Life Cycle Assessment
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Lecture – 04
LCA and Environmental Systems

So welcome back. So, we will get to the forth module for this particular week which is the week one and so far we have been kind of a talked about brief like a discussion on the sustainability aspect introduced to the concept of life cycle analysis, and we said that lifecycle analysis is essentially focused on environmentalist stuff. So, what really we are worried about in terms of the environmental issues. So, in this particular module we will try to introduce our selves to in terms of environment what. So, when we say environment or the environmental continuum as you can see, as you see in many of the lectures or environment when we say it is a sensibly what we are talking about.

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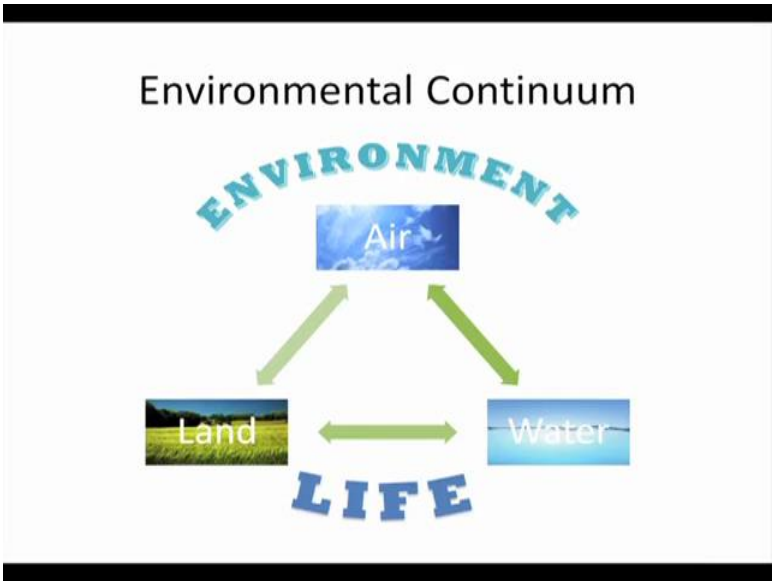

We are talking about air, we are talking about land, we are talking about water. So, this air, land and water is what is essentially your environmental aspect that is why if you have taken a course on environmental engineering or environmental science you see that water treatment, waste water treatment, solid waste management hazardous, waste management air pollution all these are taking care of these three aspects of the environment air, water, land.

And our life is depended on that, when we when I say our it is not only like a life of you and me only it also lives of all the flora and fauna, echo system, plants animals all the species around us. So, there is a impact of environment as you from if you have watching news these days or if you have following up on the environmental issues, we see lots and lots of newer kind of disease coming up, people are getting all sorts of disease at a very young age, even some birth defects are coming up, and researchers have linked these to the environmental factors; if you are familiar with Punjab area in which is in our country in India in Bathinda area there is a area which is known as cancer cluster. So, this cancer cluster of Bathinda is very much it is on, because of lot of uses of pesticides and fertilisers in the cotton growing industry, we are having lot of cancer being produced.

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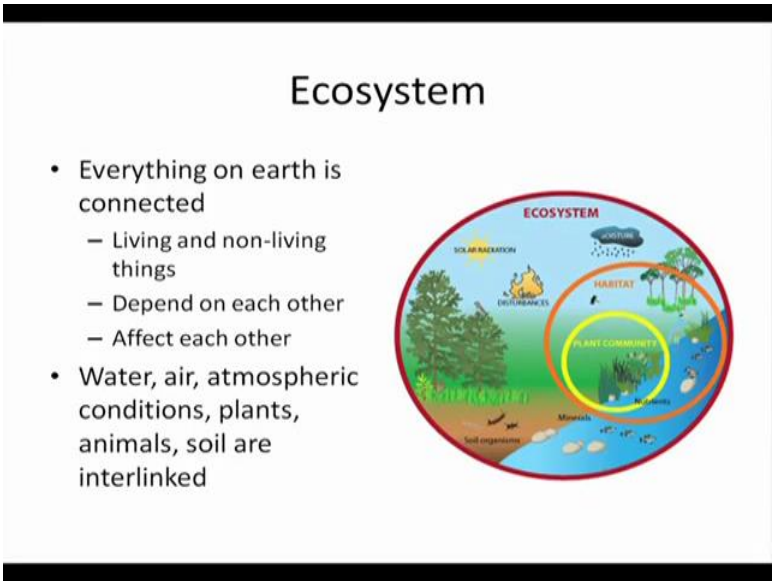

So, when we say about environment we are looking at the echo system; and this echo system is you must have seen this picture in your science book may be in the primary school itself. So, everything on the earth is connected; there are living things and the non-living things we depend on each other, we affect each other water, air, atmosphere, conditions, atmospheric conditions, plants animals, soils, all are interlinked as you can see in this picture and I do not have to explain this to you, you must have seen this so many times in your life so far in terms of different kind of books related to that.

