

SPECIAL TOPICS IN GEOGRAPHY WINTER 2023

GEOG 474

Published Jan 04, 2023

CLASS SCHEDULE

Section	Location	Time	Instructor(s)
GEOG 474 001 [SEM]	EV1 350	Wednesdays 8:30 a.m. - 11:20 a.m.	Micheal Stone mstone@uwaterloo.ca
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INSTRUCTOR / TA INFORMATION

OFFICE HOURS: (To be announced)

INSTRUCTOR: Dr. M. Stone, EV1 Room 112

TAs : TBD

COURSE DESCRIPTION

Calendar Description for GEOG 474

These courses allow for additions to the program on a short-term basis, and for the development of future permanent courses.

Prereq: Level at least 3A Honours students only

Wildfire is a global phenomenon that is expected to increase in extent and severity due to fuel accumulation, shifting land management practices and climate change. Removal of vegetation by wildfire can alter hydrologic, biogeochemical, and geomorphic processes over a range of spatial and temporal scales in a manner that can be transient or persistent. Alteration of these processes can involve complex responses in both terrestrial and aquatic ecosystems which pose significant financial, environmental, planning and management challenges. There remains a significant knowledge gap in cross-disciplinary analyses investigating how fires impact watershed processes at the landscape level.

This course will examine the role of climate warming on wildfire behavior, the impacts of wildfire on landscape form and function and its impact on hydrologic and geomorphic processes in wildfire impacted landscapes across the globe.

LEARNING OUTCOMES

By the end of this course students should be able to:

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| Examine how wildfire is a catalyst for hydrologic and geomorphic change |
| Understand the relationship between climate change and fire behavior. |
| Review the science of post-fire hydrology and geomorphology from the plot to watershed scale. |
| Quantify post-fire erosion and debris dynamics |
| Consider geomorphic legacy of wildfires and process recovery |

TENTATIVE COURSE SCHEDULE

Jan 11 WILDFIRE AS A CATALYST FOR HYDROLOGIC AND GEOMORPHIC CHANGE

- **Lecture 1** Course introduction (Shakesby and Doerr, 2006)
- **Lecture 2** Fire in the earth system (Bowman et al., 2009; Martin, 2016)

Jan 18 CLIMATE INFLUENCE ON WILDFIRE AND POST-WILDFIRE EROSION

- **Lecture 3** Fire distribution, controls and environmental drivers (Westerling, et al. 2006; Kitzberger et al. 2007; Flannigan, et al. 2009)
- **Lecture 4** Fort McMurray Wildfire

Jan 25 FIRE-INDUCED WATER REPELLENCY

- **Lecture 5** Water repellency (Scott and VanWyk, 1990; Doerr et al., 2000)
- **Lecture 6** Effects of fire on properties of forest soils (Certi, 2005; Imeson et al., 1992)
- **Assignment 1 (Due Feb 8, 2022 at 11:59 PM EST)**

Feb 1 POST-WILDFIRE HYDROLOGY 1

- **Lecture 7** Hydrologic processes and watershed response (Winkler et al., 2010)
- **Lecture 8** Lecture by Dr Peter Robichaud

Feb 8 POST-WILDFIRE HYDROLOGY 2

- **Lecture 9** Fire impacts on hydrologic processes at plot scale (Covert and Jordan 2009; Mataix-Solera et al., 2008)

Quiz 1 (Feb 9-11)

Feb 15 Reading Week

Feb 22 POST-WILDFIRE HYDROLOGY 3

- **Lecture 10** Hillslope hydrology (Ebel and Moody, 2013; Moody et al., 2008)
- **Lecture 11** Hydrological processes at watershed scale (Bladon, 2009)

Assignment 2 (Due March 8, 2022 at 11:59 PM EST)

Mar 1 POST-WILDFIRE SEDIMENT TRANSPORT DYNAMICS 1

- **Lecture 12** Post-wildfire runoff and erosion processes (Moody et al., 2013)

- **Lecture 13** Plot Scale (Covert and Jordan 2009)

Mar 8 POST-WILDFIRE SEDIMENT TRANSPORT DYNAMICS 2

- **Lecture 14** Hillslopes erosion (Moody and Martin, 2009; Sheridan et al., 2007)
- **Lecture 15** Erosion at watershed scale (Shakesby, 2011; Stone et al., 2014)

Mar 15 POST-WILDFIRE SEDIMENT TRANSPORT DYNAMICS 3

- **Lecture 16** Wildfire impacts on river channel sediment dynamics (Silins et al., 2009; Stone et al., 2010; Stone et al., 2014)

Quiz 2 (March 23-25)

Mar 22 Water Quality 1

- **Lecture 17** Post-wildfire debris flow (Staley et al., 2014; Santi et al., 2008)
- **Lecture 18** Sediment associated phosphorus dynamics (Emelko et al., 2016)

Mar 29 Water Quality 2

- **Lecture 19** Fire impacts on aquatic ecology (Silins et al., 2014)
- **Lecture 20** Fire impacts on reservoirs (Fort McMurray case study)

April 5 GEOMORPHIC LEGACY OF WILDFIRES AND PROCESS RECOVERY

- **Lecture 21** Post fire temporal changes in sediment yield (Kirchner et al., 2001)
- **Lecture 22** Temporal changes in sediment and water quality after the Lost Creek wildfire

TEXTS / MATERIALS

Title / Name	Notes / Comments	Required
See list of references below		No

Because no textbook exists that covers the breadth and depth of the subject matter presented in this course, selected readings from literature on the science of wildfire and landscape change will be used to provide background for each lecture. The reading materials for each lecture are listed below after each lecture title and full citations are provided in the following reference list.

