Hydrology (Course Code: CLM102)

Fall semester, 2018-2019

Coordinator	**Jambay**
Credits	5 ECTS (Compulsory course), 60 in-class hours
Lecturers	**Jambay** (Environment and Climate Studies, The College of Natural Resources, Royal University of Bhutan) **Ugyen Dorji** (Environment and Climate Studies, The College of Natural Resources, Royal University of Bhutan) **Jigme Thinley** (Department of Sustainable Development, College of Natural Resources, Royal University of Bhutan)
Level	BSc
Host institution	**Department of Environment and Climate Studies**
Course duration	March 01 – May 15 2019

Summary

This 5 ECTS course covers topics on hydrological cycles, evapotranspiration, infiltration, ground water, measurements, hydrological measurements, climate change impacts and mountain hydrology. Understanding the concept of hydrology and geology is vital with regard to the mountain geology, agriculture and dependence of local population on resources affected by monsoon rains.in this course, students will develop the understanding of hydrological process and how it is affected in mountain geology, and learn the different measurement techniques. Students will then apply the concepts while doing field exercises.

Target student audiences

Second year BSc students who will become professionals in environmental science.

Prerequisites

None

Aims and objectives

This module will equip the students with knowledge on the movement, distribution, and quality of water including hydrological cycle, snow and water resources constrained by climate variability and change and its impact.

General learning outcomes:

By the end of the course, successful students will:

- Explain the hydrological process linking climate and geography,
- State how data is generated and how the volume of water is calculated at household levels,
- Create hydrograph based on the available hydrology data,
- Analyse and interpret the temperature, precipitation and discharge data,
- Analyse vegetation structure and its relation to water discharge and explain how vegetation dynamics influences ground water recharge and discharge,
- Create hydrological models linking temperature, mountain glaciers, snow melt and their impact on river water discharge.

Erasmus+ CBHE project Sustainable Natural Resource Use in Arctic and High Mountainous Areas

Overview of sessions and teaching methods

The course is delivered in the mix mode of theory and practical where students learn about theory and apply the methods and processes in the laboratory and also in the field during the block week field visits. The class will be organized into lectures, quizzes, case studies, and laboratory experiments.

Course workload

The table below summarizes course workload distribution:

Activities	Learning outcomes	Assessment	Estimated workload (hours)
In-class activities			
Lectures	Understanding concepts, methodology and tools	Class participation	30
Moderated in-class discussions	Methods used in measuring discharges and generating hydrographs.	Class participation and preparedness for discussions	30
In-class assignments	Building a model to understand the watershed level hydrological cycles and the different components where hydrological cycles are affected by different components of watersheds.	Class participation	30
Independent work			
Group work: - Contribution to the case-study projects - Efficient and proper use of equipment	Ability to measure the different hydrological parameters such as stream flow, volume calculations and interpretation of hydrograph.	Quality of group assignments	20
Course group assignment	Ability to conceptualize and frame an environmental governance problem, find related literature and data, interpret data, use the concepts, tools and methods covered in the course, and draw policy/management relevant conclusions	Quality of their presentation	20
Reading and discussion of assigned papers for seminars and preparation for lectures	Choose specific component and generate measurement data creatively to clarify key concepts, tools and methods as reflected in the literature.	Class participation, creativity and validity of data generation process.	20
Total			*150*

Grading

The students' performance will be based on the following:

- Level of preparedness for participation in class discussions and seminars (20 %) (from 100 % for active participation and demonstrated familiarity with the course readings to 0 % for completely ignoring in-class discussions);
- Laboratory performance which will be assed based on the laboratory record seminar group assignments (20 %) (from 100% for reporting the laboratory record which is properly done as input to 0 % for non-reporting);
- Use of equipment and generation of quality data (20%)
- Quality of the Presentation (40%)

Course schedule

Day	Time	Topic	Lecturer
Monday 4 March	13:15 – 16:15	Basic Concepts of Hydrology Definition of Hydrology Scientific hydrology and engineering hydrology	Jambay
Wednesday 6 March	13:15 – 16:15	Cryosphere Formation of glaciers, ice caps and ice sheets	Jambay
Friday 8 March	09:15-12:15	Glacier mass balance Measuring glacier mass balance and ice dynamics	Jigme Thinely
Wednesday 13 march	13:15 – 16:15	Evaporation and Evapotranspiration Evapotranspiration Estimation of evaporation	Ugyen Dorji
Friday 15 March	09:15-12:15	Use of GIS to delineate watershed, determining the location of catchment and watersheds.	Ugyen Dorji
Monday 18 March	09:15-12:15	Infiltration Infiltration capacity Infiltration measurement Factors affecting infiltration capacity	Jambay
Friday 22 March	09:15-12:15	Streamflow Measurement Methods of measuring streamflow Monitoring of minimum environmental flow	Jambay
Wednesday 27 March	13:15 – 16:15	Legislative requirements for E-flow as per the national Acts and Regulations Tools and models used in E-flow	Ugyen Dorji
Monday 8 April	09:15-12:15	Hydrograph and Hydrological Process Components of a hydrograph	Jambay
Wednesday 10 April	13:15 – 15:16	Runoff characteristics of streams Unit hydrograph analysis and its application	Jambay
Friday 12 April	09:15-12:15	Groundwater Porosity and permeability Aquifer propertise	Jambay

Wednesday 17 April	13:15 – 16:15	Seasonal fluctuations of water table Groundwater flow	Jambay
Tuesday 23 April	13:15 – 16:15	Cryosphere and Glaciers, Glacial lakes, Measurement and monitoring.	Jigme Thinley
May 6 Monday	13:15 – 15:16	Submission of final project reports by students	Jambay

Course assignments

Course assignments will constitute a project:

- Assignment #1 (mostly in-class) – a quizzes on hydrological concepts.
- Assignment #2 (mostly in-class) – tools for measurement and their applicability for different stages of hydrological cycle such as discharge, evaporation and transpiration including precipitation.
- Assignment #3 – Laboratory work for use of equipment associated to hydrology
- Assignment#4- field work on generation of quality data.

To complete the assignments the class will be divided into several groups. **Assignment #1** will help students to understand the concepts and understanding the scope of the problem (ppts and oral presentations will be used during the class).

Assignment #2 will link Assignment #1- students will learn how to use equipmet, standardization and generating valid data (Laboratory record).

Assignment #3 – students will conduct practical classes in the laboratory and practice use of equipment (assessment will be based on the laboratory record).

Assignment #4 – students will generate quality data through field visits and maintain a field record.

Literature

1. Brooks, K.N., Ffolliott, P.F., Magner, J.A. (2012). Hydrology and the Management of Watersheds. John Wiley & Sons. ISBN: 9781118459768
2. **Dawei, H. (2010). Concise Hydrology**. **Publisher**: BookBoon, **ISBN-13**: 9788776815363
3. Garg, S.K. (2007). Hydrology and Water resources engineering. Khanna Publishers. ISBN: 81-7409-061-4
4. Reddy, P.J.R. (2005). A Text Book of Hydrology. Firewall Media. ISBN: 9788170080992