GEOG 303 – Physical Hydrology

University of Waterloo, Geography and Environmental Management

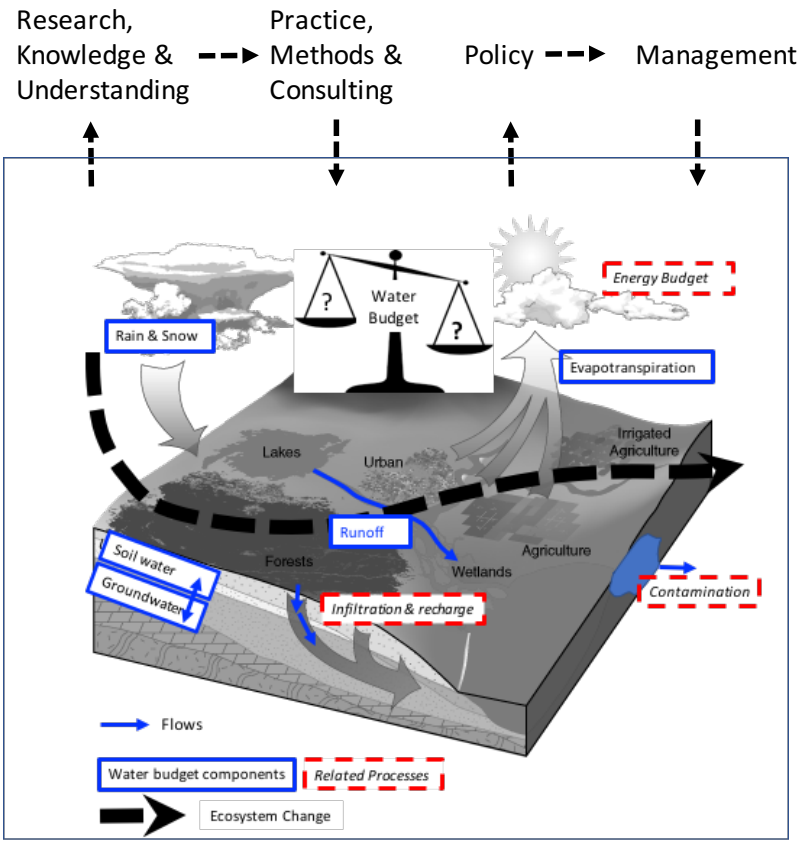
Fall 2019 (04/09/2019)

Instructor: Jonathan Price, EV1-122, jsprice@uwaterloo.ca. Office hours TBA
Teaching Assistant: TBA

Meeting times: Monday 2:30-4:20 HH 139
Wednesday 2:30-4:20 EV1 132

Course Description

How much water do ecosystems use? What environmental features control the flows and stores of water, and how do we measure and assess it? These are the fundamental questions that hydrologists address. This course will examine the key controls on each major component of the hydrological cycle that affect water cycling within and between watersheds and ecosystems, as depicted on the accompanying conceptual diagram that maps out features of the course. Take a minute to look and think about the diagram. We examine how water enters the system via infiltration and recharge of rain or snowmelt, exchanges between the unsaturated and saturated zone below the ground, and its transfer and loss to evapotranspiration and surface runoff. Hydrological controls on water quality and contamination will also be considered. An underlying theme will be to examine how environmental setting and environmental change affects ecosystem hydrology. We will explore theoretical and practical aspects of the hydrological cycle, by focusing the course around a field-based investigation designed to familiarize you with data collection, management and analysis. You will evaluate the fluxes and stores to and from a portion of Luther Marsh Wildlife Management Area and calculate the water balance and its uncertainty. In this course, you will gain knowledge and experience needed for careers that involve doing fieldwork, developing policy and implementing management of water and ecosystems.