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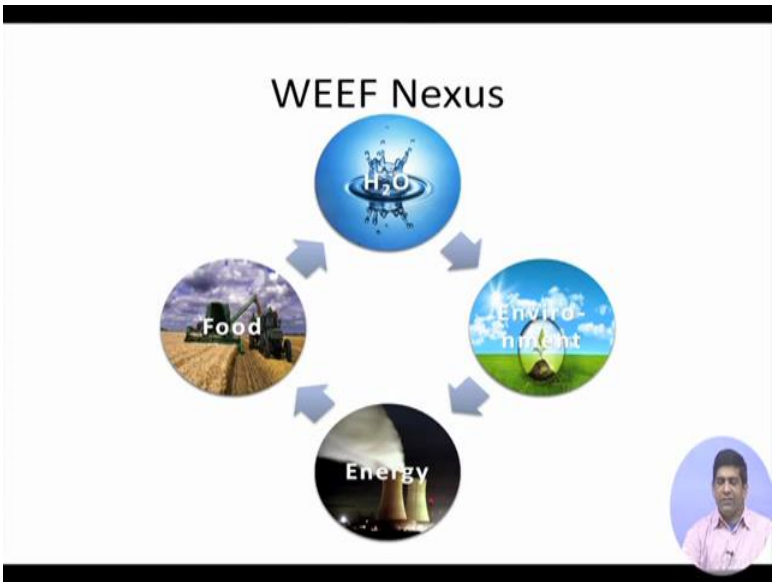

So, now the broader concept that we look at these days is the concept of this water, food, energy and environment; you will hear this term water, energy, environment, food, nexus all these four are connected. So, in next 25 some minutes in this module and then we and the module after this, we will try to understand this nexus. What is this nexus is all about how they are related, and what are the how what are the stresses of these four that are being faced today; we need water, water is essential for good environment, we cannot have good environment without good water, we need water to produce energy which I will show you in some of the slides. In cold fired thermal power plant the any sorts of energy generation uses a lots and lots of water. We need energy to produce food and at the same time we need water to produce food as well, and we need good food for of course, good like our health depends on good food. So, all these are related.

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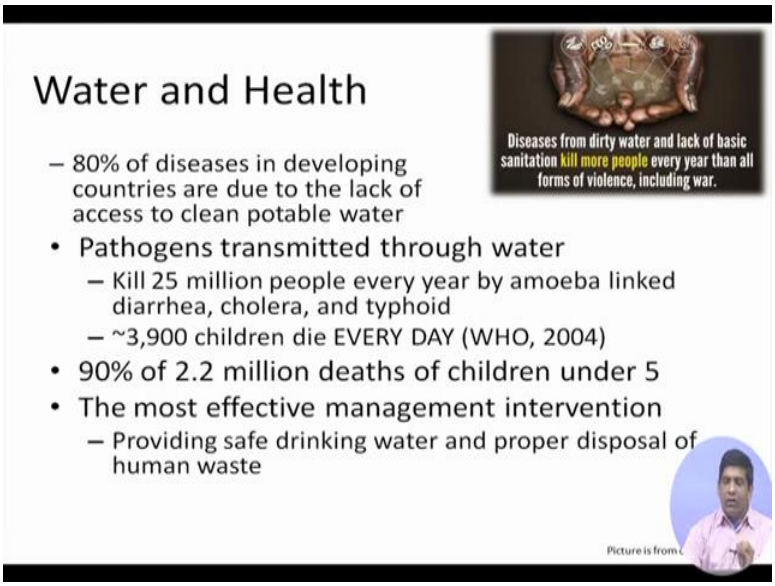

So, let us look at the first aspect the environmental health and water how these are inter related to each other. Water has a big impact on health, disease from dirty water and lack of basic sanitation they actually kill more people every year then all the forms of violence including war and other stuff. So, diseases from the dirty water, and lack of basics sanitation that is why you hear a lot of focus on these days on Swacch Bharat Mission in India we are in the Swacch Bharat mission we are working on the sanitation part, but we still we still have to do lot of work in in terms of improving the water quality system in the country. So, that is again a big problem we have. So, in terms of water and health 80 percent of the diseases in developing countries are due to lack of access to clean potable water think about that, and pathogens transmitted gets transmitted through water it kills 25 million people every year by amoeba, linked, dairrhea, cholera and typhoid can you think about it is a 25 million people dyeing very year, but we since it does not make lot news because diseases does not happen on one particular day it happens over the course of the year at a different parts of the world.

So, we do not hear about that too much, but it is it kills the pathogens transmitted through water it kills 25 million people every year. Nearly 4000 children die every day because of the lack of water. So, this data some of these data is old things may have improved a little bit, but it still that is lots and lots of work is being done, 90 percent of the 2.2 million deaths of children under 5 is because of lack of clean water, most

effective management intervention would be providing safe drinking water and proper disposal of human waste.

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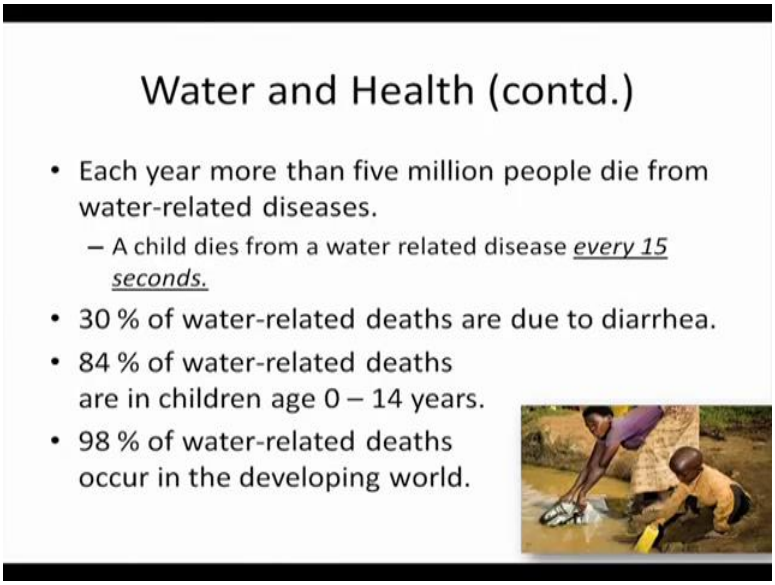

