Water Economics and Governance
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Lecture – 04
Surface Water and Ground Water Resources

Hello everyone. So, today we which is actually the; our fourth lecture, what we will be talking about is the surface water and groundwater resources in India. Primarily, we will focus on India. So, if you recall our earlier discussion when we were talking about the water availability as in all in India as well as in western countries, we did talk about these earlier.

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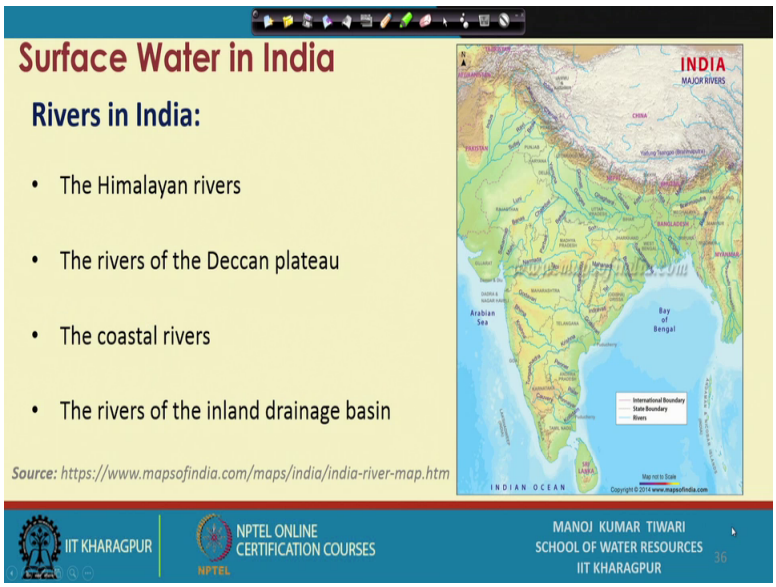

So, if we specifically if we look at India, our primary water supply or water availability is in form of surface water and to some extent groundwater the major surface water sources which we rely on are actually the our river basins.

Of course there are small lakes and all that, but when we when we distribute our based on reasonal scales we can actually assign the different regions under different river basins. So, we have in India we have actually various types of river also the major ones are the Himalayan rivers then there are rivers in the Deccan plateau while there are some small coastal rivers and inland drainage basin based rivers also.

So, if you see this is kind of a river map of India now you can see that the different river basins over here.

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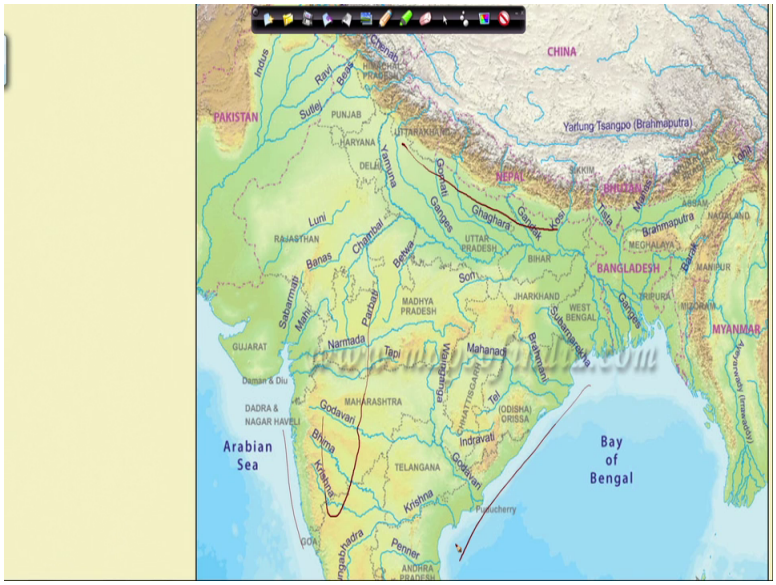

So, the rivers originating from this Himalayan belt actually are these Himalayan belt are primarily; the rivers that are of Himalayan reason while as we have rivers over in this region. And all that which actually falls in the Deccan plateau and some specific rivers particularly in the Rajasthan and all that which are based on the inland drainage system and of course, on the coastal belt of the India. If you see the entire coastal belt of India, there are very small-small rivers most of them are actually non perennial rivers. So, they also contribute to storage of some amount of waters in the basins.

So, coming back actually if you see. So, excuse me yeah.