REFERENCES

Bowman et al. 2009. Fire in the Earth system. *Science* 324.5926: 481–484.

Certi 2005. Effects of fire on properties of forest soils: a review. *Oecologia* (2005) 143: 1–10

Covert and Jordan 2009. A Portable Rainfall Simulator: Techniques for Understanding the Effects of Rainfall on Soil Erodibility. *Streamline Watershed Management Bulletin* Vol. 13/No. 1

Bladon, K. 2009. Wildfire and Watershed Hydrology: Key Findings from a Workshop. *Streamline Watershed Management Bulletin* Vol. 13/No. 1

- DeBano et al., 1970. Translocation of hydrophobic substances into soil by burning organic litter *Soil Science Society of America Journal* 34.1: 130–133.
- Doerr et al., 2000. Soil water repellency: Its causes, characteristics, and hydro-geomorphological significance. *Earth-Science Reviews* 51.1–4: 33–65
- Doerr et al., 2006. Effects of differing wildfire severities on soil wettability and implications for hydrological response. *Journal of Hydrology* 319.1–4: 295–311.
- Ebel, B. A., and J. A. Moody. 2013. Rethinking infiltration in wildfire-affected soils. *Hydrological Processes* 27.10: 1510–1514.
- Ebel B. 2012. Wildfire impacts on soil-water retention in the Colorado Front Range, United States. *Water Resources Research* 48:W12515.
- Emelko et al., 2016. Sediment-phosphorus dynamics can shift aquatic ecology and cause downstream legacy effects after wildfire in large river systems *Global Change Biology*. DOI: 10.1111/gcb.13073.
- Flannigan et al., 2009. Implications of changing climate for global wildland fire. *International Journal of Wildland Fire* 18.5: 483–507.
- Imeson et al., 1992. The effects of fire and water repellency on infiltration and runoff under Mediterranean type forest. *Catena* 19:345–361.
- Kirchner et al., 2001. Mountain erosion over 10-year, 10,000-year, and 10,000,000-year timescales. *Geology* 29:591–594.
- Kitzberger et al., 2007. Contingent Pacific–Atlantic Ocean influence on multi-century wildfire synchrony over western North America. *Proceedings of the National Academy of Sciences* 104.2: 543–548.
- Mataix-Solera et al., 2011. Fire effects on soil aggregation: A review. *Earth-Science Reviews* 109.1: 44–60
- Martin DA. 2016 At the nexus of fire, water and society. *Phil. Trans. R. Soc. B* 371: 20150172. <http://dx.doi.org/10.1098/rstb.2015.0172> (<http://dx.doi.org/10.1098/rstb.2015.0172>)
- Moody, J. A., and D. A. Martin. 2009. Synthesis of sediment yields after wildland fire in different rainfall regimes in the western United States. *International Journal of Wildland Fire* 18:96–115
- Moody et al., 2013. Current research issues related to post-wildfire runoff and erosion processes. *Earth-Science Reviews* 122:10–37
- Moody et al., 2008. Linking runoff response to burn severity after a wildfire. *Hydrol. Process.* 22, 2063–2074. DOI: 10.1002/hyp.6806
- Santi et al., 2008. Sources of debris flow material in burned areas. *Geomorphology* 96.3: 310–321.
- Santi et al., 2013. Wildfire and landscape change. In *Treatise on geomorphology*. Edited by J. Shroder, L. A. James, C. P. Harden, and J. J. Clague, 262–287. *Geomorphology of Human Disturbances, Climate Change, and Natural Hazards*. Vol. 13. San Diego, CA: Academic Press.
- Scott, D. F., and D. B. Van Wyk. 1990. The effects of wildfire on soil wettability and hydrological behavior of an afforested catchment. *Journal of Hydrology* 121.1–4: 239–256
- Shakesby, R. A. 2011. Post-wildfire soil erosion in the Mediterranean: Review and future research directions. *Earth-Science Reviews* 105.3: 71–100.

Shakesby, R., and S. Doerr. 2006. Wildfire as a hydrological and geomorphological agent. *Earth-Science Reviews* 74.3: 269–307.

Sheridan et al., 2007. Quantification of hillslope runoff and erosion processes before and after wildfire in a wet Eucalyptus forest. *Journal of Hydrology* 343.1–2: 12–28.

Silins et al., 2009. Sediment production following severe wildfire and post-fire salvage logging in the Rocky Mountain headwaters of the Oldman River Basin, Alberta. *Catena*. 79:189-197.

