Geomorphic Processes: Landforms and Landscapes
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Lecture - 7
Surface and Ground Water System and Management
(Part – I)

Welcome back. So, today we are going to talk about mainly the ground water and as relation with the surface and further to some detail about the management part.

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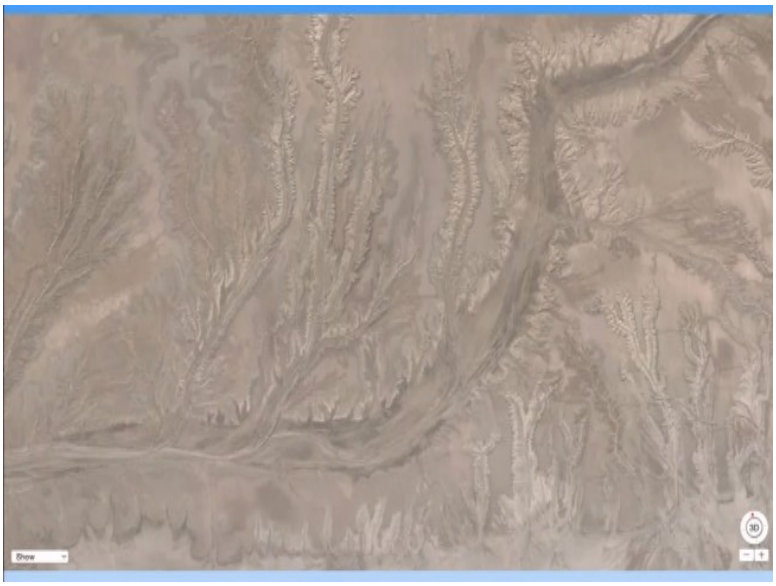

As we all know that the groundwater or the surface water moves through some system and that system is mainly the fluvial system. So, this is a picture which talks about or tells about some drainage network in a desert area, but, this part we will be covering later when we will be talking about the drainage basins and all that and talk about different fluvial landscape.

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Moving further, water is ultimate resource, this we all understand, we know very well and we always value it when it is required the most in summers. So, as per the survey by UN and this is an old survey, this is not the recent survey, but this survey has been done during 2013-14, it says that about 1.1 billion out of 7 billion people will lack access of safe water and about 2.6 billion will not have access to adequate sanitation. It has been found that 80% of all disease in the developing countries is related to contaminated water.

So, this shows that how important is this resource, that is the water, which is the ultimate resource. Global demand is project to grow by 40% in next 15 years. So, if we say that the survey was in 14, so almost 5 years are gone, so more 5 years or more 10 years to go and the demand will grow almost about 40%. So, for each and every purpose, we require water and without water it is difficult to survive. So, the demand is increasing per capita, but the resource of the water is reducing and that may be because of several other reasons or contamination of water and so on.

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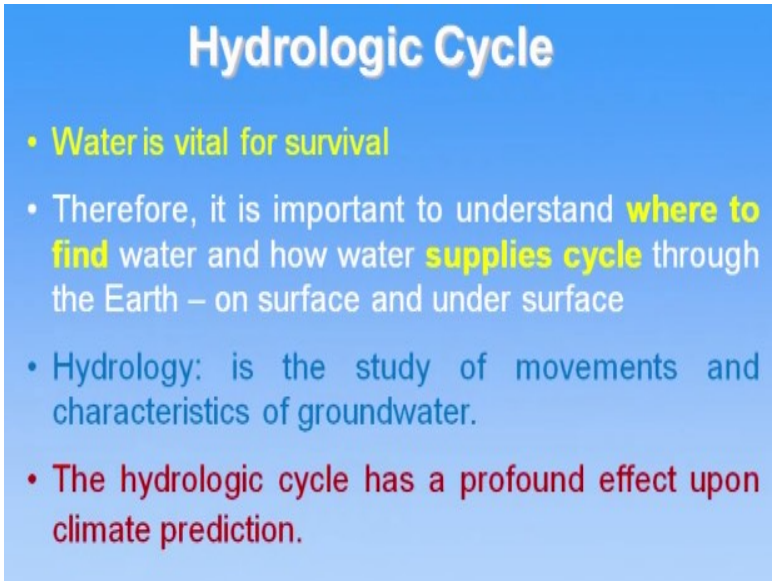

Now hydrological cycle, this is a part of what we were supposed to talk in under the atmosphere geomorphology, is also an important point to be discussed here. So water is virtually vital for survival. Therefore, it is important to understand where to find the water. Now, where to find the water means which will be a particular area where we will be able to find the water.

