

Geosciences 560: Fluvial Geomorphology

Spring 2010

University of Montana

4 credits

Monday, Wednesday 9:10-11; Clapp 348

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Office Hours: M 3:10-4 PM, W 4-5 PM, or by appointment

Fluvial Geomorphology will provide an in-depth investigation of the processes that determine the form and evolution of rivers and streams. The course will combine lectures, discussions, field data collection, and modeling activities. This is not a straight lecture class! Active learning and student participation will be an essential component.

Our inquiries this semester will be guided by several related questions / themes:

- What processes determine the form and evolution of rivers and streams?
- How can we infer process from form and vice versa?
- How do river form and process vary spatially? Temporally?
- How can we apply knowledge about fluvial geomorphic processes to river restoration and management?

Goals

As a result of your experiences in G560, you will have the opportunity to:

- gain a strong understanding of river channel processes and of the linkages between river channel form and process
- acquire fundamental knowledge about fluvial geomorphic processes needed to manage and restore rivers
- communicate an understanding of the interrelationships among fluvial geomorphic concepts and theories to peers and others
- use models, data, and logical reasoning to critically evaluate and connect information about river processes
- interpret and analyze literature about fluvial geomorphology from both secondary and primary sources
- improve your capacity to work as a member of a productive, collaborative team
- gain experience collecting and analyzing field data
- improve writing skills.

Course Website: This course will use Blackboard (<http://courseware.umt.edu/>). Please get in the habit of checking the Blackboard site DAILY for course announcements, notes, and assignments. Lecture notes will be posted when I use powerpoint but not when I rely on the board. Revised versions of the schedule for class sessions and readings in this syllabus may also be posted.

Prerequisites

There are no formal prerequisites, but some background in calculus, physics, and river processes is expected. In lectures, the textbook, and journal papers, you will see a fair amount of derivatives, integrals, and physics concepts such as force, stress, and Newton's Second Law ($F=ma$). However, what I would consider extensive manipulation of equations will not be required. A degree of computer literacy is also required. Assignments will be given involving the use of spreadsheets and retrieval of data over the internet.

Grading

- 50% Assignments: 1) periodic homework assignments; 2) group project.
- 20% Independent project
- 20% Final exam
- 10% Class participation: 1) in-class activities testing and applying material from readings and lectures; 2) leadership of a paper discussion; 3) active participation in paper discussions, 4) questions and other participation during class activities

Field trips

Two Saturday field trips are planned. Each will involve data collection and associated assignments. As a consequence, these are required; please plan your schedules accordingly.

1. Rattlesnake Creek, Saturday, March 13 (March 20 as backup weather date). Data collected on this trip will be used in the group project. It will likely be a cold day for to be in the field, but we need to collect data early enough to begin moving forward with other aspects of the project. Our field data will be used for various geomorphic calculations, modeling, and analyses.
2. Saturday, April 17. Details and site TBA.

We will likely take another field trip during the 2-hour class session at some point in the semester.

Independent project:

The final project will consist of an independent, hypothesis-driven research project on a topic in fluvial geomorphology of the student's choice. Students are encouraged to pursue a topic that will contribute to their graduate or senior thesis research; otherwise I will happily assist students in developing a project. The project must use original research (i.e., not only literature review, and not work already completed prior to this semester) to investigate and test a hypothesis about fluvial processes. A variety of tools may be used, including field data collection, modeling, GIS analysis, etc. The project will culminate in a paper of ≤ 10 pages (1.5 line spacing) and in-class presentations by each student. The paper must follow standard journal paper format (Abstract, Introduction, Methods, Results, Discussion, Conclusion, References Cited, Tables and Figures), and you should consult the "Guidelines for paper writing" posted on Blackboard. Students are encouraged to assist each other with field data collection.

Proposal due: March 24

Meeting with ACW to discuss project: before April 9

Presentations: Each student will give a 15 minute presentation on their project. Presentations will be spread out over the last 2 weeks of class. The presentations will be graded as part of your overall independent project grade.

Paper due date: May 3, 5 pm

Paper readings and discussion:

We will read 1-2 journal papers each week (see list below) and spend a portion of the Wednesday class section most weeks discussing the paper. Each student will lead one discussion and, in preparation, should read the “Guidelines for discussion leadership” posted on Blackboard. These discussions will be designed to encourage critical thinking about primary literature and broad participation.

