s on what kind of tube well ~~we also it's~~and it is much smaller ~~than~~ compared to a well.

~~So, the first type of tube~~First we discuss ~~well that we will talk about~~~~discussed is a~~ ~~cavity~~ cavity-type tube well.

~~So, over here we do not draw w~~Water is not drawn from multiple aquifers because~~,~~ in certain places ~~there are not~~ multiple aquifers are not present. So, in these cases~~,~~ ~~if there is so only a single aquifer~~ we can ~~actually~~ put a blind pipe ~~like that~~ inside ~~and we the this is a blind pipe~~ that means, there are no openings at the side ~~so, it is a blind pipe~~and only the bottom part is open and we put a mesh over there.

~~So, that you know it is some sort of~~The ~~the~~ mesh ~~that~~ allows ~~only~~ entry of ~~you know~~ water and ~~not~~ prevents ~~other~~ soil particles. ~~and all, but s~~Sometimes it can get ~~also~~ clogged.~~, but depends and how do we do this kind of wells what we do is, we start pumping the water out.~~ To prevent this,

~~When~~ we can start pumping the water ~~out~~ at a very high pressure ~~automatically~~ initially. This will result in a lot of sand, silt ~~which is their there in this particular region this will get start~~to get pumped out and ~~once it gets pumped out~~ this results in the formation of a cavity which gradually becomes bigger and bigger~~ and bigger~~ and the rate of flow becomes slower.~~,~~ ~~and once the cavity becomes bigger the rate of flow water falls down.~~

~~And when the rate of flow of water~~With the flow rate reduce~~s~~ing, ~~then~~ the amount of soil particles ~~that is are being because of this high speed of flow it was getting in it does not get seen now~~reduces. So, now we have got a cavity which gets filled with water from the surroundings at a slower pace so that there is no silt and sand inside this water and this actually could be pumped up.~~, right.~~

So, this is how we form a ~~cavity~~ cavity-type tube well. These ~~and this because of this cavity it is named cavity~~ cavity type tube well~~, and usually, it is for this~~ tube wells are for lower depths ~~not for very high depths~~only.

~~So, a~~A strainer type tube well is the most common ~~one where it is whenever we talk about~~ tube well. ~~basically we referred to strainer type tube wells these are strainer why we call it a strainer because, s~~Strainer is a fine screen which is put ~~at~~ outside the pipe ~~it~~ or can be even ~~could be either~~ welded to the pipe.

~~It could be iron mesh welded to the pipe or it could be just strong around the pipe and as you can see that at when t~~The pipe ~~is put inside this open this pipe~~ has got slots ~~that means~~or openings~~. And this these slots are~~ at the levels of the aquifer whereas, ~~in~~ along the impervious layer the pipe is blind~~, and over here we also put the straining~~.

~~So, that we can have some amount of filtration through which we can prevent only pure water to get inside the pipe, right. So, t~~The bottom part is also plugged ~~in we have a~~using concrete~~;~~ ~~plug plugging the bottom so~~thus, water only enters from the sides~~, right~~.

~~And we have both imperviousness and aquifers at multiple levels in this particular case. So, strainer or a fine screen is fitted against water water bearing stratums, fitted in the pipe at the water water bearing stratums, the wrapping of fine wire mesh around the perforated slotted pipe. So, fine wire mesh is around put around this these perforations;~~ T~~t~~he casing pipe or outer shell is 15 to 100 centimeters in size.

~~So, there are two casings of course. So, t~~The water pipe which is the one inside this is around 2.5 to 90 centimeters. ~~depends on what size so, it could be around 100 centimeters to 90 centimeters it could be a wide tube well to a wide well or it could be even 2.5 centimeters. So, it is could be a very small pipe as well.~~

~~So, A~~ gravel layer of 8 centimeters ~~between this these two pipes~~ is ~~basically put~~ placed between the outer pipe and the casing pipe~~, between the inner pipe and the outer pipe,~~ and the bottom is plugged with cement concrete. ~~So, this is one this is the strainer type of tube well.~~