Surface water will be seen easily, but mainly for the ground water, subsurface water which most of the areas in India like for example the Indo-Gangetic plain, we remove or we take out lot of ground water for irrigation purpose. So, we need to know where exactly we will be able to find the water. So, it is important to understand where to find water and how water supplies cycle through the earth. So, how this water is been supplied in a cycle through earth. So, this is mainly we talking about the hydrological cycle, whether it is in the form of water vapor in air or precipitation or on surface, so whether it is on surface or under surface.

Hydrology is a study of movements and characteristics of groundwater. So, how the ground water moves, this we will try to look at in couple of slides. So, the hydrological cycle has profound effect upon climate prediction because if the climate change has been observed, then of course, it is going to affect the hydrological cycle and definitely it is going to affect the groundwater also.

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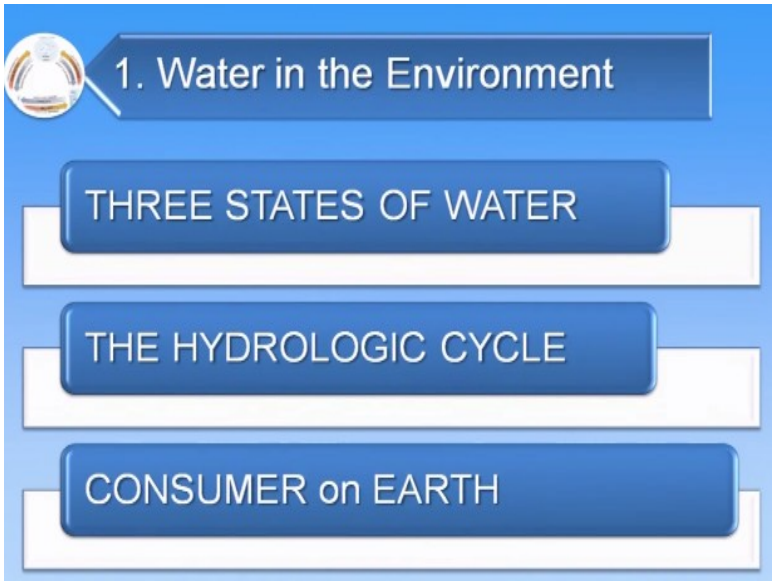

So, water in the environment we will see one by one. It appears in 3 states, then we will talk about the hydrological cycle and consumers on earth.

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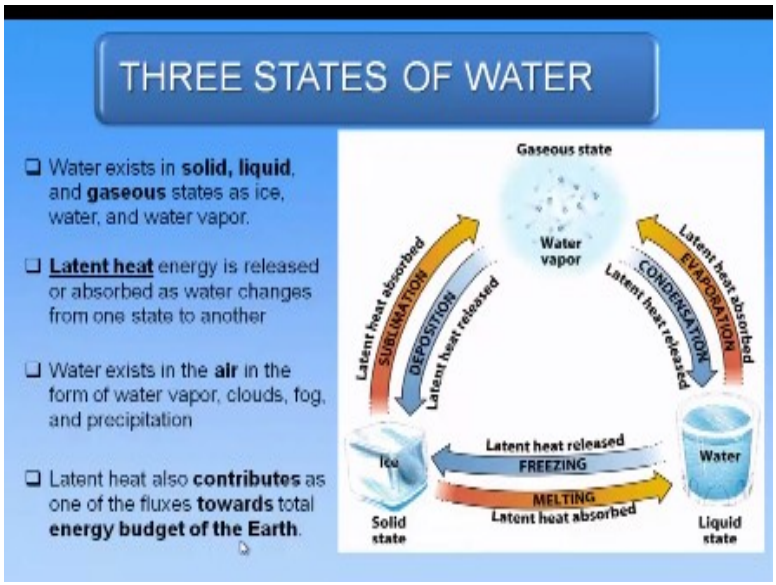

