Availability and Management of Groundwater Resources

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Lecture - 49
Groundwater Resources Planning and Management (Continued)

Welcome you all in the part 5 of the module 10 groundwater resource planning and management. So, we have discussed in greater detail about the salient aspects of the groundwater resource planning and its management as well.

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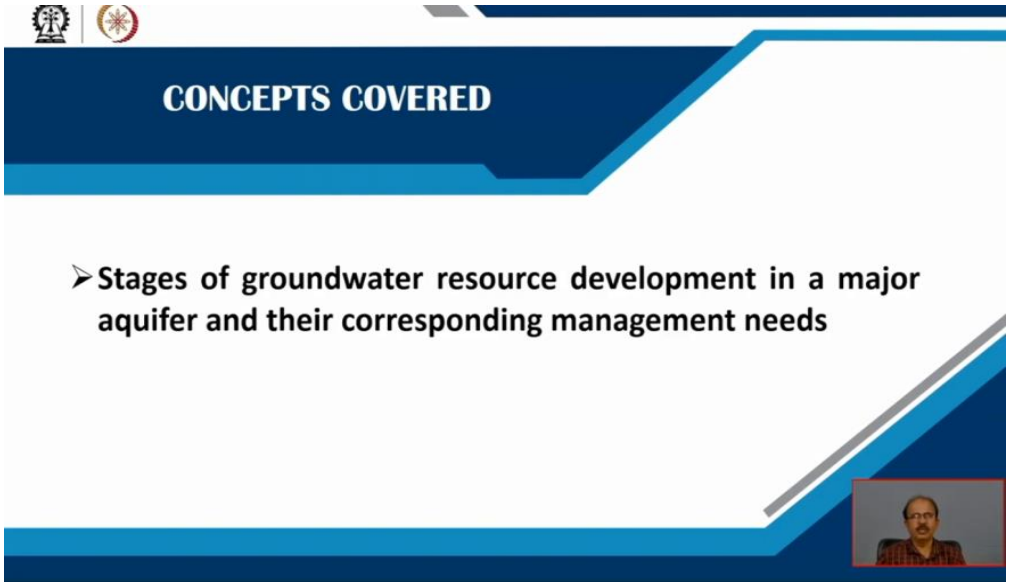

Now in this part 5 we will have the discussion on the stages of groundwater resource development in a major aquifer and their corresponding management needs.

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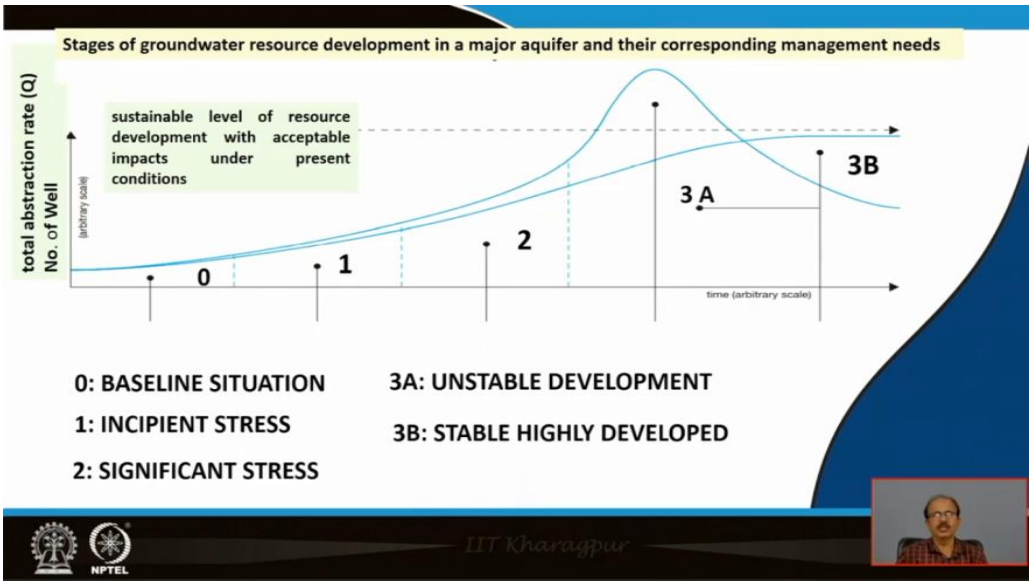

So, we will see that generally an aquifer is a rocky formation which holds the groundwater inside the earth surface underneath the earth's surface. So, we have also learned that the aquifers remain of different types some may be of the unconfined type other may be of the confined type. So, the management aspects in the different types of aquifer will always have different values different your aspects.

So, here we have just taken the stress conditions and the stable and unstable conditions of the development. So, see a graph is clearly shown here in which 0, 1, 2, 3, 3A and 3B these are the situation 0 is for the baseline situation, 1 is for the incipient stress situation, 2 is the significant stress situation, 3A is the unstable development and 3B is the stable highly developed. So, we can see here it is a case of an aquifer major aquifer.

