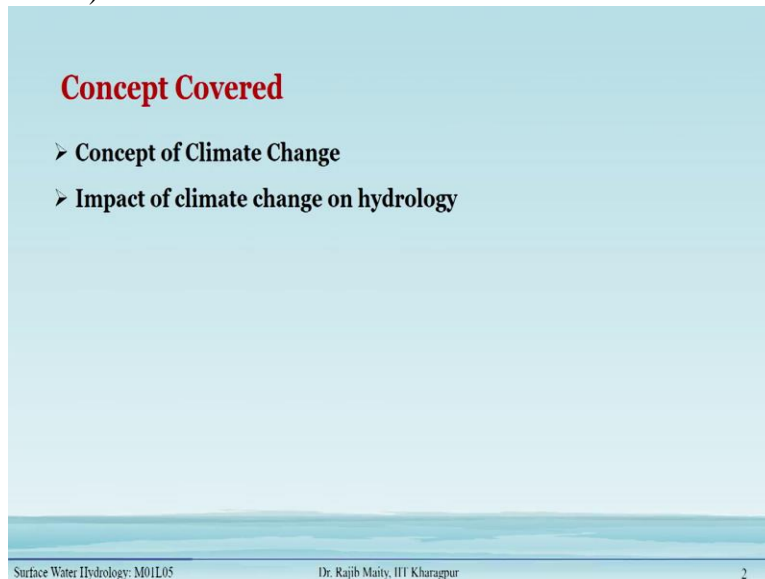


Surface Water Hydrology
Professor Rajib Maity
Department of Civil Engineering
Indian Institute of Technology, Kharagpur
Lecture 5
Hydrology and Climate Change

In this lecture, we will discuss one important issue which is related to hydrology in general, and particularly for surface water resources. It is related to the effect of climate change. So, we will just try to understand what is the link between these two? And what are the causes of concern, that are being faced by this surface water resource?

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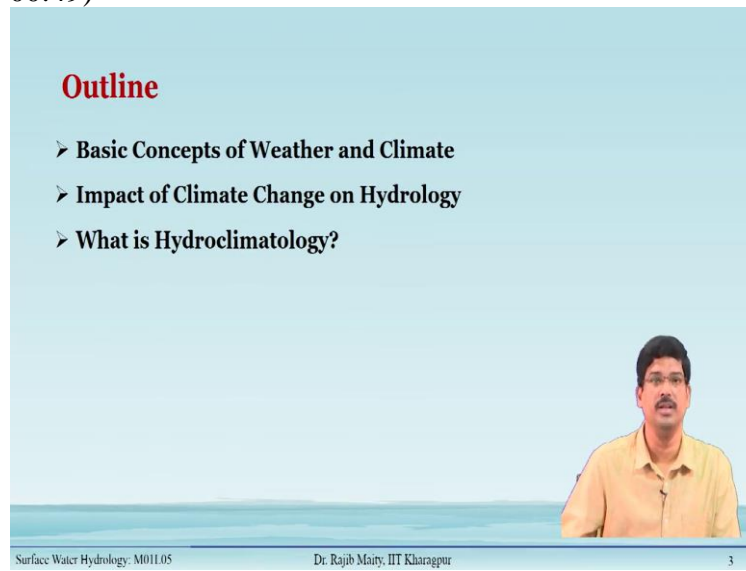
Concept Covered

- **Concept of Climate Change**
- **Impact of climate change on hydrology**

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So, we will try to know what is the concept of this climate change, and we will try to understand the impact of climate change on hydrology.

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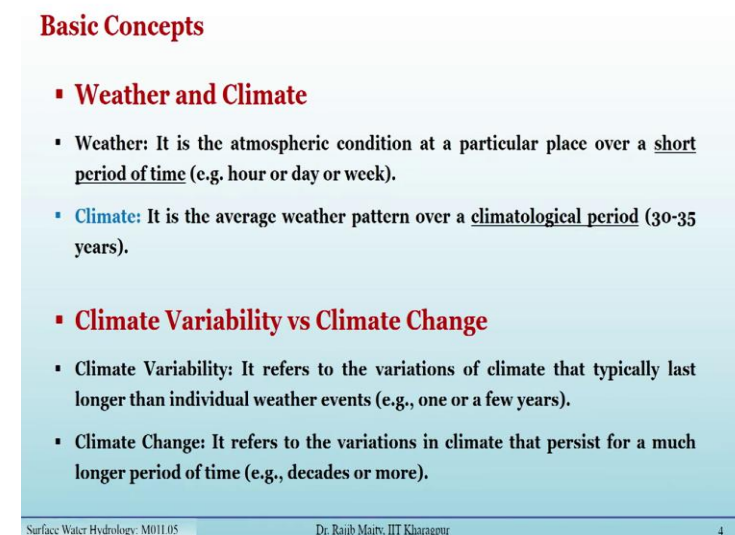
Outline