So, moving to the first part of the water environment, 3 states of water, mainly we see in a gaseous state, we see in the liquid state, and solid. So, again the transfer of from one form to another form is well known. So, the water exists in 3 forms 3 states; solid, liquid, and gases as ice, water, and water vapor. Now, during the transfer, latent heat is released and this latent heat also plays a role when we were talking about the energy budget. So, latent energy is released or absorbed as water changes from one state to another state.

So, whenever there is a conversion from ice or water vapor to ice, then the latent heat has been released. When there is a freezing from water to ice, then the latent heat is released.

When there is condensation, again the latent heat is released. So, during every process either it is evaporation, melting, or sublimation, latent heat is absorbed and released in all these processes, either it is freezing or melting; in terms of melting, the latent heat is absorbed, in terms of evaporation, the latent heat is absorbed, in terms of when you are having sublimation, the latent heat is absorbed.

Latent heat is released at the time deposition from water vapor to ice, from freezing from water to ice and then from condensation from water vapor to water. So, water exists in the air in form of water vapor, cloud, fog, and precipitation. Latent heat also contributes as one of the fluxes towards total energy budget of the earth.

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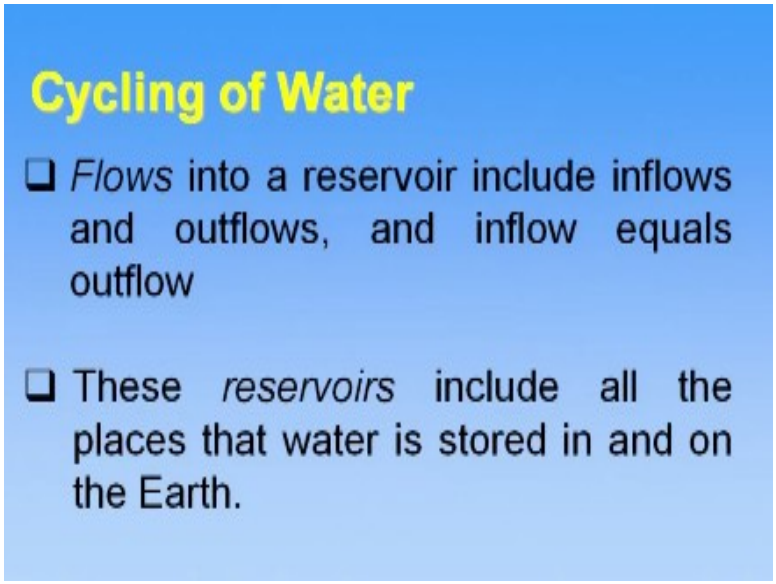

Now, cycling of water. Flows into a reservoir includes inflow and outflow, an inflow equals to outflow. This is one of the samples of the reservoir, input and output we were talking in the previous lecture. So, this reservoir includes all the places that water is stored in and on the earth's surface. So, water is cycled through the complete system whether it is on the surface or subsurface