Now total we can see the total abstraction rate is given mentioned here and the number of wells the two different lines are clearly shown here. And here we are seeing the sustainable level of resource development with acceptable impacts under present conditions. So, near to zero baseline situation you can see both the lines are at the near about at the same place but gradually it enhances and it reaches to unstable 3A situation peak is coming in 3A situation. So, now let us see one by one the after every step in the baseline situation what is happening.

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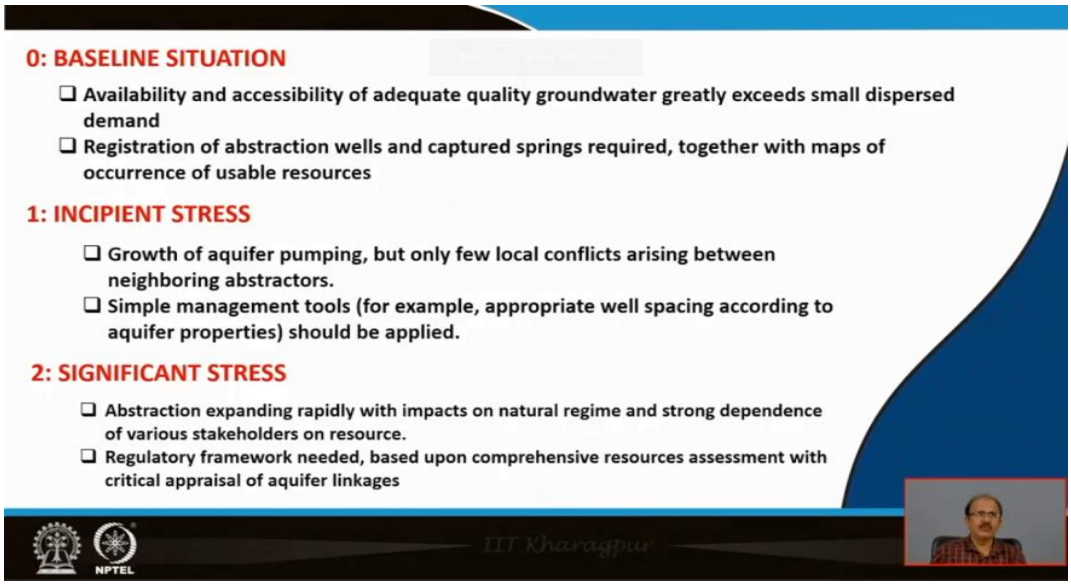

So, in the baseline availability as well as accessibility of adequate quality groundwater generally greatly exceeds small dispersed demand. So, availability a accessibility of proper quality groundwater is available. So, registration of abstraction wells and captured springs required together with maps of occurrence of usable resources. So, this is the conditions when the baseline situation remains.

Now the stress conditions are coming. Incipient stress growth of aquifer pumping. So, now the pumping has exceeded but only few local conflicts arise between neighbouring abstractors those who are extracting the groundwater. So, a local conflicts journey arising between the neighbouring abstractors. Simple management tools for example appropriate well spacing according to aquifer property should be applied in such type of condition in the type of incipient stress conditions.

Now in the type of significant stress condition what are the salient points. Abstraction expanding rapidly with impacts on natural regime. So, now the abstraction is becoming more and more and putting impact on the natural regime and strong dependence of various stakeholders on resource, so now the resource is under pressure. The regulatory framework needed here in this case based upon comprehensive resource assessment total resources assessment is required with critical appraisal of aquifer linkages.

As these are some other aquifer means linkages are there or means detail your resource assessment is required in this condition when the significant stress arise.

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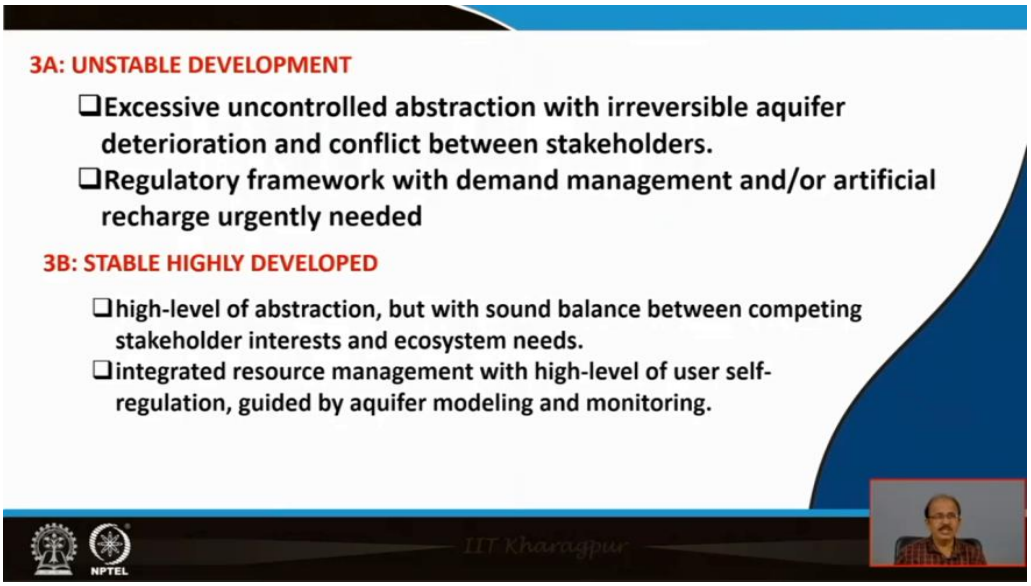

