Geography 322 – Environmental Hydrology (2014)

Class meetings: Tuesday and Thursday 14:35 – 15:55
Burnside Hall BH 1B39

Instructors: Nigel Roulet (BH620, 398-4945, nigel.roulet@mcgill.ca)
Bernhard Lehner (BH 612, 398-8794, bernhard.lehner@mcgill.ca)

Teaching Assistants: Chris Amyot and Lorna Harris

Office hours:

Roulet: Tuesday 11:00 – 12:00 and Wednesday 13:30 – 14:15
Lehner: Tuesday and Thursday 16:00 – 17:00 (and by appointment)

Teaching Assistants' Office Hours: TBA

Course Description

The movement and storage of water from the small catchments to river basins will be examined in this course. The emphasis in the first two-thirds of the course is on developing a process level understanding of what controls the rate and magnitude of water flux from its point of entry into a catchment to its exit point(s). We will begin with looking at the exchanges of water between the atmosphere and the surface of a watershed. Then we will trace the one-dimensional flow of water through soils. However, once the water reaches the groundwater system, or if the flow of soil water is impeded causing lateral surface or subsurface flow, we need to treat the catchment as a three-dimensional system. We will apply the knowledge of processes to explain seasonal and storm-event runoff generation.

In the last third of the course we will use this basic knowledge of hydrology to examine the hydrological behaviour of catchments that are located in some of Canada's prominent landscapes: e.g. forests, tundra and permafrost areas, wetlands, and lakes and reservoirs. If relevant we will also look at how human activity has modified the hydrology of the natural landscape. We will conclude the course by looking at some new emerging areas in the hydrological sciences such as the subfield of ecohydrology, and how hydrology might change, or is changing, with climate change.

The objectives of this course are to:

1. provide you with an introduction to aspects of the science of hydrology that will complement your interests in the natural environment and environmental problems;

2. advance your understanding of some of the key aspects of catchment scale hydrological science through the study of the processes that take place under natural conditions;

3. apply this knowledge to explain how water moves through some of Canada's dominant landscapes;

4. examine how human activity might be modifying the hydrology of catchments; and,

5. provide you with an opportunity to familiarize yourself with the scientific literature and peer-reviewed journals on environmental hydrology.

Course Requirements

Assignments: There will be four take-home assignments. These assignments will be introduced in class and will include problems that illustrate techniques used in hydrological analysis.

Mid-term Examination: A mid-term examination will be held, in class, on Thursday, February 20, 2014. The examination will cover the lectures and assignments up to and including the lecture of Thursday, February 13, 2014 - i.e. the first third of the course. The examination will consist of short-answer questions and may have some multiple choice questions. If you miss the mid-term examination for a legitimate reason (with supporting documentation) the value of the final examination will be prorated to include the 15% assigned to the mid-term examination.

Research Project: This year you will do an independent research project that will require you to use the primary literature on a specific topic related to hydrological processes either in small research catchments or in large river basins. The instructors will provide you with a list of landscape settings (e.g. wetlands, arid regions, boreal regions, rainforest, etc.) or large river basins to choose from. The purpose of this project is to expose you to the primary research literature in the hydrological sciences. More details will be provided on the structure of the project in the first few weeks of the course.

The project will be due ***Tuesday, April 8, 2014 at 17:00***.

To assist you with researching your topic there will be an in-class session on how to research the primary literature. This will take place on Thursday February 6, 2014 and will be presented by Ms. Jennifer Zhao, Liaison Librarian for Computer Science, Electrical and Computer Engineering, and Physical Geography, Schulich Library of Science and Engineering, McGill University (jennifer.zhao@mcgill.ca). Ms. Zhao is an excellent resource person to help you and she holds a weekly office hour in the GIC on the 5th floor of Burnside.

Final Examination: The final examination will take place during the normal examination period. The date and location of the examination will be posted by the examination office. The final examination will be three hours long. The format of the examination will be several longer format answer questions (60%), and an application of the knowledge gained in this course to a particular type of hydrological system (40%). If for some reason you need to write a supplemental examination, the supplemental will be worth 35% of the overall course grade. The final examination will cover the material from the entire course.

(Note: According to Senate regulations, instructors are not permitted to make special arrangements for final exams. Please consult the Calendar, section 4.7.2.1, General University Information and Regulations at www.mcgill.ca.)

Policy of material handed in late: Assignments and the annotated bibliography are due at the time and date specified in the course schedule. A 25% late penalty will be applied for any part of the first day an assignment or the project report is late, and an additional 10% late penalty will be applied for each additional day an assignment or essay is late.

Course Grading Scheme

Assignments (4 @ 7% each)	28%
Mid-term Examination	15%
Research project	20%
Final Examination	37%

No extra work will be accepted as a substitute for evaluation in this course.

Course Text and Readings

The textbook for this course is:

Hendriks, M. Introduction to Physical Hydrology. Oxford, 2010. (GB661.2 H46 2010)

It can be purchased at Paragraphe Bookstore (2220 McGill College Avenue Montreal QC H3A 3P9) or as an e-book from several on-line bookstores.

