Ground Water Hydrology
Prof. Anirban Dhar
Department of Civil Engineering
Indian Institute of Technology – Kharaghpur

Module No # 08
Lecture No # 38
Modeling and Management of Ground Water - Aquifer Yield Ground Water Availability - Effects of Ground Water Development - Regional Scale Development of Ground Water

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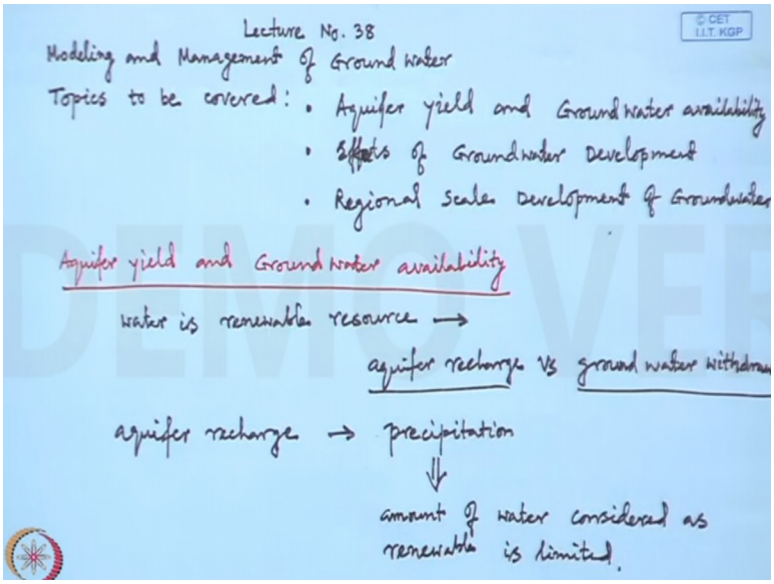

38 in this particular lecture will cover this modeling and management groundwater under this cover the topics to or aquifer yield and ground water availability second topic is effects of ground water development and the third and the last one that will cover is the regional scale development of ground water so first topic is our aquifer yield and ground water availability.

So in this particular topic we will try to see what is this ground water ground as if you can talk about this water is generally considered as a renewable renewable resource sometimes we deviate from that point view because groundwater mining is also there so the main point is the ground water is renewable resource but the problem is the aquifer recharge recharge versus this ground water withdrawal this is mostly uneven in nature.

So if recharge is coming then we should also consider the groundwater withdrawal from groundwater management point of view but sometimes there will be situations where our ground

water withdrawal is more than our ground water recharge scenario so what is the main source for this ground water recharge so aquifer is recharged aquifer recharge is mainly due to precipitation.

So the amount of water so we can say that the amount of precipitation is limited so we can say that our amount of water amount of water considered as renewable is limited so this is important point because precipitation is limited so we can consider that amount of water considered as renewable is also limited in nature so for ground water management projects it is important to find out equilibrium between this aquifer recharge and groundwater withdrawal.

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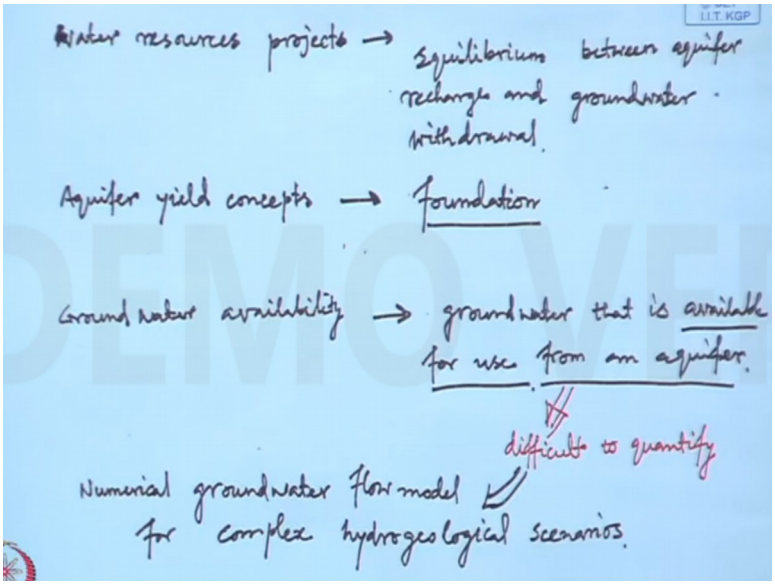

The so our ground water projects or water resources projects as equilibrium between aquifer recharge and ground water withdrawal is important so aquifer ill concepts are the fundamental things for finding out or devising any strategy for to maintain such kind of equilibrium so aquifer yield concept aquifer filled concept our foundations foundation for devising any strategy it maintain the such kind of equilibrium.