Now next is the unstable excessive uncontrolled abstraction, uncontrolled abstraction stage has come with irreversible aquifer deterioration means your recharge is becoming very less and conflict arises between stakeholders. In this case the management aspects are that regulatory framework with demand management and oblique or artificial recharge is urgently needed because you can see irreversible aquifer deterioration has started means now aquifer is not going to be recharged and conflict is also at large.

So, that is why the demand management or artificial recharge management is urgently needed at this stage. And the 3B stage is stable highly developed condition high level of abstraction is there but with sound balance between competing stakeholder interest and ecosystem needs. Although high level obstruction is there but there are some balancing between the stakeholder interest and the ecosystem needs.

So, therefore integrated resource management with high level of user self-regulation. Guided by aquifer modelling and monitoring is needed at this stage for the management of the groundwater resources. So, in such type of conditions stable highly developed condition integrated resource

management is required with self-regulation high level of user self-regulation and which is guided for modelling and monitoring.

So, these are the different stages from the deadline situation from the baseline situation to incipient states to significant stress we can see here also the graph also that it is gradually increasing and it the peak is reaching near to the 3A unstable development conditions. And then gradually it comes lower because stably high developed conditions at I get. So, sustainable level of resource development with acceptable impacts under present conditions can be monitored by assuming such type of your conditions. So, these are some of the conditions.

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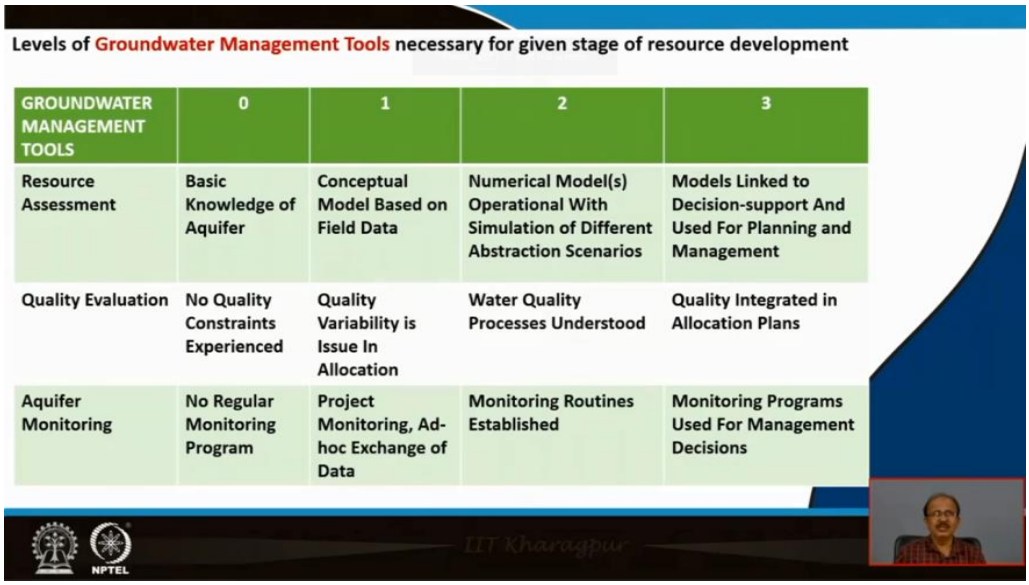

Now related to tool let us discuss the groundwater management tools of the three different condition because stages we have seen already. Now for the you can see for this is the baseline situation then the incipient state and the significance that third is the your stable and unstable development stage. So, what are the niches? The tools are resource assessment. So, in the baseline situation basic knowledge of aquifer is required.

Then conceptual model based on field data is required in the case of your incipient stress. Numerical model operational with simulation of different abstraction scenarios needed in the significant stage and the stable and unstable stage, models linked to decision support and used for

planning and management are needed. Now the second tool is the for a aquifer the first is the resource assessment second is the quality evaluation.

So, no quality constant experienced quality constants not experience quality variability issue in allocation, then water quality processes understood in the significant stress condition. And in the quality integrated in allocation plans exists in the stable and unstable phase. Now aquifer monitoring no regular monitoring program is required project monitoring ad hoc exchange of data and monitoring routines established and generally in the case of significant stress.

Now monitoring programs used for management decisions management decisions in this unstable and stable stage.