So, we are talking about the sewage which makes into all those stuff; each year more than 5 million people die from water related diseases, a child is dying every 15 seconds because of the water related disease in the world, 30 percent of the water related deaths are due to diarrhea, 84 percent of the water related death are in children age 0 to 14 years, 98 percent of the water related deaths occur in the developing world. So, after going through this data do you I do not think I need to stress upon more that we need to prevent our water resource; we need to make sure that our water is clean; we have a good access to the clean drinking water to each everyone on the planet. So, that is very very important water is the most one of the most important thing that we need is water we cannot really survive without water, and to have a and we need water for all our industrial activates.

If we have, if we do not have clean water we will have lot of disease, people will gets sick and you cannot have a healthy economy with an unhealthy work force. So, if you really want to have a good GDP numbers as we are trying to achieve and so to have a good GDP numbers you need to have healthy work force too, and for most of the industry you need good portable water anyway. So, water is one area which needs lot of focus, unfortunately sometimes we kind of get into the debate that what is our priorities.

So, if you think about today in it is sometimes it feels like are we really doing are we really putting our resources in a right area, many of the many of the railway stations in our country in India are coming up with this Wi-Fi, but most of those railway stations where this Wi-Fi is being setup it does not have clean access clean water, where water which I can go and open the open the tap and drink. So, the question is do we really need clean water first or we need this Wi-Fi first? Wi-Fi can wait clean water should be should be done in a war footing and that is needed throughout the country and of course, throughout the world as well. So, that is kind of just to stress upon you to how the water is important.

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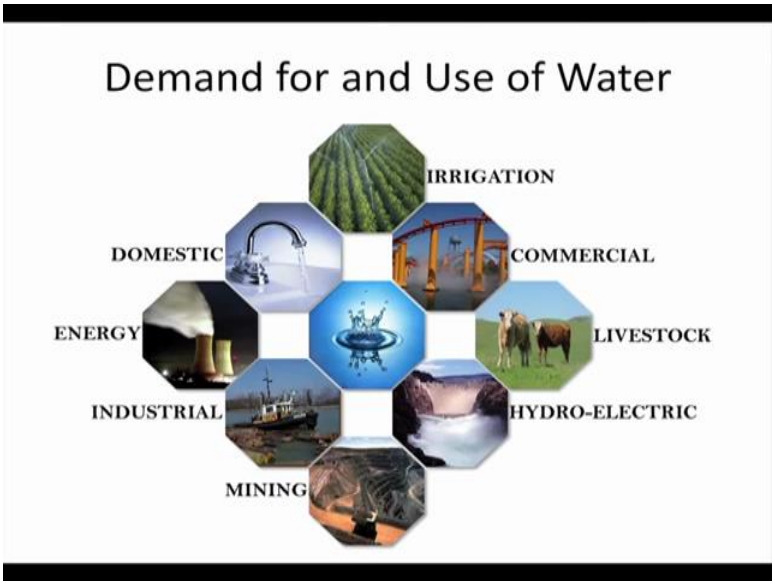

Now, if you look at the water use withdrawal and requirement where the water is used; the domestic sector where in our houses, the commercial sector uses a lot of water, irrigation that is again in country like India we use lots of lots water in irrigation, energy, livestock if we want to have either your animal protein or in the milk and all those stuff you need to grow they need they need water, hydroelectric dams need water, mining activities need water, industries need water to produce energy you need water. So, we have lots and lots of demands for water from all these different sectors.

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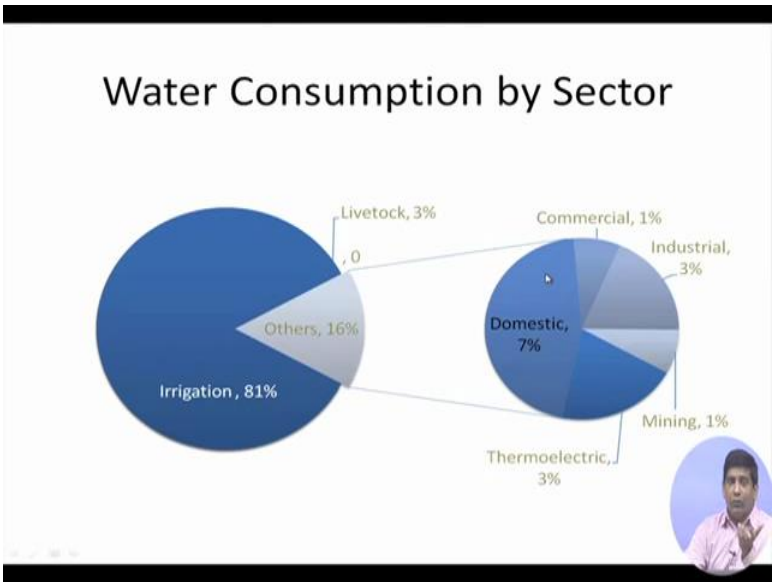

And where how it is used up? If you look at 81 percent of the water actually goes up in irrigation itself. So, 81 percent of the water goes up into irrigation, then it comes the domestic sector which is 7 percent, your industrial and thermo industrial is 3 percent. So, as thermo electric plants mining is 2 percent, mining is 1 percent and other commercial is 1 percent. So, as you can see water demand most of the water demand is in irrigation and most of the water wastage is also in in irrigation.

