FOREST AND WETLAND HYDROLOGY — 2019

NRC 528 (3 credits)
SPIRE #: 31181
305 Holdsworth Hall
MWF, 11:15-12:05 pm
Course website on *Moodle*

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Summary

This graduate-level course focuses on water movement through forest and wetland ecosystems. The water balance and the energy balance are used as the analytical frameworks for the exploration of hydrologic processes. The effects of land and natural resource use on the quantity, timing, and quality of water flow—and consequent watershed management challenges and opportunities—are also presented and discussed.

Required Book – de la Crétaz, A.L., and P.K. Barten., 2007. *Land Use Effects on Streamflow and Water Quality in the Northeastern United States.* Taylor & Francis/CRC Press, Boca Raton, FL, 319 pp. (Copy on reserve in the W.E.B. Du Bois Library …along with the electronic copy in the library collection)

Intended Audience

Seniors and graduate students in the Department of Environmental Conservation are the primary intended audience for this course. Other qualified students may enroll with my permission and assistance, if space is available. The enrollment capacity is 20; this reflects the substantial amount of one-on-one mentoring, review and grading needed to effectively deliver this course without a graduate teaching assistant.

Preparation and Expectations

Hydrology and watershed management build upon interdisciplinary training in plant biology, ecology, geology, general physics, and soil science. Part 1 (Chapters 1-5) of de la Crétaz and Barten (2007) provides background information on hydrology, environmental chemistry, aquatic ecosystems, and riparian areas that will be helpful to students who have a strong interest in this course but lack some of the background and core scientific training. Reading assignments, lectures, discussions, and the term project are based on the expectation that students have successfully completed college-level mathematics (pre-calculus), basic statistics, biology, chemistry, and ecology and are proficient with Microsoft Excel (…or can, with my help, quickly reach an intermediate level of proficiency for detailed calculations and scientific graphics). I am reluctant to add a long list of prerequisites in SPIRE that would automatically exclude some highly motivated prospective students. If, however, you are concerned about your preparation for NRC 528 please make an appointment to meet with me during the first week of classes. As the semester progresses please be proactive in seeking my help with the term project.

Here is a symbolic and visual representation of the entire course[1]

Law of Conservation of Mass and Energy: ΣInflows - ΣOutflows $\pm\Delta$ Storage = 0

Water Balance Equation: P - ET - Q $\pm\Delta$ S = 0

P = precipitation, ET = evapotranspiration, Q = water yield, S = storage

$$P - (E + T + I) - (Q_{OF} + Q_{SSF} + Q_{GW}) \pm\Delta (S_{SNOW} + S_{SOIL} + S_{WETLANDS} + S_{LAKES} + S_{STREAMS} + S_{BIOMASS}) = 0$$

Water Balance = *f* (Energy Balance, time, terrain, land use, legacy effects, climate, etc., etc.)

[1] A "water year" (beginning and ending in March) starting from the upper left and proceeding, typewriter fashion, to the lower right, 365 days later — looking from forested uplands across a wetland to an open field about 200 meters away.

