

GEO 449/549: Fluvial Geomorphology

Course Information and Syllabus, Spring 2007

Schedule: T-R, 12:30-1:50 p.m.

Location: 144 Wilkeson

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Instructor: Dr. Sean J. Bennett

Office: 112 Wilkeson Quad

Office Hours: R, 2:00-4:00 p.m.

Course Description: The course examines the classic themes in fluvial geomorphology, including channel hydraulics, sediment transport, dominant discharge, hydraulic geometry, regime theory, channel patterns, river networks, and river channel change, as well as emerging including models and prediction, riverine habitat and riparian vegetation, and stream corridor rehabilitation.

SYLLABUS

Date	Topic	Assigned Reading	Assignment Due
<i>Part 1: Flow and Sediment Transport in Rivers</i>			
1/16	Fluid Flow and Boundary Layers I	B: 17-43; K: 96-107	
1/18	Fluid Flow and Boundary Layers II	B: 17-43; K: 96-107	
1/23	Incipient Motion	B: 44-54; K: 107-113	
1/25	<i>Seminar on Turbulent Flow</i>		Seminar presentations
1/30	Sediment Transport Mechanics I	B: 55-77; K: 118-141	
2/1	Sediment Transport Mechanics II	B: 55-77; K: 118-141	
2/6	<i>Seminar on Sediment Transport</i>		Seminar presentations
2/8	Bedforms and Flow Resistance	B: 78-140; K: 187-205	
<i>Part 2: River Channel Form and Process</i>			
2/13	Hydraulic Geometry and Regime Theory	B: 165-177; K: 167-187	Short Paper #1
2/15	<i>Seminar on Bedforms and Channel Geometry</i>		Seminar presentations
2/20	Alluvial Channel Patterns I	B: 141-204; K: 205-241	
2/22	Alluvial Channel Patterns II	B: 141-204; K: 205-241	
2/27	<i>Seminar on Channel Patterns</i>		Seminar presentations
3/1	Flow in Meander Channels	B: 141-204; K: 205-241	
3/6	Confluences and Networks	B: 177-188; K: 55-64	
3/8	<i>Seminar on Confluences and Networks</i>		Seminar presentations
3/13	NO CLASS		
3/15	NO CLASS		
3/20	Longitudinal Profiles and Downstream Fining	B: 296-297; K: 242-260	Short Paper #2
3/22	Sediment Yield	B: 7-13; K: 65-95	
3/27	<i>Seminar on Catchment Processes</i>		Seminar presentations
<i>Part 3: Adjustments of the Fluvial System</i>			
3/29	Mechanics of Bank Erosion	K: 113-118	
4/3	Adjustments of the Fluvial System	B: 13-16; K: 261-335	
4/5	<i>Seminar on River Channel Change</i>		Seminar presentations
4/10	Fluvial Geomorphology and Vegetation		
4/12	River Restoration		
4/17	<i>Seminar on River Restoration</i>		Seminar presentations
4/19	Conceptual and Numerical Models I		
4/24	Conceptual and Numerical Models II		
4/26	<i>Seminar on Fluvial Models</i>		Seminar presentations
5/4			Term Paper

Required Textbook: *Rivers and Floodplains: Forms, Processes, and Sedimentary Record*, by John S. Bridge, 2003, Blackwell Publishing, 491 pp., (ISBN: 9780632064892, ISBN10: 0632064897; denoted as **B** above).

Recommended Textbook: *Fluvial Forms and Processes: A New Perspective*, by David Knighton, 1998, Arnold, 383 pp., (ISBN: 9780340663134, ISBN10: 0340663138; denoted as **K** above).

Additional Literature: Supplemental lecture material shall be derived from the following books.

Bennett, S.J., and A. Simon, eds., *Riparian Vegetation and Fluvial Geomorphology*, American Geophysical Union, Washington, DC, 2004.

Brookes, A., and F.D. Shields, Jr., eds., *River Channel Restoration: Guiding Principles for Sustainable Projects*, Wiley, Chichester, 1996.

Downs, P.W., and K.J. Gregory, *River Channel Management: Towards Sustainable Catchment Hydrosystems*, Arnold, London, 2004.