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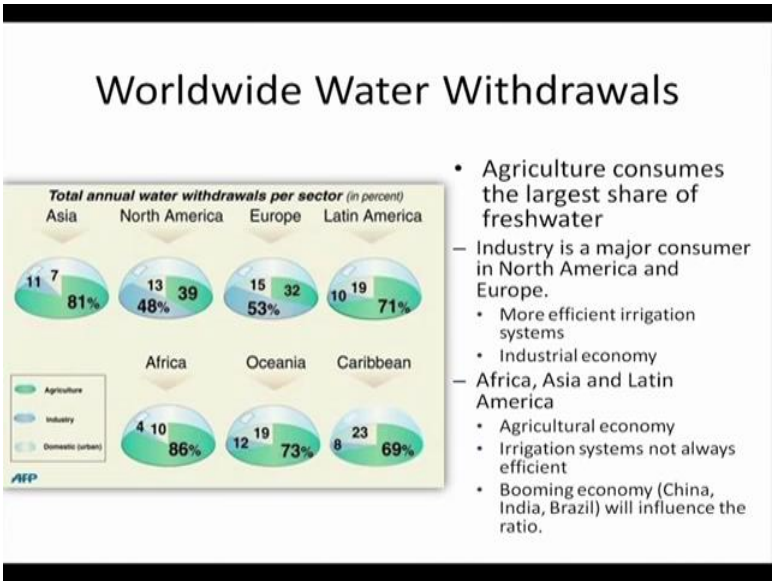

So, if you look at the worldwide water withdrawal, how the water is being used around the world as and you see from Asia, north America, Europe and Latin America, these four in Asia you see more and more water will be used in the irrigation sector, as you go to the developed economies like in north America and Europe you see less water being used like 48 percent and 53 percent. So, in a North America and Europe you have less water being used in industry sorry in agriculture as in irrigation and opposed to what you see in Asia and Latin America. Some of these is the because of the North America and Europe is a is a industrial economy they has a lot of industries are there, but at the same times some of the aspect is there they have cut down on their losses, they have come up with a efficient irrigation system as well. So, we need to build efficient irrigation system and in Asia and Latin America and Africa and those countries too you can see Africa Oceania and Caribbean which is very similar to what we see in Asia or in Latin America.

So, agriculture dominates throughout the world agriculture dominates then and as you can as opposed to north America and Europe where industry actually industry sources dominates 53 percent and 48 percent goes in industry. Other than North America and Europe other countries it is the irrigation it is the agriculture which dominates the water demand and then the rest you have the water demand from the domestic sector varies from place to place. Industry is a major consumer in North America and they also have more efficient irrigation system; Africa, Asia, Latin America it is a still agricultural economy, irrigation system not always efficient they having lot of losses and there are booming economies in terms of china India and Brazil which will actually influence this ratio in coming years.

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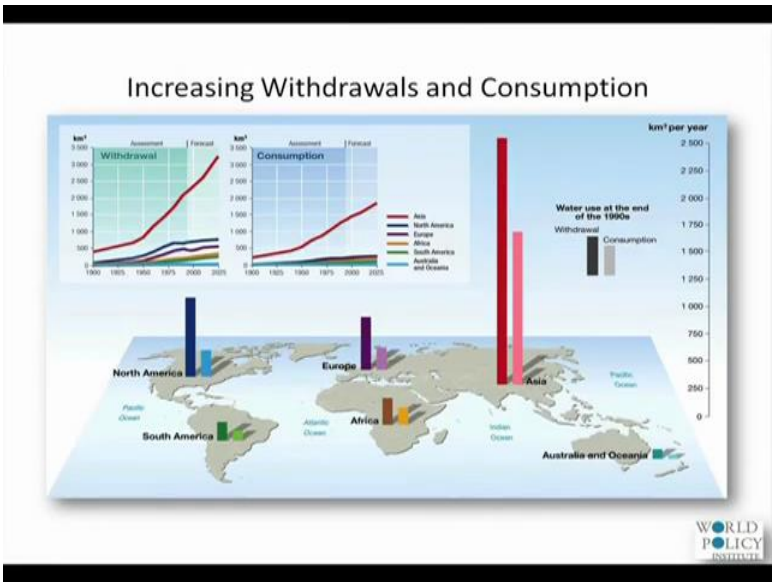

So, if you look at the increasing withdrawals what how the water is being withdrawn, and if your water use at the end of like if you look at the water that is being withdrawn over last few decades in north America, Europe, Asia and Asia you see lots and lots water being is being taken out that is the kilometre of cube per year how much water is being withdrawn. So, Asia because of the huge population, we are taking out lots and lots of water is been taking out and there is a lot of loss of water in Asia too and most of you look at the water like a demand in Asia water demand is going up.

