

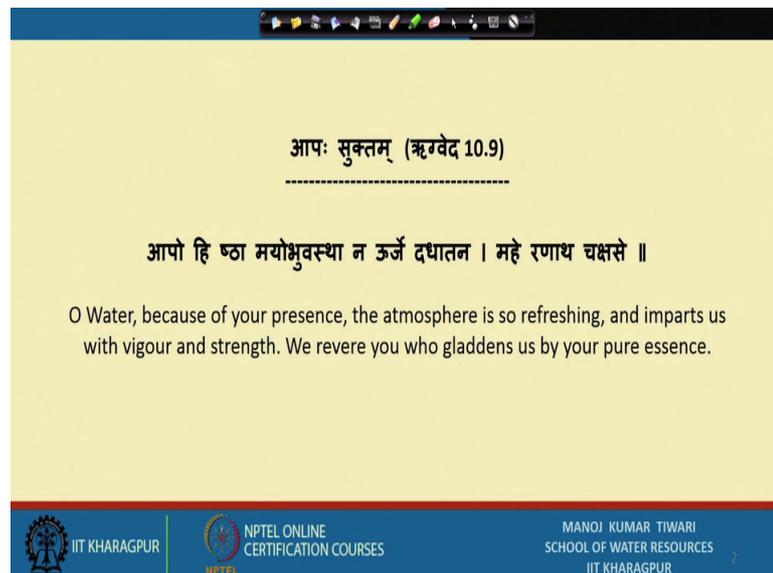
Water Economics and Governance
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Lecture – 01
Introduction

Hello folks and welcome. As you might be knowing my intro through the Lear documents, when you have registered for the course, I am Professor Manoj Tiwari, I work here at IIT, Kharagpur. Through this course onto water economics and governance, what we will be discussing primarily is the concepts and various practices onto the for the management of issues related to water economics and governance. Water is one of the most essential component in our life, in the ecosystem, in the entire universe. In fact, and it is the issues or the discussions related to water are not new.

If you see, there has been age old literature from the ancient even the what you see on your screen is basically one of the soup thumb from Righ Vedh on water which says [FL].

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आपः सुक्तम् (ऋग्वेद 10.9)

आपो हि ष्ठा मयोभ्रुवस्था न ऊर्जे दधातन । महे रणाथ चक्षसे ॥

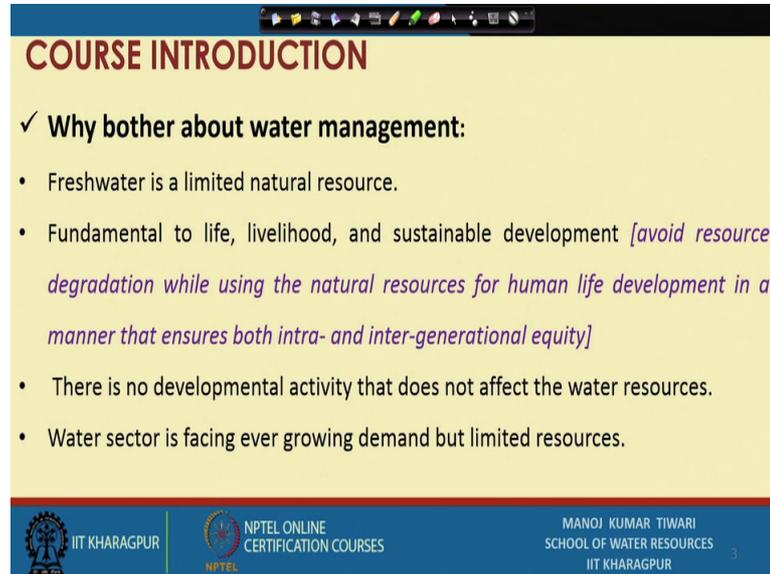
O Water, because of your presence, the atmosphere is so refreshing, and imparts us with vigour and strength. We revere you who gladdens us by your pure essence.