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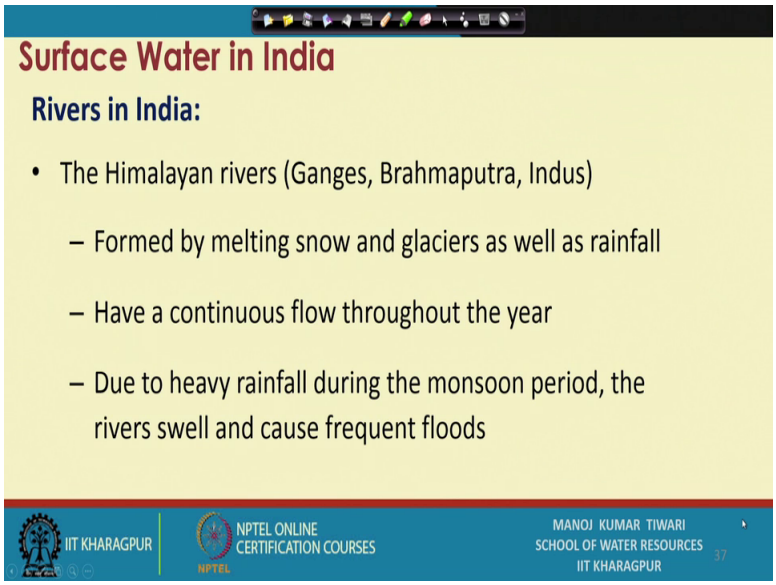

So, from if you see the these river basins the Himalayan rivers which primarily includes Ganga Brahmaputra, Indus, all these are basically formed by melting snow and glaciers that is the basic that is the basic source of water in these rivers whereas, in between their path they are fed by rainfall as well. So, the contribution overall contribution of water in these rivers is actually from the snow melts and then in line the rainfall which is coming from the catchment area of the river itself.

They have a continuous flow throughout the year there is they generally does not get dry and because these are large rivers and they already have a source of water in from in the form of glaciers and ice cap melts. So, excessive rainfall and most ever since they are arising from Himalayan region or hilly region, the rain, in this large catchment basin large area generates excessive rainfall because of very high slope. So, this excessive rainfall particularly in the monsoon period, heavy rainfall in the monsoon period will actually enhance the flow in the rivers significantly and that results in the swelling of these rivers and which sort of is the basic reason for the frequent floods that we often see in some of these rivers which are actually originating from the Himalayan Rivers.

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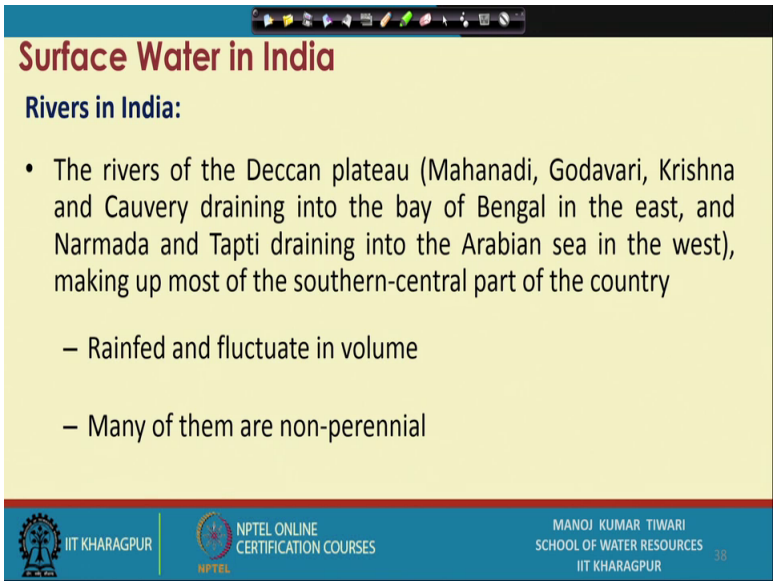

So, the other type of river actually are the river that arise from the Deccan plateau. So, there are plenty of rivers in this group the major one includes Mahanadi, Godavari, Krishna, Cauvery which actually drain eventually into the Bay of Bengal. In the eastern part of the country while there are other major rivers like Narmada, Tapti which actually drain into the Arabian Sea in the western part of the country. So, all in all this rivers from the Deccan plateau either they are going into the eastern part or they are sort of feeding the western part. So, they make most of the south central part of the country whereas, northern or northeast part mostly northern part is covered by the Himalayan is fed by the Himalayan Rivers. These type of the Deccan Plateau Rivers feeds south central part of the country.

So, they are mostly rain fed and that is why; fluctuate in the volume depending on the amount and extent of the rainfall how much rainfall is occurring. So, that will eventually govern how much how much flow the river is carrying quite a few of them are actually non perennial; that means, because the rainfall is their primary source of water; in these rivers. So, in the dry weathers or dry seasons some of them which does not have large storage resin gets dried up and that results in the non-perennial rivers.

