

DEPARTMENT OF GEOGRAPHY

University of Toronto

COURSE OUTLINE**COURSE: GGR 301S - Fluvial Geomorphology****INSTRUCTOR:** Joe Desloges (joseph.desloges@utoronto.ca) – best way to contact meOffice: ES2124 – 22 Russell St. (Earth Sciences Centre)
Office Hours: TBA**Prerequisites:** GGR270H (or equivalent)
Recommended Preparation: 10.0 FCE's including GGR100H1 or GGR201H1
Distribution Requirement Status: This is a Science course
Breadth Requirement: The Physical and Mathematical Universes (5)**Lectures/Labs:** Thur. 1-3 pm. Room 2119, Earth Sciences
22 Russell St.**Course Description:** A lecture and laboratory course that emphasizes elements of drainage basin morphology and hydrology, classification of rivers, stream patterns and hydraulic geometry. Elements of open channel flow, sediment transport and the paleohydrology of river systems. River channel adjustments to environmental change, human impact and the management/design of river habitats. Exercises include experimentation in a laboratory flume. fluvial processes, river mechanics and the association between environmental change and river regime.**Required Text:** Wohl, Ellen (2014). Rivers in the Landscape: Science and Management. Wiley Blackwell, Chichester, UK. . 318 p.**Supplemental Text Materials (Companion) Website:**<http://bcs.wiley.com/he-bcs/Books?action=resource&bcsId=8896&itemId=1118414837&resourceId=35103>**Objectives and Learning Outcomes:**

- (a) An interpretation of the morphology of rivers and fluvial landscapes.
- (b) To introduce the main processes that occur in rivers, and the means for observing them.
- (c) To learn and use some of the techniques for analysis of river morphology and processes and understand river response to natural and human induced environmental change.
- (d) To introduce the geomorphological, earth science, engineering and river management/conservation literature which is relevant to the subject.

PROGRAMME:

- (1) Lectures: A detailed outline is below.
- (2) Laboratories and Demonstrations: There will be two flume demonstrations and three exercises to be handed in for marking consisting of computational and interpretive procedures. The use of a spread sheet program (e.g. Excel, etc.) and a good scientific graphics program will greatly facilitate the laboratory exercises.

The flume is a small demonstration river channel which can only handle about 6 observers at a time. To facilitate use, the class will be divided into smaller sections for the two observation exercises. In addition to class time, groups will need to meet just before or just after class. This will be needed on only two occasions.

Unless noted otherwise, laboratory assignments are due two weeks after they are distributed. Late penalties of 10% per day apply to all assignments. Weekends count as one day.

All hardcopy assignments are to be handed in to the assignment submission box in the main Earth Sciences department, Rm 1066, 22 Russell St. The office is open M-F from 9-5. Always keep an original copy for yourself.

- (3) Thematic/Research Paper. A list of specific topics will be discussed and provided early in the term. You are expected to access the literature relevant to the topic and write a 2500 word (approx. 9 pages, double-spaced, plus any additional figures/tables) paper. You are asked to submit a proposal for your paper topic with a tentative list of the relevant literature that you will review for the paper.
- (4) A field trip to one or more river reaches in a selected GTA watershed. The trip will only occur if the weather cooperates and will depend on temperature and snowpack conditions.

Evaluation: Laboratory Exercises	33% (equal weight for each of 3)
Final Exam	34% (regular exam period)
Research Paper Proposal and literature	3%
Research Paper	30%

(see term work due dates on the detailed Class Schedule below)

General Comment: The course includes some very basic physics and fluid mechanics as well as an appropriate amount of formulation required to introduce such topics.

Summary of flume, lab assignment and research paper submission dates (see detailed schedule as well)

Lab # 1 due date;	January 26 (handed out Jan. 12)
Lab # 2 due date;	February 9 (handed out Jan. 26)
Lab # 3 due date;	March 9 (handed out Feb. 23)
Research topic and literature;	March 9
Research paper due date;	April 5

Accessibility Needs:

The University of Toronto is committed to accessibility. If you require accommodations or have any accessibility concerns, please visit <http://studentlife.utoronto.ca/accessibility> as soon as possible.