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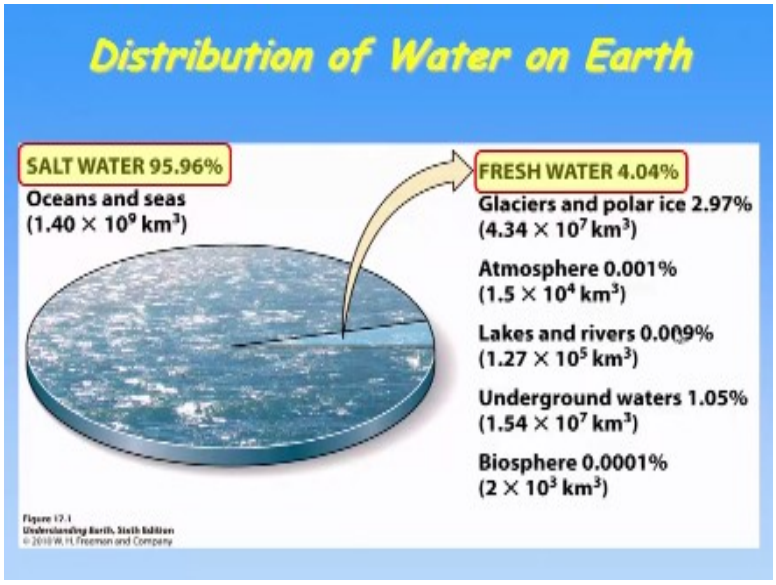

Distribution of water on earth. So, if we take, we have ninety five percent 95% of saltwater in ocean and seas, where hardly 4% is freshwater, rest has been occupied as glaciers or polar ice, atmosphere, lake and rivers, underground water and biosphere. So, this is the distribution. So you can understand that how small quantity of water is available as a freshwater which is important for us. So saltwater 95% and freshwater just 4% and what has been listed down here the glacial, this is all the freshwater we are talking about.

So, that is 4% total freshwater and then this is the part of the freshwater, the glacier and polar, atmosphere, lake, rivers, these are all freshwater. So, in total we have only 4% is the freshwater and 95% is the salt water

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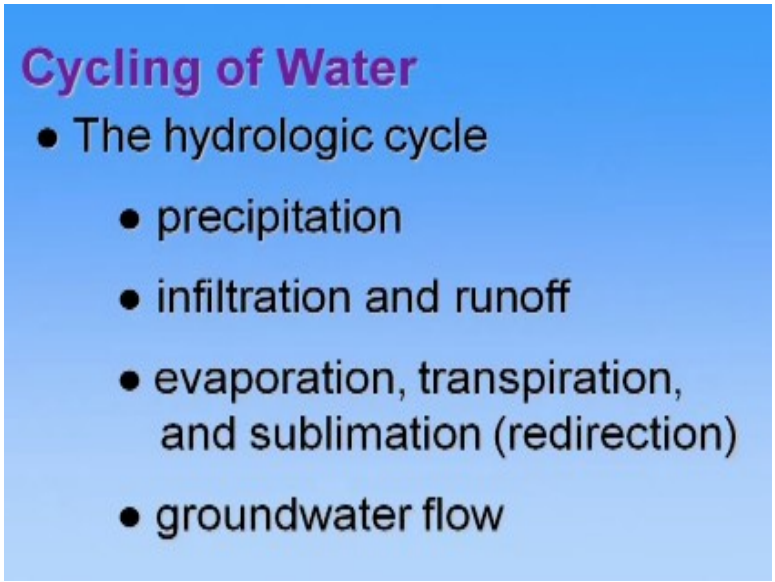

Further cycling of water is through the hydrological cycle, either through precipitation, infiltration and run off, so the typical hydrological cycle which we will be talking in the next slide, evaporation transportation, transpiration and sublimation, and groundwater flow. So, cycling of water through surface or underground.

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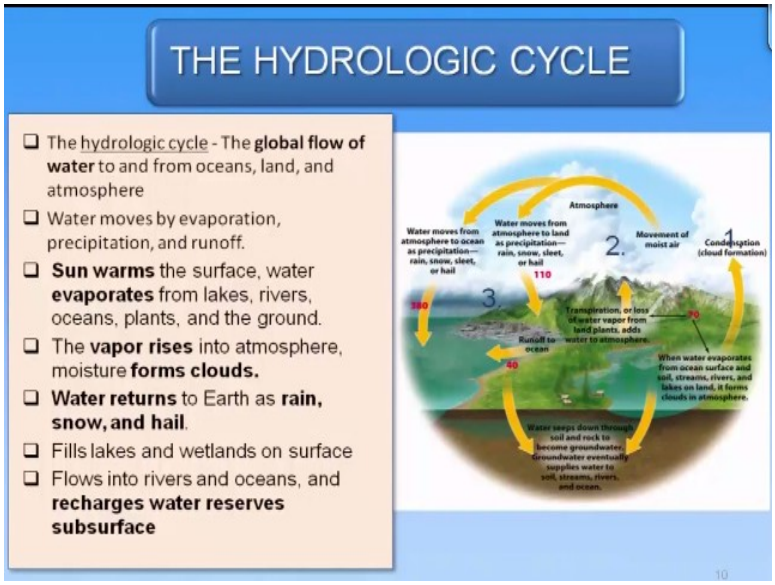

