Sustainable River Basin Management

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Module – 02
Lecture - 07
Part – 02

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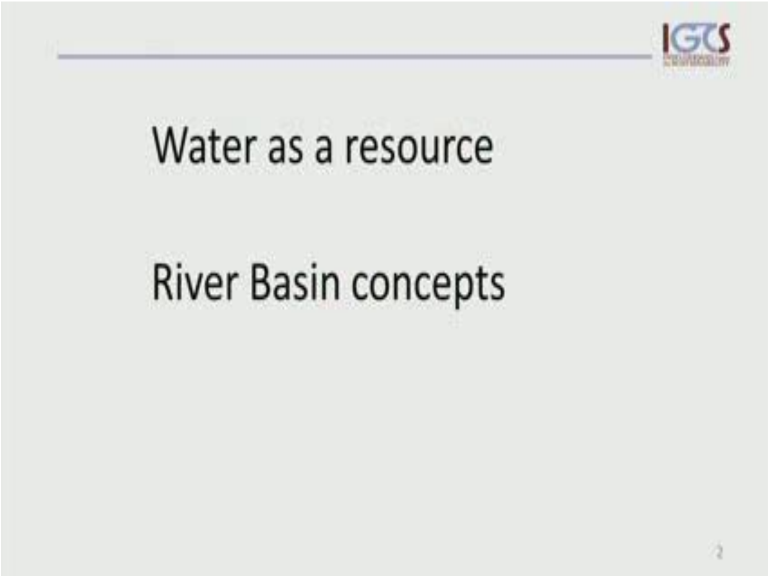

Welcome everybody to Sustainable River Basin Management, module two, part two. What we want to discuss today is, water as a resource. We want to, and we want to talk about river basin concepts.

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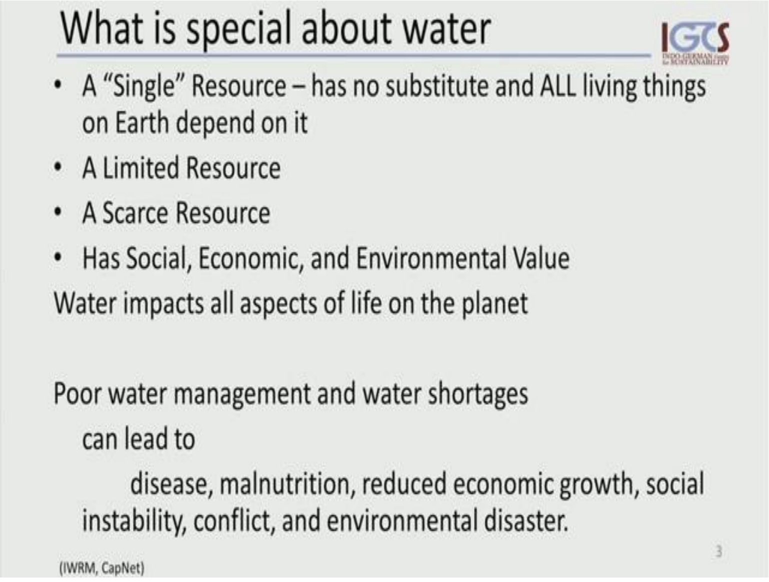

First of all, what is so special about water? We know, that water is or you should know, that water is a single resource. That means, that has no substitutes and all of the living things on earth depend on this water. And it is a limited resource, it is a scarce resource, it has a social economic and environmental value. So, that means, that water impacts all aspects of life on the planet and anybody, a scientist or not, politician or not, get involved when it comes to water and water availability.

So, poor water management, water shortages, will lead to diseases. It will lead to malnutrition, to reduced economic growth, to social instability. It will lead to conflict and environmental disasters and that is why, we have to deal with this in courses like this, sustainable river basin management.

