

Master of Science in Sustainability Management

SSM 1050 Ecosystem Science

Office Hours:

Mondays 13:00-15:00

Tuesdays 11:00-12:30

Wednesdays 13:00-14:00

Thursdays 11:00-13:00

or by appointment

e-mail:

Course Objectives:

Ecosystem science provides the scientific foundation to support the sustainable management of diverse ecosystem services including provisioning, regulating, cultural, and supporting services. A deep understanding of interactions between different ecosystem services and impacts of different human and natural disturbances on ecosystem's health is critical to design and implement sustainability management practices. This course provides an in-depth understanding of ecosystem science and ecosystem-based management systems. The course focuses on terrestrial and aquatic ecosystems. The course covers ecosystem structures and functions, ecological energetics (primary production, secondary production, and consumer energetics), biogeochemistry (carbon, nitrogen, and phosphorus cycles), nutrients and pollutants in ecosystems, ecosystem budgets, ecological restoration, ecosystem-based management, and adaptive management.

Course Materials:

No Textbook is required

Learning Outcomes:

Upon completion of this course, course participants will be able to:

- Understand how Earth's major ecosystems function;
- Understand the value of these ecosystems to humans and to animals and plants;
- Understand major biogeochemical cycles including nutrients, metals and synthetic organic compounds;
- Understand human impacts on these ecosystems;
- Understand how humans have tried to rehabilitate ecosystems;
- Understand the science, law and, policy underpinning rehabilitation and protection programs;
- Read and understand scientific terminology and graphics.

Instructional Approach:

The course will consist of lectures and in class seminars / discussions. Each week a group of students will be assigned to research a topic relating to sustainability and will lead an in-class discussion. An extensive reading list will be made available. Students will be expected to familiarize themselves with this material as papers relevant to the week's topic will be discussed in class. The in-class discussion may be based on these readings or any others that are pertinent.

A major component of the course will be a 6,000 word research paper on a topic of the student's choosing. The paper will examine a specific ecosystem and the ways in which humans have affected the form and function of that system. The paper will also consider the mechanisms by which the effects on the system were mitigated or eliminated (science, policy, legislation etc.).

Grading:

Grading scheme

Quiz	10%
Mid-term test	20%
Research Paper	30%
Student participation	10%
Final Exam	30%

Academic Misconduct:

Students should note that copying, plagiarizing, or other forms of academic misconduct will not be tolerated. Any student caught engaging in such activities will be subject to academic discipline ranging from a mark of zero on the assignment, test or examination to dismissal from the university as outlined in the academic handbook. Any student abetting or otherwise assisting in such misconduct will also be subject to academic penalties.

Normally, students will be required to submit their course essays to Turnitin.com for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the Turnitin.com reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site

Any modifications to the course will be announced and explained in class.

Class Participation:

Class participation requires you be present in the class each week, participate actively in lecture discussions as well as in student-led seminars. Class participation grades are based on the quality of your contribution to the discussions.

Course Drop Deadline:

Final date to drop full session full or half courses without academic penalty is **Monday, November 2, 2015**. Please note that MScSM Program students must have the written permission of the Program Director to drop a course. Please consult with the Program Registrar if you are considering dropping a course.

Course Schedule:

Fall 2015 Semester: Room L 1230, Innovation Complex
Wednesdays, from 9:00 am to 12:00 pm. First class is Wednesday, September 16, 2015. Last class is Wednesday, December 2, 2015.

Topics Covered:

Earth in the SOLAR system; effects of Moon on Earth (tides, animal migrations, fish migrations); major biomes; hydrological cycle; biogeochemical cycles; atmospheric structure; some basics of evolution; requirements for life; unpredictability factors;

The role of freshwater in the global context.

Aquatic ecosystems- structure and function. Physical chemical and biological aspects of aquatic systems; energy flows; primary and secondary production.

Terrestrial ecosystems – structure and function. Physical chemical and biological aspects of terrestrial systems; energy flows; primary and secondary production.

Ecosystem services. Discussion and valuation.

Drivers of ecological change. Human impacts on ecosystems- pollution (air water land), physical habitat alteration / destruction, invasive species. Economic and social drivers of human impacts. Sources of human stress on ecosystems.

Domestic governance, policy, legislation. International governance, policy, agreements.

Ecological restoration, ecosystem-based management, and adaptive management.

Managing for sustainability. Sustainable energy.

Reading List

Material discussed in class will be drawn from this list

Earth in the Solar System

Master of Management in Sustainability Management Program
Institute for Management & Innovation, Rm 2252
University of Toronto Mississauga
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Tel: 905-569-5803
Email: [mcsms.utm@utoronto.ca](mailto:mscsm.utm@utoronto.ca)
Website: www.utm.utoronto.ca/mcsms

Terrestrial, Solar and Galactic Origin of the Earth's Geophysical Variables. Nils-Axel Morner. 1984. *Geografiska Annaler. Series A, Physical Geography*. **66, 1-2**. 1-9.