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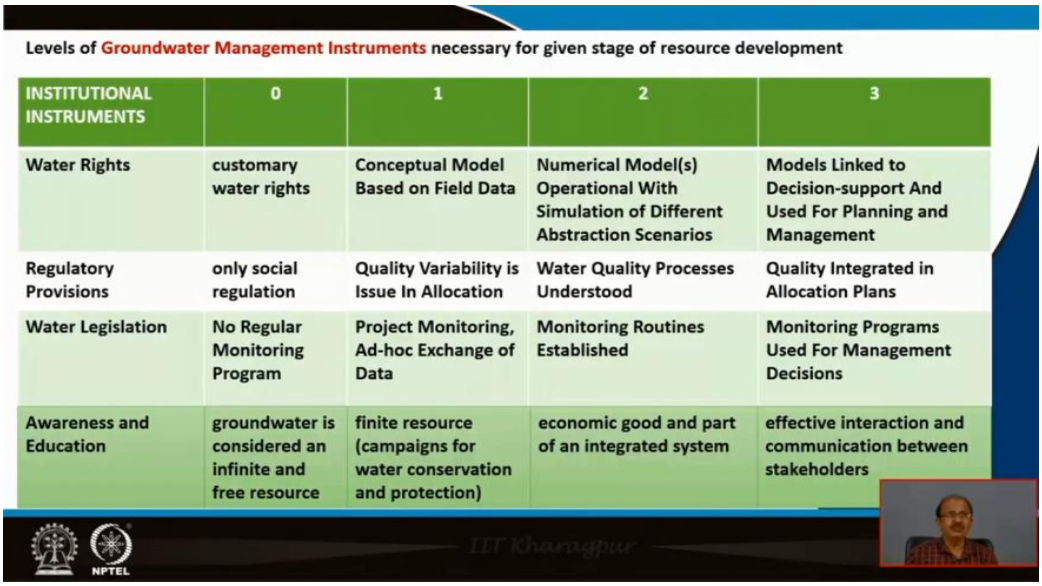

Now water rights, water rights this is first what we have discussed about the groundwater management tool. Now second is the; institutional instruments for the different stages. So, levels of groundwater management necessary of given stage of resource development are water rights. The first instruments customary water rights in the baseline situation, in the incipient situation conceptual model based on field data.

And second significant stress condition the numerical mode operational with simulation of different abstraction scenarios. And third is the models linked to decision support and used for

planning and management. Now regulatory provisions is the second institutional instruments only social regulation quality variability issue in allocation water quality processes understood and quality integrated in allocating plans.

Next is the water legislation. So, no regular monitoring program is required here in the case of business situation incipient stress condition project monitoring and lock exchange of data is required. Monitoring or routines established and the monitoring program used for management decisions. Awareness and education this is another institutional instrument for awareness and education in the baseline situation baseline stage groundwater is considered as an infinite and free resource.

So, finite resource is needed in the case of in significant in the case of your incipient stress in the case of significant stress economic good and part of an integrated system and the effective interaction and communication between stakeholders in the unstable and stable stage.

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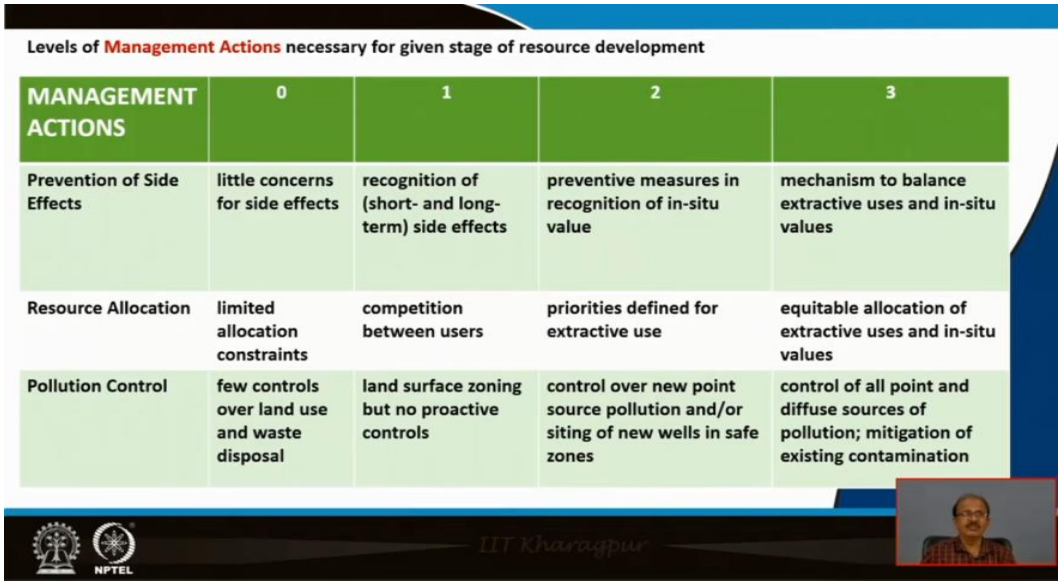

Now the management actions what are the levels of management action in the different stage in the different conditions. So, first management action is the prevention of side effects. So, in the first baseline situation little concern for side effects in the case of incipient stress condition recognition of side effects short and long term a significant stress conditions preventive measures

in recognition of in-situ value and third is the unstable stable mechanisms to balance extractive users and in situ values.