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What it refers to or what it means is that it; it sort of says for water that because of the only because of the presence of water this entire atmosphere is. So, refreshing and imparts us with vigor and strength and it pays river who is a sort of gladden us by its

sheer pure essence. So, that is the value of water which has been recognized from our almost one of the most ancient literatures.

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COURSE INTRODUCTION

✓ **Why bother about water management:**

- Freshwater is a limited natural resource.
- Fundamental to life, livelihood, and sustainable development *[avoid resource degradation while using the natural resources for human life development in a manner that ensures both intra- and inter-generational equity]*
- There is no developmental activity that does not affect the water resources.
- Water sector is facing ever growing demand but limited resources.

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Coming onto this course; so, before we go into the details of discussion on what are the what specifically, we will learn throughout this course lets first talk about why we should bother about water management at first place. So, there are several reasons for which we are sort of enforced to look for water look for a better water management we would say.

So, the basic reason is one of the most basic reason is that fresh water is very limited natural resource. There is plenty of water in the universe and we will talk about detail in terms of the quantity also over the sections when we go there, but in general, most of us are aware that most of the water what we have on the in the universe lies in the oceans and which is not worth using without proper processing or what we call in engineering terms is treatment.

So, and which is quite a costly and difficult affair. So, the fresh water that is available is very limited how much it is we will discuss when it when we go onto those specific sections, but the fresh water what the point is that fresh water is only in the in the confined spaces and only in the limited amount; however, it is the fresh water which is sort of fundamental to life livelihood and sustainable development.

Now, sustainable development what essentially means that we sort of we grow in such a manner we develop our self or all our basically human life development infrastructure development industrial growth and all that. So, whatever development activities are there we should plan it in such a way that we do not hamper we do not sort of kind of quantitatively or qualitatively degrade our natural resources now what means the qualitative and quantitative degradation of natural resources particularly we will focus onto the water as that is the focus point for the discussion.

So, qualitative and quantitative degradation of water means we should not spoil the water quality of our river ponds lakes and groundwater which is one of the major problem these days you see that the quality of water that are in our sort of most prestigious rivers Ganga, Yamuna and all; these the major rivers these days there is so much of talk onto the deteriorating water quality in these rivers apart from that there is a loss or there is a degradation in terms of quantity as well from what from rivers as well as from groundwater.

Similarly, quality aspect from rivers as well as from groundwater; so, this is not a sign of sustainable development the sustainable development essentially targets that we grow we develop in such a way that our resources are not degraded they sort of leave the same or similar same amount and similar quality of resource to the next generation that are going to follow us. So, in a way we should ensure both intra as well as intergenerational equity that is what sustainable development essentially means now if you see that apart from this there is no development activity which can take place without water having in its lifecycle at some phase some may basically need it at a very beginning or manufacturing phase some may need it towards the disposal or management phase some may need it in almost in the entire phase.

So, whether is it is a natural process ecological process or engineering process any infrastructure development any constructions any material production mining activities whatsoever, you name anything and there would be certainly some requirement of water at some stage or some point of time. So, the purpose of basically saying this is that we will need water for future development as well we will need water for growth.

Now as we were just saying that although, we will need water we should utilize this in a sustainable manner after all this what we see that our water sector is facing ever growing