Milankovitch Cycles and Their Effects on Species in Ecological and Evolutionary Time. K. D. Bennett. *Paleobiology*, **16 (1)** 1990. 11-21.

Mass Extinctions in the Marine Fossil Record. David M. Raup and J. John Sepkoski Jr. 1982. *Science*. **215**. 1501-1502.

Cycles in Fossil Diversity. Robert A. Rodhe and Richard A. Muller. 2005. *Nature*. **434**. 208-210.

The Impact of Quaternary Ice Ages on Mammalian Evolution. Adrian M. Lister. 2004. *Philosophical Transactions: Biological Sciences*, Vol. **359 (1442)**. 221-241.

Terrestrial Ecoregions of the World: A New Map of Life on Earth. David M. Olson, et al., 2001. *BioScience*. **51 (11)**. 933 – 938.

Drivers of Ecological Change

Tracking the anthropogenic drivers of ecological impacts. Eugene A. Rosa, Richard York and Thomas Dietz. *Ambio*, Vol. 33, **8**, 2004, pp. 509-512.

Integrating Social Science into the Long-Term Ecological Research (LTER) Network: Social Dimensions of Ecological Change and Ecological Dimensions of Social Change. Charles L. Redman, J. Morgan Grove, and Lauren H. Kuby. *Ecosystems*, 2004. **7**: 161–171.

Synergies among extinction drivers under global change. Barry W. Brook, Navjot S. Sodhi and Corey J.A. Bradshaw. *Trends in Ecology and Evolution* Vol. 23 **8**, 2008. 453-460.

Interactive effects of habitat modification and species invasion on native species decline. Raphael K. Didham, Jason M. Tylianakis, Neil J. Gemmill, Tatyana A. Rand and Robert M. Ewers. *Trends in Ecology and Evolution*. **22 (9)**. 2007. 489-496.

Impacts on Human and Natural Ecosystems

Global Map of Human Impact on Marine Ecosystems. Benjamin S. Halpern et al. *Science*. 2008. **319**. 948-952.

Global Water Pollution and Human Health. Rene P. Schwarzenbach, Thomas Egli, Thomas B. Hofstetter, Urs von Gunten, and Bernhard Wehrli. 2010. *Annual Review of Environmental Resources*. **35**.109–36.

Ecological and toxicological effects of inorganic nitrogen pollution in aquatic ecosystems: A global assessment. Julio A. Camargo and Álvaro Alonso. 2006. *Environment International*. **32**. 831-849.

The Economic Impacts of Aquatic Invasive Species: A Review of the Literature. Sabrina J. Lovell and Susan F. Stone. 2005. National Center for Environmental Economics Working Paper Series. Working Paper # 05-02. Washington D.C.

Interactive effects of habitat modification and species invasion on native species decline. Raphael K. Didham, Jason M. Tylianakis, Neil J. Gemmill, Tatyana A. Rand and Robert M. Ewers. 2007. Trends in Ecology and Evolution **22** (9). 489-496.

Is flooding in Toronto a concern? N. Nirupama, Costas Armenakis, Myriam Montpetit. 2014. Nat Hazards. 72:1259–1264.

Report on Public Health and Urban Sprawl in Ontario: A review of the pertinent literature. Riina Bray, Catherine Vakil and David Elliott. Environmental Health Committee, Ontario College of Family Physicians. 2005. Govt. of Ontario. Toronto. 53 pp.

Indicators and SOE Reporting

Socio-ecological indicators of sustainability. Christian Azar, John Holmberg and Kristian Lindgren. Ecological Economics. **18**, 1996. 89-112.

Indicators of Sustainability: Challenges and Opportunities at the Interface of Science and Policy. Stephen F. Mccool and George H. Stankey. Environmental Management **33**(3), 2004. 294-305.

Corporate Perspectives on the Development and Use of Sustainability Reports. Cory Searcy and Ruvena Buslovich. J Bus Ethics (2014) 121:149–169.

Quantitative assessments of municipal waste management systems: Using different indicators to compare and rank programs in New York State. Krista L. Greene and David J. Tonjes. Waste Management **34** (4). 2014. 825-836.

The Development and Implementation of Indicators of Ecosystem Health in the Great Lakes Basin. Shear, Harvey; Nancy Stadler-Salt; Paul Bertram; and Paul Horvatin. Environmental Monitoring and Assessment **88**: 119-152, 2003.

