Water Economics and Governance
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Lecture - 02
Global Water Availability and Uses

Hello. So, we are into the second lecture of first week on Water Economics and Governance. We will continue our discussions from where we ended in the previous session. Previous lecture we have basically talking about the global perspective of water resources.

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So, we did discuss that how the; what is the net estimated operated amount of the water that is available into various phases including ocean atmosphere, river streams, groundwater. So, in all these different phases what is the estimated total volume of water present on the earth? The time that water spends into these medium varies from a few days; as in case of atmosphere it is approx estimated time average time is around 9 days to tens of thousands of year or even longer when it goes in the form of ice caps and glacier.

This is what we are talking about earlier.

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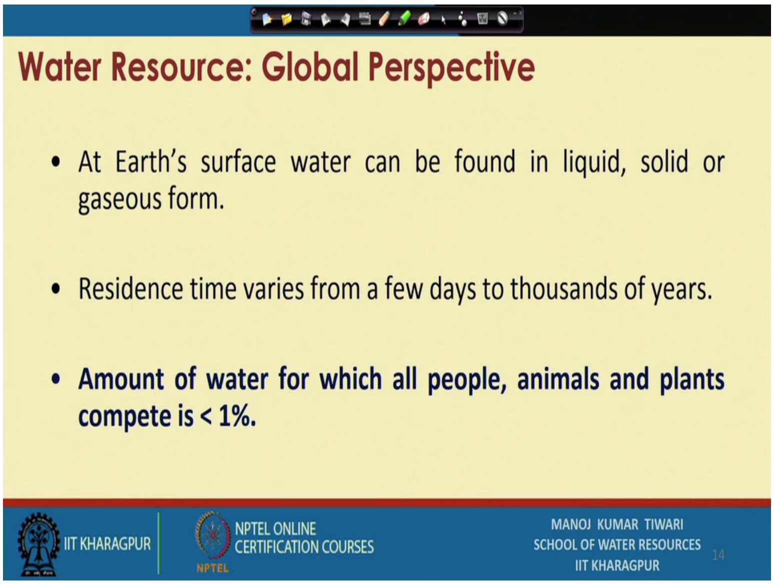

Continuing from there on if we see the Earth's surface water is found in liquid solid or gaseous form, when it is in the atmosphere it is in the gaseous form. When it is typically in the oceans of groundwater or lake rivers it is in the liquid form. However, it could be in the solid form when it is in the form of ice caps or glaciers.

We also observed that this residence time varies from a few days to 1000 of year as we were just talking about, the important point or 1 of the main concern for civilization is that the amount of water amount of fresh water that is available as if you just move back to the previous slide you will realize that if you account for all these. So, you see that the freshwater over here is actually if you see total water into the river and lakes and even including the groundwater's for which generally people compete is very less.

So, since the fresh water availability is that low. So, all of us all people around us are actually competing for that for that water which is actually less than 1 percent of the total water. So, this is what for not only just not only human beings, but human, animal, plants ecosystem all of us are competing for this water fresh water which is actually ESS than 1 percent of the total water.

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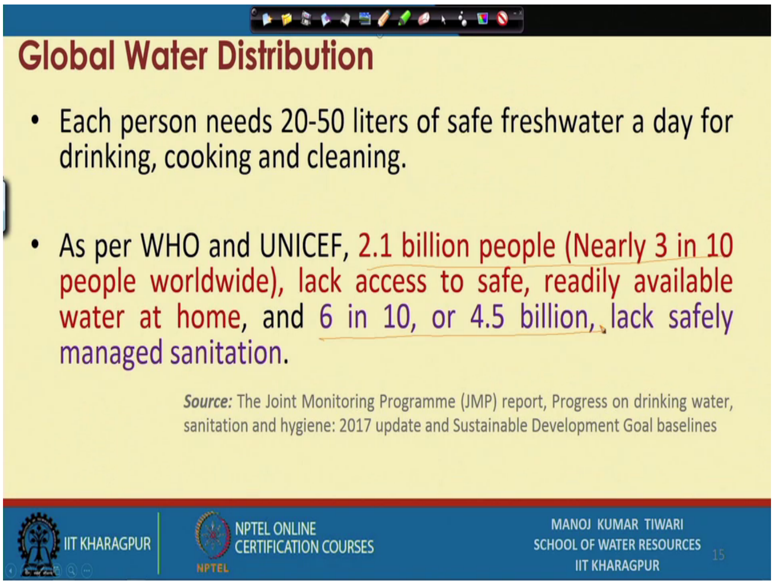