Academic Integrity:

Plagiarism is an academic offense at the University of Toronto. Plagiarism is quoting (or paraphrasing) the work of an author (including the work of fellow students) without a proper citation. Students also should not be submitting any academic work for which credit has previously been obtained or is being sought, without first discussing with the instructor. Please consult the "Rules and Regulations" section of the Arts and Science Calendar (http://www.artsandscience.utoronto.ca/ofr/calendar/Rules_&_Regulations.html) for further information and check the 'How not to plagiarize' website at <http://www.writing.utoronto.ca/advice/using-sources/how-not-to-plagiarize>

Communications Policy:

Please always use your University of Toronto email address (@utoronto.ca or @mail.utoronto.ca) for course related communications. Other email addresses may be filtered as spam, and I cannot not promise to respond to them. Please read the course handouts and check the Blackboard site before emailing a question, to make sure that it has not already been answered. For course related queries, email Prof. Joe Desloges (joseph.desloges@utoronto.ca). For department or program related queries, email Geography Department Undergraduate Advisor, Kathy Giesbrecht giesbrecht@geog.utoronto.ca

Missed Due Date for Assignments:

In addition to declaring an absence on ROSI in order to receive academic accommodation for any course work such as a late assignment, students must follow the policy outlined below for requesting special consideration. Late assignments will be subject to a **late penalty of 10% per day (weekends count as one day)** of the total marks for the assignment. **Assignments will not be accepted after marked assignments have been returned.** All assignments are due no later than 4:30 pm on the due date. This deadline is rigid and a full day late penalty applies immediately. Exceptions can be made when an assignment is late for University accepted, verifiable reasons beyond one's control.

You must inform me by email 24 hours in advance of an assignment due date of any circumstances that prevent you from submitting an assignment on time. University accepted documentation (e.g., U of T Student Medical Certificate) for late assignments and missed tests must be provided within 5 calendar days of the assignment due date. Medical Certificates or Doctor's Notes MUST be an original U of T Student Medical Certificate (available from the Office of the Registrar's web site) and MUST include the statement "This Student was unable to complete the assignment on date(s) for medical reasons". Failure to comply with this policy will result in a grade of zero for the assignment.

Writing Support

1. Students can find information about college writing centres at <http://www.writing.utoronto.ca/writing-centres/arts-and-science>. The teaching approach of the college writing centres is described at <http://www.writing.utoronto.ca/writing-centres/learning>.
2. The home page for the website "Writing at the University of Toronto" is www.writing.utoronto.ca. You can use the navigation bar or the search function to find pages relevant to your course.
 - More than 60 Advice files on all aspects of academic writing are available at www.writing.utoronto.ca/advice. A complete list of printable PDF versions are listed at

<http://www.writing.utoronto.ca/about-this-site/pdf-links-for-students>.

- "How Not to Plagiarize" and other advice on documentation format and methods of integrating sources; these are listed in the section at www.writing.utoronto.ca/advice/using-sources.

3. Writing Plus workshop series, described at <http://www.writing.utoronto.ca/writing-plus>.

4. Information about the English Language Learning program (ELL) is available at <http://www.artsci.utoronto.ca/current/advising/ell>.

The Communication Cafe, which meets weekly at four different times and locations for the first five weeks of each term for practice with oral skills like class discussion and presentations

- Reading eWriting, an online program that helps students engage course readings more effectively. You can also find further instructional advice files for students and for classroom instruction on this site. For more information, please contact the ELL Coordinator Leora Freedman at leora.freedman@utoronto.ca

Class Schedule and Reading List**WEEK 1: INTRODUCTION**

January 5 Introduction to fluvial systems
Hydrological and geological bases for fluvial networks

LAB No lab

Readings: Text ch. 1 and 2

WEEK 2: OPEN CHANNEL FLOW

January 12 Flow in Channels

***LAB 1 River hydrology** (see Text 3.2.2 and 3.2.3)

Readings: Text ch. 3

WEEK 3: SEDIMENT TRANSPORT

January 19 Sediment entrainment, suspension and transport
Sediment sampling

LAB Demonstration of flume and calibration of flow velocity
(class will be divided into at least two groups; meeting times TBA)

Readings: Text ch. 4 to page 116 (read again Figure 3.13)

WEEK 4: SEDIMENT BEDFORMS AND BANKS

January 26 Channel bedforms and sediment deposition

***LAB 2 Sediment transport and channel bedforms**
(lab #1 is due)

Readings: Text ch. 4, pages 117-124;