So this is the foundation for any kind of equilibrium concept and groundwater availability means the amount of water which is available from the aquifer so this is mainly groundwater that is available for use from an aquifer but the problem is it is not easy to define it or to quantify this particular thing that is available for use from aquifer so how to quantify that thing that is most important aspect of this particular groundwater availability thing.

So this is we can say that this part is difficult to quantify so with simple formulas or equation we cannot directly calculate this particular availability tom estimate this we need the numerical ground water models numerical ground water flow models for complex hydro geological on scenarios so one hand this is difficult to quantify on the other hand we can use our knowledge amount the numerical groundwater flow models to model this complex hydrological scenario.

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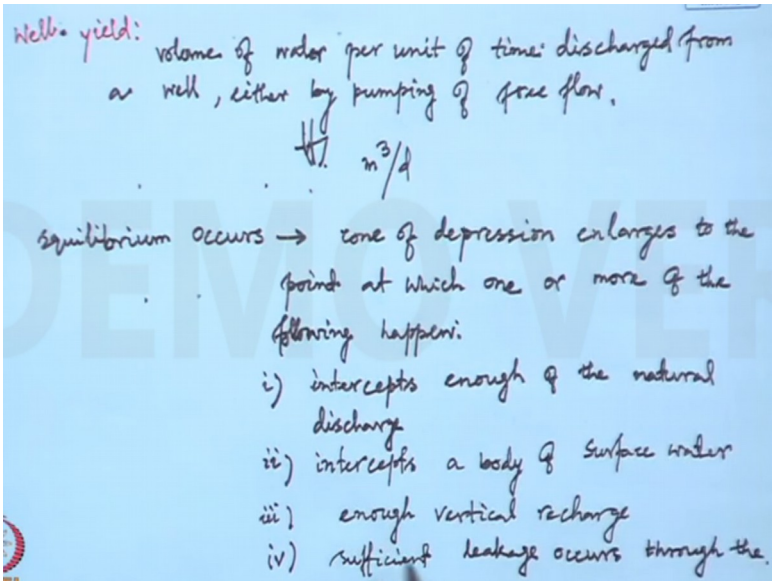

So to quantify the aquifer you the first we need to define few terms so first term is well yield first term is well yield. So what is this well yield in this thing we can define this well yield as the volume of water per unit of time discharge from a well either by pumping or free flow. So we can define it as volume of water per unit of time discharged from a well either by pumping or free flow.

So it is commonly measured as meter cube per day when a water well is pumped the quantity of water discharged initially is derived from or age and then immediately from aquifer storage around the well so equilibrium equilibrium occurs when with the cone of depression enlarges to the point at which one or more of the following one or more of the following things happen one is it intercepts enough of the natural discharge from the aquifer. Second thing it intersects a body of surface water third one is that enough vertical recharge.

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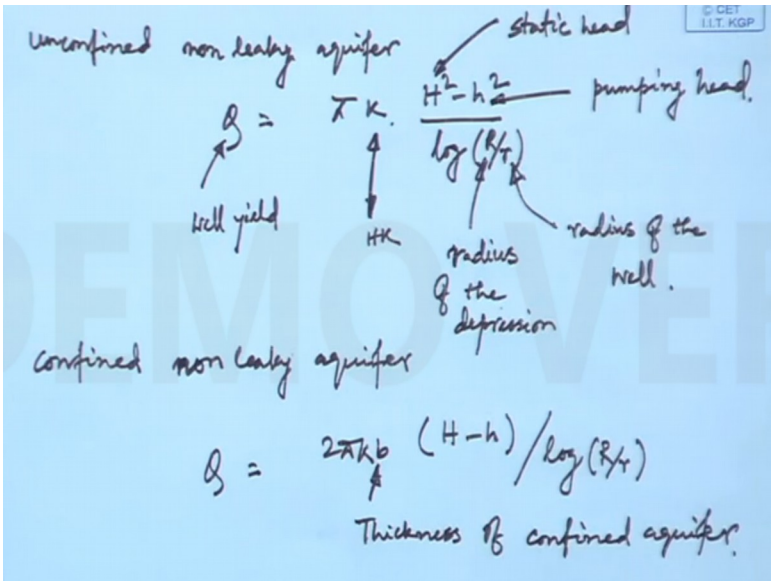

The fourth one is sufficient leakage occurs through the overlaying or underlying formations so for week discharge for any unconfined non leaky aquifer is given by Q = pie K H square - small H square divided by log R by small R where this discharge is a well yield or pumping it K is the hydraulic conductivity then this H is the static head measured from the bottom of the aquifer.