Typically if we put our emphasis onto human beings 1 person needs minimum of 20 to 15 liters of safe freshwater in a day for it is drinking, cooking and cleaning purposes that is what is the various estimates provided by the w h o or UNICEF suggest. So, 1 each person needs around 20 to 50 liters of safe water now if we see the total availability of freshwater and it is distribution of course, which we will just talk about. So, what is what is seen or what is estimated or predicted by the larger organizations like WHO or UNICEF working in the region.

So, they estimate that around 3 in 10 people worldwide which is approximately 2.1 billion people this is a very latest report this was just published in 2017 you can see the source over there. So, nearly 3 in 10 people worldwide overall estimating around 2.1 billion people on the 2.1 billion people you see here they lacks access of safe and readily available water at home. So, there is not adequate amount of water to feed in these many number of people and 3 in 10 is a large number around 30 percent of the worldwide population is sort of declined to give access to the safe and adequate amount of water and in their homes.

The situation is actually even worse for sanitation although this course primary targets water, but sanitation is another associated thing which with water and if you see the case of sanitation it is even worse as around 6 in 10 people, which goes to around 4.5 billion people in the world, around 60 percent people in the world does not haves safely managed sanitation.

So, that is the sort of scale of the issues which is very alarming the around 30 percent people do not have access to the safe water and around 60 percent people double of that do not have the access to safely managed sanitation. So, that is sort of a very the very high point of concern.

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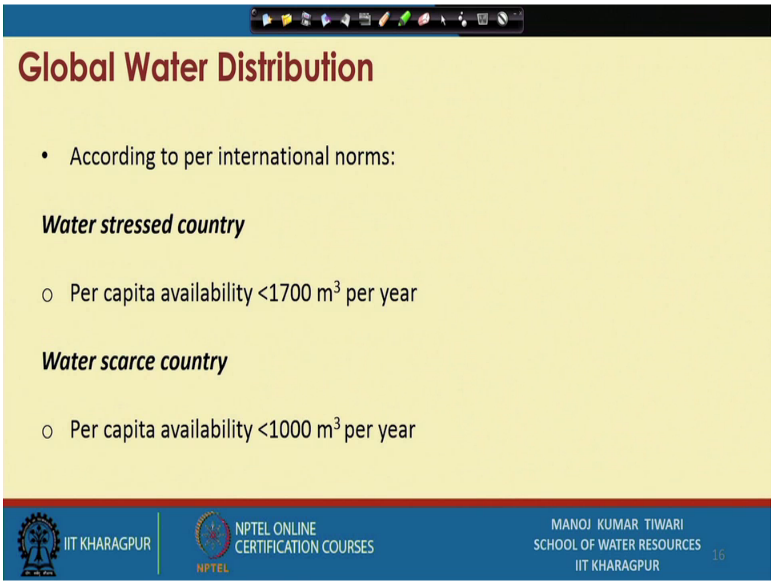

Now if you see the global criteria or international norms, when the per capita availability in a region or a zone or a continent or a country; let us talk about a country. So, in a when this per capita availability in a country is less than 1700 meter cube per year meter tube of water per year.

The country or the zone or the continent is referred as water stressed, while if it falls down below 1000 meter cube per year then the per capita availability comes below 1000 meter cube per year then we call that as a water scar country. So, that is that is how basically the terms are allotted many of the African countries we keep on saying that they are water stressed country, waters scar country, and all these terms. So, this is what these terminologies means when some when the per capita availability is less than 1700 meter cube it is water stress zone while if it dips below 1000 meter cube per year it is a water scar zone.