Students will also be asked to submit a written critical review (not a summary; ≤ 1 page single spaced) on any one journal paper other than the one for which you lead discussion (please see “Guidelines for paper review” posted on Blackboard). Due date: 4/21.

Other notes

1. *Attendance*: Much of the material covered in class will not be in the assigned reading. There will often be in-class activities that contribute to your grade.
2. *Email*. Feel free to communicate with me by email, but 1) I’m not an online help service for homeworks, i.e., don’t email me when you get stuck on a homework question- come to office hours or ask questions at the beginning of class; 2) if you miss class, please do not email me to ask what you missed- check Blackboard and/or talk to classmates; 3) if you hand in assignments electronically, they must be well organized and consolidated into at most two files; you will lose points otherwise.
3. *Late policy*: 1 assignment can be handed in late without penalty, reason, or prior communication. Otherwise 2% of total points are deducted per day late. No credit allowed for assignments handed in > 1 week after due date or after answer key posted, whichever comes first.
4. *Academic Integrity*: All students need to be familiar with and abide by the Student Conduct Code and its definitions of academic misconduct. The Code is available for review online at <http://life.umt.edu/SA/documents/fromWeb/StudentConductCode1.pdf>.
5. *Equal Access*: The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students (DSS). If you think you may have a disability adversely affecting your academic performance, and you have not already registered with DSS, please contact DSS in Lommasson 154. I will work with you and DSS to provide an appropriate accommodation.

Course schedule:

- Class meeting topics are subject to change
- Readings must be completed before class on the day listed; I will try to guide you toward specific sections of Dingman text that are most important for each week.
- Any updates to the syllabus will be announced in class and posted on Blackboard

<i>Wk</i>	<i>Date</i>	<i>Topics</i>	<i>Readings (tentative)</i>	<i>Notes</i>
1	Jan. 25 Jan. 27	Introduction River hydraulics	Dingman 1, Appx A	
2	Feb. 1 Feb. 3	River hydraulics	Dingman 4, 6	
3	Feb. 8 Feb. 10	River hydraulics	Dingman 3 (107-136), 5	
4	Feb. 15 Feb. 17	No class, Presidents Day River hydraulics	Dingman 8	
5	Feb. 22 Feb. 24	Hydraulics Sediment transport	Dingman 9 Dingman 2 (42-57) Wilcock et al. 2009	HEC-RAS lab
6	March 1 March 3	Sediment transport	Dingman 12 Wilcock et al. 2009	
7	March 8 March 10	Sediment transport	Dingman 12 Wilcock et al. 2009	BAGS lab 3/13: Field trip
8	March 15 March 17	Sediment transport	Dingman 12 Wilcock et al. 2009	
9	March 22 March 24	Flow regimes Dominant discharge	Dingman 61-80 Wolman and Miller 1960	3/24: Independent project proposals due
10	April 5 April 7	Hydraulic geometry Bedforms Flow in bends	Dingman 2 (81-93) Parker et al. 2007	4/9: Deadline for project meeting with ACW
11	April 12 April 14	Meandering Floodplains	Dingman 2 (21-42) Braudrick et al. 2009 Lauer and Parker 2008	4/14: Group project due 4/17: Field trip
12	April 19 April 21	Long profiles Bedrock rivers	Whipple 2004	4/21: Paper review due
13	April 26 April 28	Ecogeomorphology River management	Wohl 2006	Student presentations
14	May 3 May 5	Restoration Wrap-up	Schmidt & Wilcock 2008	Student presentations 5/3: Independent project due
15	May 14	Exam (10:10-12:10)		

Topics covered

1. Introduction: Overview of river processes, dichotomies in approaches
2. River hydraulics / Flow mechanics
 - a. Overview of open-channel flow
 - b. Conservation equations
 - c. Types of flow (Steady uniform flow, super vs subcritical, turbulent vs laminar)
 - d. Flow resistance and shear stress partitioning
 - e. Velocity profiles
3. Sediment transport
 - a. Forces on particles
 - b. Incipient motion & critical shear stress
 - c. Estimating transport rates
 - d. Armoring, supply effects
 - e. Sediment transport and channel change
 - f. Sediment budgets
4. Channel morphology (alluvial rivers)
 - a. The bankfull channel
 - i. Hydraulic geometry
 - ii. Flow regimes and dominant discharge
 - b. Bedforms
 - c. Bars and meandering
 - d. Multi-thread channels
 - e. Floodplains and terraces
 - f. River long profiles: Graded streams, base level, downstream fining
 - g. Channel classification
 - h. Interpreting channel condition
5. Bedrock rivers
 - a. Morphology
 - b. Erosion processes
 - c. Role in landscape evolution
6. Ecogeomorphology
 - a. Riparian vegetation
 - b. Large woody debris
7. River management and restoration
 - a. Dams
 - b. Linking process knowledge to restoration