Static head and small H is the pumping head and R is the radius of depression radius of the depression small R is the radius of the well so for confined aquifer confined non leaky aquifer this Q is 2 pie K B and H this is again log R / small R where this B is the saturated thickness or thickness of the confined aquifer so it properly conducted pumping test can reveal the groundwater scenario or important facts about any particular aquifer.

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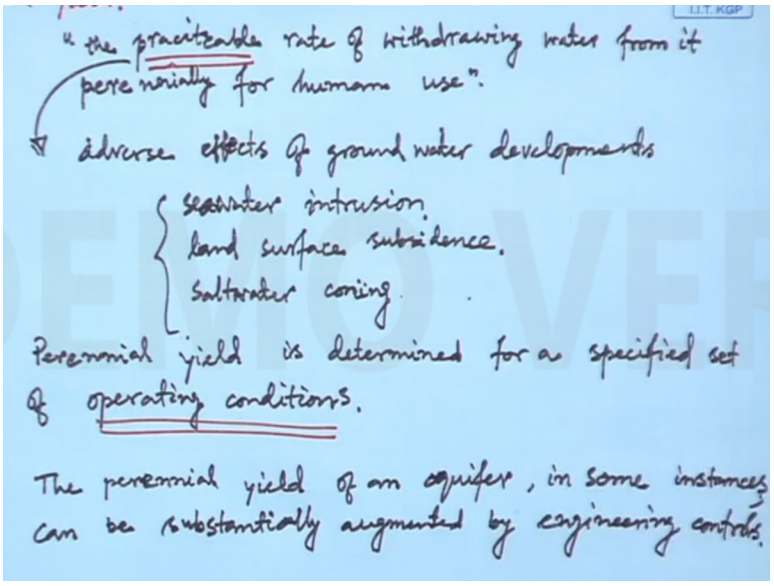

Next important type of yields is the perennial yield or so this perennial yield is defined as the practicable rate of withdrawing water from eight perennially for human use so this word practicable is important here because this practicable quantity or practicable rate is which we need to quantify in case of a particular aquifer but this practicable means that the adverse effects of any adverse effects or side effects of any groundwater development.

Groundwater development such as sea water intrusion land surface subsidence saltwater coning these are included in this practicable thing. So it should be such that there will not be any adverse effect related to the groundwater development so perennial yield we can say that this perennial yield is determined for a specified set of operating conditions so this perennial yield is similar to the perennial flow in our surface water systems of from a designated reservoir would be achieved.

If artificial discharge by the well we are apart in so as to reduce the discharge from reservoir and induce recharge in an equal amount and if storage were utilized only to provide some kind of regulation of the fluctuating inflow and to meet the demand of the well so it is important that so it should be under certain kind of operating conditions.

So we can have the next term as saiful but this perennial yield of the aquifer can be thought of some kind of engineer controlled some kind of yield where the perennial yield of an in some instances can be substantially by this engineering controls so next term is say field. So what is

this safe yield so safe yield most of the hydrologists prefer this safe yield because this perennial yield but problem is that safe yield is such ill which is not controlled by any other operating condition.

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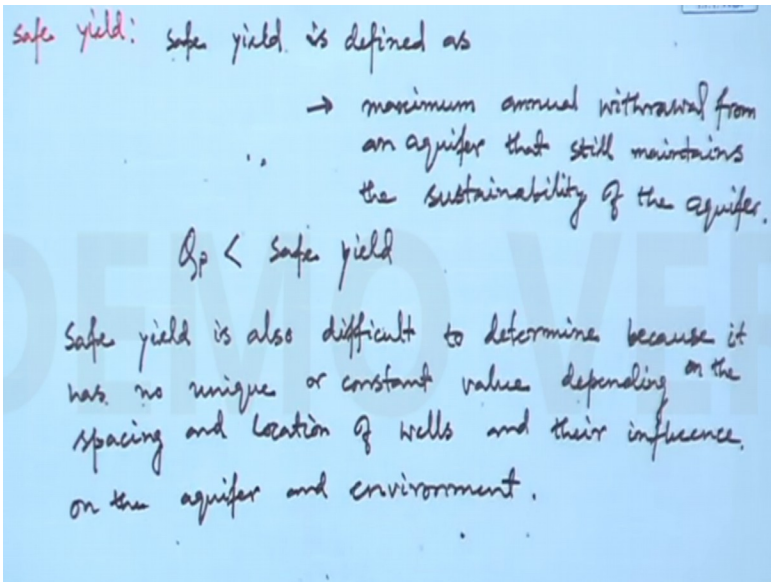

Then we can say that safe yield is defined as the maximum annual withdrawal from an aquifer that still maintains the sustainability of the aquifer so we can say that water resources of an aquifer could be maintained indefinitely if pumping does not exceed the safe yield so this pumping value or QP should be less than the safe yield.