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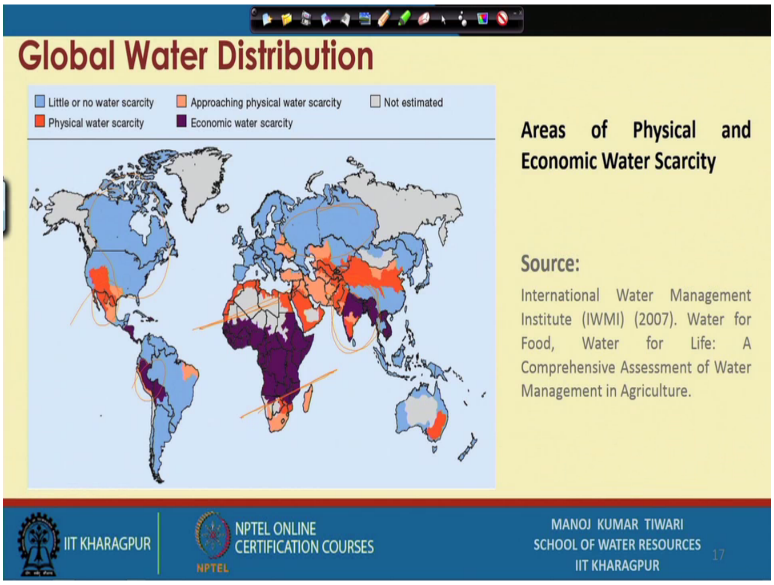

Now if you see the global water distribution how this water is distributed it is sort of you see that the even the natural distribution of water is not very judicious, if you see the civilized growth of civilization as per the growth of civilization or as per the habitat areas you see that the global water distribution. So, there are countries if you see this whole lot of Europe European belt over here you see they have plenty of water there is a little or no water scarcity ok.

Large part of US is more or less do not have too much of water crisis or water issues although there are some states over there, which you can see the Southern part also you can see over here that there are issues related to water which leads to physical water scarcity mostly or approaching physical water scarcity as you seen in many of the Asian countries over here there are economic water scarcity as well if you see the large part of your Africa is under the economic water scarcity. Similarly in India conditions are not very bright in our own country if you see. So, you see that most of the Indian territory are either under physical water scarcity economic water scarcity or approaching towards physical water scarcity the central part that some of the central region that you can see off.

So, that is how the water is sort of distributed the natural distribution of water across the across the different continents different countries as you can make it out from here.

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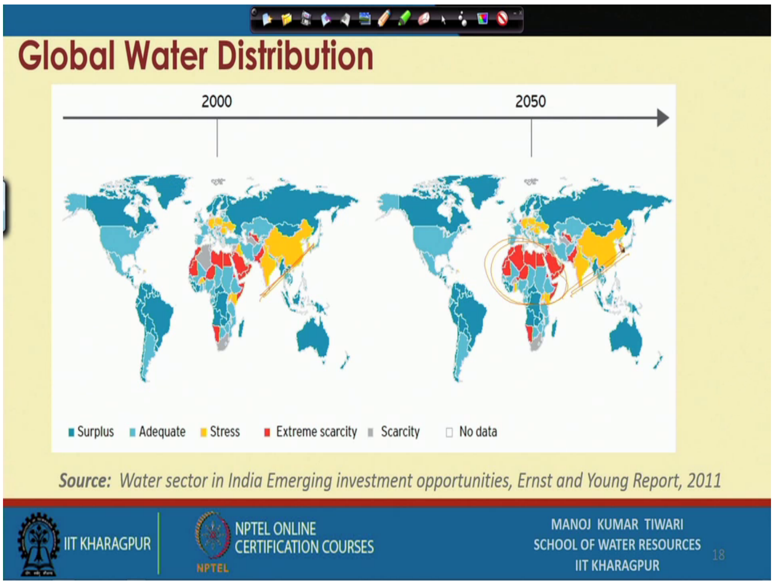

There have been several studies estimating the water availability or scarcity in future as well. So, quite a few of such information is available 1 such information is presented here which you can see you on your screens which is from study by Ernst and young done in 2000 and 11. So, they figured out that apart from of course, few African countries where there is a stream water scarcity as you can see it here in India and china are kind of the largest countries, which are or which are which are actually underwater stress now and the problem is not looking brighter in future as well if you see.