Other topics that may be covered as time permits:

- The channel width problem
- River basin morphology (drainage networks, runoff processes)
- Climate change and river processes
- Geomorphic effects of ice jams
- Modeling tools (computational, physical, remote sensing)

Readings:

Required texts:

Dingman, S.L. (2009) *Fluvial Hydraulics*, Oxford UP.

Pitlick, J., Y. Cui, and P. Wilcock (2009), *Manual for computing bed load transport using BAGS (Bedload Assessment for Gravel-bed Streams) software*, Gen. Tech. Rep. RMRS-GTR-226, 45 pp, U.S. Department of Agriculture, Forest Service, Fort Collins, CO. (free download: <http://www.treesearch.fs.fed.us/pubs/32965>)

Wilcock, P., J. Pitlick, and Y. Cui (2009), *Sediment transport primer: Estimating bed-material transport in gravel-bed rivers*, Gen. Tech. Rep. RMRS-GTR-223, 78 pp, U.S. Department of Agriculture, Forest Service, Fort Collins, CO. (free download: <http://www.treesearch.fs.fed.us/pubs/32966>)

3 other useful references:

Parker, G. *1D Sediment Transport Morphodynamics with Application to Rivers and Turbidity Currents* (e-book; free download: http://vtchl.uiuc.edu/people/parkerg/morphodynamics_e-book.htm)

Knighton, D. (1998), *Fluvial Forms and Processes*, 383 pp., Arnold, London.

Wohl, E. (2000), *Mountain Rivers*, 320 pp., American Geophysical Union, Washington DC.

Tentative list of journal papers for discussion:

Walter, R.C. and D.J. Merritts. 2008. Natural streams and the legacy of water-powered mills. *Science* 319:299-304.

Comments by Bain et al, Wilcock, and Response by authors, *Science* 2008

Montgomery, D. R. 2008. Dreams of natural streams, *Science*, 319(5861), 291-292.

Church, M. 2006. Bed material transport and the morphology of alluvial river channels. *Annual Review of Earth and Planetary Sciences* 34: 325-354.

Montgomery, D.R. and J.M. Buffington. 1997. Channel reach morphology in mountain drainage basins. *GSA Bulletin* 109: 596-611.

Buffington, J. M., and D. R. Montgomery. 1999a. Effects of hydraulic roughness on surface textures of gravel-bed rivers. *Water Resources Research* 35:3507-3521.

Comments by Wilcock, Millar and Rennie, and Reply to comments by authors

Wolman, M.G. and J.P. Miller. 1960. Magnitude and frequency of forces in geomorphic processes. *Journal of Geology* 68: 54-74.

Parker, G., P. R. Wilcock, C. Paola, W. E. Dietrich, and J. Pitlick (2007), Physical basis for quasi-universal relations describing bankfull hydraulic geometry of single-thread gravel bed rivers. *J. Geophys. Res.* 112, F04005, doi:10.1029/2006JF000549.

Braudrick, C.A., W.E. Dietrich, G.T. Leverich, and L.S. Sklar. 2009. Experimental evidence for the conditions necessary to sustain meandering in coarse-bedded rivers. *Proceedings of the National Academy of Sciences* 106(40): 16936-16941.

Lauer, J. W., and G. Parker. 2008. Modeling framework for sediment deposition, storage, and evacuation in the floodplain of a meandering river: Application to the Clark Fork River, Montana. *Water Resources Research* 44, W08404, doi:10.1029/2006WR005529.

Wohl, E. 2006. Human impacts to mountain streams. *Geomorphology* 79:217-248.

Schmidt, J.C. and P.R. Wilcock. 2008. Metrics for assessing the downstream impacts of dams. *Water Resources Research* 44, W04404, doi:10.1029/2006WR005092.