Second management action is the resource allocation limited allocations constant competition between users in the case of significant stress condition priority is defined first active use and third equitable allocation of extractable usage and in-situ values in the case of stable and unstable and stable development stage. Now pollution control; few controls over land use and waste disposal in the case of your baseline situation land surface zoning but no proactive controls.

Then the control over new point source pollution and oblique and or citing of new wells in safe zones and the control of all point and few sources of pollution, migration of existing contamination. So, generally these are the different two management actions which can be fixed or which can be allocated such type of management actions in the different stage of conditions starting from baseline to the developed stage conditions.

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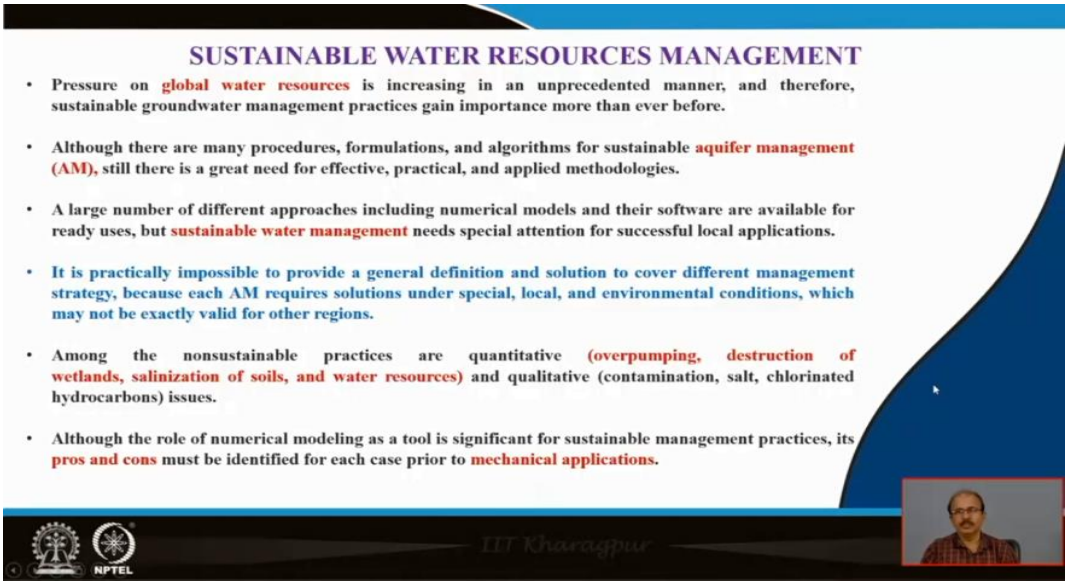

So, we have discussed about the groundwater management tools in institutional your frameworks and management actions regarding a aquifer which is holding the groundwater resources. Now few salient points about the sustainable water resource management are as we can see in this way that the pressure on global water resources is increasing in unprecedented manner and therefore sustainable groundwater management practices gain importance more than ever before.

Earlier it was not so much required but at present days everywhere we are having the water resource management aspects because day by day the groundwater level is declining. Although there are many procedures formulations and algorithms for sustainable aquifer management but still there is a great need for effective practical and applied methodology. Because we; have discussed already that the groundwater which is lying in a geological formation and an underground in the different types of rock formations.

So, the different types of rocks formations are having the different characteristics also. The amount varies from place to place. So, although there are many procedures are available for the aquifer management sustainable aquifer management. But still there is some need for its practical methodology or some effective methodology so that the groundwater resource can be managed properly.

Still, we are lacking in some aspects that is why we are we are not 100% managing the aquifer resource. So, a large number of different approaches including numerical models and their software are available for ready uses. But sustainable water management needs special attention for successful local applications. Suppose we are having so many software so many models that that is with us but the problem is that we should know about the local problems also.

Local aquifer also we should know about the quality of the local aquifer the quality of the local groundwater the different characteristics of the underlying aquifer locally not the regionally. That regionally it is all right because sustainable management will be done when we have thus regional approach but local approach is also very important for the management of the groundwater resources.

It is practically impossible to provide a general definition and solution to government different management strategy. It is a little bit difficult also it is impossible but each aquifer management requires solution under special local and environmental conditions which may not be exactly valid for other regions. So, for different, different types of areas it is having different types of local characteristics then the environmental conditions.

So, solution is also solution should be based on the availability of the information of the local aquifer, availability of the information of the environmental conditions of the area then only the proper aquifer management can be done otherwise we cannot manage the aquifer properly. So, although it is practically impossible but if we will consider the local aquifer characteristics local environmental conditions and then we may manage the aquifer in a greater way in a better way.