So, hydrological cycle basically the global flow of water to and from ocean, land, and atmosphere, when we talk about the land, it also includes the ground water. Water moves by evaporation, precipitation, and runoff. Sun warms the surface, water evaporates from lake and rivers, ocean, plant and ground. The vapor rises into atmosphere from clouds. Water returns to the earth in form of rain, snow or hail. Fill lakes and wetlands on surface. Flows into river, ocean and recharge the water reservoirs subsurface. So, this is the complete cycle which we should know and which is important.

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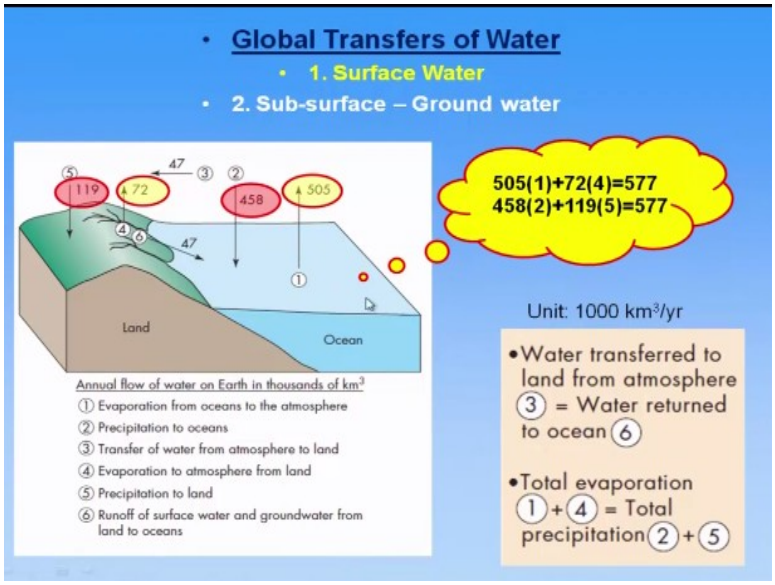

Global transfer of water if you look at is one is the surface water, second is the groundwater. So, now, if you look at this figures here, what we have one, so this is an annual flow of water on earth in thousands of cubic kilometers. So, one is evaporation from ocean to the atmosphere. So, this is the number which have, this is very much similar to what we are talking about the energy budget. So, this is in thousands of cubic kilometer, so evaporation from ocean to atmosphere. Second is precipitation to ocean.

So, one is from ocean to atmosphere and then second one is the precipitation to ocean which is coming back. Third is transfer of water from atmosphere to land, this one is third, so transfer ocean to atmosphere to land, it is from atmosphere that is from the ocean side through atmosphere to land. Fourth is evaporation to atmosphere from land. So, these 2 components are the evaporation to atmosphere, one is from ocean, another is from land. So, it is 72 and 505.

Precipitation to land, this is number 5 and number 6 is runoff, this one is runoff. So run off of surface water and groundwater from land to ocean. So, this is again very much similar to the balance water transfer like similar to what we were talking about the energy budget. So if you add 1 and 4, it becomes 577 and then if you add up 2 and 5, it is the incoming. So precipitation to ocean and one was evaporation.

So 1 and 4 is again evaporation to atmosphere from land and 1 is evaporation from ocean to atmosphere. So, if you add 1 and 4, 2 and 5 which is coming in, it makes the same input and

output, whereas water transferred to land from atmosphere is equal to water returned to ocean, that is 3 and 6.

