Syllabus: GGR206 Introduction to Hydrology

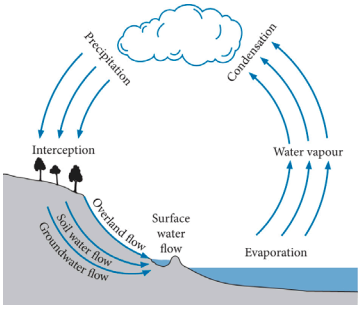
Class Tuesdays 12 to 2 pm

Online

Instructor

Instructor Email: jing.chen@utoronto.ca

Office Hours: 2-4 pm, Tuesdays



Hydrological cycle involving the major processes of evaporation, condensation, precipitation, interception, and runoff.

Course Description

Hydrology is the science dealing with the waters of the earth, their occurrence, distribution and circulation, their chemical and physical properties and their interaction with the environment". This course encompasses major hydrological processes, including precipitation, evaporation, transpiration, rainfall interception, soil water, ground water, and runoff. The emphasis of this course will be on the basic principles of these physical processes forming the complete hydrological cycle at global, regional and watershed scales. A series of 4 assignments are given for students to gain practical skills in hydrological analysis.

Learning Outcomes

Hydrological phenomena are happening around us every day. Through this course, students will develop appreciation of the physical world in which we live and the role of water in various natural phenomema. Students will also develop basic skills in using and analyzing hydrological data for addressing scientific and societal issues related to water.

Course Organization

All teaching materials, including lectures in Power Point, readings, assignments, etc., will be provided in Quercus. The assignments will also be submitted to Quercus.

Assignments and Evaluation

4 assignments 40%; mid-term exam 20%; final exam 40%.

Assignment 1 – Unit Conversion and Precipitation

Due on 13 October, 10%

Knowing the basic physical units is essential in understanding hydrological processes. Some selected unit conversions will be practiced to help understand several key units. It is important that you understand the meaning of speed, acceleration, force, pressure, etc. through the unit conversion.

Some calculations of saturated water vapor pressure and relative humidity will be practiced in preparation for understanding precipitation processes. A local rainfall record will be analysed and compared with a global precipitation intensity chart.

Assignment 2 – Evapotranspiration

Due on 27 October, 10%

Evapotranspiration (ET) consists of transpiration from vegetation and evaporation from wet vegetation and soil surfaces. Several ET models will be practiced using a set of input data.

Assignment 3 – Rainfall Interception and Soil Water

Due on 17 November, 10%

A simple physically-based model will be used to calculate rainfall interception by vegetation of various densities under different rainfall intensities. Calculations of soil moisture will be made using gravimetric measurements. Hydraulic conductivity will be estimated from soil moisture for different types of soils.

Assignment 4 – Runoff

Due on 8 December, 10%

Various semi-empirical models will be evaluated for estimating river runoff as a result of lateral water flows over land and in the ground. The emphasis is on understanding hydrographs resulting from various processes controlling quick and base flows.

Late Penalties

Late assignment reports will be penalized at 10% of the portion of the lab for each day of delay, i.e., a multiplying factor of 0.9 will be used for 1-day delay, and 0.8 for 2-day delay, etc.

Required Text

Textbook (students need to have your own copy)

Ward, R. C. and M. Robinson, 2011, Principles of Hydrology. 4th Edition. McGraw-Hill India. ISBN 1259002241

Reference books (relevant chapters will be provided in Quercus)

Hendriks, M. R., 2010, Introduction to Physical Hydrology, Oxford, ISBN: 9780199296842.

Jones, J. A. A., 1997. Global Hydrology: Processes, Resources and Environmental Management. Longman.

Course Schedule

Week 1, 15 September

Introduction to the course and global hydrological cycle (I)
Questions:
(1) Why is hydrology important and how is it related to daily life and society?
(2) What are the significances of water phase changes among gaseous, liquid and solid forms?

Readings: WR 1.1 – 1.3
WR: Ward and Robinson (2011) – textbook
H: Hendriks (2010) – reference book
Jones: Jones (1997) – reference book

Week 2, 22 September

Topic: global hydrological cycle (II) and precipitation processes (I)
Questions:
(1) What are the major processes in the global hydrological cycle?
(2) Under what conditions do clouds form and precipitate?

Readings: WR 1.1 – 1.3, WR 2.1 – 2.1.1

Week 3, 29 September

Topic: precipitation processes (II) and precipitation measurement
Questions:
(1) What are the major clouds and weather systems that produce rain and snow?
(2) What are the major equipment and instruments for measuring precipitation and how?

Readings: WR 2.1 – 2.2.3, H 2.4

Week 4, 6 October

Topic: precipitation analysis and evaporation processes
Questions:
(1) What are the major methods for analyzing the spatio-temporal patterns of precipitation?
(2) What are the physical characteristics of evaporation and how to quantify evaporation?

Readings: WR 2.6; H2.5, WR 4.1 – 4.2

Week 5, 13 October

Topic: transpiration processes and evapotranspiration estimation and measurements
Questions:
(1) What are the driving forces for transpiration from plant leaves?
(2) What are the major models for estimating ET and major techniques for measuring ET?

Readings: WR 4.4.3 – 4.4.4; WR 4.6.1 – 4.6.2, H2.56 – 2.7

Week 6, 20 October

Topic: mid-term exam and rainfall interception

Questions:

(1) How do vegetation density and rainfall intensity affect rainfall interception?
(2) What is the difference between interception and interceptional loss?

Readings: WR 3.1 – 3.4; WR 3.6

Week 7, 27 October

Topic: soil water properties and soil water movement (I)

Questions:

(1) What are soil moisture content, soil water storage, wilting point, field capacity and water potential?
(2) What are the forces causing soil water movement?

Readings: WR 6.1 – 6.3.2; WR 6.3.3 – 6.3.5

Week 8, 3 November

Topic: soil water movement (II) and soil water measurement

Questions:

(1) How does soil texture affect water infiltration, vertical redistribution and capillary rise in the soil?
(2) What are the major instruments for measuring soil moisture and water potential and their physical principles?

Week 9, 10 November

Reading week

Week 10, 17 November

Topic: ground water properties and ground water movement (I)

Questions:

(1) What are aquifer, aquitard, confined aquifer and perched aquifer?
(2) What are the forces causing ground water movement?

Readings: WR 5.1 – 5.4.1; WR 5.5 – 5.5.2

Week 11, 24 November

Topic: ground water movement (II) and runoff sources and processes

Questions:

(1) How do soil texture and geological structure affect ground water movement?
(2) What are the major sources of river runoff?

Readings: WR 5.5.3; WR 7.1 – 7.3.4

Week 12, 1 December

Topic: event-based runoff and temporal variations of runoff

Questions:

(1) What are the Hortonian and Hewlett hypotheses for event-based runoff?

(2) What are the main controls on daily, seasonal, decadal and long-term variations in hydrographs?

Readings: WR 7.4.1 – 7.4.2; WR 7.4.1 – 7.4.2

Week 13, 8 December

Topic: spatial variations of runoff and review for the final exam
Questions:

(1) What are watershed morphological effects on runoff?
(2) What are the major Canadian and global runoff patterns?

Readings: Jones 4.2.1 and 6.1.1

Departmental Course Policies

The department will insert a full list of policies before syllabi are posted on the website (see https://geography.utoronto.ca/wp-content/uploads/2019/07/Graduate-Course-Policies-DRAFT-FINAL-July-3-2019.pdf).