So, among the non-sustainable practices are some of the non-sustainable practices are quantitative. This is for the quantitative purpose over pumping. Suppose pumping we are knowing about the level of the water inside the aquifer but over pumping is going on. Destruction of wetlands are going on, salination of soils are going on then what will happen again we will unable to manage the aquifer we will unable to manage the water resource.

And qualitative wise we can see contamination due to the contamination it cannot be used due to your salt and chlorinated hydrocarbons it will become an without any use. So, this unsustainable practice quantitatively and qualitatively is also contributing for the some of the problems for the proper sustainable groundwater resource management. The role of numerical modelling as a tool is significant for sustainable management practices.

Nowadays numerical modelling has become one of the tool for management practices, its pros and cons must be identified for each case prior to the mechanical application because see the case of water, water flows from one place to another. So, the inside the earth surface also the water from one aquifer to another aquifer generally it moves. So, the practice your management practices will also vary from place to place it will not remain common for every place.

So, whatever method you are going to apply for the water resource management. First of all, you should be aware about the characteristics of the underlying aquifer in local level and the environmental conditions which are prevailing in the local level only. So, then you consider the case from the regional level. So, then only you can manage the water resource groundwater resource sustainability.

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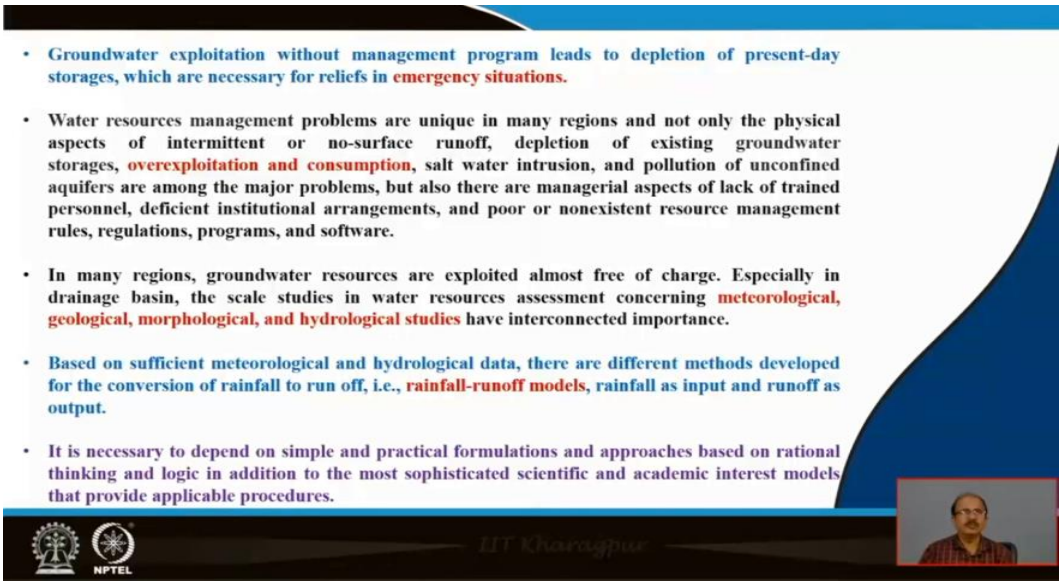

Now groundwater exploitation without management program leads to depletion of the present-day shortages. Present day whatever we are hearing lots of fights are going on for getting the groundwater resource because exploitation are being done but without any management program, then what is happening the declination declining of the water table in the area. So, if the groundwater exploitation will remain continue and without the management practices.

Then what will happen there will be emergency situation will be existed. So, water resource management problems are unique in many regions and not only the physical aspects of intermittent or no surface runoff depletion of existing groundwater shortages, over exploitation and consumption, salt water intrusion and pollution of unconfined aquifers are among the major problems.

These are not only the major problems physical aspects of intermittent or no surface runoff, depletion of existing groundwater shortages, over exploitation and consumption salt water intrusion and pollution of unconfined aquifers are among the major problems. But also, there are managerial aspects of lack of trained personnel deficient institutional arrangements and poor or non-existent resource management rules regulations programs and software.

So, this also we have to think over it. In many regions groundwater resources are exploited almost free of charge, no charge especially in the drainage basin the scale studied in water resource

assessment concerning meteorological geological morphological hierarchical studies have interconnected importance. So, in many regions you may get the normative resource exploitation in free of charge.

But meteorological studies, geological, morphological hydrological studies all are having the interconnected importance for the water resource management. Based on sufficient meteorological and hydrological data there are different methods developed for the conversion of rainfall to runoff. Example is rainfall random models rainfall as input and runoff edge output what we have studied in the very beginning in this course availability and management of groundwater resources.