Fall 2019 Schedule

Date	Lecture/Discussion Topic	READ	Project Report DUE
W, 4 Sep	Introduction and overview of the course	Ch. 1	
F, 6 Sep	Key concepts: variability and probability of occurrence		
M, 9 Sep	The water balance, water year, and annual hydrograph	Ch. 2	
W, 11 Sep	**Term Project workshop → Part 1**		
F, 13 Sep	The energy balance and energy exchange		
M, 16 Sep	• Solar radiation, terrestrial radiation		
W, 18 Sep	• Latent heat flux, advection, convection, conduction		
F, 20 Sep	Precipitation: storm types, intensity, effects		
M, 23 Sep	**Term Project workshop → Part 2**		**Part 1 due**
W, 25 Sep	Snow		
F, 27 Sep	Snow …continued		
M, 30 Sep	**NO CLASS** …Prof. Barten in Woods Hole, MA for NAS NYC Watershed Project		
W, 2 Oct	Water movement through soils – physical and hydraulic properties	Ch. 3	
F, 4 Oct	• Soil water potential [energy] and hydraulic gradients		
M, 7 Oct	• Permeability and Darcy's Law		
W, 9 Oct	• Infiltration, soil compaction, heat flow		
F, 11 Oct	Interception		
	Columbus Day, 14 October		
Tues, 15 Oct	("Monday") Soil-plant-atmosphere continuum and evapotranspiration		
W, 16 Oct	**Term Project workshop → Part 3**		**Part 2 due**
F, 18 Oct	Streamflow generation – pathways and rates of flow		
M, 21 Oct	Variable Source Area Concept – old water/new water		
W, 23 Oct	Wetland hydrology – unique features and functions		
F, 25 Oct	Wetland hydrology – reservoir routing analogy		
Sat., 26 Oct	**Harvard Forest Study Tour, 9:00 am – 3:00 pm; meet at vans behind Holdsworth Hall[2]**		
M, 28 Oct	Wetland hydrology – flow routing		
W, 30 Oct	Wetland hydrology – vernal pools/ephemeral wetlands		
F, 1 Nov	Riparian Areas		
M, 4 Nov	**Term Project workshop → Part 4**		**Part 3 due**
W, 6 Nov	Aquatic Ecosystems and the River Continuum Concept	Ch. 5	
F, 8 Nov	Open Channel Hydraulics	Ch. 4	
	Veterans' Day, 11 November		
W, 13 Nov	Manning's equation for open channel flow		
F, 15 Nov	Forest management and natural disturbances	Ch. 6	
M, 18 Nov	Forest/wetland conversion to agriculture	Ch. 7	
W, 20 Nov	Forest/wetland conversion to suburban and urban land use	Ch. 8	
F, 22 Nov	**Term Project workshop → Part 5**		**Part 4 due**
	Thanksgiving Recess, 23 November – 1 December		
M, 2 Dec	Mixed land use and cumulative effects	Ch. 9	
W, 4 Dec	Land use effects workshop		
F, 6 Dec	**Exam on Chapters 6-9, de la Crétaz and Barten (2007) (bring a laptop)**		
M, 9 Dec	Case study (TBD) or flex time		
W, 11 Dec	Conclusions and watershed management implications	Ch. 10	
M, 16 Dec	***Term project final report due***		**Part 5 due**

[2] Bring water and a lunch, wear boots or hiking shoes, bring rain gear, a hat, and an extra layer. Hopefully it will rain (data).

Term Project Hydrometeorological Analysis and Interpretation	**Due date**
Part 1: Set-up, temperature and precipitation calculations …scientific graphing	**23 Sep**
Part 2: Snow accumulation and melt, streamflow, and hydrologic response ratio	**16 Oct**
Harvard Forest NSF LTER Study Tour, 9:00 am – 3:00 pm, meet behind Holdsworth	**26 Oct**
Part 3: Evapotranspiration calculations (PET and est. AET) and climatographs	**4 Nov**
Part 4: Nelson Brook/Black Gum Swamp and Bigelow Brook flow regimes	**22 Nov**
Part 5: Final figures and table, discussion and interpretation, peer-review → **Report**	**16 Dec**

Project Grading note: Part 2 grade, if higher, replaces Part 1 grade, …Part 3 grade, if higher, replaces Part 2 grade …Part 4 grade, if higher, replaces Part 3 …Part 5 grade, if higher, replaces Part 4. Otherwise, the sequential grades will be averaged. Your work is due (as a Word file, via *Turnitin* on Moodle) before midnight on the dates listed above. Please schedule your work in NRC 528 and other classes to ensure timely completion of each assignment. Late work will be accepted, but with a 20% deduction. Your project grade will then be the average of the parts.