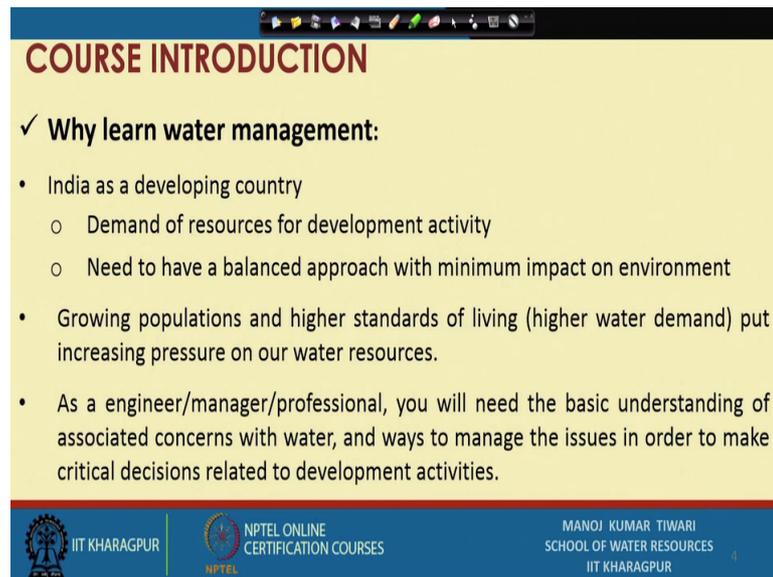
demand why because as just we were referring that there is no development activity possible without water resources and these are age for growth or development for several underdeveloped or developing countries even in the developing developed world as well.

So, there is lot of growth happening and that is leading to lot of demand of water our lifestyle is changing our facilities infrastructure the way we use to operate is changing people earlier used to take bath in just say lets a bucket and all that. So, maybe a couple of buckets of water 30, 40 liters their they used to basically take bath, but what you observe these days that they will use their bathtubs in the swimming in their bathroom or use showers which operate for 10 minutes 20 minutes. So, how long who knows. So, and then there are Jacuzzis and all that coming up. So, the point is that you see with the practices or with the sort of growth the requirement of water is also changing it is shifting and the safety is mostly from lower requirement towards higher requirement.

So, the per capita demand what typically we call in terms of water engineering the per capita demand means per head requirement of water or if we say that per capita demand per day which is termed at l p c d liters per capita per day is typically increasing apart from our sort of daily life. There are lot of industrial activities new industrial activities and all that coming up infrastructural growth is taking place and all of these needs water.

So, overall the demand of water is increasing for almost all sectors be it industrial be it domestic municipal sector recreational activities or even agricultural. So, demand of water is increasing; however, resources are limited now this calls for concern and that is why we bother about water management that how nicely we can manage our water resources our existing our existing fresh water resources in a manner that we can able to handle this growing demand in a sustainable way that is all about water management basically.

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COURSE INTRODUCTION

✓ **Why learn water management:**

- India as a developing country
 - Demand of resources for development activity
 - Need to have a balanced approach with minimum impact on environment
- Growing populations and higher standards of living (higher water demand) put increasing pressure on our water resources.
- As a engineer/manager/professional, you will need the basic understanding of associated concerns with water, and ways to manage the issues in order to make critical decisions related to development activities.

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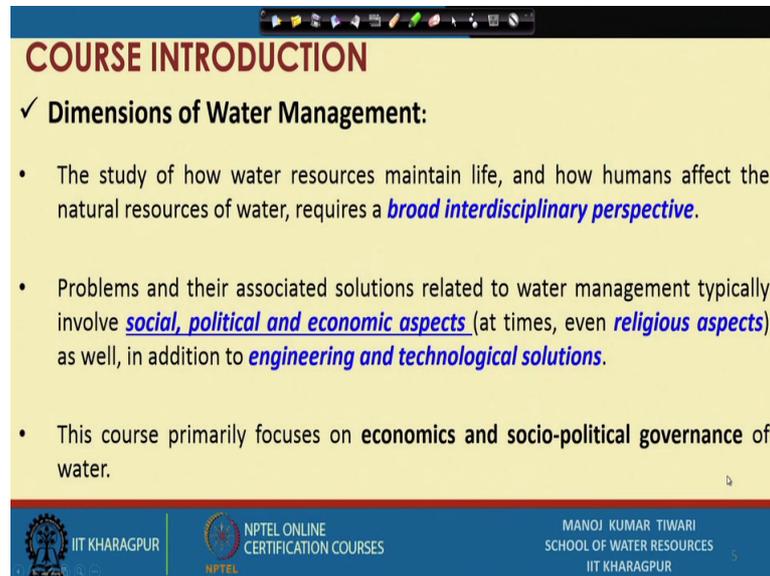
Now why we learn water management as continuing; what we discussing earlier is basically you see, India is a developing country and there is a lot of demand of resources for development activity we need to have a balanced approach. So, that we lead to minimum impact on environment primarily on natural water resources what we mean to say.