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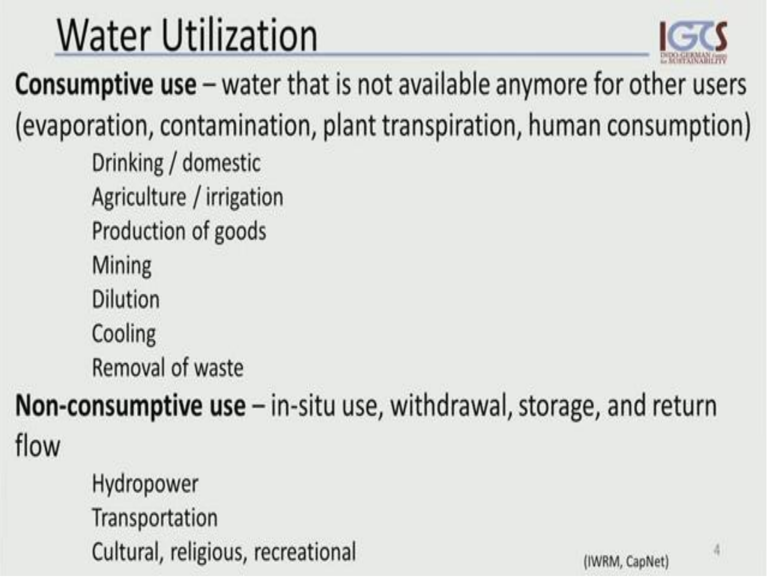

Let us reflect upon water utilization and we can differentiate water utilization to categories, first being consumptive use. What do you mean by consumptive uses? That water that has been used will not be available any more for other uses.

Consumptive use could be evaporation, it could be contamination, it could be plant transpiration, it could be human consumption. Well, such consumptive use occurs is, was domestic water use, is irrigation, in agriculture, is the production of goods, is mining, dilution, dilution leads to contamination, was cooling and was the removal of our waste, our sanitation, water based sanitation systems.

And the second category is the non consumptive use, which means, either in-situ use of water, it could be the withdrawal of water, the storage of water and the return flow of water. And such utilizations would be in hydropower generation, in transportation and in cultural, in religious or recreational uses.

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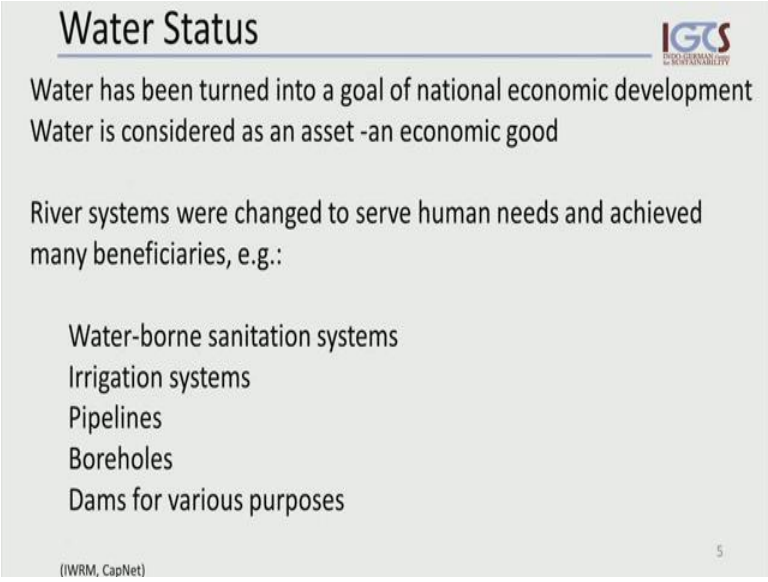

Now, what is important to keep in mind when we come to water management is, that water has been turned into a goal of national economic development. That means, water is considered as an asset and asset comes from the financial word. It is, has become an economic good.

What you also have to keep in mind is, that river systems were changed over as long as humans on earth and they were changed to serve our human needs. And we also have to be clear upon the fact, that we have achieved many beneficiaries by changing, adjusting all this river systems to our needs.

Let us just think of the water borne sanitation systems, our irrigation systems, our pipelines that take water to where we need it instead of forcing people to settle close to the water sources. Let us think of the clean revolution that was made possible by, by the possibility of excess ground water through boreholes and the construction of dams for various purposes.