So this safe yield is a popular concept in ground water resources management and it is generally used for different kind of management problems and this kile perennial the same will also difficult to quantify also difficult to quantify or to determine because it has no unique or constant value depending on the spacing and location of wealth and their influence influence on the aquifer and environment next comes this optimal yield.

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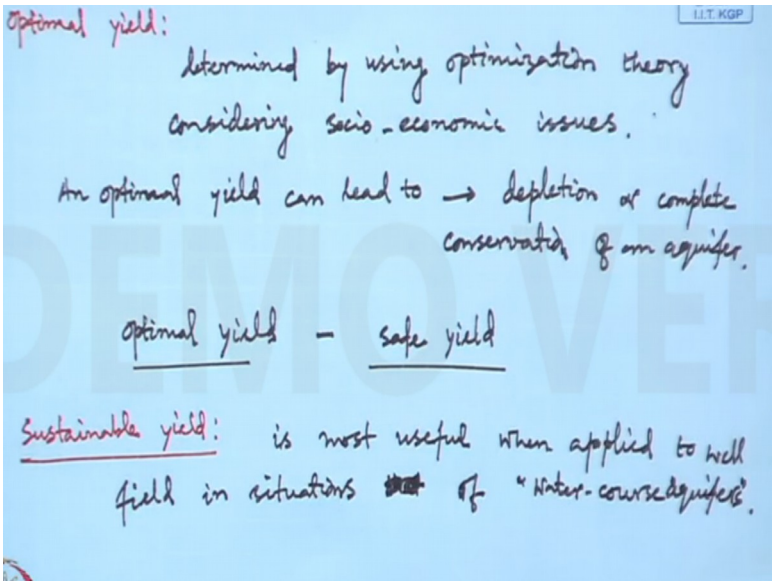

So this is determined by using optimization theory considering socio economic issues so optimal yield of an aquifer is determined by selecting optimal management approach for any particular aquifer or optimal yield can lead to optimal yield can lead to depletion or complete conservation of an aquifer. So it is important to distinguish between this optimal yield and safe yield.

So this optimal yield can lead to depletion of the aquifer whereas the safe yield will maintain the aquifer level or the storage within the aquifer next important term is sustainable yield what is this sustainable in sustainable yield is most useful when applied to well feel in situations that is that Thomas has termed as this Thomas is scientist who has stunned as watercourse aquifers situations we can say that in field situations of water course aquifers.

So such aquifer general such an aquifer generally underlies plain of major river system and is in hydraulic conduct with the water in river so sustainable yield is the minimum so sustainable yield is the minimum rate of pump age sustainable under all conditions of rivers discharge by a specified well filled that tap the alluvial aquifers so we have seen that perennial yield safe yield optimal yield and then this sustainably.

So in case of perennial yield we have seen that we need to maintain some practicable rate of withdrawing water from the aquifer in case of safe yield it should be the maximum annual withdrawal from an aquifer that still maintains the sustainability of the aquifer and optimally this

is determined by optimization theory considering socio economic so here socio economic issues are important in case of sustainable this is mostly applicable it.

Water course aquifers and this is the minimum rate of on page sustainable under all conditions by of river discharge by a specified well field that as the alluvial aquifer.

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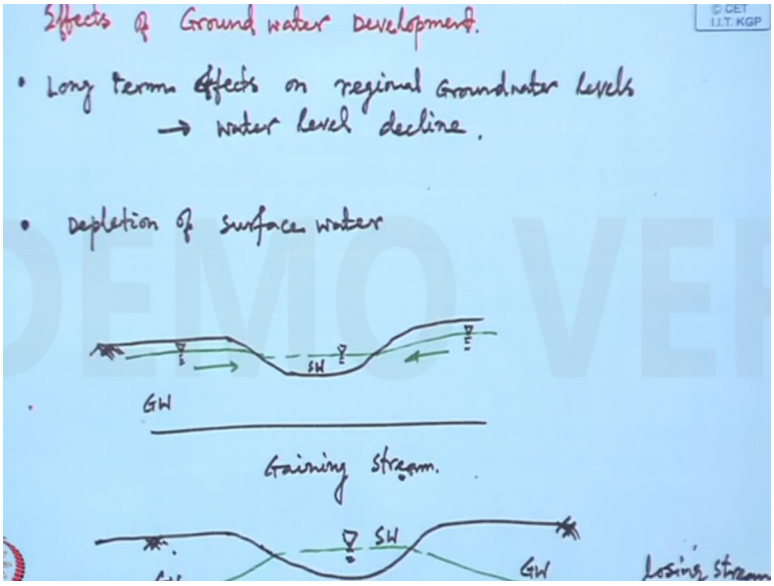

Next point that we need to discuss is the effects of ground water development so what are the effects of groundwater development the first effect is a water level decline. So long term effects on regional groundwater levels that is water level decline as long as water is mind that is withdrawal of water in excess of the induced recharge plus the reduced ground water discharge from an aquifer.