- Basic Concepts of Weather and Climate
- Impact of Climate Change on Hydrology
- What is Hydroclimatology?

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In this outline, first of all, we try to note the basic concept of weather and climate, what is the difference between these two. Then impact of climate change on hydrology, and then we should know a new term, that is called hydro climatology.

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Basic Concepts

- **Weather and Climate**
 - **Weather:** It is the atmospheric condition at a particular place over a short period of time (e.g. hour or day or week).
 - **Climate:** It is the average weather pattern over a climatological period (30-35 years).
- **Climate Variability vs Climate Change**
 - **Climate Variability:** It refers to the variations of climate that typically last longer than individual weather events (e.g., one or a few years).
 - **Climate Change:** It refers to the variations in climate that persist for a much longer period of time (e.g., decades or more).

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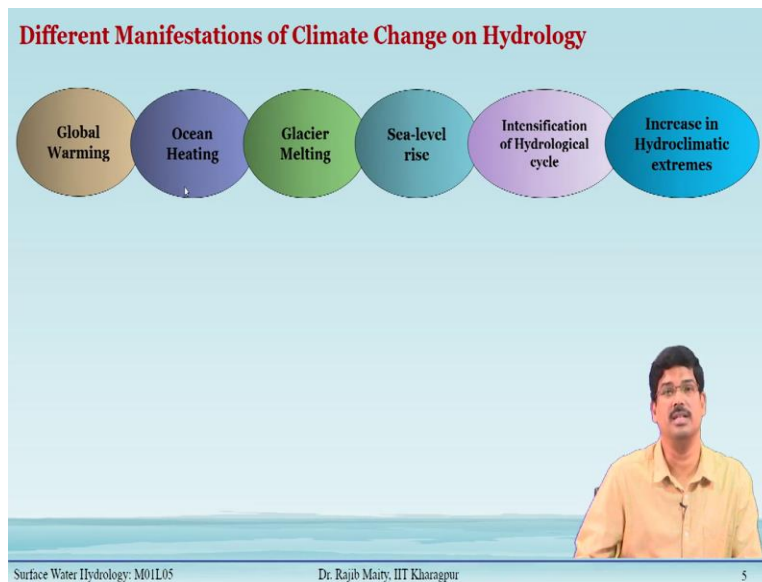
Weather and Climate

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- **Climate:** It is the average weather pattern over a climatological period (30-35 years).

Climate Variability vs Climate Change

- Climate Variability: It refers to the variations of climate that typically last longer than individual weather events (e.g., one or a few years).
- Climate Change: It refers to the variations in climate that persist for a much longer period of time (e.g., decades or more).

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Different manifestations of climate change are as follows:

1. Global Warming
2. Ocean Heating
3. Glacier Melting
4. Sea-level rise
5. Intensification of Hydrological cycle
6. Increase in Hydroclimatic extremes

Different Manifestations of Climate Change on Hydrology

- Intensification of water cycle means that all of its components are enhancing, i.e. more evaporation, more precipitation and more run-off etc. Many strong evidences for such intensification have been reported.
- The warmer climate increases the moisture holding capacity of atmosphere. Moreover, with increase in average surface temperature, evaporation and evapotranspiration from land-mass and ocean are likely to increase. More evaporation leads to more rainfall which is expected to fall predominantly over land. Thus enhancing each components of Hydrological cycle.

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Many times, in recent years, we have seen that our cities or our different locality in India and in general in all over the world, are receiving some unprecedented rainfall. So, it is causing some temporary waterlogging and there are so many devastating things that we see. So, this is thought to be one of the major impacts of climate change and that hydrology, in general, should be concerned with. And of course, surface water management is one of the major issues in this aspect.