A slotted type of tube well is ~~again fitted when~~used in case ~~we have got~~of lower number~~s~~ of ~~water~~ water-bearing stratum~~. and it~~It is a wrought iron pipe ~~is used, but its this wrought iron pipe have has got~~with slots ~~like over here and the slot size something~~ range~~ings~~ from 25 mm into 3 mm and spacing of around 10 to ~~12~~ 12-millimeter ~~centre~~ center to ~~centre~~center~~; .~~. ~~and t~~The slotted parts are covered with shrouding or gravel and bajri in between the casing and slotted pipe. ~~So, here we have a casing pipe and then there is the inner pipe as well.~~

~~So, we what we do is w~~We put in this gravel layer inside and then we start pumping at a high rate. ~~and we draw water from this and when it happens this~~The surrounding silt and clay start~~s~~ getting ~~inside this~~pumped outside and when it happens then, automatically the ~~clay sorry automatically this~~ shrouding gradually goes down and it fills up ~~this~~ the bottom area. This

~~And it the shrouding is sucked into this area and it~~ creates a filter layer and only clear water goes through this shrouding. ~~it gets filtered and only that can enter into the pipe which could be drawn from outside, right. So, this is a slotted type of tube well.~~

So, these are the different kinds of tube wells that are ~~possible that are~~ usually constructed both in urban and rural areas.

Conclusion

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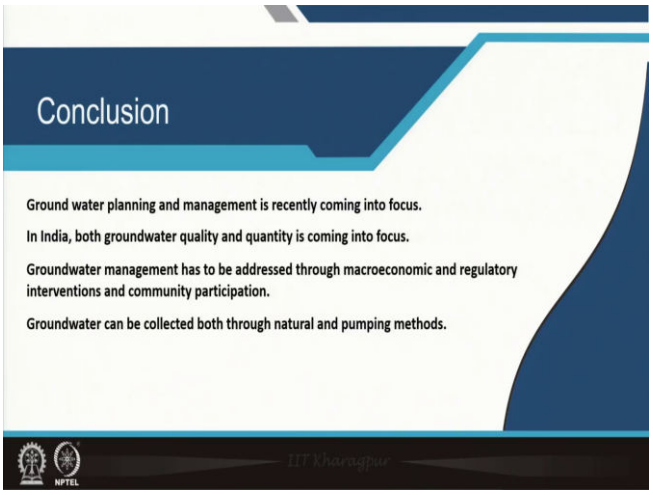

~~So, to conclude g~~Groundwater planning and management ~~is~~ are recently coming into focus. In India, both groundwater quality and quantity ~~is~~ are coming into focus because~~,~~ both ~~is~~ are an issue in India. Groundwater management has to be addressed through macro-economic and regulatory interventions and community participation.

~~So, c~~Community participation is very important if the community does not wants to we cannot ~~you know~~ help them manage groundwater

~~and g~~Groundwater can be collected both through natural and pumping methods.

References

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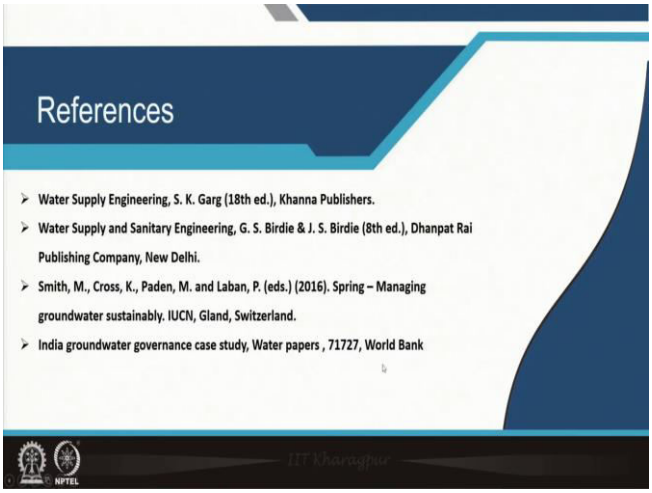

~~So, these are some of the references you can study.~~

~~Thank you.~~