So, on the basis of the meteorological and hydrological data generally we are considering the rainfall data then the temperature humidity data and hydrological data the details about the aquifer characteristics is its yield. So, these all are there are different method developed for the conversion of rainfall to runoff. We have solved some of the numerical also when we were solving the problems of runoff surface runoff and rainfall.

And on the basis of this conversion from rainfall to runoff the rainfall runoff models have been developed rainfall as the input unit as a runoff output you need. So, on such basis also by development of such type of model we can also have the idea about the groundwater resource management in a particular area. So, it is necessary therefore it is necessary to depend on simple and practical formulations and approach it based on rational thinking.

And logic in addition to the most sophisticated, scientific and academic interest, models that provide applicable procedures it is very important. So, always we should think that then that the simple and practical formulations and approaches are essential for the management of the groundwater resources at any cost.

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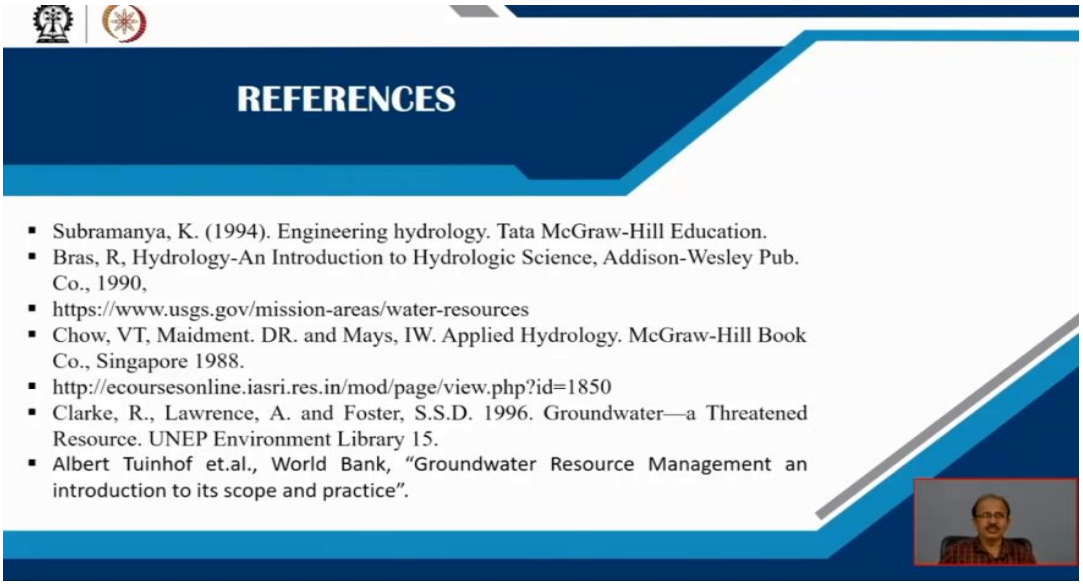

The references have been taken from these books textbooks as well as some of the other sites which is mentioned you also go through this these books if possible.

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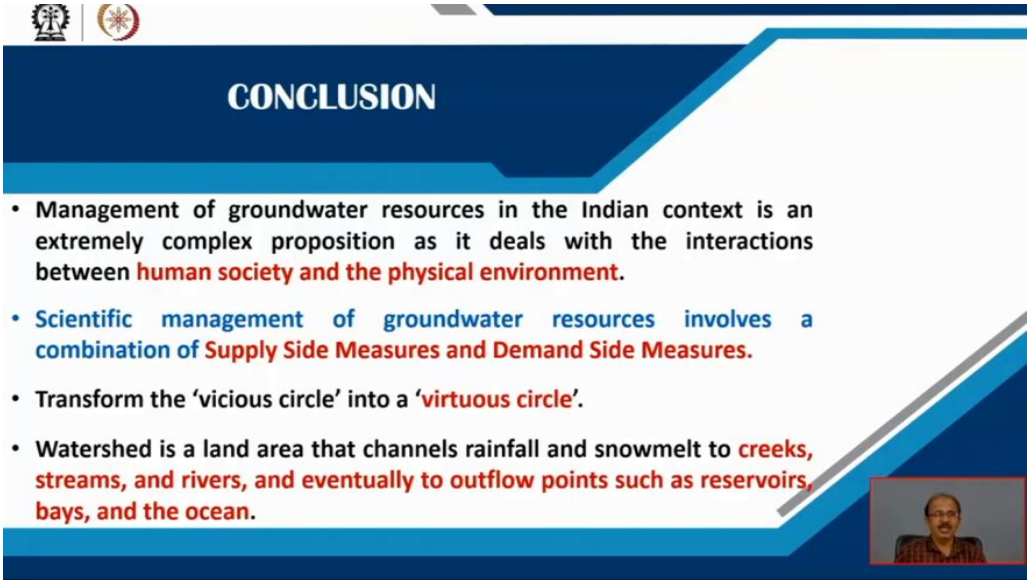

And the conclusion of the chapter 10 that is water resource management and planning groundwater resource management and planning is the that the management of groundwater resources in the Indian context is an extremely complex proposition as it deals with the interaction between human society and the physical environment. See we have already seen from now we have reached to the water resource planning and management part.