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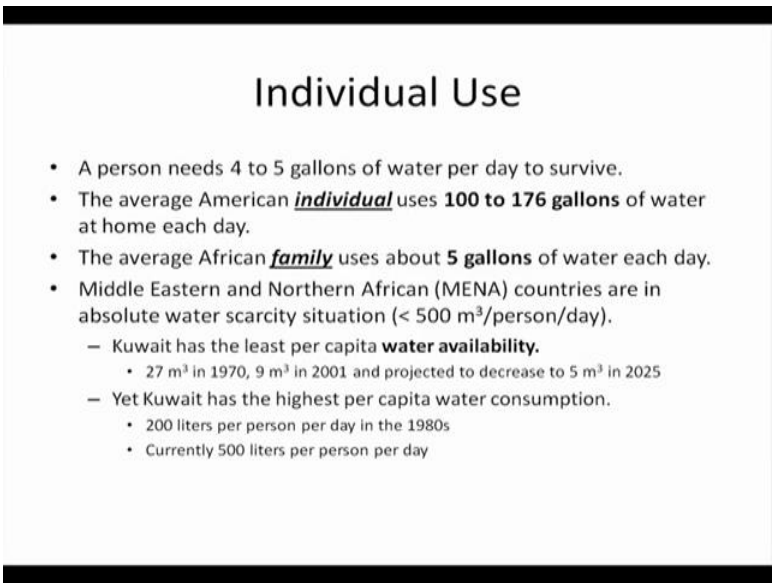

We are using lots and lots of water, but still we are far behind that what is being used in the developing countries. In American country for example, like theoretically or may be say by some research it has been shown that a person needs around 4 to 5 gallons of water per day, when we say 5 gallons it is one gallon is 3.78 litres, for our calculation purpose even if you say assume 4 litres of we are talking around 20 litres of water per day.

So, we need around 20 litres of water per day to survive; and an average American individual uses 100 to 176 gallons. So, that is a lot of water they use per at home each day, average African family they uses around 5 gallons of water each day. So, middle eastern and north American north African countries are in absolute water scarcity situation, Kuwait has the least per capita water availability and it is a it is going may be go down to 5 meter cube of water in 20-25 per capita per person. But Kuwait has the highest per capita water consumption because they are able to import water, they are using 200 litres of water per person per day in the 1980s currently they are having 500 litres of per person per day. So, they are using lots and lots of water and they can afford to, they it is an oil economy they can afford.

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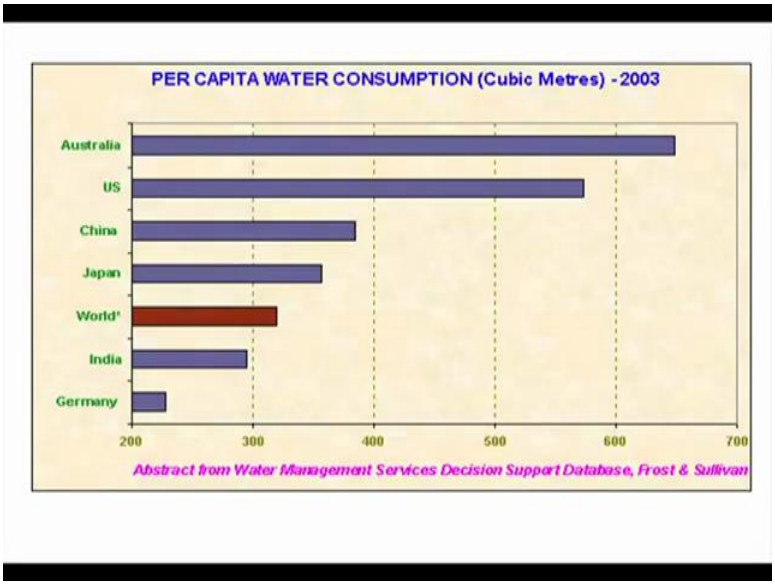

So, they are bringing water from the other countries; in terms of the water usage and here the water consumption is includes everything not only the domestic use industrial use all sorts of usage are being added, that is why you see Australia being on the top. This is per

capita per person all though Australia has a very low population, but the per capita usage of water is very high in Australia because a lots of mining happening in Australia today.

So, because the lots of mining happening you see for our several you see the water usage is very high because water mining uses a lot of water, US is on the second position, India is slightly below the world average, the world average is red there which is around 320 330 cubic meters per capita water consumption. In India we are slightly below the world average we are below the 300 mark Germany is even less than us, because Germany or they may be they are probably not in terms of the domestic usage they might be using more water than us, but they are more efficient they are able to more efficient system less like a leaks and they can manage their water more effectively.

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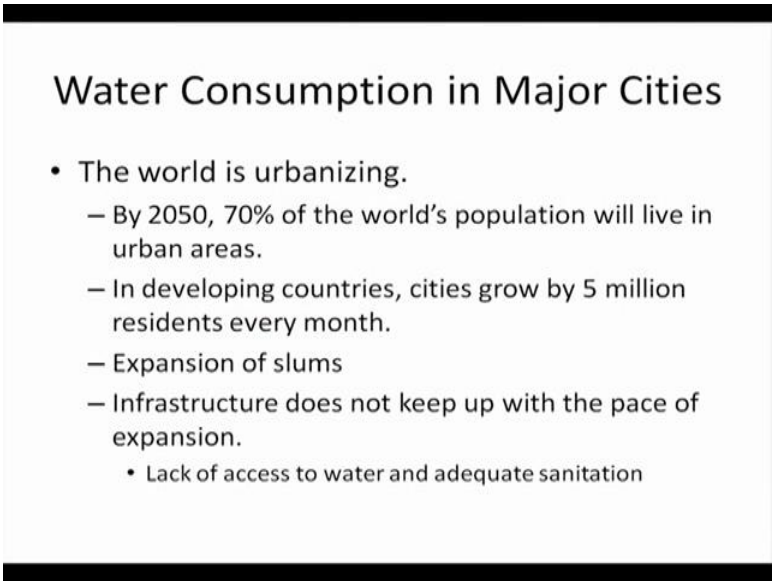

In terms of the major world is urbanizing by 20, 50, 70 percent of the world population will live in urban areas, in India also you see more and more urban growth. So, in developing countries cities are growing by 5 million residence every month, there are lot of slumps being expanded infrastructure is not able to keep up with the pace of expansion and that becomes because of lack of that leads to lack of access of water and adequate sanitation, and that leads to lot of problems in terms of the environmental health issues and human health issues as well as.

