Geology 472/572
Surface Water Hydrology
Fall 2015

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Office Hours: MWF 3 to 4 pm, or by arrangement

Text: Physical Hydrology 3nd Ed., S. Lawrence Dingman, 2015

Introduction
Surface water hydrology focuses on the factors that affect near surface runoff and streamflow in a watershed. I use the Lake Whatcom watershed as a model in this course to examine precipitation, evaporation, evapotranspiration, soils and infiltration, snow hydrology, and runoff processes. Through weekly Excel and GIS based exercises we explore data collection and analysis techniques and mathematical modeling in examining hydrologic processes. This course also offers 2 writing proficiency credits so you will learn how to effectively present scientific information in a technical report format.

Course Structure
Lectures
One-hour lectures will be on MWF in room ES 223.

Computer Labs
A one-hour lab will be on Tuesday in the ES230 computer lab.

Assessment
There are six or so projects during the quarter. The projects are Excel and writing intensive, and four involve GIS. The motivation for the projects is to allow you to couple classroom theory with a local watershed and learn how to gather, analyze, and interpret real data from the watershed, and write professional reports.

This course offers 2-credits for writing proficiency. As such, I require that three projects to be presented in a technical report format. I will provide a separate document outlining my requirements for the reports.

Projects will be due at the beginning of the class period of the due date. Projects will be deducted 10% for each day they are late. Projects will not be accepted after graded projects are returned.

Projects
Project 1 – GIS: Characterizing the Lake-Whatcom Watershed
Project 2 – GIS: Areal precipitation estimates in the Lake-Whatcom Watershed (technical report)
Project 3 – GIS: Soil properties and predicting infiltration rates (Green-and-Ampt Model)
Project 4 – Estimating free-water evaporation from Lake Whatcom (technical report)
Project 5 – GIS: Estimating evapotranspiration using the Penman-Monteith model
Project 6 – Smith Creek Hydrograph Analysis (technical report)

Secondary Exercises
Exercise 1 – Frequency analysis of precipitation data
Exercise 2 – Predicting snow melt using an energy-budget approach
Exercise 3 – Measuring stream discharge using the USGS Midsection method (field groups)

Note: Graduate students will be responsible for an independent research project that will be worth 10% of the Geol572 grade. I suggest a topic that relates to or contributes to your thesis research.

Exams

There is one midterm and a final exam. The final exam is comprehensive, but is weighted more on the second half of the course. The exams are typically short answer essay with an emphasis on process description. At times I integrate problems that require calculations. You are not required to memorize equations, I provide them during exams.

You will be required to take all exams at the scheduled times. Make-up exams will be given only in the case of official prearranged absences or emergencies. An excused absence form from the office of Student Affairs is required.

Grading

The grading break down will be as follows:

Projects………..…45%	(35% for graduate students and 10% for the term project)
Midterm…………25%	
Final Exam………30%	(The final is scheduled for Wed, Dec 9 from 8:00 to 10:00 am)

A grading scale will be as follows (a curve is possible but not certain):
100-93 = A, 92-90 = A-, 89-88 = B+, 87-83 = B, 82-80 = B-, 79-78 = C+, 77-73 = C, 72-70 = C-, 69-68 = D+, 67-63 = D, 62-60 = D-, 60 or below = F

Academic honesty is an important part of every course at WWU. For students, academic integrity means challenging yourself, striving for excellence, taking risks and learning from your mistakes, doing your own work, and giving credit whenever you use the work of others. It boils down to caring about your schoolwork and always being honest in carrying it out.

I begin with the assumption that you come to Western and this class with integrity. However, academic integrity and honesty can be challenging due to such things as ignorance, confusion, stress, bad advice, and bad choices. So to help you keep your integrity and good reputation intact, I have resources for you (meaning, by the way, that ignorance will not be an excuse):

- WWU's Integrity Website http://www.wwu.edu/integrity/ provides all the information you need, including why integrity is important, how to promote it, as well as types of academic dishonesty and how to avoid them, particularly plagiarism. It also includes WWU's policy and procedures on academic honesty (appendix D of the WWU Catalog).