WEEK 5: RIVER REGIME AND HYDRAULIC GEOMETRY

February 2 Tractive force and regime concepts
Hydraulic geometry of river channels

LAB **Flume Experiment** continue with Lab #2 (sediment transport and bedforms)

Readings: Text, ch 5 to page 132

WEEK 6: HYDRAULIC GEOMETRY AND RIVER CHANNEL MORPHOLOGY

February 9 Channel Form
Hydraulic adjustments of the channel cross-section

LAB no lab meeting
(lab #2 is due)

Readings: Text ch. 5, pages 133-149

WEEK 7: STABILITY OF RIVER CHANNELS

February 23 Stability approach to river channel patterns

***LAB 3 Classification of river channel patterns**
Final selection of the topic for research paper

Readings: Text ch. 6

****READING WEEK ****

February 20-24 – no classes

WEEK 8: EXTRA-CHANNEL ENVIRONMENTS

March 2 Formation and classification of floodplains
Valley sediment infills and river sedimentology

LAB No Lab

Readings: Text ch. 6 (continued)

WEEK 9: CHANNEL RESPONSES

March 9 Channel aggradation/degradation: responses to base level and sediment yield changes

LAB Research paper proposal and literature due.
(lab #3 due)

Readings: Text ch. 5 (sections 5.4 and 5.5)

WEEK 10: HUMANS AND RIVERS

March 16 Human alterations and impact
Traditional approaches to river engineering and management -
intended and unintended consequences

LAB No Lab (reminder: research papers due April 3rd)

Readings: Text ch. 7 (to page 214)

WEEK 11: CHANNEL MANAGEMENT, DESIGN AND SUSTAINABILITY

March 23 Natural channel design

LAB No Lab (reminder: research papers due April 3rd)

Readings: Text ch. 7 (page 215 to end)

WEEK 12: RIVERS: NATURAL AND HUMAN HERITAGE

March 30 Topography, tectonics and river history

Research Papers due April 5

Text ch. 8 (to page 240)

GGR 301 Selected Supplementary References

- Allen, J.R.L. 1970. Physical processes of sedimentation. London, Unwin.
- Anderson, M.G., Walling, D.E. and Bates, P.D. 1996. Floodplain processes. John Wiley and Sons, London, 658 p.
- Arnell, N. 1996. Global warming, river flows and water resources. John Wiley and Sons, Chichester, 224 p.
- Ashworth, P.J., Bennett, S., Best, J.L. and McLelland 1996. Coherent flow structures in open channel flow. John Wiley and Sons, p. 733.
- Ashmore, P., Church, M. 2001. The impact of climate change on rivers and river processes in Canada. Geological Survey of Canada Bulletin 555: Ottawa, Canada.
- Bagnold, R.A. 1966. An approach to the sediment transport problem from general physics. United States Geological Survey Professional Paper 422-I: Washington, DC.
- Bagnold, R.A. 1980. An empirical correlation of bedload transport rates in flumes and natural rivers. In: Thorne, C.R., MacArthur, R.C., Bradley, J.B. (eds.), *The Physics of Sediment Transport by Wind and Water*. American Society of Civil Engineers, New York: 323–345.
- Baker, V.R., Kochel, R.C. and Patton, P.C. 1988. *Flood Geomorphology*. John Wiley and Sons. 350 p.
- Bennett, S.J. and Simon, A. (editors) 2004. *Riparian vegetation and fluvial geomorphology*. American Geophysical Union, Washington, D.C., 281 p.
- Beven, K. and Carling P. (eds.) 1989. *Floods: hydrological, sedimentological and geomorphological implications*. John Wiley and Sons, 290 p.
- Beven, K. and Kirkby, M.J. (eds.) 1989. *Channel network hydrology*. John Wiley and Sons, 319 p.
- Billi, P., Hey, R.D., Thorne, C.R. and Tacconni, P. (eds). *Dynamics of gravel-bed rivers*. John Wiley and Sons, Chichester.
- Boon, P.J., Calow, P. and Petts, G. (eds.) 1992. *River conservation and management*. John Wiley and Sons, 470 p.
- Brown, A.G. and Quine, T.A. (eds), 1999. *Fluvial Processes and Environmental Change*. John Wiley and Sons, Chichester, 413 p.
- Brierley, G.J., Fryirs, K. 2005. *Geomorphology and River Management: Applications of the River Styles Framework*. Blackwell, Oxford. DOI: 10.1002/9780470751367