The diagrams used in the lectures come from the textbook and other standard hydrology textbooks, some of which are listed below. We asked the Schulich Science and Engineering Library to place these books on reserve:

Arnell, N. Hydrology and global environmental change. Prentice Hall, 2002 (GB665 A76 2002)

Dingman, S.L. Physical hydrology. Prentice Hall, 2002 (GB661.2 D56 2002)

Hewlett, JD. Principles of forest hydrology. University of Georgia, 1982 (GB842 H48 1982)

Hornberger, G. et al. Elements of physical hydrology. John Hopkins, 1998 (GB661.2 E44 1998)

We also use a few articles from the electronic Encyclopedia of Hydrological Sciences http://onlinelibrary.wiley.com/book/10.1002/0470848944/toc or hydrological journals during the course. You have to be logged onto a McGill computer (or if using a remote connection you will need to connect through a McGill VPN) to access the EHS. The relevant articles appear in the reading column on the course schedule. Below appears the full citations for the relevant material:

Alley, W.M., La Baugh, J.W. and T.E. Reilly. 2006. Groundwater as an Element in the Hydrological Cycle. Encyclopedia of Hydrological Sciences. John Wiley & Sons, doi: 10.1002/0470848944.hsa153

Bachmair, S. and Weiler, M. 2011. New Dimensions of Hillslope Hydrology. Pages 455-479 in D. F. Levia, editor. Forest Hydrology and Biogeochemistry: Synthesis of Past Research and Future Directions. Springer, New York. doi: 10.1007/978-94-007-1363-5_23.

Brown, R.D. and B.E. Goodison. 2006. Snow Cover. Encyclopedia of Hydrological Sciences. John Wiley & Sons, doi: 10.1002/0470848944.hsa165

Buttle, J. 2006. Rainfall-Runoff Processes: Isotope Hydrograph Separation of Runoff Sources, Encyclopedia of Hydrological Sciences, John Wiley & Sons, doi: 10.1002/0470848944.hsa120

Das Gupta, A. 2008. Implication of environmental flows in river basin management. Physics and Chemistry of the Earth, 33: 298–303.

Hinzman, L.D., Kane, D.L. and M.-K. Woo. 2006. Snow and Glacier Hydrology: Permafrost Hydrology. Encyclopedia of Hydrological Sciences. John Wiley & Sons, doi:10.1002/0470848944.hsa178

Holden, J. 2005. Peatland hydrology and carbon release: why small-scale process matters. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 363:2891-2913.

IPCC Assessment Report 4, Working Group 2. 2007. Chapter 3.4: Freshwater resources and their management, Key future impacts and vulnerabilities. Available at http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch3s3-4.html

McDonnell, J. J. 2013. Are all runoff processes the same? Hydrological Processes (early view). doi: 10.1002/hyp.10076

Pidwirny, M. and M. Pelto. 2006. Glacier. In: Encyclopedia of Earth. Available at http://www.eoearth.org/article/Glacier

Spence, C. 2010. A Paradigm Shift in Hydrology: Storage Thresholds Across Scales Influence Catchment Runoff Generation. Geography Compass 4:819-833.

Winter, T. C. 1999. Relation of streams, lakes, and wetlands to groundwater flow systems. Hydrogeology Journal 7:28-45.

Winter, T. C. 2001. The Concept of Hydrologic Landscapes. Journal of the American Water Resources Association 37:335-349.

McGill myCourses

The myCourses on-line system will be used to post lecture material (sometimes in advance of lectures, sometimes after lectures); assignments; supplemental readings and periodic announcements. In this course we try to use as little paper as possible so we will only use hand-outs when it is necessary. We will investigate the electronic submission of assignments and project report. We will also use the gradebook on myCourses if we can master it.

Communications by e-mail between students and the instructors

On January 1, 2004, McGill University instituted a policy that e-mail will be the official channel of course communication between instructors and students (see http://www.mcgill.ca/email-policy/). The e-mail address for that communication is the McGill e-mail address you were assigned when you registered. If you use another e-mail address it is up to you to ensure that the e-mail is forwarded.

For communicating general course news and announcements the instructors will use News on myCourses. The instructors will not answer e-mails on substantive or concept issues about the course material or assignments by e-mail. They are happy to address these questions during their regularly scheduled office hours or will arrange to meet you in an extraordinary appointment if you cannot make their scheduled office hours for legitimate reasons (e.g. course conflicts or scheduling problems; but inconvenience is not a legitimate reason!). The instructors will try to answer your e-mails within 24 hours Monday – Friday during normal business hours (i.e. ~ 08:30 – 17:00) but do not answer e-mails in the evenings or on weekends and holidays.

Academic Integrity at McGill University

McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/students/srr/honest/ for more information).