So, perennial rivers are the one which actually very rarely will get dry. So, they will have flow throughout the throughout the year without any interruption.

The scale may be low or high the flow may be reduced level or the flood level; however, they will have flow in that whereas, the other river which at least typically has one phase in a year when they do not have water in it or significant water in it. So, those type of river which gets dry at least once in a year are called non Perennial River.

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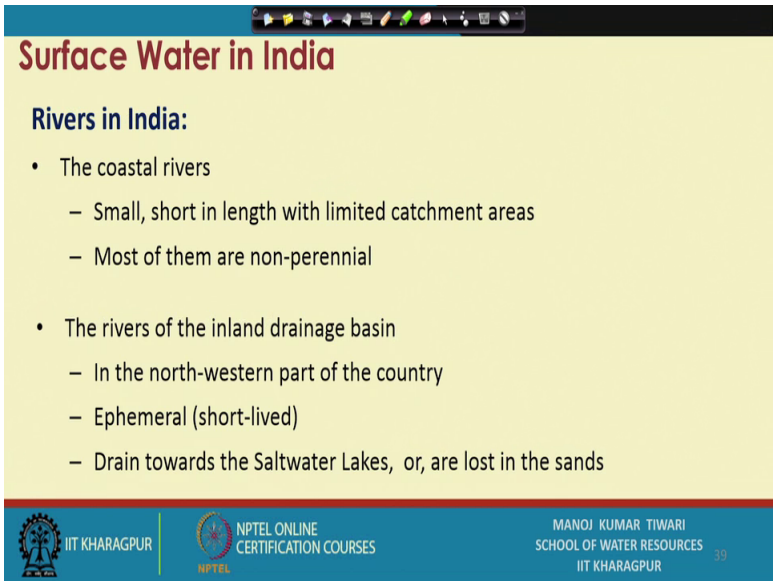

So, quite a few of these rivers are non-perennial then there are minor categories of river as we were discussing earlier. So, there are coastal rivers which are basically in the coastal region. So, they are small sort in length with limited catchment area and most of them are actually non perennial. So, you will there are very local rivers. So, local name even not many popular rivers you will see in this category these are all small rivers typically in the coastal belt. So, many time carrying water from the different in in the coastal belts actually the major rivers also at times split into sub ones and then there are local names given accordingly.

Then the rivers of the inland drainage basin which is sort of the inland drainage at times from rainfall or from the some other sources may be originating from some small water drainage systems. So, they are the these type of rivers are also very very sort of ephemeral means very short lived for short span of time the states of Rajasthan and to some extent even Gujarat has some of these type of water drainage systems.

So, there are some small rivers of this nature these eventually in the sort of northwestern parts that includes Rajasthan primarily and to some extent Gujarat and these states. So,

they have these typically drains towards salt water lake there are quite there are some saltwater lakes in Rajasthan as you may be aware or they will lost in the sands in their path.

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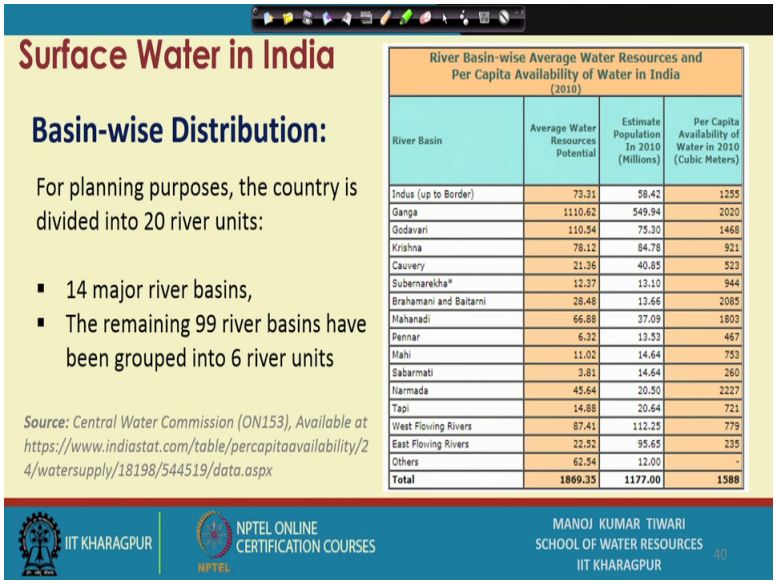

So, this type of rivers are typically found in the northwestern part of the country. So, these are our typical river systems which are carrying flowing of the different reason now as was discussing that these rivers typically are the one which carry which sort of utilized primarily utilized for surface water requirements for feeding surface water requirements or their primary source of water wherever they are available if there is no river available then people look for the groundwater or other sources. So, for planning purpose our entire country is divided into 20 river units.