The water levels of the potentiometric surface will be continuously lower in elevation on a year by year basis and this will create problem and this problem is due to the ground water development second is depletion of surface water depletion of surface water is another major reason here because let us say that this is our groundwater thing and we have this ground surface this is our ground surface and we have water level like this.

So this is basically we can say that gaining stream where our water level is here which is above the water level in surface water this is ground water. So ground water level is more than surface water so we can say that as gaining stream otherwise if this ground water level is below the

surface water then there will be movement of water from movement of water from surface water towards the ground water body then we can say that as losing stream.

So this is surface water this is ground water level and this is our ground surface so it is important that ground water development can also lead to either losing or gaining steam there is too much of pumping in the aquifer then there will be depletion of ground water and there will be losing stream situation in the aquifer region.

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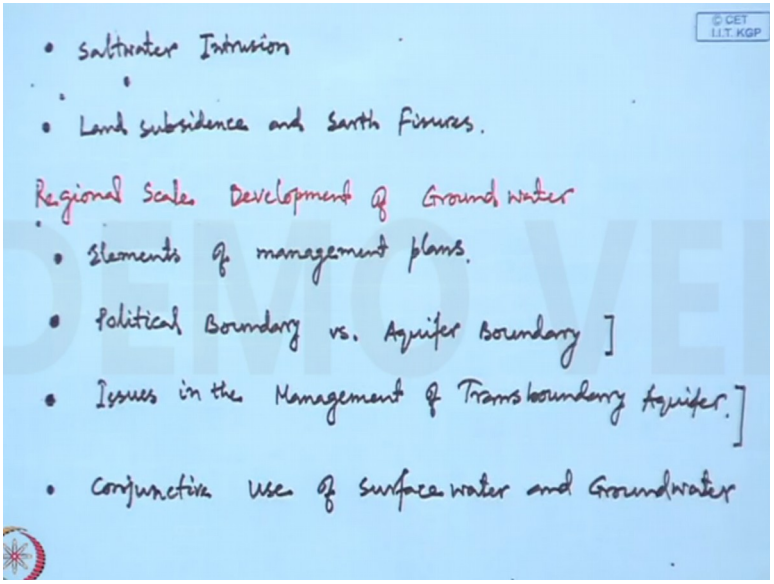

Also salt water intrusion is another effect that we have already discussed in our previous lectures salt waster intrusion so in coastal areas if there is heavy pumping there will be movement of salty water towards the fish waster aquifers and the fourth scenario or forth important point is that land subsidence and earth fishes so land subsistence is gradual settling or certain thinking of surface.

Going to surface water movement and so ground water development can also lead to surface this land subsidence there will be generation of fishes so next point is regional scale ground water development issue first is a management aspect so elements of management plants. So once management check tips are adapted activities and costs of planning and investigation must be developed in sufficient details.

To obtain authorization funds for the study and identification of different management aspects should be fixed and the next point most important is that political boundary versus aquifer

boundary so for finding out the yield for any particular aquifer we need to have certain ground water flow models and in that one we need to have certain boundary conditions either we can have political boundary in our regional scale model or in our aquifer boundaries.

But the problem is that most of the cases aquifers are shared by to a political two or more political regions so that creates problem for any regional scale development scenario in ground water and this identification of boundary conditions become important and this political boundary or aquifer boundary can be used for modeling purpose next aspect that is most important is that transponder ratio of trans boundary aquifers.

So Tran's boundary ground water refers to continues ground water reservoir and it is shared by two or more political jurisdictions. So here the fixing boundary condition boundary condition is important here different management aspects are important that is joint management plans can be devised for better management of groundwater aquifers also a conjunctive use of surface water and groundwater is important from the regional scale development aspect.

So in regional scale the use of river water or the surface water available should be supplemented by this groundwater or water from the ground water aquifer .So these are the three major issues related to modeling and management of groundwater aquifer that is aquifer yield and groundwater availability then we have discussed the effects of groundwater development and the finally we have discussed this regional scale development off groundwater so this ends this lecture number 38.