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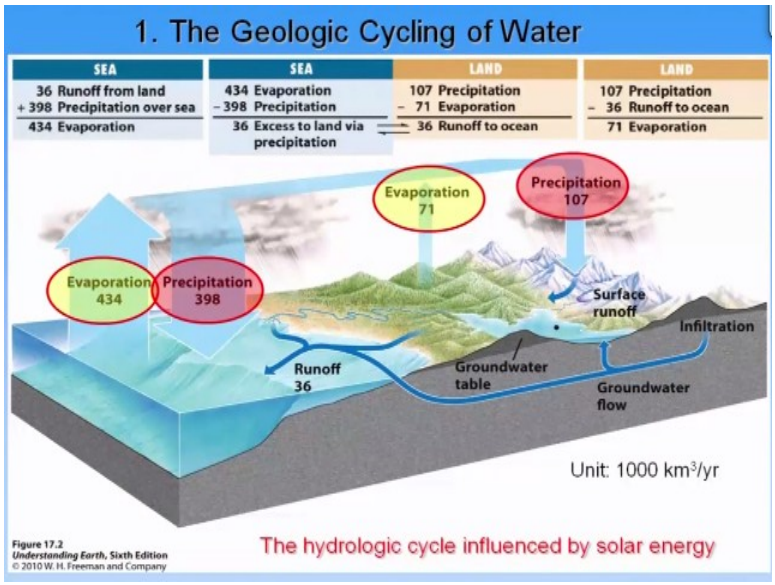

This model is similar diagram which explains the incoming precipitation and outgoing evaporation from ocean as well as from land and precipitation coming in to land as well as to ocean in the form of rain and then transferred through underground subsurface or through runoff on surface. So, this is basically the hydrological cycle or you can say geological cycle of water. So, this yellow one is showing outgoing and incoming precipitation by red.

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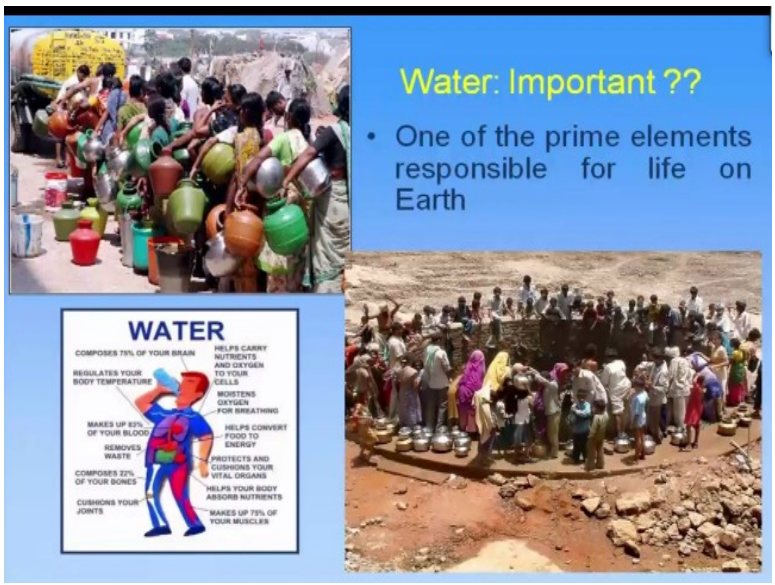

Now, one of the prime elements responsible for life on earth is your water and this is what we keep experiencing every summer and mostly the villages where the water supply is very

sparse. So, these are the 2 pictures which shows the conditions in villages and now slowly this is also touching towards the cities. So water is helpful in all ways.