Out of these 20, there are 14 major river basins which sort of on its own large river having its own river basin while there are various other small rivers. So, they have been grouped into 6 river units. So, 14 river basins independently while 6 other clump of various river units making it to a 20 if you see the average water resource potential and the per capita availability of water in these river basins which is sort of data from our central water commission. So, that if you intend to see this table over here we can see that the Indus which is sort of a fairly small because major part has gone to other nation, but Ganga is our the largest river basin in terms of average water resource potential of 11; 10.62 while the while per capita availability.

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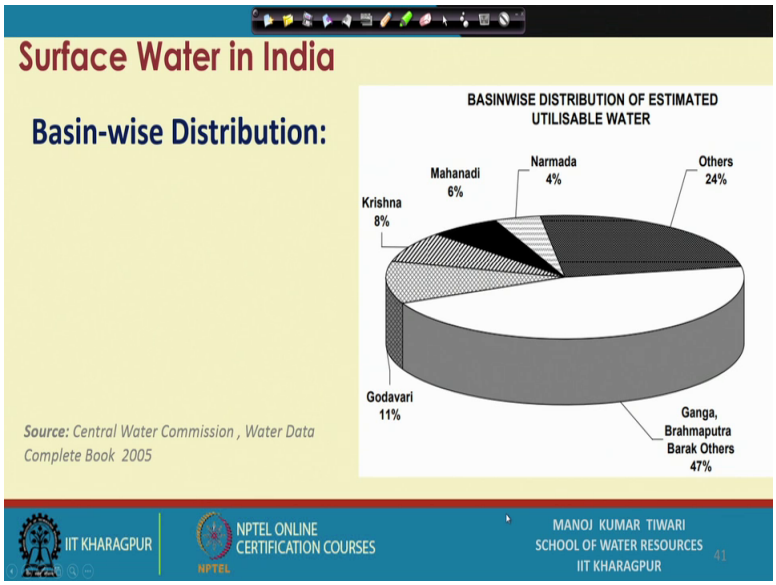

If you see here is 20-20 cubic meters annual per capita availability in river Ganges which is one of the highest although there are as high as Narmada accounting for some over 22000, then other major other major ones are your Baitarni and Brahamani and Baitarni Brahamani and Baitarni rivers. So, they are the one then of course, there is Ganga as we told the Subernarekha has in the range of 1000, which is actually not only Subernarekha, but includes a couple of other small rivers as well. So, there are there are then we have Mahanadi of the order of 1803.

So, there are rivers which are having significant amount of water storage on an average; however, the same time if you see the critical ones. So, there are rivers like Sabarmati with very low water availability 260. Similarly there are there are Pennar which is little over than 415, then there are this one is Kaveri which is with 523. So, there is a huge variation huge gap into the water availability of these rivers that way population wise also.

If you see the Ganga is the one which is feeding most of the population of the order of around 550 million people which primarily includes from UP, Bihar, West Bengal and Uttarakand; of course, from where it originates the other there are waste flowing rivers which fed of around hundred 12 million people and Krishna is Krishna and Godavari are the other major ones which combinely can sort of cater about some hundred sixty million people over in that range.

So, this is about the distribution basin wise now clearly it is the Ganga, Brahmaputra and Barak rivers sort of give the 47 percent around 47 percent. This is data from the central water commission. So, they give around 47 percent of the total utilizable water the Godavari is the next major contributor by 11 percent Krishna Mahanadi Narmada are the other major ones while the rest in combination provides around 24 percent of the water resources.

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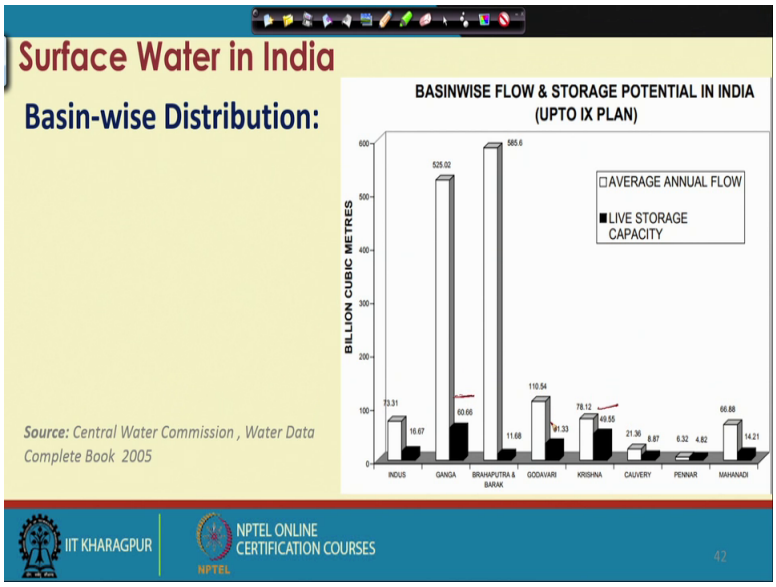

Total water resources utilizable water which is to be available for the human uses in different sectors of course.