Julien, P.Y., *River Mechanics*, Cambridge University Press, New York, 2002.

Robert, A., *River Processes: An Introduction to Fluvial Dynamics*, Arnold, London, 2003.

Resources: All students are encouraged to secure copies of the textbooks. All graphics shown in class will be posted on Ublearns in PDF format.

Course Evaluation: Two (2) minor papers, one (1) term paper, and three (3) seminars per student.

The minor papers are relatively short discussions (~5 pages long, 12-point font, and single-spaced in addition to figures, tables, and references) of a specific topic, focusing on the importance, relevance, and novelty of the subject. Brevity and clarity in writing style and organization will be stressed. Work is based solely on published literature. Plagiarism or the submission of work not your own will result in "0" grade. Topics must be approved by the instructor. No papers will be accepted after due date.

The term paper is a relatively long discussion (~12 pages long, 12-point font, and single-spaced in addition to figures, tables, and references) of a topic, focusing on the critical evaluation of the subject. It will include a literature review, identified gaps in current knowledge, and insight into new research opportunities. For undergraduate students, this paper will be based on published literature. For graduate students, this paper will be an independent project and may entail the collection of field or experimental data, the reduction and analysis of previously collected data, the testing of new hypotheses, and/or the formulation or application of conceptual or numerical models. Plagiarism or the submission of work not your own will result in "0" grade. Topics must be approved by the instructor. No papers will be accepted after due date.

Topical seminars will be presented by students based on a paper selected from the reading list, and these choices must be pre-approved to avoid duplication. Each seminar day will comprise 3 to 4 student presentations, with ~8 minute allotments per presentation with 5 minutes for discussion. A computer with projector and overhead projector will be available for student use. In addition, each student presenter must prepare a 300-word extended abstract of the chosen paper, written in their own words. Attending and participating in seminars is mandatory.

Grades: Below is a table of all required work, deadlines, and the percentage points for student evaluations. Normal university grading procedures will be employed. I reserve the right to add a few percentage points to every student's final grade.

Required Work	Date Due	% of Total Grade
Short Paper #1	5:00 pm, 2/13	15%
Short Paper #2	5:00 pm, 3/20	15%
Term Paper	5:00 pm, 5/4	30%
Seminar Presentations (3)	TBA	8% each (24% total)
Seminar Abstract	Day of Seminar	2% each (6% total)
Class Participation	NA	10%

General Guidelines for Papers:

- Papers should have an Abstract (250-word maximum), Introduction (with objectives of the paper), Methods (if applicable), Results, Conclusions, and References
- Papers will be assessed for content, accuracy, originality, presentation, organization, and overall quality of the writing
- Write concisely
- Keep observations, measurements, and results separate from discussion and interpretations
- Use your own voice; plagiarism will not be tolerated
- All figures and tables require a caption
- Equations should be numbered sequentially in order of appearance, and all variables defined
- All material presented must be accurately and correctly cited
- Citations and references should follow the style and format of the American Geophysical Union
- For short paper, multiple papers on the same topic work best
- For term paper, collection of new data and their presentation works best

General Guidelines for Seminars:

- Students will present seminars standing in front of the class
- Students are allotted ~8 minutes per presentation, with 5 minutes for questions; do not run over time
- Format should be restricted to ~8 to 10 overhead transparencies or slides, focused on the main points of the paper—title and author(s), main ideas, hypotheses, or objectives of the paper, select observations, plots, graphs, or mathematical formulations, and concluding statements or summary
- PowerPoint presentations work best
- Ensure all visual equipment is secured, in place, and working properly with the intended presentation
- Rehearsing the presentation is strongly recommended
- “Less” is generally “more”
- Speak to the audience and not the screen, use a relaxed, confident, and authoritative tone, make eye contact with the audience, and minimize gestures
- Listen to the questions, and respond in a courteous, relaxed manner
- Respect each other at all times
- Students will be evaluated on the clarity, style, and professionalism of their presentation, their command of the topic, the effectiveness of the visual aids, and their time management
- Attendance and participation by all students is mandatory

Reading List. This list represents a selection of recently published papers (primarily in 2006) on topics to be presented and discussed during the seminars. All papers are available in the Science Library, and most are available in electronic form.