- Buffington, J.M., Montgomery, D.R. 1997. A systematic analysis of eight decades of incipient motion studies, with special reference to gravel-bedded rivers. *Water Resources Research*, 33: 1993–2029. DOI: 10.1029/96WR03190
- Burchsted, D., Daniels, M., Wohl, E.E. 2014. Introduction to the special issue on discontinuity of fluvial systems. *Geomorphology*, 205: 1–4. DOI: 10.1016/j.geomorph.2013.04.004
- Burt, T., Allison, R. 2010. *Sediment Cascades: An Integrated Approach*. John Wiley & Sons, Oxford. DOI: 10.1002/9780470682876
- Carling, P.A. and Petts, G.E. (eds.) 1992. *Lowland floodplain rivers: geomorphological perspectives*. John Wiley and Sons, 302 p.
- Charlton, R. 2008. *Fundamentals of Fluvial Geomorphology*. Routledge, New York, 234 p.
- Chorley, R.J. (ed.) 1969. *Introduction to physical hydrology*. London, Methuen.
- Church, M. 1992. Channel morphology and typology. In: Calow, P., Petts, G.E. (eds.), *The River Handbook: Volume 1*. Blackwell Scientific Publications, Oxford: 126–143.
- Collinson, J.D. and Lewin, J. (eds.) 1983. *Modern and ancient fluvial systems*. International Association of Sedimentologists Special Publication 6, Blackwell Scientific Publications, Oxford.
- Desloges, J.R., Church, M. 1989. Canadian landform examples; 13, Wandering gravel-bed rivers. *The Canadian geographer*, 33: 360–364. DOI: 10.1111/j.1541-0064.1989.tb00922.x
- Dunne, T. and Leopold, L.B. 1978. *Water in environmental planning*. San Francisco, Freeman.
- Ferguson, R.I. 1981. Channel form and channel changes. In: Lewin, J. (ed.), *British Rivers*. Allen & Unwin, London: 90–125.
- Ferguson, R.I. 1987. Hydraulic and sedimentary controls of channel pattern. In: Richards, K. (ed.), *River Channels – Environment and Processes*. Blackwell, Oxford, UK: 129–158.
- Ferguson, R.I. 2005. Estimating critical stream power for bedload transport calculations in gravel bed rivers. *Geomorphology*, 70; 33–41. DOI: 10.1016/j.geomorph.2005.03.009
- Ferguson, R.I. 2012. River channel slope, flow resistance, and gravel entrainment thresholds. *Water Resources Research*, 48: W05517. DOI: 10.1029/2011WR010850
- Goudie, A.S. 2006. Global warming and fluvial geomorphology. *Geomorphology* 79, 384–394.
- Gregory, K.J. and Walling, D.E. 1973. *Drainage basin form and process*. London, Arnold.