Intended Learning Outcomes

At the end of the course student should be able to:

1. Describe the key controls on each major component of the hydrological cycle
2. Relate the sensitivity of these components to different environmental settings and environmental changes
3. Use field methods to collect and collate raw data, perform lab-based soils analyses to characterize key physical and hydraulic properties
4. Calculate the hydrological fluxes and water stores for a given field site, and complete the water budget
5. Evaluate the reliability of these (imperfect) data and calculations
6. Synthesize the results in the context of current knowledge, by preparing a journal-style report

Evaluation

Lab exercises	25% (10+10+5)
Field Trip Report	10%
Term Assignment	25%
Quizzes (10% each)	30% (best 3 of 5)
Participation‡	10%

Lectures

Class time will be used for a series of lectures, labs, help sessions and discussion periods, following the itinerary set out below as much as possible. Material will be drawn from a variety of sources, but mainly from the assigned text and readings provided, including web resources provided in the "Course Organization Table" below. This table will be updated weekly (on LEARN) as lecture materials, labs, etc. approach. Slides used in the lectures will be available before the lecture, so you may use them for taking notes. You are expected to read the relevant section of text in advance of the lecture.

Term Assignment and Labs

The Field Trip* and Labs will provide students an opportunity to see and measure some of the important hydrological processes. The objective is to collect samples and data that will be used in the Labs and ultimately for the Term Assignment**. You will be required to meet outside EV2 at the designated time for the bus. Students require appropriate dress, including rubber boots and miscellaneous items noted by the instructor in advance of the lab (e.g. field book). **Students who miss the fieldwork are required to do the alternate assignment.** You will provide an independent field trip report. The Labs will be done and submitted in groups of two. The Term Assignment may also be submitted by the group, or individually if desired. **The penalty for late labs or assignments is 10% per day (including weekends).**

***Field Trip:** There will be an all-day field trip on **Sunday September 15** to Luther bog, near Arthur, Ontario. Travel time ~45 minutes. Field trip fees may be applicable.
If you cannot attend the field trip you must submit a paper (~1500 words + diagrams and references) reviewing methodologies for measuring hydraulic conductivity (one of the important tasks you will be missing). You will be supplied data to complete the term assignment, but this must be done on your own (not in a group).

****Term Assignment:** The Term Assignment is to write a report on the water budget of Luther bog. Instrumentation has been set up to continuously measure rainfall, evapotranspiration, water table and soil moisture. On the field day you will measure water table, hydraulic conductivity and other characteristics of the system, to estimate groundwater discharge. You will also collect soil samples for hydraulic analysis. The term assignment incorporates the data analysis and interpretation you have done in the labs, set into a technical report in the style of a research paper.

Assessment Methods

Each major component of the hydrological cycle will have a quiz associated with it. This will be multiple choice, fill in the blanks, short answer, etc., and some will require calculations. These should encourage you to keep up with the readings and participate in the lectures and discussions. The three best marks on five quizzes will be counted towards your final grade.

‡Your participation mark will be assessed through submitting an annotated photograph that somehow relates to the component of the hydrological cycle we are examining. You will provide one such photo, with a caption that 1) Provides the context of the photo in relation to the hydrological component; and 2) Raises a question that you would like to know about this issue. For each part of this caption you will get a score of either 0 (irrelevant, late or not submitted); 1 (weak); 2 (sufficient); or 3 (strong), and these will be the basis for your participation mark.

Following the field trip, you will provide a copy of your notes, and a description of the study area and methods. This can be used later in your term assignment. The report will be assessed based on the accuracy, clarity and completeness. The feedback you receive will be important for your final term assignment.

The lab exercises portion of your mark will focus on 1) groundwater characterization and parameterization; 2) soil water characterization and parameterization; and 3) evapotranspiration. You will calculate the fluxes and/or storage changes for each of these, which will be used in your final assignment. Your mark will be based on correctly using the data and answering the associated questions that are designed to make you think about the process.

The final assignment is your opportunity to communicate the results of the water balance study, in an effective, scientific format. The field-trip report and lab exercises will provide the base for the final assignment, including all the quantitative information you will need. The objective is to have you synthesize the findings, contextualize them on the basis of related literature, and to learn and use good writing techniques.