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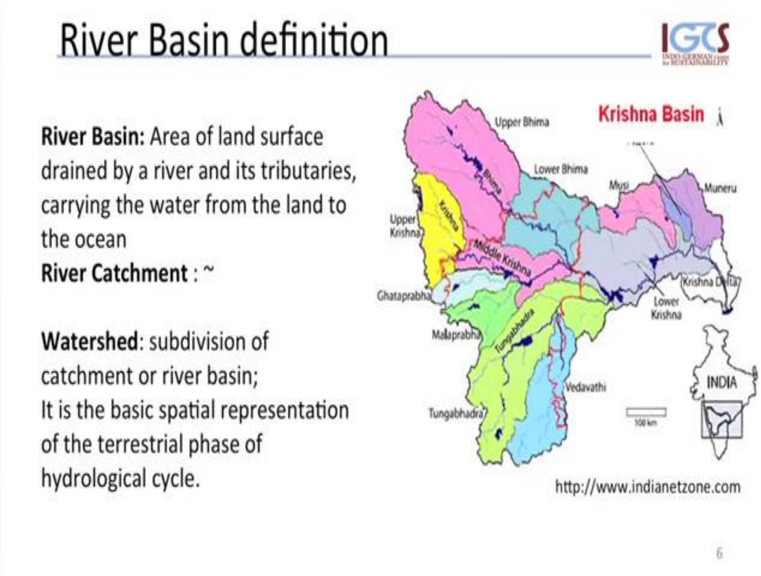

Now, let us set this aside, but keep it in mind and let us start from the basics. First of all, I have to define river basin, the term river basin and I am showing here an example of river basin, this is from India. So, you can see on the map here, the Krishna basin. So, what a river basin is essentially the part of the land surface where one top of order would drain through tributaries, streams, small rivers and two major streams and eventually reach an ocean, like in this example. Now, we also often hear the term river catchment and what you mean by river catchment is essentially same as this river basin. We can use those terms exchangeably.

And a third term, that often appears, which is watershed. A watershed is not same as the basin. Watershed is subdivision of catchment or river basin, which means, looking into our example here, those colored sub areas would correspond to watersheds or sub catchments of the catchment area of the Krishna basin. We can study all those individually or we can, looking at this river basin scale, depending on our needs and purposes.

So, what we can summarize is, that our watersheds are the spatial or basic spatial representation of the terrestrial phase of our hydrological cycle. So, we are not looking at what happens in oceans, oceans alone, if we talk about river basin management.

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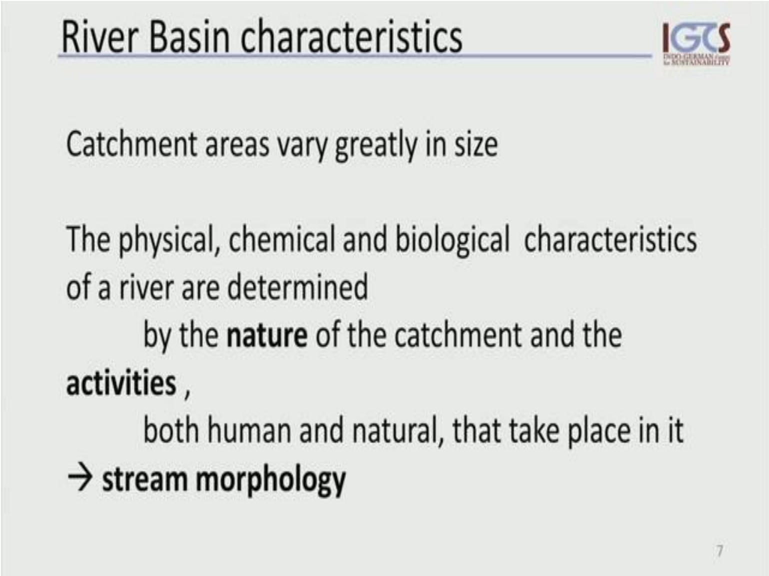

Now, the river basins are appear in very different sizes, from very small, from a few square kilometers to many 100's, 100's of 1000's of square kilometers, and India has several examples of these very large river catchments in the north for example, fairly small, comparably small river catchments into the west, south west.

The physical, chemical and biological characteristics of these river systems are determined by the nature of the catchment and the activities that take place in such catchments, means the nature, the physical conditions of the area, the climate, climatic conditions. And activities means, any of the human or biological activities that take place. And all of this we can summarize under the science of the stream morphology. And we will come back to stream morphology when we talk about the river restoration at a later point again.