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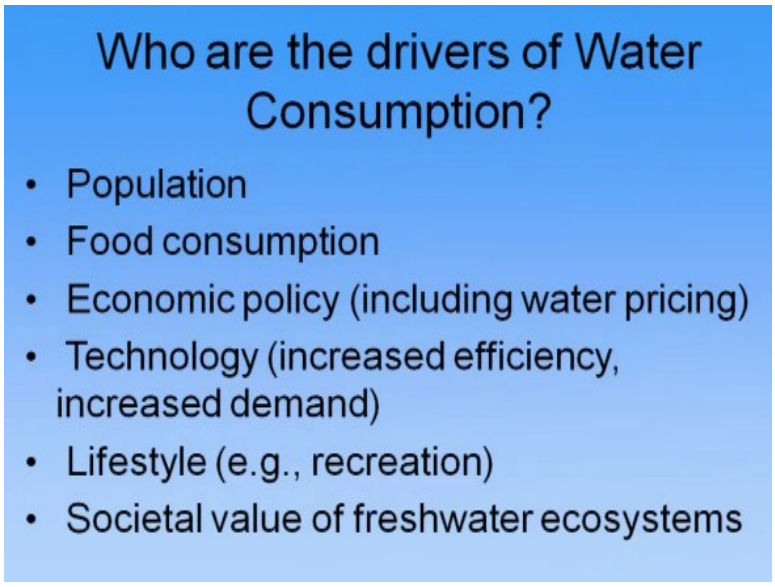

So, who are the drivers of water consumption? Population, food consumption, economic policies including water pricing. Technologies, increased efficiency, increased demand. Lifestyle, recreation. Societal value for freshwater ecosystem. So, these are the main drivers of water consumption. So, as we were talking about that if we see the increase in the population, of course the demand is going to increase.

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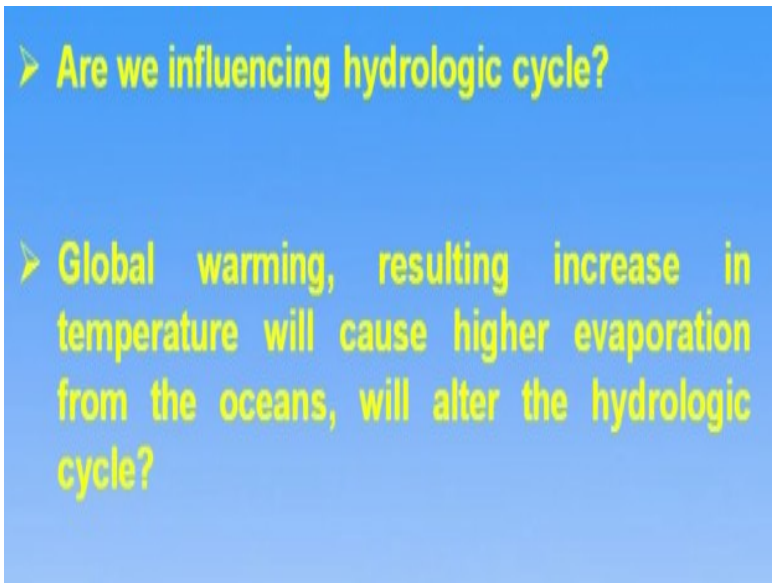

Now are we influencing hydrological cycle? Global warming resulting increase in temperature will cause higher evaporation from the ocean will alter the hydrological cycle. So, this portion, it suggests or clearly indicates that the global warming which is again

influenced by the humans will increase the temperature result into the increasing in temperature and that will result higher evaporation from ocean and will alter the hydrological cycle. So, the answer is yes, we are influencing the hydrological cycle.