Now, the baseline basin wise flow if you see and the storage potential. So, this also gives an interesting finding that you see the storage potential which is defined in terms of the size of the river how much water it can store in a way. So, in overall how much volume of water that river can retain if you see the Ganga and Krishna the; this can be actually seen in this figure over here. So, Ganga which is having some arounds over sixty over sixty billion cubic meters of storage potential followed by the Krishna and then there are then there are other rivers as well.

So, this is live storage capacity so; that means, this much of water can be stored at any given point of time in the river while the average annual flow from that river is much higher. So, if you see like the Brahmaputra and Barak that way. So, they have a huge average annual flow. So, getting from the rainfall we know that how from this

Brahmaputra is for flooding. So, they actually transport huge amount of flow and that is evident some around close to 600 billion cubic meters of water is annually flowed or annually transported in Brahmaputra and Barak river basins.

However the storage capacity is fairly small because of the channels is not that wide and based on the width of channel depth and length; you see the at a given point of time the live storage capacity of this is just close to 12 billion cubic meters; however, it around transports 600 billion cubic meter of water. So, that much water actually is being carried out, but storage capacity is not there same is for you see the Ganga which is having although fairly large storage capacity still there is the if you see the volume of water that it flows. So, it is around 525 billion cubic meters which is huge volume and it can store at a time only 60 billion cubic meter.

So, that much of water or which is actually the fresh water rainwater, if you see this much amount of fresh water rainwater or glacier melts and all these are being transported and if unutilized, they eventually are going to sea and turning into the saline water. So, that is sort of a prospect that if somehow this water can be managed judiciously either entrapped or stored on some other way utilized. So, we will at least get a very good very significant amount of freshwater without much of the interventions other otherwise like desalination in these kind of interventions are the one that we are looking after these days.

In terms of in terms of the average annual flow versus live storage capacity there are few rivers like Krishna which is fairly good it has a capacity of some 50 billion cubic meter and average annual flow little under than 80 billion cubic meter. So, not much is lost over there and of course, there are some smaller rivers also that fall in that category. So, this is this gives us a this data gives us a prospect of looking at that how much water river carries in it is in a year whereas, how much it can store at any given point of time.

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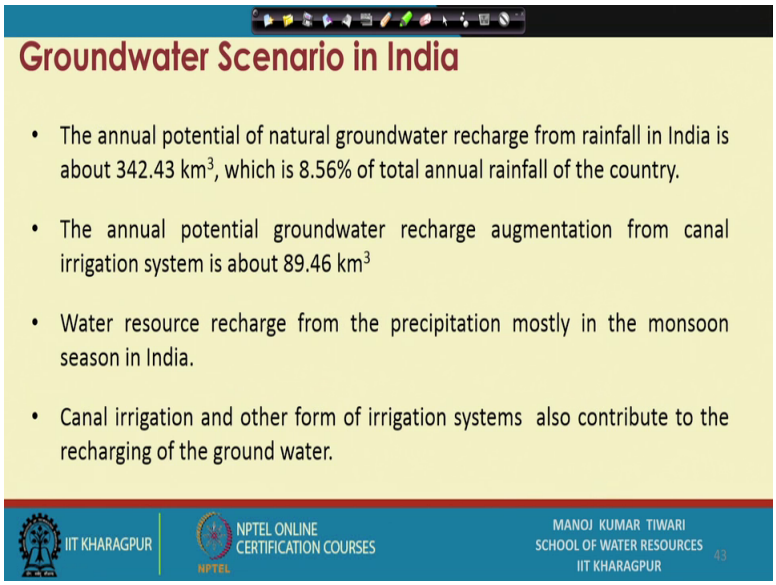

Now, if you see the annual potential of groundwater. So, so far we have been discussing primarily about the surface water sources, but if we look at the groundwater sources as well, the annual potential of natural groundwater recharge from rainfall in India is about 342 kilometer cube of water which is just little under 10 percent of the total annual rainfall in the country.