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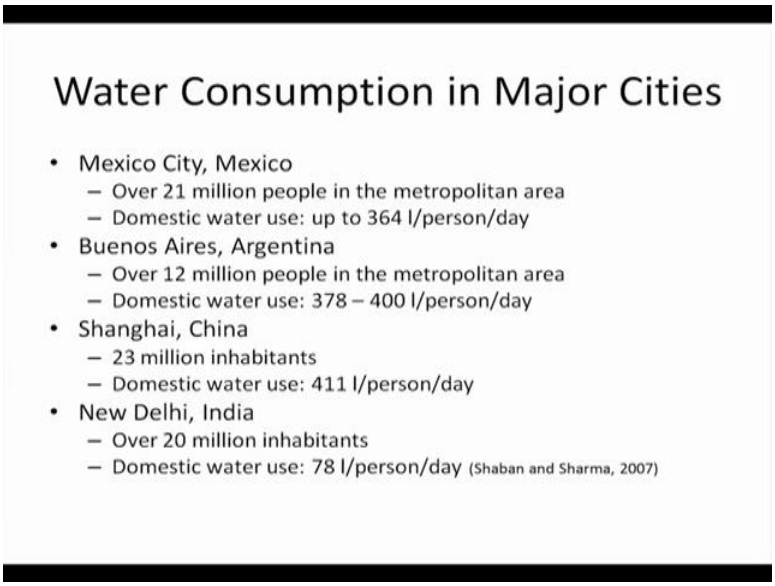

Some example: Mexico City over 21 million people in the metropolitan area. So, lot of people over there domestic water use is up to 364 litres per person per day a very high usage as well. Buenos Aires Argentina 20 million people in the metropolitan area where and they also use around 375 to 400 litres person per day, shanghai very high usage 410 411 litres person per day 23 million people new Delhi not far behind 20 million people, but in terms of the water usage is much yes 78 litres per person per day. But then again the data from the New Delhi we need to be little bit careful, because people may have their own ground water wells as well as and there may be extracting the water which does not show up in this particular data.

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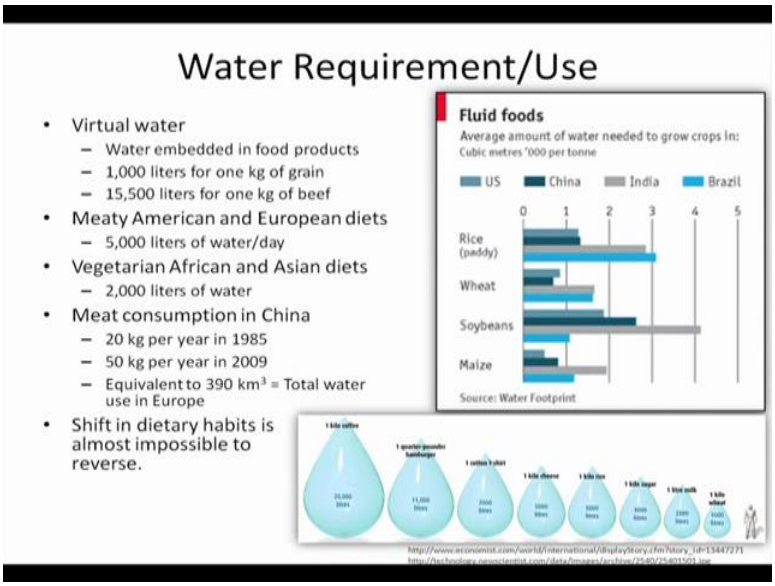

So, water is needed water is needed in say if you all sorts of stuff water is needed. So, we will start from the agricultural sector, because the water is needed to grow crops. So, if you look at the average water needs to grow crops in this is in cubic meters per 1000 tons in US for example, the top one is us then we have China then we have India and then Brazil the top. So, in terms of the growing rice as you can see compared to India and brazil, US and china uses much less much less water requirement over there because they are using the variety of rice which can grow even with less water same thing for the wheat and soya bean or for example, maize. So, they have much less water food print, what you what you picture oversee over here this is the water food print per 1000 tonnes of these types of crops. So, in developed countries in US and to some extent in china now as well, they have come up with a better variety of seed which uses much less water and produces this food for us.

So, whatever is the water is inside these food items they are known as the virtual water because the water is embedded in the food products. So, when we say food is wasted when the food is wasted water is also wasted. So, water embedded in food products 1000 litres for 1 kg of grains; sometimes you in an average for 1 kg of grain you need 1000 litres of water, but if you are a beef or a meat eater it becomes 15500 litres for 1 kg of beef. So, that is why people say that if you want to prevent the environment damage if you are what if you are environmental friendly, you should not go for like a non-veg or those kind of stuff. Meaty American European diets 5000 litres of water per day. So, to

make the food on the table it is does not take in into account all the water that you drink 5000 litres of water per day is consumed to get the food that the meaty American European diets have. If you have a vegetarian African and Asian diet you are around 2000 litres of water per day.