1. Turbulent Flow

- Buffin-Bélanger, T., S. Rice, I. Reid, and J. Lancaster, Spatial heterogeneity of near-bed hydraulics above a patch of river gravel, *Water Resour. Res.*, 42(4), W04413, 2006.
- Carollo, F.G., V. Ferro, and D. Termini, Analyzing turbulence intensity in gravel bed channels, *J. Hydr. Engrg.*, 131, 1050-1061, 2005.
- García, C.M., M.I. Cantero, Y. Niño, and M.H. García, Turbulence measurements with acoustic Doppler velocimeters, *J. Hydr. Engrg.*, 131, 1062-1073, 2005.
- Ettema, R., G. Kirkil, and M. Muste, Similitude of large-scale turbulence in experiments on local scour at cylinders, *J. Hydr. Engrg.*, 132 (1), 33-40, 2006.
- Hofland, B., and J.A. Battjes, Probability density function of instantaneous drag forces and shear stresses on a bed, *J. Hydr. Engrg.*, 132(11), 1169-1175, 2006.
- McLean, S.R., and V.I. Nikora, Characteristics of turbulent unidirectional flow over rough beds: Double-averaging perspective with particular focus on sand dunes and gravel beds, *Water Resour. Res.*, 42(10), W10409, 2006.
- Muste, M.; K. Yu, I. Fujita, and R. Ettema, Two-phase versus mixed-flow perspective on suspended sediment transport in turbulent channel flows, *Water Resour. Res.*, 41(10), W10402, 2005.

2. Sediment Transport

- Abrahams, A.D., and P. Gao, A bed-load transport model for rough turbulent open-channel flows on plane beds, *Earth Surf. Proc. Landforms*, 31, 910-928, 2006.
- Almedeij, J.H., P. Diplas, and F. Al-Ruwaih, Approach to separate sand from gravel for bed-load transport calculations in streams with bimodal sediment, *J. Hydr. Engrg.*, 132(11), 1176-1185, 2006.
- Gaeuman, D., and R.B. Jacobson, Acoustic bed velocity and bed load dynamics in a large sand bed river, *J. Geophys. Res.*, 111(F2), F02005, 2006.
- Hassan, M.A., R. Egozi, and G. Parker, Experiments on the effect of hydrograph characteristics on vertical grain sorting in gravel bed rivers, *Water Resour. Res.*, 42(9), W09408, 2006.
- Oldmeadow, D.F., and M. Church, A field experiment on streambed stabilization by gravel structures, *Geomorphology*, 78, 335-350, 2006.
- Sklar, L.S., and W.E. Dietrich, The role of sediment in controlling steady-state bedrock channel slope: Implications of the saltation-abrasion incision model, *Geomorphology*, 82, 58-83, 2006.
- Vericat, D., M. Church, and R.J. Batalla, Bed load bias: Comparison of measurements obtained using two (76 and 152 mm) Helley-Smith samplers in a gravel bed river, *Water Resour. Res.*, 42(1), W01402, 2006.
- Wang, H.T., X.H. Zhang, Z.B. Dong, and M. Ayrault, Experimental determination of saltating glass particle dispersion in a turbulent boundary layer, *Earth Surf. Proc. Landforms*, 31, 1746-1762, 2006.