The annual potential of this recharge augmentation from canal irrigation system because we have large canal network also at least some states in India have a very large and very good canal network. So, the canal irrigation network and recharge from this is of the order of ninety kilometer cube. So, water resource recharge from precipitation is mostly in the monsoon period because we get over 70 percent 7.

In fact, larger than that around ninety percent of the rainfall in the monsoon period if we see the complete four month of which also the seventy percent is primarily contributed from June to or even July to September. So, this is the sort of prospect of groundwater recharge in India the state wise groundwater resource availability if you see. So, this is the data compiled from ministry of water resources sort of and it is available on the net the link is given.

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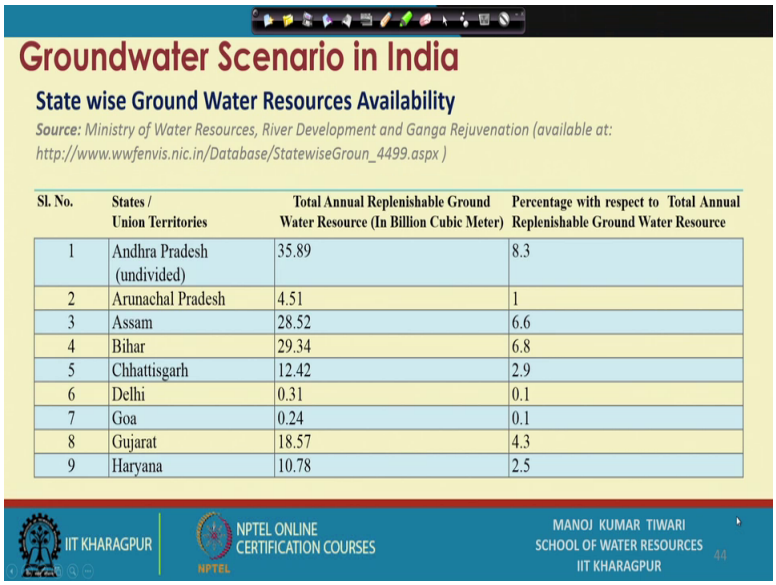

So, the state wise if you see the total annual replenishable groundwater available and the percentage with respect to the total annual replenishment groundwater you see. So, there are there are some states which actually we will see eventually in this table there are some state which has almost negligible amount of replenishable groundwater or because it is very hard to retrieve that.

So, there might be water in our too much of depth, but we are talking about the replenishable groundwater resources. So, that is limited. So, if you see this table over here the undivided Andhra. Now it has been basically bifurcated in Telangana as well, but this data is actually of 2013 probably. So, undivided Andhra is having sort of good amount of replenishable ground water resource 30s around 36 billion cubic meter which is 8.3 percent of the country 8.3 percent of the total annual replenishable ground water resources.

The other major ones are Assam and Bihar whereas, there is all very little Delhi, Goa these are anyways small states.

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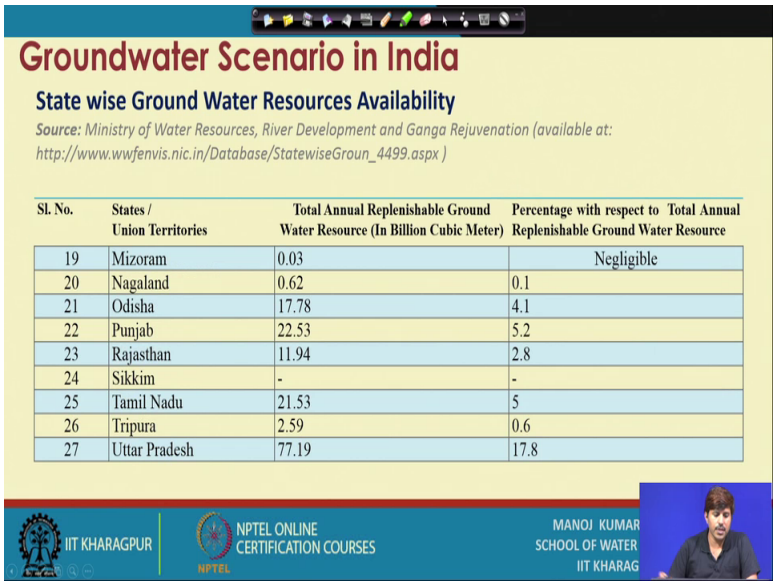

So, not that way again Himachal and so because of hilly terrain Himachal, Jammu will not see much of the potential in that sense the MP and Maharashtra, again, the larger states have significant amount of significant amount in compression we are talking about comparing to the other states as well. So, it is not in isolation, but in compression significant amount of replenishable resources in the odd order of around 35 billion cubic meter while.