So, we have seen how the groundwater is being created inside the earth surface. We have seen a rock is responsible for storing the water inside the earth surface this rock is called as the aquifer and this aquifer may be lying at a shallower depth or at deeper depth but it is it should have some properties the property is essential for sowing the water is your porosity and permeability. So, if the and the recharge source is only and only one that is the precipitation.

Yes, now the surface water seepage etcetera they also just recharge at certain areas. But the main source of preposition recharging of the groundwater resource is the precipitation. But the point is that the management may vary from place to place why because the geological formations remain different at different places, at different depths, at different rocks you may get the storage of groundwater resources.

So, this management of groundwater resources in Indian condition is an extremely complex as it deals with the interaction between human society and the physical environment. So, since human beings are just taking the groundwater resource as a purest form of water for portable engineering purposes. So, scientific management of groundwater resources involves combination of supply side measures and demand side measures we have discussed in greater detail.

The point for this where; that time also discussed that the transformation of the vicious scale circuit into a virtuous circle. So, virtuous circle is a less expensive your management scale. So, this is the required transformation of the vicious circle into a virtuous circuit. Watershed we have also discussed in brief is that it is a land area that channels rainfall and snow melt to streams and rivers and eventually to outflow points such as reservoirs behind the ocean.

So, a small land area which generally channeling the rainfall and snow melt so this is called as watershed. Watershed why is management is a better way of management of the groundwater resources. Nowadays it is generally integrated watershed management approach is being followed for the water resource planning water resource management in different areas.

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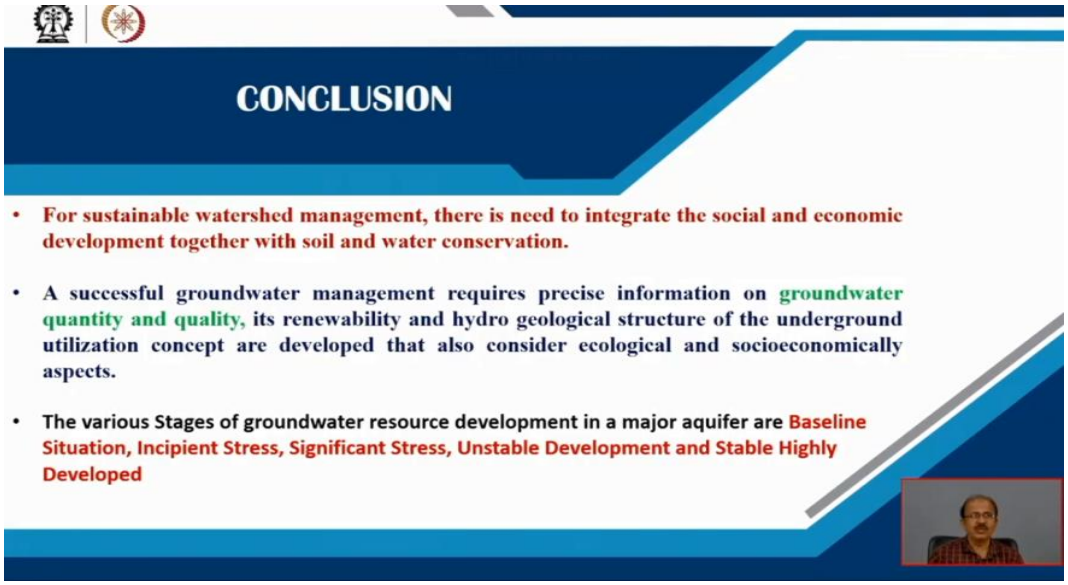

For sustainable watershed management there is a need to integrate the social and economic development together with soil and water conservation also. A successful groundwater management requires precise information on groundwater quantity and quality. So, for management aspects never bother for the care of only one point that is quantity no. Quantity as well as quality we have discussed in greater detail that.

Suppose a rock is holding or storing too much of groundwater but if it is also receiving some contaminant and polluting the groundwater then those rich amounts rich storage of groundwater is of no use. So, successful groundwater management always requires the good groundwater quantity and the good groundwater quality. As well as its renewability means having the availability to renew also.

And some hydrogeological structure which requires for the underground utilization concept that should be considered along with the ecological and socioeconomical aspects. So, then only we can say the groundwater resource management is the procedure is the successful procedure. When we will have the strict information about the correct amount of the groundwater quantity quality its renewability then we can tell it that the groundwater management is all right at this place.

The various stages of groundwater resource development in a major aquifer generally are seen such as baseline situation, incipient stress situation, significant stress situation, unstable

development and stable highly developed situation. So, as per the situation the as per the situation the conflicts arise and as per the present status the different management tools the institutional frameworks are required for sustainable management of the groundwater resources in a major aquifer or in any aquifer and it requires. So, for this, thank you very much to all.