So, we grow or we develop in such a way that we need to have minimum impact on environment the growing population and higher standards of living leading to higher water demand the point what we are discussing just earlier is increasing pressure on our water resources and as a engineer or manager or professional from whatsoever stream one is one need the basic understanding of all the associated concerns with water and the major ways with which one can manage the issues related to water and make critical decisions related to the development activities.

We do not want one does not expect to stop all the development activities for the purpose of securing or saving water at the same time we should not allow injudicious usage of water. So, that we end up leaving nothing for future generation that is what has happened with coal all of us are aware that we have been exhaustively using coal for our energy requirements and the time now has come that barely the entire coal reserve will last nearly hundred fifty years more. So, what will be after that? So, that is sort of an prime

example of unsustainable development and the current water management practices or current water uses also are onto similar paths which one should avoid.

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COURSE INTRODUCTION

✓ **Dimensions of Water Management:**

- The study of how water resources maintain life, and how humans affect the natural resources of water, requires a *broad interdisciplinary perspective*.
- Problems and their associated solutions related to water management typically involve *social, political and economic aspects* (at times, even *religious aspects*) as well, in addition to *engineering and technological solutions*.
- This course primarily focuses on **economics and socio-political governance** of water.

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What are the basic dimensions of water management is sort of if we see the study of water management holistic study of water management how water should manage. So, the study of how water resources maintain life they there are two aspects what effect water causes on us and what effect we cause on water resources.

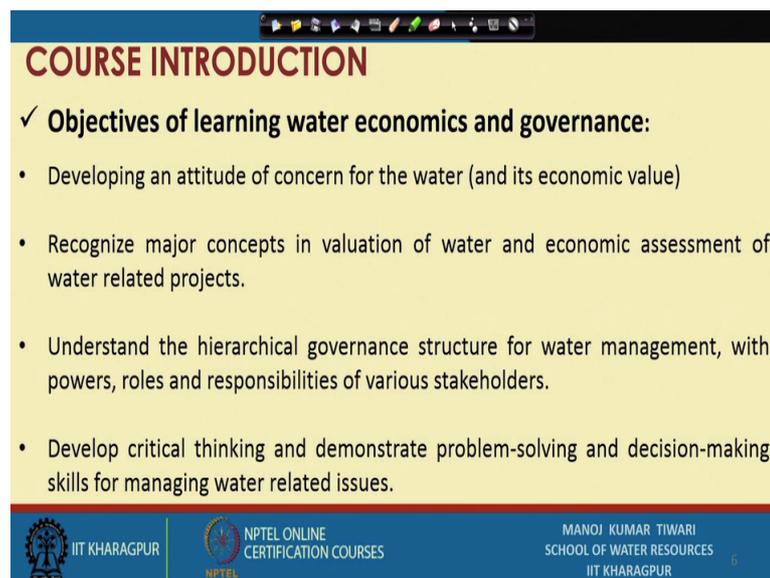
So, that in a integrated manner needs a broad interdisciplinary perspective. So, one need to sort of one need to understand that how water resources are helping us in maintaining life maintaining ecosystems maintaining our growth and in turn what effects we humans are creating through various anthropogenic activities onto the natural resources of water for understanding this as we were saying that it is an interdisciplinary.

We need a interdisciplinary perspective and the problems and their associated solution related to the management typically will involve multiple disciplines they are there are basically social aspects of water management political aspects economic aspects actually at times even religious suspects are also there when we talk about the managing of water in river Ganga or cleaning of Ganga or basically sort of controlling several activities pollution leading to Ganga there is a lot of religious aspect involved.