3. Bedforms and Channel Geometry

- Ashmore, P., and E. Sauks, Prediction of discharge from water surface width in a braided river with implications for at-a-station hydraulic geometry, *Water Resour. Res.*, 42(3), W03406, 2006.
- Cooper, J.R., S.J. Tait, and K.V. Horoshenkov, Determining hydraulic resistance in gravel-bed rivers from the dynamics of their water surfaces, *Earth Surf. Proc. Landforms*, 31, 1839-1848, 2006.
- Federici, B., and G. Seminara, Effect of suspended load on sandbar instability, *Water Resour. Res.*, 42(7), W07407, 2006.
- Fernandez, R., J. Best, and F. López, Mean flow, turbulence structure, and bed form superimposition across the ripple-dune transition, *Water Resour. Res.*, 42(5), W05406, 2006.
- Flores, A.N., B.P. Bledsoe, C.O. Cuhaciyan, and E.E. Wohl, Channel-reach morphology dependence on energy, scale, and hydroclimatic processes with implications for prediction using geospatial data, *Water Resour. Res.*, 42(6), W06412, 2006.
- Giri, S., and Y. Shimizu, Numerical computation of sand dune migration with free surface flow, *Water Resour. Res.*, 42(10), W10422, 2006.
- Lee, J.-S., and P.Y. Julien, Downstream hydraulic geometry of alluvial channels, *J. Hydr. Engrg.*, 132, 1347-1352, 2006.
- Milzow, C., P. Molnar, B.W. McArdeall, and P. Burlando, Spatial organization in the step-pool structure of a steep mountain stream (Vogelbach, Switzerland), *Water Resour. Res.*, 42(4), W04418, 2006.
- Sukhodolov, A.N., J.J. Fedele, and B.L. Rhoads, Structure of flow over alluvial bedforms: an experiment on linking field and laboratory methods, *Earth Surf. Proc. Landforms*, 31, 1292-1310, 2006.
- Wilcox, A.C.; J.M. Nelson, and E.E. Wohl, Flow resistance dynamics in step-pool channels: 2. Partitioning between grain, spill, and woody debris resistance, *Water Resour. Res.*, 42(5), W05419, 2006.

4. Channel Pattern

- Bertoldi, W., and M. Tubino, Bed and bank evolution of bifurcating channels, *Water Resour. Res.*, 41(7), W07001, 2005.
- Coulthard, T.J., Effects of vegetation on braided stream pattern and dynamics, *Water Resour. Res.*, 41(4), W04003, 2005.
- Eaton, B.C., M. Church, and T.R.H. Davies, A conceptual model for meander initiation in bedload-dominated streams, *Earth Surf. Proc. Landforms*, 31, 875-891, 2006.
- Harmar, O.P., and N.J. Clifford, Planform dynamics of the Lower Mississippi River, *Earth Surf. Proc. Landforms*, 31, 825-843, 2006.
- Lanzoni, S., and G. Seminara, On the nature of meander instability, *J. Geophys. Res.*, 111(F4), F04006, 2006.
- Richard, G.A., P.Y. Julien, and D.C. Baird, Statistical analysis of lateral migration of the Rio Grande, New Mexico, *Geomorphology*, 71, 139-155, 2005.
- Sambrook Smith, G.H., P.J. Ashworth, J.L. Best, J. Woodward, and C. J. Simpson, The sedimentology and alluvial architecture of the sandy braided South Saskatchewan River, Canada, *Sedimentology*, 53, 413-434, 2006.

Tiegs, S.D., and M. Pohl, Planform channel dynamics of the lower Colorado River: 1976–2000, *Geomorphology*, 69, 14-27, 2005.

5. Confluences and Networks

- Corney, R.K.T., J. Peakall, D.R. Parsons, L. Elliott, K.J. Amos, J.L. Best, G.M. Keevil, and D.B. Ingham, The orientation of helical flow in curved channels, *Sedimentology*, 53, 249-257, 2006.
- Cudennec, C., and Y. Fouad, Structural patterns in river network organization at both infra- and supra-basin levels: the case of a granitic relief, *Earth Surf. Proc. Landforms*, 31, 369-381, 2006.
- Moody, J.A., and D.A. Kinner, Spatial structures of stream and hillslope drainage networks following gully erosion after wildfire, *Earth Surf. Proc. Landforms*, 31, 319-337, 2006.
- Paz, A.R., W. Collischonn, and A.L. Lopes da Silveira, Improvements in large-scale drainage networks derived from digital elevation models, *Water Resour. Res.*, 42(8), W08502, 2006.
- Rinaldo, A., J.R. Banavar, and A. Maritan, Trees, networks, and hydrology, *Water Resour. Res.*, 42(6), W06D07, 2006.
- Sklar, L.S.; W.E., Dietrich, E. Foufoula-Georgiou, B. Lashermes, and D. Bellugi, Do gravel bed river size distributions record channel network structure? *Water Resour. Res.*, 42(6), W06D18, 2006.
- Turowski, J.M., D. Lague, A. Crave, and N. Hovius, Experimental channel response to tectonic uplift, *J. Geophys. Res.*, 111(F3), F03008, 2006.