So, 2000 litres of water is used so much less. So, if the whole world change into vegetarian that there would be other consequences of that, but in terms of the water food print it will be a better thing to do and, but as know that the world is growing some of these countries like India china and other places they are becoming wealthier people are becoming more wealthier. So, one sign of getting wealthier is the change in the food pattern, and food pattern is more and more meats gets added to the food item. So, meant consumption in china has grown up to 2.5 times from 1985 to 2009. So, over the cause of 24 year it has become 2.5 times, earlier it used to be 20 kg per year per person now it is 50 kg per year per person.

So, that leads to around 390 kilo meter cube of extra water requirement and that is equivalent to the total water used in Europe. So, think about that. So, that is a shift in dietary habit is also impossible to reverse. So, that is a there is the more and more water requirement would be there in China. The bottom sketch that you see over here where you see lots of water droplets these are the water that is required the bigger the droplet more is the water food print, and we are going from 1 kilo of wheat at the end to 1 kilo of coffee at on my left which is the biggest bubble. So, 1 kilo wheat requires 1000 litres then milk requires 2000, sugar is 3000, rice is 5000, cheese 5000 again cotton t shirts 7000 litres to make one cotton t shirt you spend 7000 litters, one quarter pounder hamburger 11000 litres and 1 kg of coffee 20000 a litres.

So, if you are a coffee drinker as opposed to tea drinker and you are having a bigger part of the food print, as you can know you can actually calculate your water food for your daily requirement.

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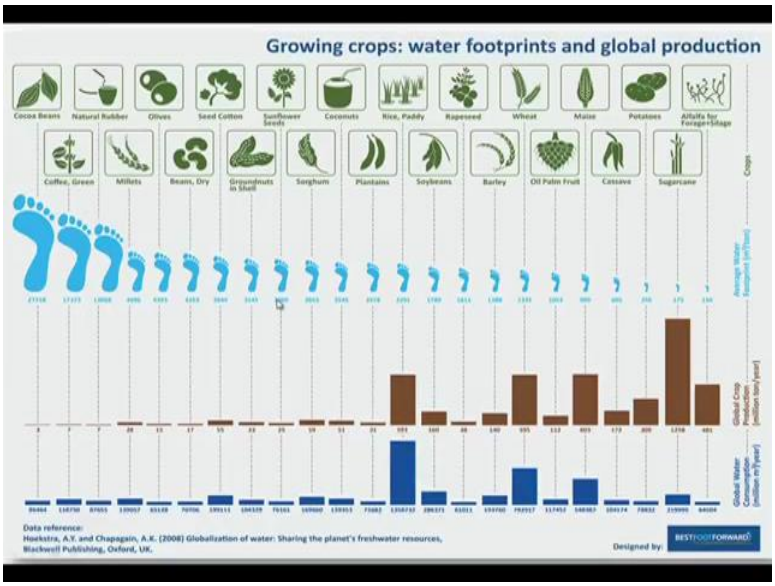

Say if you similar things on the next graph which is again if you look at the different food that is being produced from left to right as you as you move from left to right left being the lowest water footprint as we go into the light right we see a higher and higher water footprint that is why you all the footprint signs that you see at the in the middle, bigger the foot size bigger is the of course, bigger is the water footprint. So, the lowest water footprint is the for foliage, forage and silage, but then we have sugar cane, potato, cassava which is big fruit in African country, maize, oil palm, wheat, barley, rapeseed, soybean rice, plantain coconut, sorghum, sunflower seed, then cotton olives, natural rubber, cocoa beans, coffee millets, beans, ground nuts stem cells sorghum. So, these are as we go on the on the left my left hand side on the left hand side of this graph you see the bigger and bigger footprint. So, that is why if you think about the area on this side is those are the products which we produce a more.

So, the if you look at this particular a graph which is the second from the bottom those tells you the global crop production, this is the million tonnes per year and the bottom one which is the blue bars they show you the global water consumption with the million meter cubes per year. So, as you can see we have we produce more of the material which has a lesser carbon lesser water footprint as opposed to the material which is more water footprint. The coca bean which goes into your coffee sometimes like coke and also to your chocolates, they it has a very big water footprint. So, if you love chocolates actually you have a bigger water footprint as well. So, these are some of why I have these slides

over there this is basically to a stress upon that water, good clean, drinking water is needed; if we do not have that we cannot really produce anything. So, to produce good food to produce to you know to have a good energy water is needed.

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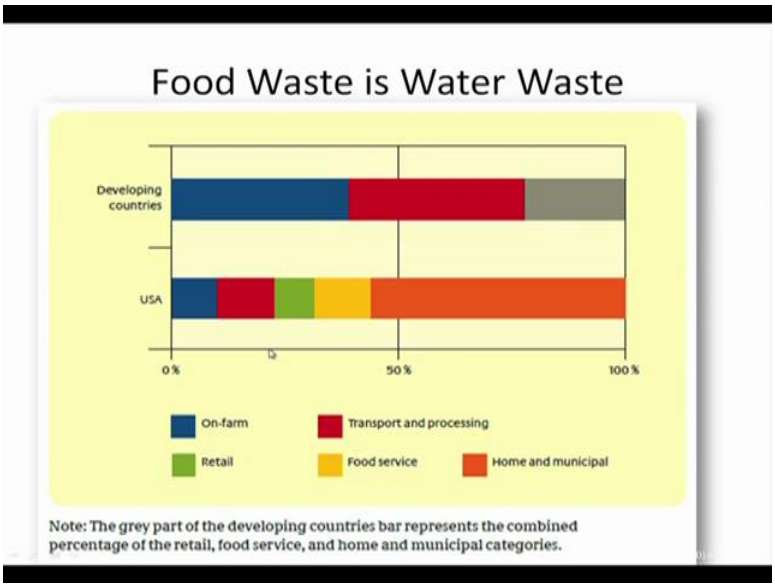

And when there Ares lot of as you can see from the last few slides food waste would be a water waste too, because many of these food items have embedded energy embedded water sorry embedded water.