- Gregory, K.J. (ed.) 1977. River channel changes. Chichester, Wiley (U.K.).
- Gurnell, A. and Petts, G. 1995. Changing River Channels. John Wiley and Sons, Chichester, 442 p.
- Hauer, F.R. and Lamberti, G.A. (editors) 2007. Methods in stream ecology (2nd ed.). Academic Press, Boston, 877 p.
- Henderson, F.M. 1966. Open channel flow. New York, Macmillan.
- Herschy, R.W. 1995. Streamflow Measurement (2nd edition). E & FN Spon, London., 524p.
- Hey, R.D., Bathurst, J.C. and Thorne, C.R. (eds.) 1982. Gravel-bed rivers: fluvial processes, engineering and management. Chichester, Wiley (U.K.).
- Ikeda, S. and Parker, G. 1989. River meandering. Water Resources monograph 12, American Geophysical Union.
- Kellerhals, R., Church, M., Bray, D.I. 1976. Classification and analysis of river processes. American Society of Civil Engineers Journal of the Hydraulics Division, 102: 813–829.
- Kellerhals, R. and Church M. 1989. The morphology of large rivers: characterization and management. In Dodge, P. (ed.). Proceedings of the Large Rivers Symposium, Special Publication of Fisheries and Aquatic Sciences, 106, 31-48.
- Knighton, A.D. 1998. Fluvial Forms and Processes: A New Perspective. Arnold: London. DOI: 10.1002/(SICI)1096-9837(199904)24:4<378::AID-ESP958>3.0
- Leopold, L.B., 1994. A view of the river. Harvard University Press, Cambridge. 298 p.
- Leopold, L.B., Maddock, Jr., T. 1953. The hydraulic geometry of stream channels and some physiographic implications. United States Geological Survey Professional Paper 252: Washington, DC.
- Leopold, L.B., Wolman, M.G. 1957. River channel patterns: Braided, meandering, and straight. United States Geological Survey Professional Paper 282-B: Washington, DC.
- Leopold, L.B., Wolman, M.G. and Miller, J.P. 1964. Fluvial Processes in Geomorphology. Freeman, San Francisco
- Linsley, R.K., Kohler, M.A. and Paulhus, J.R. 1982. Hydrology for engineers. N.Y. McGraw-Hill, 3rd ed.
- Darrel Maddy, Mark G. Macklin, Jamie C. Woodward (eds.) 2001. River basin sediment systems : archives of environmental change. Balkema, 503 p.,
- James, L.A., Rathburn, S.L. and Whittecar, G.R. (editors) 2009. Management and restoration of fluvial systems with broad historical changes and human impacts. Geological Society of America, Boulder Colorado. 244 p.

- Kondolf, G.M. and Pilegay, H. (editors) 2003. Tools in fluvial geomorphology. Chichester, England, 688 p.
- Mackin, J.H. 1948. Concept of the graded river. Geological Society of America Bulletin, 59: 463–511. DOI: 10.1130/0016-7606(1948)59[463:COTGR]2.0.CO;2
- Mayer, L. and Nash, D. 1987. Catastrophic Flooding. Binghampton Symposia in Geomorphology 18. Allen and Unwin
- Miall, A.D. (ed.) 1977. Fluvial Sedimentology. Memoir 5, Canadian Society of Petroleum Geology.
- Miall, A.D. 1985. Architectural-element analysis: A new method of facies analysis applied to fluvial deposits. Earth Science Reviews, 22: 261–308. DOI: 10.1016/0012-8252(85)90001-7
- Miall, A.D. 2010. Alluvial deposits. In: James, N.P., Dalrymple, R.W. (eds.), Facies Models 4. Geological Association of Canada, St. John's, Newfoundland: 105–138.
- Middleton, G.V. and Southard, J.B. 1977. Mechanics of sediment movement. Society of Economic Paleontologists and Mineralogists, Short Course 3.
- Miller, A.J. and Gupta, A. (eds) 1999. Varieties of fluvial form. Chichester ; New York John Wiley & Sons, 521 p. :
- Morisawa, M. 1968. Streams: their dynamics and morphology. McGraw Hill.
- Nanson, G.C., Croke, J.C. 2002. Emerging issues in flood plain research. In: Dyer, F.J., Thoms, M.C., Olley, J.M. (eds.), The Structure, Function and Management Implications of Fluvial Sedimentary Systems, IAHS Publication No 276, International Association of Hydrological Sciences Press, Wallingford: 271–278.
- Nanson, G.C., Croke, J.C. 1992. A genetic classification of floodplains. Geomorphology, 4: 459–486. DOI: 10.1016/0169-555X(92)90039-Q
- Nanson, G.C., Knighton, A.D. 1996. Anabranching rivers: Their cause, character and classification. Earth Surface Processes and Landforms, 21: 217–239. DOI: 10.1002/(SICI)1096-9837(199603)21:3<217::AID-ESP611>3.0.CO;2-U
- National Research Council (Canada), 1989. Hydrology of floods in Canada: a guide to planning and design. Associate Committee on Hydrology. Government Publications of Canada, 245 p.
- National Research Council (USA), 1999. Improving American river flood frequency analysis. Committee on American river flood frequencies. National Academy Press, Washington, DC, 120 p.

