

**Master of Science in Sustainability Management****SSM 1050 Ecosystem Science****Lecture and seminar course****L 1230****Wednesdays 2-5 pm****September 11, 2019 – December 4, 2019**

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**Course Objectives:**

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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:**

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**No Textbook is required****Learning Outcomes:**

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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:**

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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.

One component of the course will be a **Briefing Note** on a topic to be assigned.

A second component of the course will be a **3,000-word policy 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 consider the policy options open to government by which the effects on the system can be mitigated or eliminated (science, policy, legislation etc.).

A third component will be an **in-class simulation of an interagency (government, NGO, Universities, industry) meeting** to discuss approaches to implementing the Paris Agreement on Climate Change in light of present political uncertainties.

A fourth component will be a **case study based on what you have learned from the four core courses and other sources, this term.** Details of this will be provide by Prof. Kant in late November. This case study is common to all first semester courses.

### **Grading:**

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<b>Grading scheme</b>		
<b>Due October 21, 2019</b>	Briefing Note	15%
<b>November 6, 2019</b>	Simulation of an interagency meeting	15%
<b>December 5, 2019</b>	Case Study	15%
<b>Due December 15, 2019</b>	Final Exam (Take Home)	30%
<b>Due December 20, 2019</b>	Policy Paper	15%
<b>Student participation (including seminar)</b>		10%

### **Academic Misconduct:**

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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 work to Turnitin.com for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their work 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](http://Turnitin.com) service are described on the [Turnitin.com](http://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.

### **Dropping the Course:**

This is a required course of the program. Please consult with the Program Coordinator and the Program Director if some unavoidable situation arises and you must drop a required course of the program. The drop date is **October 28, 2019**.

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### **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.

**Special Lecture in Class- How to write a policy paper- Michael Kaler (Robert Gillespie Academic Skills Centre) - September 27, 2019 2-3 pm**

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**Briefing Note Due October 21 at 11.59 pm**

Students will prepare a two-page briefing note on a topic to be assigned. This is a take home assignment, so I expect a high-quality product. Details about the topic, the format etc. will be posted on Quercus one week before the due date

**In class simulation of an Intergovernmental Meeting to Implement the Paris Agreement on Climate Change:**

This will be held on **November 6, 2019 from 2.30-5.00 in the Council Chambers (DV 3130)**. Details will be posted on October 23, 2019 on Quercus. Prof. Besco will give a special lecture on international agreements to help you prepare for this assignment.

**Take home final exam:**

Due **December 15, 2019 at 11.59 pm**. The exam will be posted on Quercus on **December 14, 2019 at 12.01 am**. You will have 48 hours to complete the exam and submit it as an **MS Word** file to Quercus. Since you will have access to any relevant materials, I expect the answers to be more complete, well thought out and organized than might be the case with an in-class exam.

**Policy Paper:**

Due **December 20, 2019, 11.59 pm**. Students will prepare a paper of about **3 000 words** plus appropriate graphics and references, on a topic of their choice. The format is **double spaced in MS Word**. **A pdf will not be accepted**. The content will be based on critical / independent thought of a calibre expected of graduate students, considering principles from the lectures in any of your MScSM courses, primary literature, government information from acceptable sources and acceptable internet sites. The paper will be evaluated on the basis of the Grading Scheme at the end of this syllabus.

Students will select a topic by the **30<sup>th</sup> of September**. They will submit an electronic **proposal (due at 11.59 pm on September 30, 2019) to Quercus**. The proposal should be 1-2 pages single spaced.

Format-

1. Your Name
2. Preliminary Title of your paper (this may change as you develop your topic)
3. Introductory paragraph explaining why the topic is important based on any preliminary research;  
Body paragraph explaining how you are going to approach the topic.  
Do not say "I am going to use the library and research published papers" or anything such as this. I want to know what **analytical** approach you are going to take.  
You may use references if you want.

The policy paper will be submitted to **Quercus, and to Turn-it-In (instructions regarding Turn-it-In will be posted on Quercus)**.

There will be a **10% per day penalty** for late submission, up to a maximum of 5 days, at which point the assignment will receive a grade of zero.