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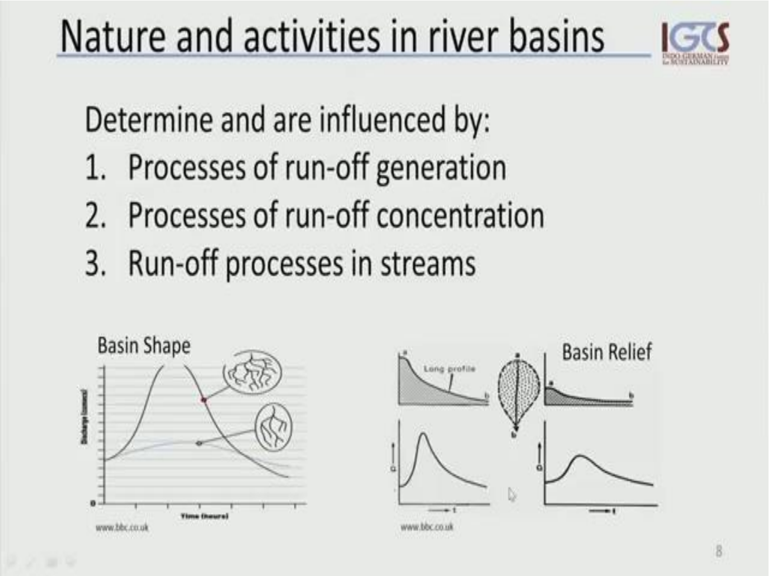

Now, the nature and the activities in river basin determine and also influenced by the loop process, the processes of runoff, generation from rainfall, how and how much of runoff is generated. It influences and also determines process of runoff concentration and it determines how this runoff has been channeled to streams, and how streams after all work and function.

Just two examples here, the basin shape, we have two different, two different types of basin shapes, one was many tributaries and one was very few and here runoff discharge. Raiding curves, what you can see is such, we get a very flat discharge over time in a small or a less tense river system compared to very large discharge and very steep, comparably steep discharge curve over time for a more dense river basin system. This can be used for analysis, for predictions, for forecast and in modeling.

And let us look at a second example, the basin relief. The elevation that we observe in one river basin example here, the water moving from A to B and A to B or F and D associated to nearly discharge curve to it. What you can see is such in a very steep river catchment, we have very concentrated steep discharge taking place into a very comparably rapid, response rapid occurrence. And in a more, in a flat or flatter terrain we observe a discharge that is more slow on setting and more evenly distributed and not developing such a peak like in a steeper terrain. And again, this can be used for predictions and for flood monitoring or flood prevention measures, as an example.

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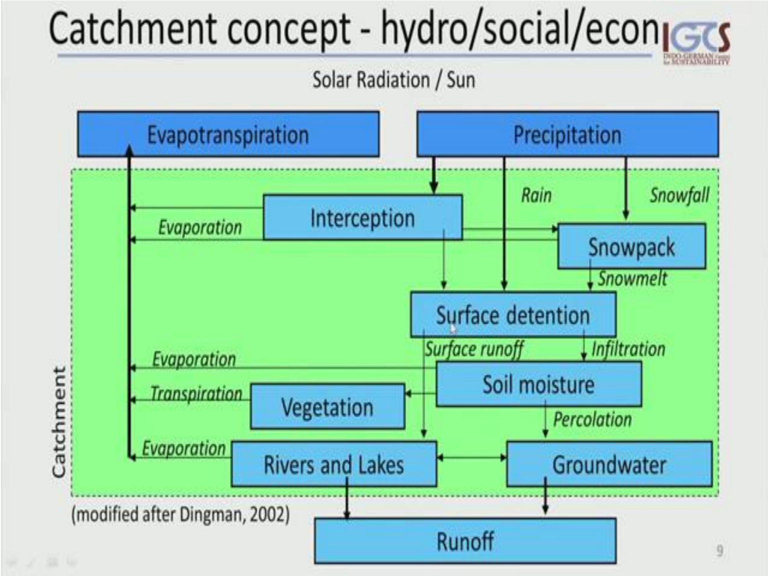

Now, let us look into the catchment concept in, for a hydrological, social and economic perspective. Remember, how we looked into the different concepts, models. When we talked about the water cycle, we only looked at the hydrological part and not the social and economic.