Students are expected to be proficient in the use of a spreadsheet (e.g. Excel).

Course Organization Schedule (Key dates, unless notified otherwise)

Monday	Wednesday
	Sept 4 Course Organization Overview of the Local Hydrological Environment *Blackport et al. 2014 Waterloo Moraine*
Sept 9 Introduction to Groundwater Processes *Hendriks p. 49-70;* *Groundwater and wine (YouTube)*	**Sept 11** Groundwater Systems: Measuring and Quantifying Flow in porous media. *Hendriks Sec. 3.11& 3.12* Lab 1 and Field trip preparation
Sunday September 15 Field Trip	
Sept 16 Test 1 Groundwater Processes Groundwater Systems (continued …) Groundwater Case Study (*Grundling et al., 2015*)	**Sept 18** Lab 1 Help. *Victor Mine Case Study* Photo/caption due (groundwater)
Sept 23 Soil Water Processes *Hendriks Sec. 4.0-4.5; Sandbox Demo (YouTube)* *Additional Readings: 1) SW Basics, 2) SW Ret'n*	**Sept 25.** Soil Water Movement. *Hendriks Sec. 4.6-4.8 (to p.170), 4.9. Additional Reading: 3) SW Movement* Lab 1 Due
Sept 30 Test 2 Soil Water Processes Lab 2 Calculating soil water movement and storage	**Oct 2** Lab 2 continued
October 7 Lab 2 Help Photo/caption due (soil water)	**Oct 9** Case Study TBA Lab 2 Due;
Oct 14/16 Thanksgiving and Reading Week	
Oct 21 Atmospheric Processes: Energy Balance and Evapotranspiration. *Hendriks Sec. 2.6&2.7; Box 2.12 (esp. p.39 on energy budget); and Box 2.13.*	**Oct 23** Atmospheric Processes: Evapotranspiration (continued) Lab 3 Calculating Evapotranspiration
Oct 28 Test 3 Atmospheric Processes Atmospheric Processes Evaporation Discussion *Reading* (Price, 1991 - see questions) Lab 3 Help.	**Oct 30** Atmospheric Processes: Precipitation and Interception. *Hendriks Sec. 2.4&2.5; Box 5.10* Photo/caption due (evapotranspiration)
Nov 4 Water Budget Lecture Lab 3 due	**Nov 6** Water Budget (Term) Assignment Photo/caption due (precip/interception)
Nov 11 Snow Hydrology: *Reading TBA*	**Nov 13** Catchment and Hillslope Runoff Processes *Hendriks Sec. 5.5; TBA* Photo/caption due (streamflow/runoff)
Nov 18 Streamflow Character and Analysis. *Hendriks p.244; TBA;* Case Study (*TBA*) **Test 4 Runoff processes**	**Nov 20** Water Budget Assignment Help Session
Nov 25 Water Quality, Contaminant Hydrology *Reading Sanderson et al.1995 (KW area)*	**Nov 27 Test 5 Water Quality: due Dec 3** Water Quality/Contamination Case Study
Dec 2 Water Budget (Term) Assignment due	

Required Text: Hendriks, M.R. (2010) Introduction to Physical Hydrology. Oxford University Press, 331p.

Academic Honesty

Academic Integrity: To create and promote a culture of academic integrity, the behaviour of all members of the University of Waterloo is based on honesty, trust, fairness, respect and responsibility.

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70 - Student Petitions and Grievances, Section 4, http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm

Discipline: A student is expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 – Student Discipline. For information on categories of offenses and types of penalties, students should refer to Policy 71 - Student Discipline, http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm

Appeals: A student may appeal the finding and/or penalty in a decision made under Policy 70 - Student Petitions and Grievances (other than regarding a petition) or Policy 71 - Student Discipline if a ground for an appeal can be established. Read Policy 72 - Student Appeals, http://secretariat.uwaterloo.ca/Policies/policy72.htm