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Different Manifestations of Climate Change on Hydrology

- As an overall consequence of global warming and intensification of global water, hydroclimatic extreme events are increasing in different parts of the globe. Numerous studies have proved that, not only the magnitudes, the frequencies of extreme events are increasing too (IPCC, 2013).
- Incidents like intense rainfall, heat waves, droughts, floods, cyclones are more frequent and severe in the recent past.
- Such extreme events have some fatal immediate and far-reaching consequences like loss of lives, property, food grains, infrastructure, which affect the socio-economic growth of a country.

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Introduction to Hydroclimatology

Hydrology is the science that involves studies related to occurrence and movement of water in the combined system of surface, subsurface and atmosphere.

Climatology is the field of study related to exchange of mass, momentum and energy between land/ocean surface and atmosphere. Vertical and horizontal uses of these quantities drive the interaction between earth surface (both land and ocean) and atmosphere.

Hydroclimatology is an interdisciplinary area of study that deals with the interaction between hydrology and climatology to identify the influence of the climatic system on different hydrologic processes, which are the parts of hydrologic cycle.

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These are kind of interrelated. ‘Interrelated’ means if the climatological processes, happen between the land surface and the atmosphere, influenced the hydrological processes very much. This we have learned from the hydrologic cycle, in general. Now, these two fields lead to an interdisciplinary field, which is known as *hydroclimatology*.

Thus, *Hydroclimatology* is an interdisciplinary area of study that deals with the interaction between hydrology and climatology to identify the influence of the climatic system on different hydrologic processes, which are the parts of hydrologic cycle.

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Role of Hydroclimatology in Surface Water Hydrology

Atmospheric component of hydrologic cycle is coupled with climatic phenomena and thus, any change or variability may affect each other through different feedback systems.

- For example, hydrologic variables, such as rainfall, soil moisture, streamflow etc. are significantly influenced by various global or local scale atmospheric circulations.
- In the context of climate change, role of hydroclimatic studies have become crucial in many applications.

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Impact of Climate Change on Surface Water Hydrology

- Climate change is considered as one of the most important burning issues in this 21st century's world. It has already been proved that world's climate has changed significantly in the past and it will continue in the future too.
- This changing scenario of climate has many immediate and far-reaching impacts at global, as well as at regional level. Such impacts can be identified in water resources sector, agricultural sector and socio-economic sector of a country.
- Due to its strong association with the economic prosperity of a nation, climate change has got widespread attention.
- Heavy rainfall, floods, droughts are some of the global concerns and thus emerges as a multi-dimensional research domain.

Source: <https://climate.nasa.gov/>

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Why is it important in Surface Water Hydrology?

- The arithmetic mean of any variable (e.g. precipitation, streamflow) over a climatological period is considered as climatologically 'normal'. Climatologists most often compare present climatological situation to that of the past or what is considered 'normal'.
- Such studies have shown that the 'normal' behaviour of different variables throughout the world is changing all across the world due to the effect of 'Climate Change'.



Heavy Precipitation in Assam
(<https://weather.com/> July 2019)

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Such studies have shown that the 'normal' behaviour of different variables throughout the world is changing all across the world due to the effect of 'Climate Change'. The image in Fig. 1 shows a snapshot of heavy rainfall in Assam in July 2019.



Fig. 1: Heavy Precipitation in Assam (<https://weather.com/> July 2019)

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Summary

- Climate change is likely to have various immediate and far-reaching impacts on water resources.
- Overall different components of hydrological cycles is accelerated causing intensification of hydrological cycle.
- This has imposed new set of challenges in the conventional approaches in surface water hydrology.
- Hydroclimatology is an interdisciplinary area of study that deals with the interaction between hydrology and climatology to identify the influence of the climatic system on different hydrologic processes, which are the parts of hydrologic cycle.

Summary

In summary, we learnt following points from this lecture:

- Climate change is likely to have various immediate and far-reaching impacts on water resources.
- Overall different components of hydrological cycles is accelerated causing intensification of hydrological cycle.
- This has imposed new set of challenges in the conventional approaches in surface water hydrology.
- Hydroclimatology is an interdisciplinary area of study that deals with the interaction between hydrology and climatology to identify the influence of the climatic system on different hydrologic processes, which are the parts of hydrologic cycle.