So, at times we may even not may not be valid for all water resources, but for few and at times there are these; these religious aspects are also there which you can club of course, with social aspect though. So, there are social aspects political aspect economic aspects apart from the well known engineering and technological solution. So, we are not dean no one is denying that engineering and technological solutions are not needed for managing water of course, we cannot manage it without sound engineering and technological knowledge. But apart from that there are social political and economic angles involved and that needs to be considered while we target a holistic management of water.

The present course primarily focuses on this your social economic and political aspects. So, economics and socio political governance of water is the; is what basically we will be looking after in this in this course that is basically our prime objective prime target.

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COURSE INTRODUCTION

✓ **Objectives of learning water economics and governance:**

- Developing an attitude of concern for the water (and its economic value)
- Recognize major concepts in valuation of water and economic assessment of water related projects.
- Understand the hierarchical governance structure for water management, with powers, roles and responsibilities of various stakeholders.
- Develop critical thinking and demonstrate problem-solving and decision-making skills for managing water related issues.

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Now, so far, we talk about why we should learn water management what is there in the water management what is the importance of having multiple disciplines in the water management now coming onto the e; specifically the objectives of learning water economics and governance which is focused onto this course. So, the major objective means of learning water economics and governance because engineering and technological solutions are being taught since quite some times in several decades now.

However generally many times, people overlook the economic aspects social aspects governance aspects how difficult it is to govern water. So, all those aspects are many time overlooked this course primarily focuses onto those thing within objectives of sort of learning for water economics and governance is the first and foremost is to develop an attitude of concern for water.

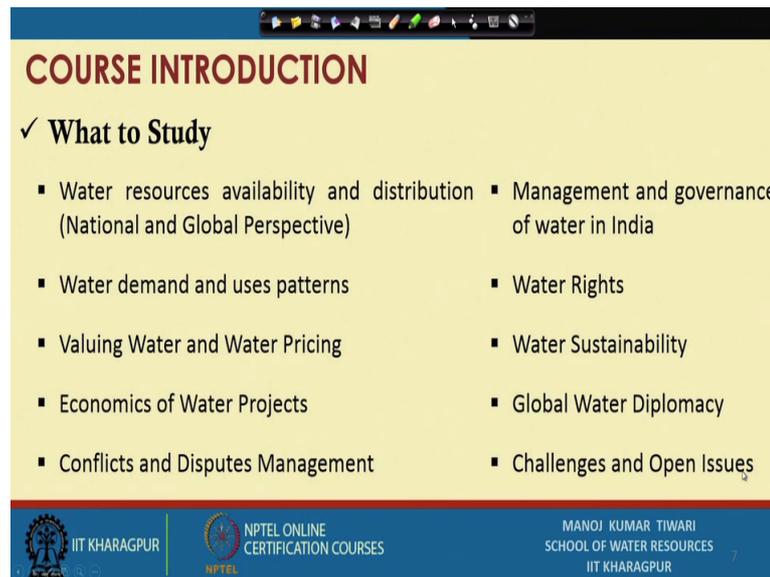
Now when we say that develop an attitude of concern for water it means one want to one must. In fact, understand what is the value of what is the economic value of water when somebody opens a tap while brushing he might be wasting some ten liters of water because he is not paying for it. So, if we are not paying for it directly if we are not bothered about that we are making some financial losses while doing all this activity people does not bother much.

Now, that can only be changed when concern attitude of concern is developed and that would that is the first and foremost objective for making people aware with the economic values of water. So, that will be one of the that is one of the objectives of the course, then the course will target to recognize major concepts in valuation of water and economic assessment of water related projects.

So, how what are the concepts through what means what approaches the water is valued what is the value of water that we will we will discuss and how we can economically assess the water related project that will be the another part then to understand the hierarchical governance structure of water management because water being a. So, important aspect; so, important part of one's life; one need to understand that if I am getting water in my tap, from where it is coming, how many people are involved in bringing this water to my tap; what are the governance structure for this; what is the cost that I am paying or government is paying or whosoever is paying?