- O'Halloran, D., Green, C., Harely, M., Stanley, M. and Knill, J. (eds.) 1994. Geological and landscape conservation. Proceedings of the Malvern International Conference 1993. Geological Society of London. 530 p.
- Perillo, G.M.E. (eds). 1995. Geomorphology and sedimentology of estuaries. Developments in Sedimentology 53. Elsevier, 471.
- Petts, G. and Foster, I. 1985. Rivers and Landscape. Arnold.
- Petts, G. with Moller, H. and Roux, A.L. 1989. Historical change of large alluvial rivers: western Europe. John Wiley and Sons.
- Petts, G. and Calow, P. (eds), 1996. River flows and channel forms. Blackwell Science, Oxford. 262 p.
- Poepppla, RE, Keesstrab, SD and Maroulisb, J. 2017. A conceptual connectivity framework for understanding geomorphic change in human-impacted fluvial systems. *Geomorphology* 277, 237–250.
- Raudkivi, A. 1976. Loose-boundary hydraulics. 2nd ed. N.Y., Pergamon.
- Reid, I. and Frostick, L.E. 1994. Fluvial sediment transport and deposition. *In* Sediment Transport and Depositional Processes. K. Pye (ed). Blackwell Publications, Oxford, p. 89-155.
- Richards, K.S. 1987. Rivers channels: environment and processes. Institute for British Geographers, Special Publication 18. Basil Blackwell, Oxford. 320p.
- Rhoads, B.L. 1987. Stream power terminology. *The Professional Geographer*, 39: 189–195. DOI: 10.1111/j.0033-0124.1987.00189.x
- Rhodes, D.D. and Williams, G.P. 1979. Adjustments of the fluvial system. Dubuque, Kendall-Hunt.
- Rice, S.P., Roy, A.G. and Rhoads, B. L. 2008. River confluences, tributaries, and the fluvial network. John Wiley & Sons, Hoboken NY. 456 p.
- Richards, K. 1982. Rivers: form and process in alluvial channels. London, Methuen.
- Richardson, K. and Carling, P.A. 2005. A typology of sculpted forms in open bedrock channels. Geological Society of America, Boulder, Colo., 108 p.
- Robert, A. 2004. River Processes. Arnold, London, 214 p.
- Rosgen, D.L. 1994. A classification of natural rivers. *Catena*, 22: 169–199. DOI: 10.1016/0341-8162(94)90001-9
- Schumm, S.A. 1977. The fluvial system. N.Y., Wiley.

- Schumm, S.A., Lichty, R.W. 1965. Time, space and causality in geomorphology. *American Journal of Science*, 263: 110–119. DOI: 10.2475/ajs.263.2.110
- Schumm, S.A., Dumont, J.F. and Holbrook, J.M. 2000. *Active tectonics and alluvial rivers*. Cambridge University Press, 276.
- Schumm, S.A., Mosely, M.P. and Weaver, W.E. 1987. *Experimental fluvial geomorphology*. New York : Wiley, 413 p.
- Sear, D.A, Newson, M.D. and Thorne C.R 2010. *Guidebook of applied fluvial geomorphology*. Thomas Telford, London 257 p.
- Smith. N.D. and Rogers, J. (eds.) 1999. *Fluvial Sedimentology VI*. Special Publication 28 of the International Association of Sedimentologists, Blackwell, 478 p.
- Stott. T. 2010. Fluvial geomorphology. *Progress in Physical Geography* 34(2) 221-245
- Thorne, C.R., Bathurst, J.C. and Hey, R.D. (eds.) 1987. *Sediment Transport in Gravel-bed Rivers*, John Wiley & Sons
- Thorne, C.R., Hey, R.D. and Newson, M.D. 1997. *Applied fluvial geomorphology for river engineering*. John Wiley, New York, 376 p.
- Thorp, J.H., Thoms, M.C. and Delong, M.D. 2008. *The riverine ecosystem synthesis : toward conceptual cohesiveness in river science*. Academic Press/Elsevier, Boston, 208 p.
- Webb, R.H, Schmidt, G., Marzolf, R. and Valdez, R. (eds), 1999. *The Controlled Grand Canyon Flood*. Geophysical Monograph 110, American Geophysical Union, Washington, DC. 367.
- Wohl, E, 2013. (ed). *Fluvial Geomorphology – Vol 9*. In *Treaties in Geomorphology*, F. Schroder (ed.). Elsevier, 6386 p.
- Wolman, M.G. and Riggs, H.C. 1990. *Surface Water Hydrology*. Geological Society of America. *The Geology of North America*, v.O-1.