So, in around 2050 also you see and even now even though now although there is a debate because if you see the per capita water availability at the time there are different agencies have a report different numbers we are actually at doing at around 1800 or so that way terming us as a water stress by international norms is little tricky business. However, yes we are in that range. And by 2050 we will certainly most part of India or bearing a few actually will be under significant water stress. This which is actually leading to as was discussed earlier also that due to the increasing demand as well as increasing demand arising from the population growth as well as the developmental activities.

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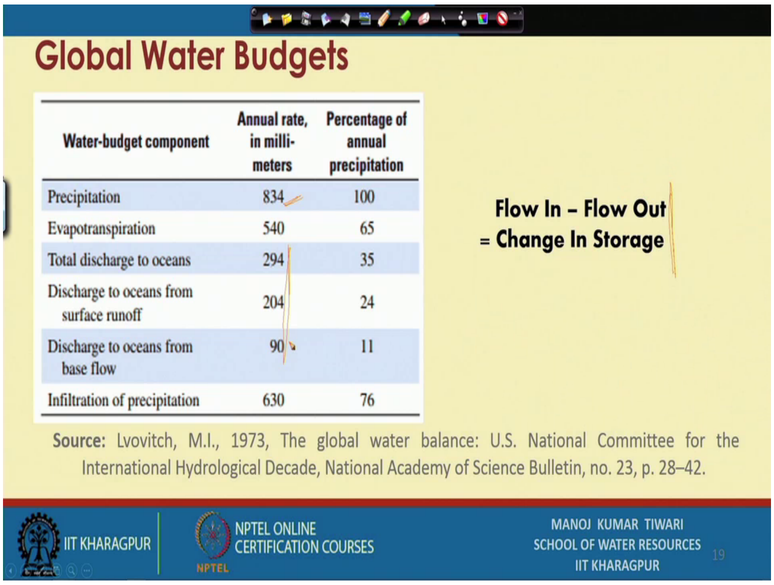

So, demand is increasing resources are same there are no like new resources coming out from for freshwater. So, with the same resources if demand is increasing population is increasing so; obviously, per capita availability is likely to fall and that is what is reflected in these studies that predict India to be water stressed very soon or even some already have declared it. Now if you see that from where this water comes and where it goes of course, we did had a look at water cycle involving different processes how water changes phrase phases from 1 to another. So, keeping those in count the budgeting of water is done either for a continent of a for a nation or for a even for a simple small water set.

So, if we consider this entire globe as a watershed and try to get the global water budget what we see that the inflow is actually in the form of precipitation mostly that. So, typical water budget equation or any budget equation for that matter will be as you see here that the flow coming in minus flow going out would be equal to the change in the storage.

So, in terms of water if you see that if you consider our surface let us say as a boundary, so that way flow coming in maybe in the form of precipitation. So, that is estimated to be 834 millimeters now this unit millimeter means the as we predict the rainfall and all this thing in the in mm and that way. So, it has to be sort of multiplied to the overall global surface area in order to get the total volume of the precipitate precipitation. So, as was sort of estimated in the earlier slides that you saw, of which the large portion goes to evapotranspiration some goes to the some is discharged to the oven oceans.

The discharge to the oceans from surface runoff is around 2 0 4 discharge to oceans from base flow is around 90. So, this gives you the total discharge to oceans of around 2 ninety 4 the 6, 630 millimeter of water actually goes to infiltration. So, that is that is how this this water budget suggest that these are the roots of water flow.