Climate Change

Intergovernmental Panel on Climate Change Reports. <http://www.ipcc.ch/report/ar5/index.shtml>

Climate change and Great Lakes water resources: avoiding future conflicts with conservation. Noah D. Hall and Bret B. Stuntz. 2008. Hamline Law Review. **31**, p. 641-677.

Confronting Climate Change in the Great Lakes Region: Impacts on our Communities and Ecosystems. Kling, G.W., K. Hayhoe, L.B. Johnson, J.J. Magnuson, S. Polasky, S.K. Robinson, B.J.

Shuter, M.M. Wander, D.J. Wuebbles, D.R. Zak, R.L. Lindroth, S.C. Moser, and M.L. Wilson (2003). Union of Concerned Scientists, Cambridge, Massachusetts, and Ecological Society of America, Washington, D.C.

Ecological and Evolutionary Responses to Recent Climate Change. Camille Parmesan. *Annu. Rev. Ecol. Evol. Syst.* 2006. 37:637–69.

Potential effects of climate changes on aquatic systems: Laurentian Great Lakes and precambrian shield region. J. J. Magnuson, K. E. Webster, R. A. Assel, C. J. Bowser, P. J. Dillon, J. G. Eaton, H. E. Evans, E. J. Fee, R. I. Hall, L. R. Mortsch, D. W. Schindler And F. H. Quinn. (1997). *Hydrological Processes*, 11, 825 - 871

Ocean acidification: the other climate change issue: Carbon dioxide from the atmosphere reacts with coastal water to increase the acidity of the ocean, a trend that threatens many marine ecosystems. Johnson, Ashanti, and D. Natasha White. (2014). *American Scientist* **102.1**: 60.

The potential impact of climate change on Great Lakes international shipping. Frank Millerd. *Climatic Change* (2011) **104**:629–652.

Managing for Sustainability

Great Lakes Water Resources: Planning for the Nation’s future. Brad Everhardt. 2001. *Toledo Journal of Great Lakes Law, Science and Policy*. **3**. 90-111.

Institutional arrangements for managing the great lakes of the world: Results of a workshop on implementing the watershed approach. Lisa Borre, David R. Barker and Laurie E. Duker. 2001. *Lakes & Reservoirs: Research and Management* **6**: 199–209.

Toward Integrated Resource Management: Lessons about the Ecosystem Approach from the Laurentian Great Lakes. Susan H. Mackenzie. 1997. *Environmental Management*. **21 (2)**. 173–183.

Re-Thinking Environmental Flows: From Allocations and Reserves to Sustainability Boundaries. Brian D. Richter. 2010. *River Research and Applications*. **26**. 1052–1063.

Managing aquaculture for sustainability in tropical Lake Kariba, Zimbabwe. Berg, H; Michelsen, P; Troell, M; et al. 1996 *Ecological Economics* 18 (2). 141-159.

Perspective Changes Everything: Managing Ecosystems from the Inside Out. David Waltner-Toews, James J. Kay, Cynthia Neudoerffer and Thomas Gitau. 2003. *Frontiers in Ecology and the Environment*, **1 (1)** 23-30.

A one hundred year review of the socioeconomic and ecological systems of Lake St. Clair, North America. Melissa M. Baustian, Georgia Mavrommati, Erin A. Dreelin, Peter Esselman, Steven R. Schultze, Leilei Qian, Tiong Gim A, Lifeng Luo, Joan B. Rose. 2014. *Journal of Great Lakes Research*. **40**. 15–26.

Perspectives on an ecosystem approach to ecogenic challenges in the Great Laurentian Basin and beyond. Henry Regier. 2013. *Aquatic Ecosystem Health & Management*. **16 (1)**. 6–19.

The science of ecosystem-based management on a global scale: The Laurentian Great Lakes, Lake Ontario, and the Bay of Quinte as a nested case study. C. K. Minns. 2013. *Aquatic Ecosystem Health & Management*. **16 (3)**. 229–239.

Ecosystem Services

The value of the world's ecosystem services and natural capital. Robert Costanza, Ralph d'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert V. O'Neill, Jose Paruelo, Robert G. Raskin, Paul Sutton, Marjan van den Belt. 1997. *Nature*. **387**. 253–260.

Pricing the invaluable: the value of the world's ecosystem services and natural capital. Salah El Serafy. 1998. *Ecological Economics* **25**. 25 – 27.

Why not to calculate the value of the world's ecosystem services and natural capital. Michael Toman. 1998. *Ecological Economics*. **25**. 57 – 60.

Measuring and managing ecosystem goods and services in changing landscapes: a south-east Australian perspective. Himlal Baral; Rodney J. Keenan; Nigel E. Stork and Sabine Kasel. 2014. *Journal of Environmental Planning and Management*. **57 (7)**. 961–983.