So, all that aspects needs to be understood clearly and that is one of the objective with what are the powers roles and responsibilities of various stakeholders in the water management or particularly the governance of water then one of the objective be to develop critical thinking and. So, that the attendees those who are attending the course can develop that critical thinking and demonstrate some problem solving and decision making skills for managing water related issues.

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COURSE INTRODUCTION

✓ **What to Study**

- Water resources availability and distribution (National and Global Perspective)
- Water demand and uses patterns
- Valuing Water and Water Pricing
- Economics of Water Projects
- Conflicts and Disputes Management
- Management and governance of water in India
- Water Rights
- Water Sustainability
- Global Water Diplomacy
- Challenges and Open Issues

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So, that will be sort of when we may discuss some specific case studies that time these aspects will be elaborated further.

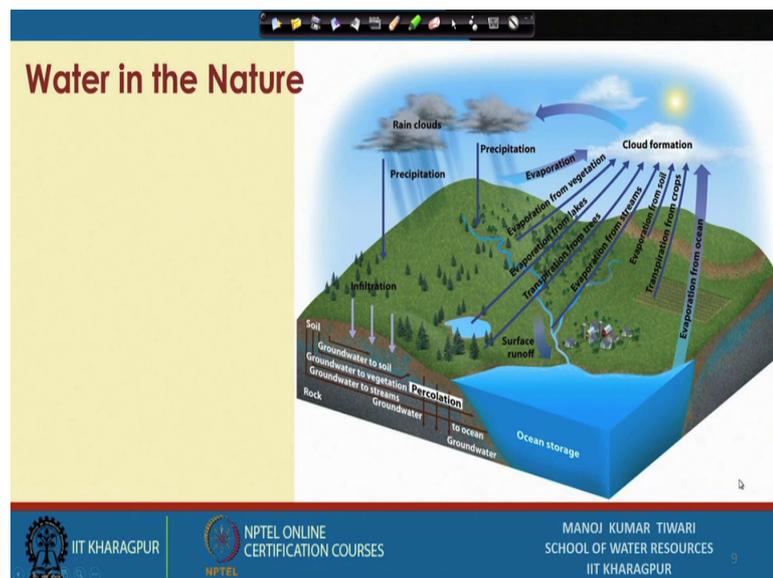
What eventually we will study through this course sort of content of this course although it will be available to you separately, but what primarily we are going to discuss is onto the water resources availability and distribution. So, what are the national and global prospective onto the water resource availability and distribution then the demand and use patterns how what is the demand of water how much water is being used in various sectors and all that we will get the quantitative assessment of these things, then we will also be talking about how we value water and what is the basically price of water how water is priced.

So, we will have discussions onto valuing water and water pricing we will also talk about the economics of water projects apart from that the water rights what is water sustainability how the water is managed and what is the governance of governance structure of water particularly in India towards the end of the course, we will talk about the global water diplomacy conflicts and dispute managements and some of the major challenges and open issues that needs to be taken care while discussing or while addressing water issues.

So, that was about sort of general introduction to the course and its importance why at first place one should study this; what one should expect while attending this course. So,

that was some introductory remarks onto that and with this we would now come onto the specific topics as just in the previous slide we were telling that we will discuss several sections one by one. So, what we are going to start with is the availability of water and its uses.

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Now, if you see the water in the nature, remains in various forms and as from the these days, even from the basic schools, people are being taught about the water cycle or hydrological cycle. So, many of us are aware that there is something called water cycle or the water cycle which sort of informs about the movement of water from one phase to another phase.

In this process, what we tend to what information we tend to get is where water is stored and through which process or which means it can change its storage destination this storage destination no way storage destination is permanent water has some lifespan in different mediums and that lifespan varies from very small to a very great extent, but it is a cyclic process and water basically changes phases and that way through various processes.