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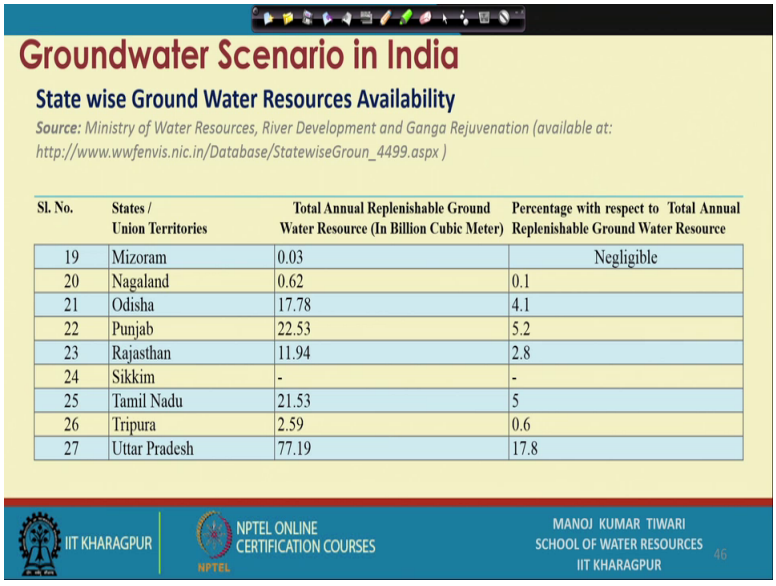

There are various other small states see the critical conditions if you see are actually for Rajasthan which is being one of the largest state in terms of the area and if you see that the replenishable groundwater resources are little under 12 billion cubic meter.

So, the crisis the level of crisis you can see that they do not have large rivers flowing. So, there are not large sources of surface water there are some lakes although there are quite a few lakes in the different cities and towns, but there are no major river that contributes some significant discharge into the state and the ground water resources situation are also alarming. So, they have based if you look at the size of the area which is probably the largest state now after the partition of UP and MP. So, being the largest state still the amount of the replenishable groundwater available is very low as compared to several other states.

In this regard UP which is one of the major state in indo Gangetic basin. So, the Ganga river basin it is one of the major states along with the Bihar. So, this has substantial potential of annual replenishable groundwater seventy seven billion cubic meter.

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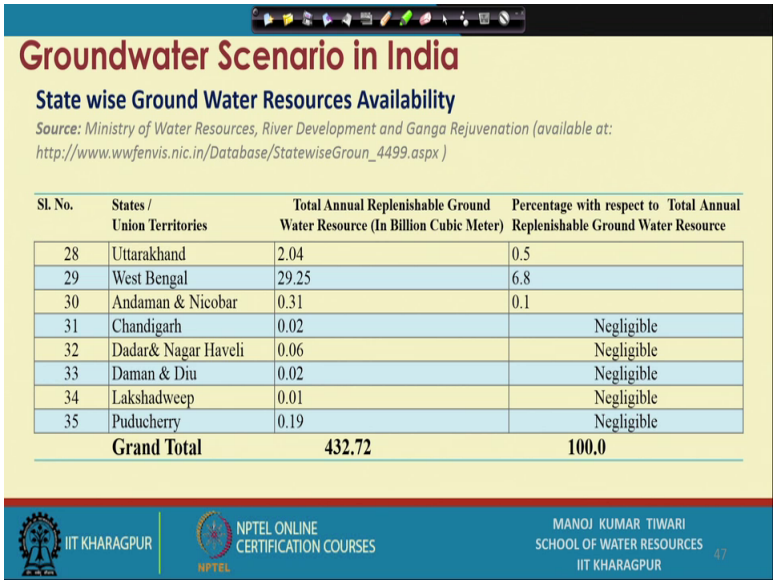

Which is around 18 percent of the total; West Bengal also has a fairly good amount of groundwater available in comparison of course. So, the again although; we are talking about the groundwater resources here, but if you see in the terms of groundwater also the leaving the leaving the states which are on the hilltops and all that of course, there would

not be much of the groundwater available ground water resources replenishable because of high most of the rainwater converts to runoff.

But if you see the states like UP, West Bengal to some extent, Bihar have a good amount of groundwater resources, also prime primarily because the interaction of surface water and groundwater is linked and when these have significant availability in terms of surface water; they get better recharge and that is why the large amount of annual replenishable resources as well while few other places and union territories you will see almost negligible share that way.