**SSM 1050**

**Grading Rubric: Policy Paper**

Student's Name:

Student's Number:

Title of Policy Paper:

<p><b>Quality of Response to the Task:</b></p> <ul style="list-style-type: none"> <li>• Paper must have:             <ul style="list-style-type: none"> <li>○ Clear issue statement, argument and options for policy recommendations;</li> <li>○ Insights relevant to assignment;</li> <li>○ Accurate claims supported with detailed, referenced evidence;</li> <li>○ Appropriate quantity and quality of primary and secondary sources;                 <ul style="list-style-type: none"> <li>▪ Note: paper should indicate that it is built upon the information presented in <b>references</b>.</li> <li>▪ <b>Note: lecture notes should NOT be cited as references.</b></li> </ul> </li> </ul> </li> </ul>	<p><b>50</b></p>
<p><b>Organization of Content:</b></p> <ul style="list-style-type: none"> <li>• <b>Essay must include the following sections (you may use subheadings as well):</b> <ul style="list-style-type: none"> <li>○ <b><u>Introduction:</u></b> <ul style="list-style-type: none"> <li>▪ introduces subject;</li> <li>▪ identifies the question or issue under discussion;</li> <li>▪ clearly defines the question and explains why this subject is important;</li> <li>▪ explains approach (e.g. analysis of government data OR analysis of private sector information to topic etc.)</li> <li>▪ identifies the limitations of approach (if any);</li> </ul> </li> <li>○ <b><u>Background:</u></b> <ul style="list-style-type: none"> <li>▪ gives relevant history on the issue to set it in context so that the reader understands why it is important;</li> </ul> </li> <li>○ <b><u>Discussion or Analysis section:</u></b> <ul style="list-style-type: none"> <li>▪ discusses the issue and different perspectives;</li> <li>▪ provide policy options to address the issue;</li> </ul> </li> <li>○ <b><u>Recommendation:</u></b> <ul style="list-style-type: none"> <li>▪ Provide a recommended policy approach flowing logically from preceding arguments.</li> </ul> </li> </ul> </li> </ul>	<p><b>35</b></p>
<p><b>Presentation:</b></p> <ul style="list-style-type: none"> <li>○ includes cover page (which clearly identifies course number and course title) and has an informative title;</li> <li>○ pages are numbered;</li> <li>○ margins are 2.5 cm;</li> <li>○ has 12-point font (Arial, Times Roman or similar easy-to-read font);</li> <li>○ uses <a href="#">APA</a> format;</li> <li>○ has citations <b>included in the text:</b> (example--Smith and Jones, 2005);</li> <li>○ has a bibliography (called References):             <ul style="list-style-type: none"> <li>▪ all references are clearly identified;</li> <li>▪ all Internet sources include URL and date of access;</li> </ul> </li> </ul>	<p><b>15</b></p>

<ul style="list-style-type: none"> <li>▪ only uses Internet sites from universities, governments or recognized NGOs (non-governmental organizations);</li> <li>▪ does not list sources that are not used in the text of the paper;</li> <li>▪ <b>has no footnotes or endnotes;</b></li> <li>○ total word length should be <b>3000</b> words</li> <li>○ all writing is double-spaced as per APA format</li> <li>○ uses graphs, charts, photos to support written material:             <ul style="list-style-type: none"> <li>▪ <b>Note: references, graphics and photo captions DO NOT COUNT as part of the 3000 words;</b></li> </ul> </li> <li>○ Graphs and tables should be <b>PART OF THE TEXT, NOT at the end as an appendix</b></li> <li>○ grammar and spelling should be free of error:             <ul style="list-style-type: none"> <li>▪ does not have typos:                 <ul style="list-style-type: none"> <li>• do NOT rely entirely on spell check: often two words sound the same (homonyms) but mean different things (example our-hour);</li> </ul> </li> <li>▪ has complete sentences;</li> <li>▪ has paragraphs that are logical and well-constructed, have one main idea, and use evidence to support claims introduced in a clear topic sentence;</li> <li>▪ <b>has scholarly writing style – not chatty as if talking to a friend;</b></li> <li>▪ has no repetition;</li> <li>▪ uses appropriate and effective vocabulary;</li> <li>▪ avoids fluff, vague generalities, and biased language;</li> <li>▪ NOTE: if English is not the student's first language, someone who speaks English as a first language should check over the grammar and spelling;</li> </ul> </li> <li>○ HAS NO EVIDENCE OF PLAGIARISM, INTENTIONAL OR OTHERWISE.</li> </ul>	
<p><b>Total:</b></p>	
<p><b>Late Penalty</b> (10% / day to a maximum of 5 days, then zero will be assigned to the assignment):</p>	
<p><b>Grand Total:</b></p>	

## Reading List

*Material discussed in class may be drawn from this list. Other material used in class will be referenced so that students can retrieve it easily.*

### Earth in the Solar System

**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.** MelissaM. 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.

**Terrestrial Ecosystems**

*Principles of Terrestrial Ecosystem Ecology*. 2002. F. Stuart Chapin III; Pamela A. Matson; Harold A. Mooney. Springer- Verlag Inc. New York. 396 pp.