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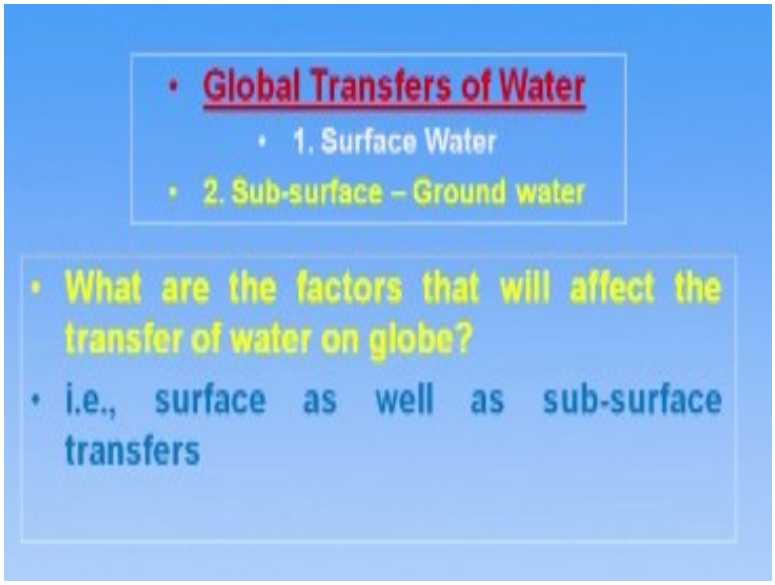

Global transfer of water in surface and again subsurface we are talking about. Then what are the factors that affect the transfer of water on globe, that is surface as well as subsurface transfer. Let us see quickly.

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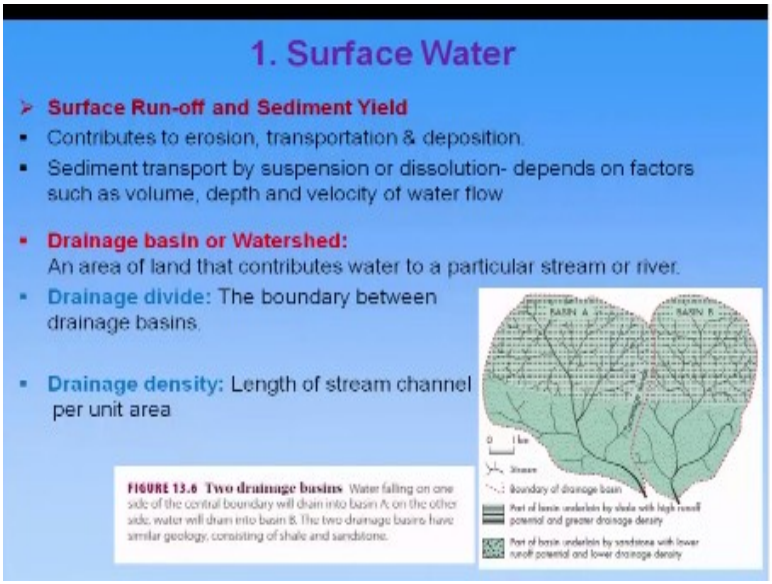

So, surface water. For surface water, it is extremely important to know and understand the drainage basins and the major streams which are carrying the sediments as well as the water. So what, it will result into the surface runoff. So, when there is a precipitation or the rain water which falls on the surface, it will result into the runoff as well as erosion. So, it will

contribute to erosion, transportation, and the position. Then sediment transport by suspension or dissolution, this will depend on the factors such as volume, depth, and velocity of the water flow.

Drainage basin and watershed areas, then an area of land that contributes, particularly this is a drainage basin that contributes to a particular stream or a river. So, if you see on the right hand side, there is the basin A and basin B and in the next slide, we are going to talk about lithology also, what is the importance of the lithology because that will also contribute in terms of the runoff, in terms of the erosion and then the sedimentation.

The drainage density if you look at on this basin A and basin B, the upper portion of both the basins as higher as compared to the lower portion because the part of the basin underlain by shale with high runoff potential and greater drainage density, this part, and this one that is the upper part this one. So, more of the drainage density has been seen in the upper part of that and this is occupied by the shale. Now, part of the basin underlain by sandstone with lower runoff potential and lower drainage density.

Now this part is very important because when we are talking about the runoff, we were talking in terms of the hydrological cycle, so the yield of water or the supply in form of runoff will be controlled by the subsurface lithology mainly, so in one part just looking at the morphology of the surface, you can easily make out that what is the subsurface lithology or what are the rock types on which this river is flowing or the drainage exist. So, this is very important for us and this is the most important point which helps us in understanding the landforms also. So, I will stop here and we will continue in the next lecture. Thank you so much.