It changes phases quality volume everything the ocean is sort of the biggest storage or biggest you can say the sink of water from where you can take at this as a start point or end point whichever way one sees and then through evaporation it goes to the

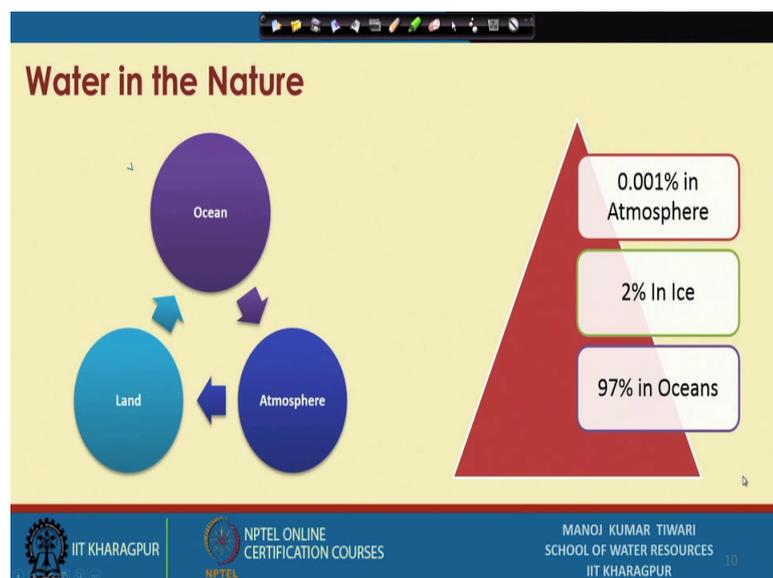
atmosphere where there are cloud formation and this thing the cloud formation is takes place.

These clouds travel in the atmosphere and then come down to the soil in the form of precipitation which could be rainfall or snowfall any form of precipitation. Now when water comes onto the soil part of it infiltrates to the groundwater which again flows or percolates to the ocean eventually through migrating maybe there are intermediate storages.

It could go to the lake it could go to the rivers or it could eventually like rivers also connect to the ocean that way, but it will eventually find its way towards the ocean the one that actually is goes into the subsurface infiltrates. So, there is it; although, it is stored for a quite some time and that is what is groundwater what we refer to; however, part of it from the soil surface itself goes again into the atmosphere in the form of evaporation or transpiration which is from the green surfaces. So, through this evapotranspiration part of water again goes to the atmosphere.

So, this cycle of ocean to atmosphere to soil to basically subsoil or subsurface again to ocean. So, this cycle keeps on running ok.

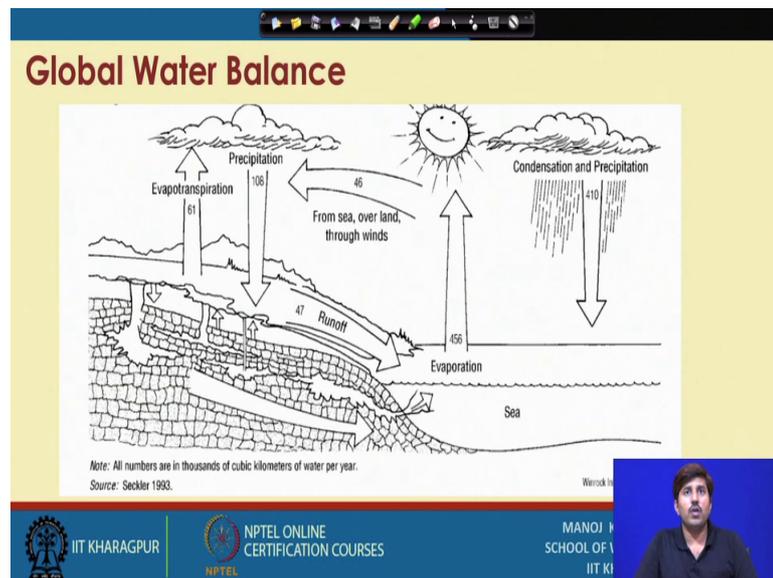
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And that is how the water moves in the nature if we have a cross quantitative estimate what we see is that around 97 percent of the total water lies in the oceans. So, although