6. Catchment Processes

- Carretier, S., B. Nivière, M. Giamboni, and T. Winter, Do river profiles record along-stream variations of low uplift rate? *J. Geophys. Res.*, 111(F2), F02024, 2006.
- Huang, X., and J.D. Niemann, An evaluation of the geomorphically effective event for fluvial processes over long periods, *J. Geophys. Res.*, 111(F3), F03015, 2006.
- Kimoto, A., M.A. Nearing, M.J. Shipitalo, and V.O. Polyakov, Multi-year tracking of sediment sources in a small agricultural watershed using rare earth elements, *Earth Surf. Proc. Landforms*, 31, 1763-1774, 2006.
- Menounos, B., E. Schiefer, and O. Slaymaker, Nested temporal suspended sediment yields, Green Lake Basin, British Columbia, Canada, *Geomorphology*, 79, 114-129, 2006.
- Singer, M.B., and T. Dunne, Modeling the influence of river rehabilitation scenarios on bed material sediment flux in a large river over decadal timescales, *Water Resour. Res.*, 42(12), W12415, 2006.
- Sivakumar, B., Suspended sediment load estimation and the problem of inadequate data sampling: a fractal view, *Earth Surf. Proc. Landforms*, 31, 414-427, 2006.
- Slaymaker, O., Towards the identification of scaling relations in drainage basin sediment budgets, *Geomorphology*, 80, 8-19, 2006.
- Wilkinson, S.N., I.P. Prosser, and A.O. Hughes, Predicting the distribution of bed material accumulation using river network sediment budgets, *Water Resour. Res.*, 42(10), W10419, 2006.
- Yang, Z., H. Wang, Y. Saito, J.D. Milliman, K. Xu, S. Qiao, and G. Shi, Dam impacts on the Changjiang (Yangtze) River sediment discharge to the sea: The past 55 years and after the Three Gorges Dam, *Water Resour. Res.*, 42(4), W04407, 2006.

7. River Channel Change

- Eaton, B.C., Bank stability analysis for regime models of vegetated gravel bed rivers, *Earth Surf. Proc. Landforms*, 31, 1438-1444, 2006.
- Gordon, E., and R.K. Meentemeyer, Effects of dam operation and land use on stream channel morphology and riparian vegetation, *Geomorphology*, 82, 412-429, 2006.
- Graf, W.L., Downstream hydrologic and geomorphic effects of large dams on American rivers, *Geomorphology*, 79, 336-360, 2006.
- Hazel, J.E., Jr., D.J. Topping, J.C. Schmidt, and M. Kaplinski, Influence of a dam on fine-sediment storage in a canyon river, *J. Geophys. Res.*, 111(F1), F01025, 2006.
- Nelson, P.A., J.A. Smith, and A.J. Miller, Evolution of channel morphology and hydrologic response in an urbanizing drainage basin, *Earth Surf. Proc. Landforms*, 31, 1063-1079, 2006.
- Saynor, M.J., and W.D. Erskine, Spatial and temporal variations in bank erosion on sand-bed streams in the seasonally wet tropics of northern Australia, *Earth Surf. Proc. Landforms*, 31, 1080-1099, 2006.
- Simon, A., and M. Rinaldi, Disturbance, stream incision, and channel evolution: The roles of excess transport capacity and boundary materials in controlling channel response, *Geomorphology*, 79, 361-383, 2006.