Now, let us take a catchment as a system and the theme will show us, showing as a system. This box is our system and it corresponds to a catchment. And we have as an outside energy source, our sun. And now we have this one input component, inputting component or precipitation. We have as an outgoing a component or run off from our catchment, which could be a runoff into the ocean. And we have as a second output component, evaporation or evapotranspiration taking place from our system.

Now, the first, that will happen, you can expect is interception and those are different storages that I am describing here. So, interception means, that when rainfall occurs, or when some precipitation occurs, then it will be intercepted before it reaches the ground. It will be deposited, stored temporarily or long term above the ground and it will evaporate eventually or continue or move ((Refer Time: 12:37)) and become a runoff.

We could also have in the term, in the type of precipitation, rainfall or snow, if you have, which would form a snowpack as a temporary storage. Again, which then will and as snow is melting join another temporary storage compartment, which we called surface detention. This can be, this detention is, can be in the size of millimeters, square millimeters, square centimeter or even larger. In large depressions of a very important surface detention is where water is being stored intermittent and eventually generates surface runoff and infiltration and this will, surface run off would join our runoff, over run off from, eventually from our catchment is surface infiltration, will move our water particles into, in another storage compartment forming soil moisture and part of that again will evaporate.

Now, from our soil moisture parts of water will join yet another storage compartment, which is vegetation. And again, transpiration and evapotranspiration will take place from here and some of this water from our soil moisture, from our and such ((Refer Time: 14:25)) will reach the ground water in a saturated zone and will remain in our ground water storage for a longer period. And again, eventually, join our runoff out of our system, our catchment. The major part of it will move into the storage compartment of rivers and lakes and become runoff out of our catchment or evaporate. So, this can be analyzed individually in much more detail depending on our needs and our objectives.

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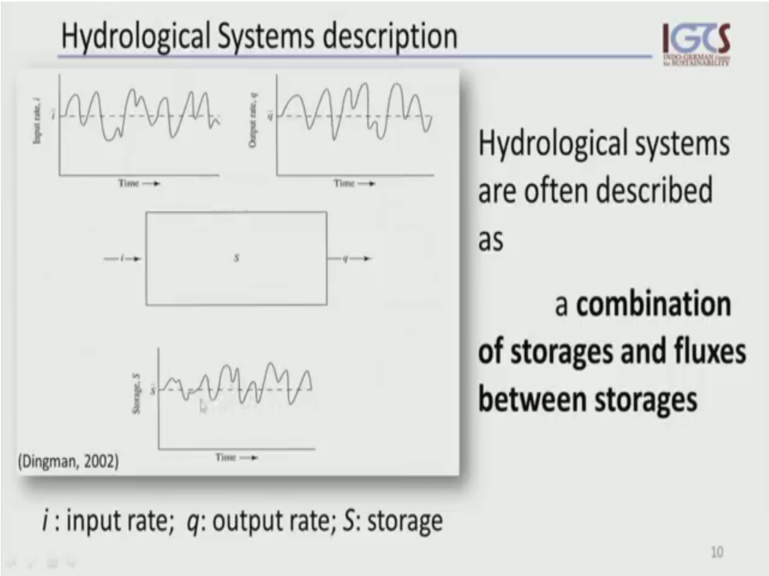

Now, let us look into the hydrological systems, the ways of describing it. And what you have seen or sensed from the previous slide was, that we describe the hydrological systems. So, combining storages and the fluxes taking place between those storages, what happens, what is a size of our storage, how long does it remain in our storage, and how, under which physical condition, water particles removed from that storage into another storage.

So, we can visualize this in an example like this one where we have our input over time, measured input rate and we have, we can express or monitor, measure our output, right output over time, and in between something is happening because both of the graphs are different from each other. And this is what has been that transformation is taking place in our storages. So, the transformation function of this is probably look like this.