So, when you use this when you waste this food your water is wasted as well. So, if in terms of the developing countries if you compare this situation in developing countries with the situation in US for example, there are the two graphs over here the top one shows you for the developing countries, the bottom one is for the US, the blue is for on farm on farm what is like a lost then the red tells us the home and municipal and the last one the grey tells us which is like a some way of other three like a transport processing, foods service and retail. So, in developing countries we are seeing more and more damage in on farm in terms of the storage is storage on farm, in terms of the grown food being wasted because it cannot be transported in time cannot be taken to a transport system on time does not get processed quickly.

So, because of the lack of efficience collection of these food items and transportation of these food items as well as the storage of the food item we do not have the refrigeration system in place in many parts of the country. So, that leads to damage of lot of food and

when we when the food is wasted as you saw from the earlier slide water is wasted as well. So, that is like we see lot of damage lot of things happening in the in the farm, then we saw we see a some in terms of the home and municipal transport and processing that is another area where you see the damage as well like transport and processing area where things gets delayed, that is and at the end you have your some other factors comes in picture over there.

In terms of you go to the developed countries like in US you do not see much damage being happened in the farm things are efficient they gets collected there are some damage in the transport and processing there are some into the retail sector, some in the food services sector, but you see a big chunk of food being wasted in from the houses. So, that is a big problem in a country in like country like US or in many of the developed countries they have been some studies done which shows that almost 1000 pounds. So, 1000 dollars, 1000 US dollars' worth of food get wasted per year. Say if you think about a family of four 1000 US dollar is a lot of money that can easily buy 4 good Christmas gift each worth of 250 dollars, you can buy a good mini laptop these days oh sorry mini ipad or pads in in in in those money for that.

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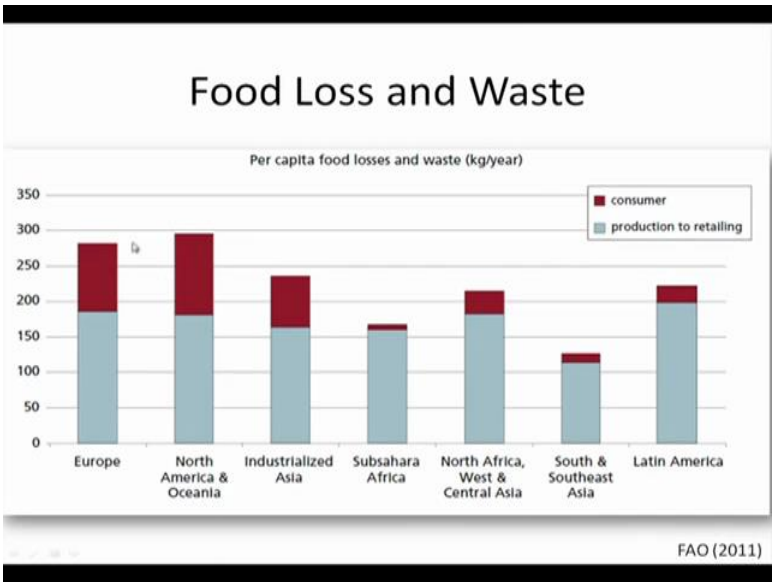

So, food loss per capita food loss you can as you can see the consumer the blue one the black part of the pump of these columns are lost in the consumer side, and the blue colour light blue colour is from the production to retailing sides as you move from

developed countries to the developing countries you see that bar keeps on changing and if you are in Asia for example, industrialized Asia you see less lost in consumer side more in production to retailing; say north America and Oceania again you see a big on production to retailing and consumer is wasting as well and, but the portion of these keeps on changing as you move from one place to another in south and south west it is a production or retailing which our country will belong to this particular pie chart with we see a lot of damage in the production and retailing side then that opposed to the consumer one, the which is your maroon in colour and the bottom one is the light blue colour.

So, with that like a if you think about what we have covered just if you can you can summarise that what we looked at in this module is essential the role of water, we introduced our selves to what is the environment we looked at the air land and water issues and with the air land and water issues we focused on the water side, there is a water demand water is needed for each and every activity from the morning we get up to the evening till we go to the bed we consume water throughout the day direct as well as indirect. You saw that most of the food items almost all the food items have embedded water there and it some food items we actually end up using more water as opposed to some other food items.

So, we are consuming those food items we are consuming water. So, that is that needs to be taken into account, again water a what we said is water is very important we need at to access to give good clean water for drinking purposes we need good portable water for our industrial processes. If we do not have access to good water if you have our water is contaminated we have issues of health issues environmental issues if you do not have health if you have health problem in your work force, if you do not have your healthy work force you cannot have healthy economy. So, to have an healthy economy healthy work force is needed. So, have a good clean water is very much essential and that is needed for all sorts of industry in the next module I will also show you how it is how it is related to the energy sector.

So, with that we will try to we will wrap up this particular module and now will have another module left for this particular week and then we will have a for as you probably know for every week you have some you will have a quiz. So, do keep revising these material and I like you will have access to the pdf version pdf version of the slides as

well. So, listen to the video look at the pdf version of the slides and so that you can do well in all those quizzes like a weekly assign weekly quizzes which will be given to you at the end of the week.

Thank you.