8. River Restoration

- Ahmadi-Nedushan, B., A. St-Hilaire, M. Bérubé, É. Robichaud, N. Thiémonge, and B. Bobée, A review of statistical methods for the evaluation of aquatic habitat suitability for instream flow assessment, *River Research and Applications*, 22, 503-523, 2006.
- Brooks, A.P., T. Howell, T.B. Abbe, and A.H. Arthington, Confronting hysteresis: Wood based river rehabilitation in highly altered riverine landscapes of south-eastern Australia, *Geomorphology*, 79, 395-422, 2006.
- Finger, D., M. Schmid, and A. Wüest, Effects of upstream hydropower operation on riverine particle transport and turbidity in downstream lakes, *Water Resour. Res.*, 42(8), W08429, 2006.
- Gurnell, A., and G. Petts, Trees as riparian engineers: the Tagliamento river, Italy, *Earth Surf. Proc. Landforms*, 31, 1558-1574, 2006.
- Monk, W.A., P.J. Wood, D.M. Hannah, D.A. Wilson, C.A. Extence, and R.P. Chadd, Flow variability and macroinvertebrate community response within riverine systems, *River Research and Applications*, 22, 595-615, 2006.
- Newson, M.D., and R.G. Andrew, Large natural rivers, hydromorphological quality and river restoration: a challenging new agenda for applied fluvial geomorphology, *Earth Surf. Proc. Landforms*, 31, 1606-1624, 2006.
- Palmer, M.A., and E.S. Bernhardt, Hydroecology and river restoration: Ripe for research and synthesis, *Water Resour. Res.*, 42(3), W03S07, 2006.
- Schläpfer, F., and P.-J. Witzig, Public support for river restoration funding in relation to local river geomorphology, population density, and mean income, *Water Resour. Res.*, 42(12), W12412, 2006.
- Shields, F.D., Jr., S.S. Knight, and J.M. Stofleth, Large wood addition for aquatic habitat rehabilitation in an incised, sand-bed stream, Little Topashaw Creek, Mississippi, *River Research and Applications*, 22, 803-817, 2006.
- Wynn, T.M., and S. Mostaghimi, Effects of riparian vegetation on stream bank subaerial processes in southwestern Virginia, USA, *Earth Surf. Proc. Landforms*, 31, 399-413 2006.
- Yarnell, S.M., J.F. Mount, and E.W. Larsen, The influence of relative sediment supply on riverine habitat heterogeneity, *Geomorphology*, 80, 310-324, 2006.

9. Fluvial Models

- Birkinshaw, S.J., and J.C. Bathurst, Model study of the relationship between sediment yield and river basin area, *Earth Surf. Proc. Landforms*, 31, 750-761, 2006.
- Coulthard, T.J., and M.J. Van De Wiel, A cellular model of river meandering, *Earth Surf. Proc. Landforms*, 31, 123-132, 2006.
- Cui, Y., and G. Parker, Numerical model of sediment pulses and sediment-supply disturbances in mountain rivers, *J. Hydr. Engrg.*, 131, 646-656, 2005.
- Istanbulluoglu, E., and R.L. Bras, Vegetation-modulated landscape evolution: Effects of vegetation on landscape processes, drainage density, and topography, *J. Geophys. Res.*, 110(F2), F02012, 2005.
- MacVicar, B.J., L. Parrott, and A.G. Roy, A two-dimensional discrete particle model of gravel bed river systems, *J. Geophys. Res.*, 111(F3), F03009, 2006.
- Miori, S., R. Repetto, and M. Tubino, A one-dimensional model of bifurcations in gravel bed channels with erodible banks, *Water Resour. Res.*, 42(11), W11413, 2006.
- Nicholas, A. P., D.E. Walling, R.J. Sweet, and X. Fang, Development and evaluation of a new catchment-scale model of floodplain sedimentation, *Water Resour. Res.*, 42(10), W10426, 2006.
- Yue, W., C.-L. Lin, and V.C. Patel, Large-eddy simulation of turbulent flow over a fixed two-dimensional dune, *J. Hydr. Engrg.*, 132 (7), 643-651, 2006.

Seminar Schedule: All students must sign up for three (3) seminars, but not in successive weeks. Extra credit will be given to those presenters on 1/25 (+2 pts. or 20%) and 2/6 (+1 pt. or 10%).

Please select a topic and date for three (3) seminars by writing your last name in the spaces provided.

Date	Topic	Presenter 1	Presenter 2	Presenter 3	Presenter 4
1/25	Turbulent Flow*				
2/6	Sediment Transport**				
2/15	Bedforms & Channel Geometry				
2/27	Channel Pattern				
3/8	Confluences and Networks				
3/27	Catchment Processes				
4/5	River Channel Change				
4/17	River Restoration				
4/26	Fluvial Models				

*2 percentage points awarded as extra credit

**1 percentage point awarded as extra credit