What former students have to share with you about the term project…

"Many aspects of your time at UMass are intended to prepare you to become a member of the professional workforce. While leaving school with a high GPA is obviously helpful in indicating your qualifications and preparedness to a potential employer, even more so is leaving with a concrete example of the quality and breadth of technical work and professional writing you are able to do. Immediately after graduation, I started a job as a Park Ranger with the MA Department of Conservation and Recreation. I had little relevant work experience, but with my application I attached my term project report for Forest and Wetland Hydrology. It demonstrated to the people hiring me that I was able to produce high quality, well-researched, thorough work, beyond what the other candidates had provided. It was instrumental in landing the job. The format and timeline of this project is an accurate and useful representation of the type of work that will be expected of any student interested in entering the field of environmental science and management, and the inclusion of it in the Forest and Wetland Hydrology course was invaluable for preparing me to become a professional in the field."

Charlotte Axthlem, BS Psychology (with NRC minor), MS (July 2019) in wetlands, hydrology, and soil science

"Even as a student outside of the Department of Environmental Conservation, Forest and Wetland Hydrology was one of the most useful classes I took at UMass. The report is worth the hours of work for the Excel practice alone – hardly a day goes by at my job when I don't open up the program. After graduation, I accepted a position as a landscape architect with an engineering firm specializing in water and transportation. Along with my portfolio and resume, I brought a bound copy of my report for this class and my interviewers were beyond impressed. Without even reading it, the report *looks* impressive (so make sure you spend time on your graphics!) and it proves to your potential employer that UMass has taught you skills that you will actually be using in your day-to-day life as a professional."

Rachel Guilfoil, BLA (with NRC minor), May 2018 …Landscape Designer, Water Services Group, CDM Smith, Boston (https://www.cdmsmith.com/en)

"I have referred back to this project and report several times throughout the past year to complete work for other classes. It also landed me the interview and an internship with MassDEP. They asked for a writing sample with the application packet. The exact words of the Section Chief who conducted the interview were …"Very impressive, it's why you're here. I honestly can't say enough good things about that NRC 528 term project. It was challenging and I had a love/hate relationship with it at times. However, I can definitely say it's one of the most valuable experiences I've had in grad school."

Dorothy Lawrence, Master of Regional Planning and MS3, May 2019

Attendance Policy: Reasonable, case-by-case exceptions will be made for illnesses, family emergencies, or UMass athletic team members. The Health Center, Office of Student Affairs, or Athletic Department can provide documentation for excused absences. **I take attendance at the beginning of every class.** You are responsible for keeping me informed, in advance if possible, about absences and to make arrangements to complete required work.

Course Grade = (((# sessions - # unexcused absences)/# sessions)*100) * 0.1)
+ (Term Project final grade * 0.7) + (Exam grade * 0.2))

Letter grade	Point total
A	>92.5
A-	90 – 92.4
B+	87.5 – 89.9
B	82.5 – 87.4
B-	80 – 82.4
C+	77.5 – 79.9
C	72.5 – 77.4
C-	70 – 72.4
D	60 – 69.9
F	<60

Incomplete Policy – An incomplete (INC) will be submitted if, *and only if*, the student has a documented medical absence (Health Plan) or family emergency (Dean of Student Affairs) during the semester as described in the UMass Amherst attendance policy. In all other cases, the course grade will be calculated as noted above from the work that has been submitted by the last due date (17 Dec).
For 64 pages of detail go to: http://www.umass.edu/registrar/sites/default/files/academicregs.pdf

Statement on Academic Honesty – It is expected that all students will abide by the UMass Amherst Academic Honesty Policy (available online at www.umass.edu/dean_students/codeofconduct/acadhonesty). Sanctions for acts of dishonesty range from receiving a grade of F on the paper/exam/assignment or in the course, loss of funding, being placed on probation or suspension for a period of time, or being dismissed from the University. All students have the right of appeal through the Academic Honesty Board.

This is not a prohibition on working and learning together with fellow students. It is simply a reminder that all submitted work must ultimately be your own, with appropriate attribution of reference material and data sources. Specifically, **you must develop your own spreadsheet for the term project**, including all of its component parts (data, formulae, and graphs), as well as the four interim reports and the final term project report.