- See me if you have any concerns or questions about academic integrity regarding yourself or your classmates. An ounce of prevention is worth a pound of cure, especially where penalties and one's reputation are at stake. I am here to help. Please read the Integrity section

Please feel free to **talk to me** anytime about your performance in the course or possible ways you can improve.

If you have a documented **disability** you must report to me during the first week of class to discuss your needs. If you need disability-related accommodations, please notify Student Support Services at 650-3083 (phone) or 650-3725 (TTY) or http://www.wwu.edu/depts/drs/

I reserve the right to change the syllabus as required throughout the term to better meet the instructional needs of the class.

SURFACE-WATER HYDROLOGY TOPICS

Introduction – Chapter 1

1. Definition of hydrology and hydrologic cycle and water budgets
2. Elements of a watershed

Streamflow Measurements – Handout and Appendix E

3. Measurement of stage, velocity, and discharge
4. Stage-discharge relation and rating curves

Precipitation - Chapter 4 and Chapter 3 pp. 111-119 and Appendix B

5. Properties of water: hydrogen bonds, heat capacity, latent heats, phase changes, vapor pressure, humidity
6. Physics of precipitation formation
7. Cooling mechanisms (fronts, convective processes, and the orographic effect)
8. Precipitation variability and point measurement
9. Areal averages (arithmetic, Thiessen polygon, and isohyetal methods)
10. Frequency analysis of precipitation data (Appendix C)

Water in Soils: Infiltration and Redistribution – Chapter 8

11. Physical process of infiltration (surface tension and capillarity)
12. Soil-water content, pressure head (suction) and soil-water characteristic curves
13. Hydraulic conductivity (saturated and unsaturated)
14. The infiltration process and the Green-and-Ampt Model
15. Groundwater and baseflow

Evapotranspiration – Chapter 6 and Appendix D and Appendix E

16. Evaporation and mass transfer
17. Evaporation and energy
18. Modeling evaporation (Penman method)
19. Transpiration basics (plant physiology)
20. Interception and leaf-area index
21. Canopy conductance and atmospheric conductance
22. Estimating potential evapotranspiration (Thornthwaite and Penman-Monteith methods)

Snow and Snowmelt – Chapter 5

23. Snow formation, distribution and measurement
24. Snow metamorphosis and snow-water equivalent
25. Snow-pack energy budgets and snow melt
26. Snow melt modeling

Stream Response to Water-Input Events – Chapter 10

27. Contributions to stream flow
28. Hydrographs and hydrograph analysis
29. Effective rainfall

Outcomes Assessment for Geology 472/572

<table>
<tr><th>Course Outcomes</th><th>Course Objectives</th></tr>
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Students will understand the factors that determine the magnitude and timing of stream flow in a watershed, including:

1. the spatial and topographic characteristics of a watershed

2. PNW weather patterns, precipitation formation, and rainfall measurement

3. the relationship between soil physics, infiltration, unsaturated flow and runoff

4. the physics of lake evaporation and forest evapotranspiration

5. snow formation, accumulation and metamorphosis, snow-water equivalent, and snowmelt

6. runoff processes and hydrograph analysis.

Students will also understand:

7. How to properly communicate technical information in a professional written report format.
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Students will be able to:

1.1 Use Hydrology tools in ArcGIS to establish a watershed from a DEM.

2.1 Retrieve precipitation data from internet archives and analyze the frequency distribution of rainfall.

2.2 Apply ArcGIS to estimate areal rainfall averages in a watershed and to analyze precipitation lapse rates.

3.1 Identify a soil using the USDA soil textural classification scheme and import STATSGO soil coverages into ArcGIS

3.2 Determine how soils influence infiltration, subsurface flow, and runoff use the Green-and-Ampt model.

4.1 Estimate lake evaporation using the Penman method and local weather variables

4.2 Import NOAA landcover data into ArcGIS and estimate forest evapotranspiration using the Penman-Montheith method

5.1 Retrieve and analyze data from a SNOTEL site.

5.2 Estimate snowmelt quantities using energy balance model.

6.1 Measure stream discharge and create a rating curve that relates discharge to river stage height.

6.2 Analyze discharge data and quantify hydrograph elements and timing and how they relate to runoff processes.

7.1 Write a professional technical report.
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