L'université McGill attache une haute importance à l'honnêteté académique. Il incombe par conséquent à tous les étudiants de comprendre ce que l'on entend par tricherie, plagiat et autres infractions académiques, ainsi que les conséquences que peuvent avoir de telles actions, selon le Code de conduite de l'étudiant et des procédures disciplinaires (pour de plus amples renseignements, veuillez consulter le site www.mcgill.ca/students/srr/honest/).

Student assessment policy

For information on university and department policies for student assessment, please go to http://www.mcgill.ca/geography/studentassessment

Policy on language on assignments and projects

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.

Conformément à la Charte des droits de l'étudiant de l'Université McGill, chaque étudiant a le droit de soumettre en français ou en anglais tout travail écrit devant être noté (sauf dans le cas des cours dont l'un des objets est la maîtrise d'une langue).

Course Evaluation

As with all McGill University courses the evaluation of this course is done on-line through the Mercury system. We value your comments. Please participate in doing the evaluation. We will post when the evaluation period begins.

Copyright of Course Material

Instructor generated course materials (e.g., handouts, notes, summaries, exam questions, etc.) are protected by law and may not be copied or distributed in any form or in any medium without explicit permission of the instructor. Note that infringements of copyright can be subject to follow up by the University under the Code of Student Conduct and Disciplinary Procedures.

GEOG 322 Environmental Hydrology
Course Schedule 2014

Wk	Class	Date	Day	Instr.	Activity NR	Readings	Assignments
1	1	07-Jan	Tues.	NR / BL	Introduction to Environmental Hydrology		
1	2	09-Jan	Thurs.	BL	Basic concepts of catchments and hydrological systems	1-13	
2	3	14-Jan	Tues.	BL	Precipitation I: Measurement and distribution	14-32	
2	4	16-Jan	Thurs.	BL	Precipitation II: Interception and throughfall	14-32	Assignment 1: Precipitation and evaporation ***Due Jan. 30***
3	5	21-Jan	Tues.	BL	Precipitation III: Snow (maybe also glaciers)	Brown&Goodison; Pidwirny&Pelto	
3	6	23-Jan	Thurs.	BL	Evapotranspiration	32-48	
4	7	28-Jan	Tues.	NR	Soil water I: storage and forces	49-55; 141- 163	
4	8	30-Jan	Thurs.	NR	Soil water II: Darcys equation and hydraulic conductivity	62 - 68	***Assignment 1 due***
5	9	04-Feb	Tues.	NR	Soil water III: flux and continuity – Richard's equation	163- 176; 186 - 199	Assignment 2: Soil water ***Due Feb. 18***
5	10	06-Feb	Thurs.	JZ	Research Workshop: Search the Hydrological Literature		
6	11	11-Feb	Tues.	NR	Groundwater I: Physical properties and processes	49-79; 92- 96	
6	12	13-Feb	Thurs.	NR	Groundwater II: Scales of GW flow; Surface water/groundwater interaction	96 – 104; Alley et al. 2005; Winter 1999	
7	13	18-Feb	Tues.	NR	The runoff hydrograph and hydrographic separation	232 – 252; Buttle 2006	***Assignment 2 due***
7	14	20-Feb	Thurs.		**Mid-term test**		
8	15	25-Feb	Tues.	NR	Runoff generation I: Area of low infiltration capacity & Subsurface stormflow	263 - 269	
8	16	27-Feb	Thurs.	NR	Runoff generation II: Areas of high infiltration capacity	269 - 276	Assignment 3: Runoff ***Due Mar. 18***
		04-Mar	Tues.		**Reading Break - no class**		
		06-Mar	Thurs.		**Reading Break - no class**		

Wk	Class	Date	Day	Instr.	Activity NR	Readings	Assignments
9	17	11-Mar	Tues.	NR	Hydrology of Canadian landscapes: Forested catchments		
9	18	13-Mar	Thurs.	NR	Hydrology of Canadian landscapes: Permafrost and cold regions	Hinzman et al. 2006	
11	19	18-Mar	Tues.	NR	Hydrology of Canadian landscapes: Wetlands and peatlands	Holden 2005; Winter 2001	***Assignment 3 due***
11	20	20-Mar	Thurs.	BL	Stream flows I: Discharge measurement	200-201; 221-223; 225-232; Discharge measurement USGS et al. (PDF on myCourses)	Assignment 4: Discharge ***Due Apr. 3***
12	21	25-Mar	Tues.	BL	Stream flows II: Discharge indices and regionalization	Flow_Duration_Analysis; (PDF on myCourses)	
12	22	27-Mar	Thurs.	BL	Stream flows III: Extreme flows, floods and droughts	USGS_100-year-flood; (PDF on myCourses)	
13	23	01-Apr	Tues.	BL	Lakes and reservoirs	Lake_stratification EPA_Illinois (PDF on myCourses)	
13	24	03-Apr	Thurs.	BL	Ecohydrology: Concept of environmental flows	DasGupta	***Assignment 4 due***
14	25	08-Apr	Tues.	BL	Hydrology and climate change	IPCC AR4 WG2, Chapter 3.4	***Research project due***
14	26	10-Apr	Thurs.	BL NR	Summary and review	Slides, readings & course notes	