there are various agencies and the number varies slightly not very drastically means no one will claim that there is only 90 percent water in the ocean, but somebody says is 97; 97.2; 97.3 and the those sort of variations could be there from source to source generally what we see that on and overall around 90 percent, 97 percent of water is in oceans 2 percent approximately 2 percent in the form of ice which is ice caps and glaciers and of or very little water. If you see in the terms of percentage of the total water available in the biosphere it is only point double 01 percent that lies into the atmosphere.

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The global water balance if you see if you try to see it in terms of number quantitatively again there are different sources. So, one of the sources that you see on your screen is from Shackler which was estimated in 1993 in terms of sort of numbers. So, you see that the almost around 400, 10,000 cubic kilometers of water per year comes from precipitation while 456 leaves in the form of evaporation from the ocean from the sea surfaces while evapotranspiration leads to almost just like 61000 cubic kilometers water and precipitation brings down to one naught 8000 cubic kilometers the atmospheric transport in the form of cloud and all that takes 46000 cubic kilometer of water.

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Water Resource: Global Perspective

✓ The World's Water Supply:

Location	Surface Area (km ²)	Water Volume (km ³)	Percentage of Total Water	Estimated Average Residence Time of Water
Oceans	361,000,000	1,230,000,000	97.2	Thousands of years
Atmosphere	510,000,000	12,700	0.001	9 days
Rivers and streams	—	1,200	0.0001	2 weeks
Groundwater (shallow to depth of 0.8 km)	130,000,000	4,000,000	0.31	Hundreds to many thousands of years
Lakes (freshwater)	855,000	123,000	0.01	Tens of years
Ice caps and glaciers	28,200,000	28,600,000	2.15	Tens of thousands of years and longer

Source: U.S. Geological Survey.

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The better estimate in terms of number is provided by the US geological survey which says that you can see on your screen the total numbers over there. So, you see that if in terms of either volume of water or surface area of ocean or the total percentage almost 97.2 percent of the water is in the ocean as per the estimation by the us geological survey as we were saying that atmospheric part is very low, then there are the next significant part is in the form of ice caps and glacier which is 2.15 percent the freshwater resources what we have what is sort of usable freshwater resources generally we cannot use water in the ocean although after purification and all that we can, but mostly the ocean water is not suitable for human usage.

So, if we discard that we cannot use the water in the ice caps and glaciers. So, even if we discard that. So, 97.2 plus 2.15 makes it 99.35 percent. So, what we are left with is just around 0.65 percent of the total water for our uses and if you see that the fresh water what we primarily used from river of a stream is point triple 0 1. The ground water is 0.31 and in the forms of lake and all that is 0.01.

So, in fact, this is the amount of water this the one that you are seeing here this is the amount of water for which all of us are competing all of us means not just human beings, our ecosystems also because our ecosystems are mostly based on freshwater systems. So, the requirement of ecosystem requirement of human beings requirement of development

growth activities all that mostly rely on this and that is why we say that fresh water is limited resources.

There are there are sort of different residence time of water in the different mediums if you see that. So, the resonant time in the ocean varies thousands of year, while in the atmosphere is as low as 9 days in the river streams, it takes typically two weeks the average time by the time it takes the water to the sea or to the ocean the largest residence time is in form of the ice caps and ice caps and glaciers.

So, something that goes there does not moves for tens of thousands of years and even longer then similarly the groundwater depending on whether it is shallow groundwater or deep groundwater you may the residence time varies largely it may be just hundred years or it may actually extend to several thousands of years. So, that is how the water retains in different mediums in different systems.

So, with this, we will end our; this first session and we will see you all for the next subsequent session where we will continue our discussions from this point forward.

Thank you.