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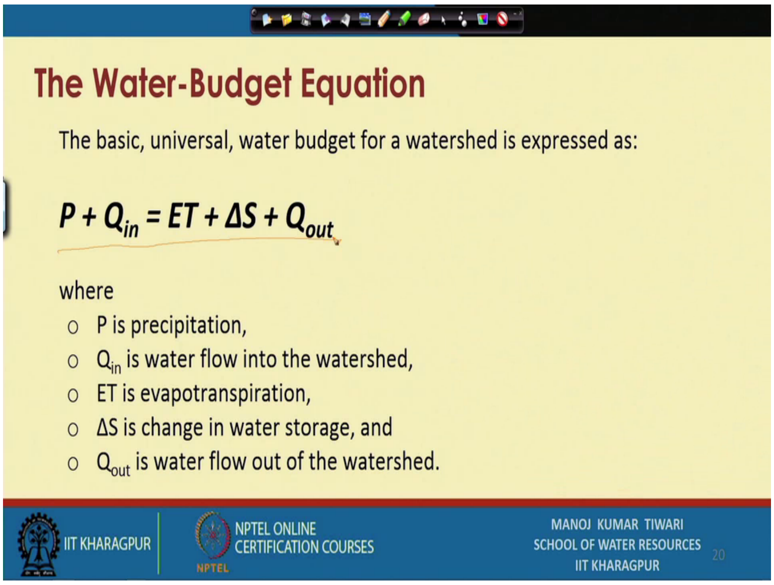

Now, if you look at the water budget equation the basic very basic universal water budget equation for any water set can be expressed in the terms of equation that you are seeing on your screen over here. So, P plus Q in where P is your precipitation and Q is the discharge of water that flows into the watershed.

Now, in case of when we basically sort of fix a water set there might be some there might be some inflow other than precipitation as well as some river might be coming into that watershed some so that those sort of floors are inflows to the water set. So, the precipitation is 1 inflow which could be in the form of either the precipitation here is not limited to just rainfall it includes rainfall as well as snow and other form of water which comes into the into the watershed from atmospheric roots.

So, that is your precipitation and then q in is the surface water flow into the water set that is the total water coming into the water set. Now if you see that the basic equation inflow minus outflow is going to equal to the storage. So, your inflow will totally be equal to the outflow plus change in the storage or that way outflow primarily is in the form of evapotranspiration e t that you are seeing this term over here.

Now, this ET includes or evapotranspiration includes both evaporation from the water bodies or either surface water bodies or what whose what so ever water bodies particularly in the region while transpiration or other surfaces while transpiration from the plant or green surfaces that way what we call. So, evaporation is the entire water skipping to the atmosphere either through evaporation or transportation. So, that is 1 way of out from the watershed which is your ET the another Q out is water outflow from the watershed any river, canal channel, which is taking water away from the watershed is your Q out, then you see the other term which is change in the water storage is in the watershed.

Now, water storage changes do occur at surface level as well as subsurface level. So, 1 can split this term into the infiltration plus change in the surface water storage, because change in the storage as I told you that will have surface component as well as subsurface component. Now this subsurface component could further be sort of because when the water infiltrates through infiltration it is not necessary that all the water will reach to the aquifer and all that some maybe it is basically get stored as a soil moisture in the subsurface.

So, that is also a form of water which is or change in storage water. So, earlier your soil moisture could be low while after precipitation when the water infiltrates water goes thoughts your soil moisture levels maybe high, those kind of storage in the soil moisture E storage in the surface water bodies what we what you see the increased level of water in the lakes ponds increased flow in the river at any given point of time.

So, all those changes in the surface water storage plus changes in the ground water storage plus changes in the soil moisture or other form. So, collectively that tom is mentioned here in the delta S which is change in the water storage within the watershed. So, that is what that is what is your typical water budget equation which is used for which is used for any watershed and that way we can have an idea that how much water is coming in from which forms it is coming in and how much water is leaving the watershed and in what forms.

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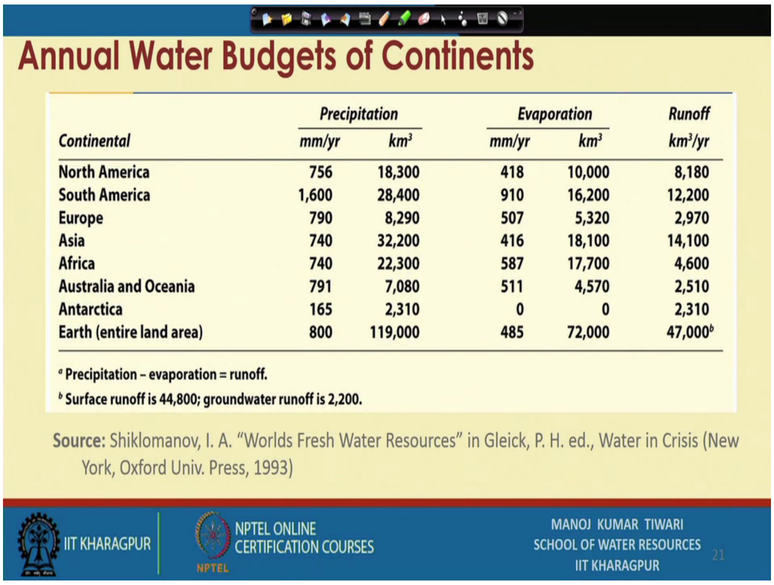