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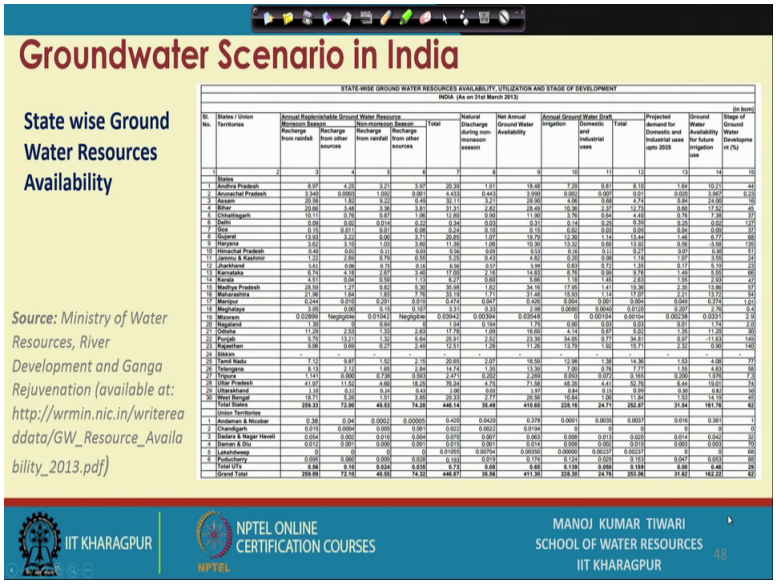

So, total if you see the estimate is around 432.72 billion cubic meters in India.

Of course these estimates change based on the agency and from time to time at times. So, this is kind of a summary of groundwater resources availability state wise this table may not be readable as in this way, but one can see that this is based on this state wise this data is again from the ministry of water resources which is available on the website of ministry. So, this is updated as on 31st March of 2013.

So, this tells about the annual replenishable groundwater resources in monsoon season, non monsoon season is specifically then what is the total amount what is the natural discharge during non-monsoon season net annual groundwater availability and then annual groundwater draft how much is the draft from irrigation you can see here in the

annual draft from irrigation domestic and Industrial uses and the total then projected demand for domestic and Industrial uses up to 25.

So, that is also listed in here and then availability for future irrigation use and stage of groundwater development in the state particularly state. So, you see this last column is also very like kind of leading very interesting information that; what is the state of groundwater development. So, there are a few states where you can see that the state of groundwater development are actually over hundred percent. So, they are over exploiting there are quite a few states which are actually over splitting their; their groundwater resources while there are quite a few states which have not developed their groundwater resources fully. So, this kind of information is compiled and this information is available.

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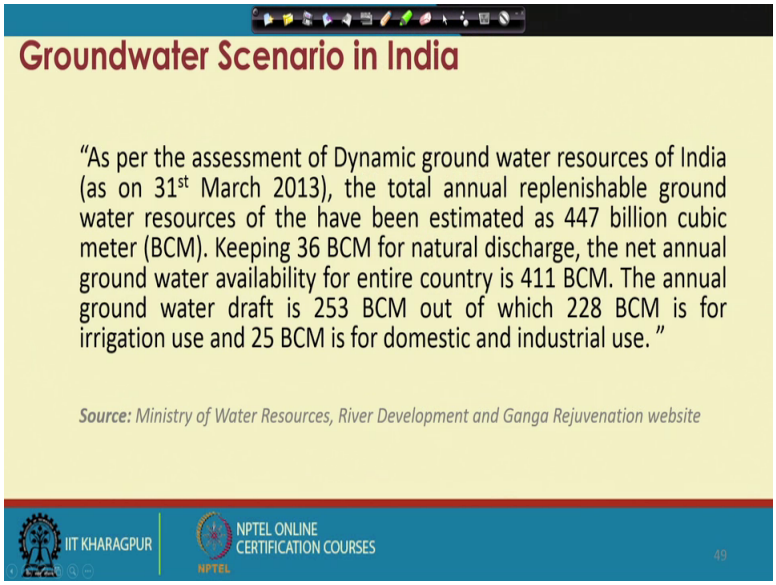

So, this is kind of all about the availability of surface water and groundwater resources and we will sort of if you see the overall scenario of groundwater as mentioned on the ministry of water resources website. So, it reads that the total annual replenishable groundwater resources has been estimated 447 billion cubic meter keeping 36 billion cubic meter for natural discharge the net availability of the entire country is 411 billion cubic meter.

Now this annual groundwater draft is 253 billion cubic meter of this availability 253 million cubic meters are actually drafted out of which 228 billion cubic meter goes for irrigation while 25 billion cubic meter is for domestic and Industrial uses.

So, that kind of summarizes the groundwater scenario and we discussed surface water scenarios earlier. So, we will end up this session over here and continue our discussion in the next one.

Thank you.