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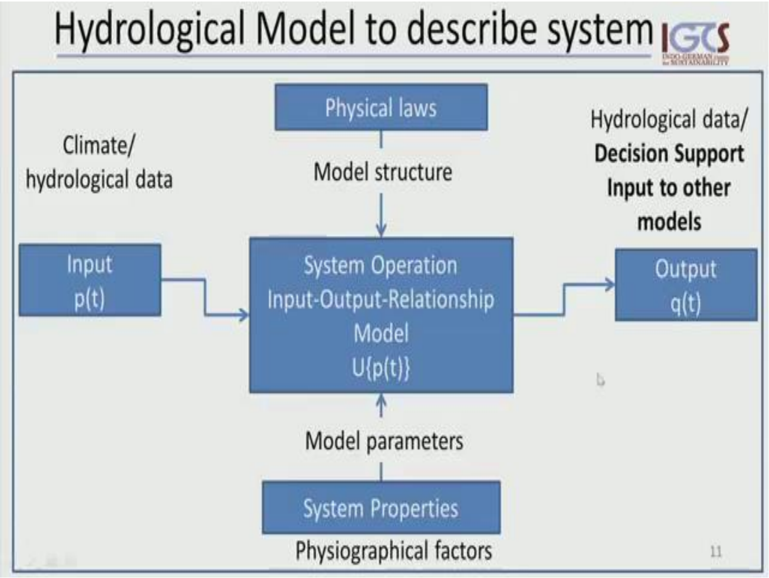

Now, let us simplify this in the following scheme where we depart from these, depart from our physical laws and we depart from our system properties, our physiographical factors or ((Refer Time: 16:50)) climate factors, vegetation, soil, conditioned soil types, all of those physiographical factors. And those we use to define our model structure and also those define our model parameters. You may have a few parameters, you may have many parameters and if you are able to get those details and all of us has to serve a purpose and want to generate an output, information over time.

It could be a hydrological data. It could be more often and more important decision support or it could be an input to other models. In such an input, for instance, when we just look into hydrological models at one, two sustainability analysis, this has to be what comes from a hydrological model, we combine input to other models, which can incorporate social and economic aspects of water use, water utilization.

Usually, we start a hydrological mass with an input component as in the form of climate or hydrological data, which have to be measured and those are connected through a system operation and we call this an input-output relationship model that relates, for instance, rainfall to a specific runoff.

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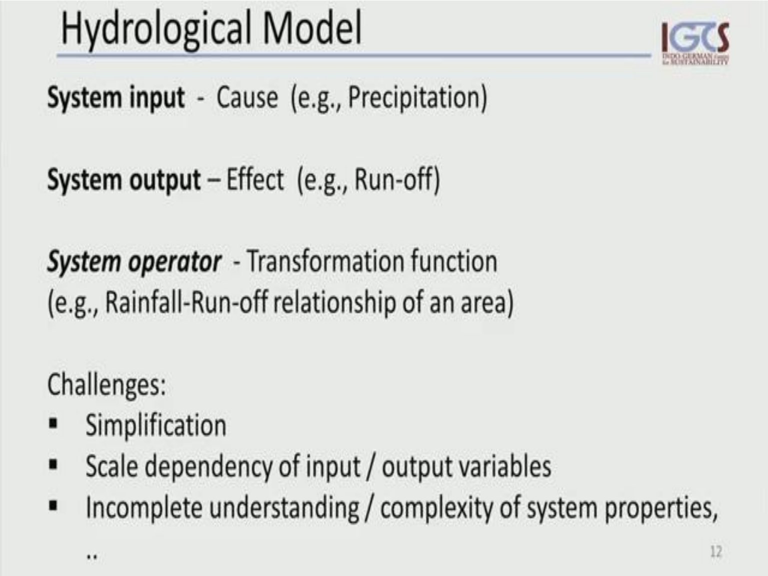

Now, let us simplify the hydrological model theory a little bit more. What we do is, that we reduce the system input to a cause and the cause would be, for instance, precipitation and we will choose our system output to the effect and effect would be a runoff and I link those two through a system operator or a transformation function and that would create our rainfall-run off relationship of a specific area of interest, the catchment area for instance.

Now, there are limitations to it, challenges, but real limitations to it. It is obviously a simplification, which depends, we cannot change our physical laws, but we can, we have, may not have all our physiographical parameters at end. So, we have to simplify, we have, want to simplify, that is why it is a model that also challenges, challenging our scale dependency of our input and output variables.

Remember, our last class on this issue and our incomplete understanding otherwise the complexity of our systems and obviously, we may take this as a, as a system. We are not looking, we are not able to incorporate any other outside effects or the system components such as the feedback loops caused by our way of using our water resources or how we shape our river basins ((Refer Time: 20:36)) as biological factors, which influence and shape on river basins.

So, these are some of the challenges or limitations of such hydrological models. I want to stop here and we continue next time on what are budgets.