Continental	Precipitation mm/yr	Precipitation km³	Evaporation mm/yr	Evaporation km³	Runoff km³/yr
North America	756	18,300	418	10,000	8,180
South America	1,600	28,400	910	16,200	12,200
Europe	790	8,290	507	5,320	2,970
Asia	740	32,200	416	18,100	14,100
Africa	740	22,300	587	17,700	4,600
Australia and Oceania	791	7,080	511	4,570	2,510
Antarctica	165	2,310	0	0	2,310
Earth (entire land area)	800	119,000	485	72,000	47,000[b]

The based on similar exercises a gross estimate has been developed it was published in word press water resources in a chapter in book edited by Gleick which is titled as water in crisis. So, they estimated that the different forms or they estimated the quantities of precipitation evaporation and runoff for different continentals.

So, as you see this is sort of very interesting info the South America particularly is sort of the richest continent in terms of water inflow. So, you see that around 16000 meter 1600 millimeter per year or if you see in the total quantity it is close to 28 more than. In fact, 28000 kilometer cube of water coming in through precipitation. While of course, when the precipitation is high you will see the higher losses in form of evaporation and runoff the Asian countries also have a significant amount of water coming in form of precipitation, but if you see because that is primarily because they have a large area. So, the 32 over 32 kilometer cube of water that is coming is actually coming from an average annual precipitation of 740 per mm ok.

So, this large number is not because of large inflow, but because of large area. So, that is what is the what total water coming in and this total corresponding total evaporation is of the order of 18000 meter 18000 kilometer cube, while runoff is of the order of 14000 kilometer cube. So, that is what are the number for Asia the conditions if you see are bearing south America, which is very rich the average precipitation if you see is more or less in the similar ranges across Australia, Africa, Asia, even Europe and Northern part of

America. Still we see that if we go in detail into the these specific continents like if you see the details of water storage in or water coming in Africa you will see that the southern part of Africa or in and around south Africa there is adequate amount of water relatively, while if you move up you see that the most of those countries are in under water scarcity.

So, that is that is if we go into the more fine details if we go into the deeper into the specific continents, but otherwise as per the estimates if we go by these numbers the average annual precipitation more or less in the similar range a little plus minus over here and there, except south America which is having a very high precipitation so with these.

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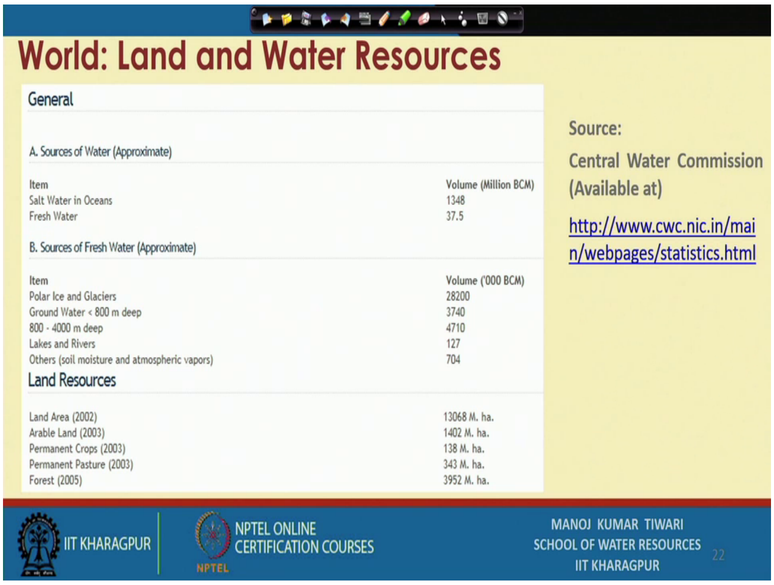

Now if you see the total land and water resources globally which is sort of this information is given in our central water commission website. So, total water resources global if you see it is the again if you go by the volume around 14000 billion cubic meter lies in the in the form of salt water which is in the oceans while 37.5 million BCM lies in the form of freshwater.