Silins et al., 2014. Five-year legacy of wildfire and salvage logging impacts on nutrient runoff and aquatic plant, invertebrate, and fish productivity, *Ecohydrology*, DOI: 10.1002/eco.1474

Staley et al., 2014. Characterizing the primary material sources and dominant erosional processes for post-fire debris flow initiation in a headwater basin using multi-temporal terrestrial laser scanning data. *Geomorphology* 214:324–338.

Wester et al., 2014. Functional and structural connectivity within a recently burned drainage basin. *Geomorphology* 206:362–373.

Stine M.B. 2013. Fire as a Geomorphic Agent. Reference Module in Earth Systems and Environmental Sciences. *Treatise on Geomorphology*. Volume 12, 2013, Pages 236-251

Stone et al., 2010. Biostabilization and erodibility of cohesive sediment deposits in wildfire-affected streams. *Water Research*.45:521-534.

Stone et al., 2014. The use of composite fingerprints to quantify sediment sources in a wildfire impacted forested landscape, Alberta, Canada. *Science of the Total Environment* 473–474; 642–650.

Westerling et al., 2006. Warming and earlier spring increase Western U.S. forest wildfire activity. *Science* 313:940–943. [doi:10.1126/science.1128834

Winkler et al., 2010. Hydrologic processes and watershed response. In: *Compendium of forest hydrology and geomorphology in British Columbia*. Editors: R.G. Pike, T.E. Redding, R.D. Moore, R.D. Winkler, and K.D. Bladon

STUDENT ASSESSMENT

Component	Value
2 Quizzes (20% Each)	40%
2 Assignments (10% Each)	20%
Final Exam	40%

ASSIGNMENT SCREENING

No assignment screening will be used in this course.

ADMINISTRATIVE POLICY

Territorial Acknowledgement: The University of Waterloo acknowledges that much of our work takes place on the traditional territory of the Neutral, Anishinaabeg and Haudenosaunee peoples. Our main campus is situated on the Haldimand Tract, the land granted to the Six Nations that includes six miles on each side of the Grand River. Our active work toward reconciliation takes place across our campuses through research, learning, teaching, and community building, and is centralized within the [Office of Indigenous Relations](https://uwaterloo.ca/indigenous) (<https://uwaterloo.ca/indigenous>)

Mental Health: The University of Waterloo, the Faculty of Environment and our Departments/Schools consider students' well-being to be extremely important. We recognize that throughout the term students may face health challenges - physical and / or emotional. **Please note that help is available.** Mental health is a serious issue for everyone and can affect your ability to do your best work. Counselling Services <https://uwaterloo.ca/campus-wellness/> (<https://uwaterloo.ca/campus-wellness/>) is an inclusive, non-judgmental, and confidential space for anyone to seek support. They offer confidential counselling for a variety of areas including anxiety, stress management, depression, grief, substance use, sexuality, relationship issues, and much more.

All students are encouraged to download the WatSAFE app which is available free through the google and iOS app stores. The WatSAFE app provides on- and off-campus contacts for students in distress, including international students, and other information related to campus safety and security.

Religious Observances: Students need to inform the instructor at the beginning of term if special accommodation needs to be made for religious observances that are not otherwise accounted for in the scheduling of classes and assignments.

Communications with Instructor and Teaching Assistants: All communication with students must be through either the student's University of Waterloo email account or via LEARN. If a student emails the instructor or TA from a personal account they will be requested to resend the email using their personal University of Waterloo email account.

Recording lecture: Use of recording devices during lectures is only allowed with explicit permission of the instructor of the course. If allowed, video recordings may only include images of the instructor and not fellow classmates. Posting of videos or links to the video to any website, including but not limited to social media sites such as: facebook, twitter, etc., is strictly prohibited.

UNIVERSITY POLICY

Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check [the Office of Academic Integrity](https://uwaterloo.ca/academic-integrity/) (<https://uwaterloo.ca/academic-integrity/>) for more information.]

Grievance: A student who believes that a decision affecting some aspect of their university life has been unfair or unreasonable may have grounds for initiating a grievance. Read [Policy 70, Student Petitions and Grievances, Section 4](https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70) (<https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70>) . When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for their actions. [Check [the Office of Academic Integrity](https://uwaterloo.ca/academic-integrity/) (<https://uwaterloo.ca/academic-integrity/>) for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to [Policy 71, Student Discipline](https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71) (<https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71>) . For typical penalties,

check [Guidelines for the Assessment of Penalties](https://uwaterloo.ca/secretariat/guidelines/guidelines-assessment-penalties) (https://uwaterloo.ca/secretariat/guidelines/guidelines-assessment-penalties) .

Appeals: A decision made or penalty imposed under [Policy 70, Student Petitions and Grievances](https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70) (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70) (other than a petition) or [Policy 71, Student Discipline](https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71) (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71) may be appealed if there is a ground. A student who believes they have a ground for an appeal should refer to [Policy 72, Student Appeals](https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-72) (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-72) .

Note for students with disabilities: [AccessAbility Services](https://uwaterloo.ca/disability-services/) (https://uwaterloo.ca/disability-services/) , located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

Turnitin.com: Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit alternate assignment.