The sources of freshwater if you see again the different estimates so the estimates are this is the all the information available at the CWC website, but the information that is presented is more or less same that 1 we saw from the USGS us geological survey.

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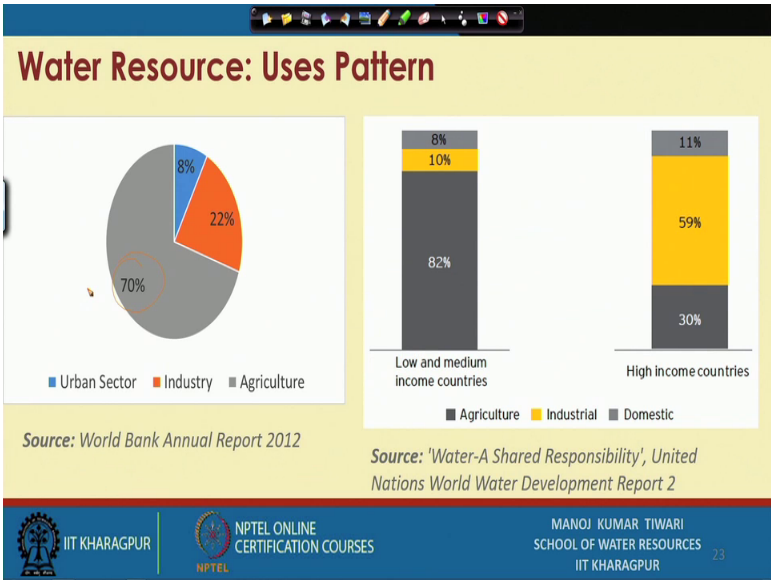

So, let us move ahead and what we see that how the water is getting used because. So, far we have been talking about the availability now let us talk about how this water is being used on a global scale first. So, the World Bank annual report suggests that globally around 70 percent of water goes for agriculture sector so that you can see here that 70 percent of water goes under agricultural sector.

The next largest is industrial sector accounting for around 22 percent total consumption of water, while the domestic sector or what we can call it urban sector consumes around 8 percent of the total freshwater. So, that is World Bank as per World Bank annual report while if we go into the sort of if we bifurcate this uses in terms of underdeveloped or developing countries and developed countries.

So, there is a interesting shift of water use pattern which can be observed. The low and medium income countries, typically which we call that underdeveloped countries or developing countries, the large portion of water because in these countries the major source of income and major source of habitation is agriculture obviously the large sector goes to the agriculture which is which accounts for around 82 percent of the total water consumption.

This is as per the united nations world water development report 2 10 percent goes to the industrial and 8 percent goes to the domestic sector or what we call urban sector urban or rural whatever 8 percent goes to the domestic sector. Now if we shift focus to high income countries or developed countries you see that in this is grossly known by 1 and all that there is agricultural, there is more of industrial activities in developed world as compared to the agriculture. And that is seen in the water consumption as well the water consumption is in the industrial sector in the developed world or a high income countries is of the order of 60 percent a remarkable shift from 10 percent in the low and medium income countries to of the order of 60 percent the estimated number is 59 percent though so of around 59 percent in high income countries.

This shift is again because of the high industrial growth you see the agricultural on the other hand agricultural sector which consumes around over 80 percent in the low and medium income countries the consumption in agricultural sector in high income countries is around 30 percent of the order of 30 percent. So, the major consumer there becomes industrial sector, whereas agricultural sector takes the second place the consumption in the domestic sector in the developed countries is estimated to be around 11 percent. So, that is how this uses of water or consumption of water or demand of water from different sector to sector changes when we look the when we look the country to country that way.

So, we will end this lecture over here and discuss the remaining sections in subsequent lectures.

Thank you.