COLUMBIA UNIVERSITY
School of Professional Studies

Master of Science in Sustainability Science

SUSC PS5001 Fundamentals of Sustainability Science
Tuesdays, 4:10-6:00 PM at 606 Lewisohn Hall
3 Credits

Instructor: Arthur Lerner-Lam, Lamont Research Professor in the Lamont-Doherty Earth Observatory of Columbia University, Senior Advisor to the Deans of the Climate School, lerner@ldeo.columbia.edu, (845) 365-8348

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Office Hours: Tuesdays from 2:00-4:00 PM by email appointment at 504D Lewisohn Hall.

Response Policy: Instructor is available for short discussions before class or via email. Longer meetings should be scheduled during Office Hours.

Course Overview

This course provides an introduction to the major themes explored in the Sustainability Science Masters curriculum with a focus on the application of science to the practice of sustainability. Basic research, especially in the environmental and social sciences, explores the Earth as a system of systems, wherein the physical, chemical and biological systems interact with each other as well as human systems to affect our future. The results of this research are often difficult to apply in practice unless the research is translated into actionable advice for individuals, governments and private enterprise. Even so, the actual or perceived complexities of interactions between human and "natural" systems are often seen by decision makers as barriers to long-term planning, an essential element of pursuing sustainability. A simple definition of sustainability is based on intergenerational equity. Thus, the relationships between the here-and-now and possible global futures need to be understood. Students enrolled in this course will discuss:

1. Definitions of sustainability, including environmental, cultural and socio-economic components.
2. Technologies for observing natural systems and their impacts on human systems.
3. Summaries of scientific understanding of global-scale climate dynamics, natural hazards, biodiversity, environmental stressors and anthropogenic inputs to coupled human-natural systems.
4. An overview of the strengths and weaknesses of science-based prediction.
5. An introduction to geoengineering.
6. Developing the evidence base for sustainability decisions.
7. An introduction to risk assessment, perception and management.
8. Decision making under uncertainty.
9. General principles of sustainability management.

An undergraduate background in any field of science or engineering and mathematics through statistical and time-series analysis is required. An interest in coupled natural-human systems is desirable.

This course is required of all first-year students in the M.S. in Sustainability Science program.

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Learning Objectives

By the end of this course, students will be able to:

L1: Elucidate the physical, cultural and socio-economic components of sustainability and describe in general terms the interactions among coupled human-natural systems.

L2: Describe in general terms how an understanding of applied sustainability science informs risk assessment, perception and management.

L3: Enumerate the areas of basic physical and social science research most applicable to applied sustainability science, translate basic scientific research for application, and describe the role of hypothesis testing and the limits of prediction.

L4: Describe the technologies necessary for environmental observation and assessing impacts on human systems, and interrogate databases containing information relevant to sustainability science.

L5: Effectively communicate the importance of sustainability science for effective sustainability management by applying their knowledge of scientific observation and monitoring, analysis and modeling, as well as the use of scientific tools in organizations.

Readings

Core Text: Matson, P., Clark, W.C., Andersson, K. *Pursuing Sustainability: A Guide to the Science and Practice.* Princeton University Press, 2016. ISBN 978-0-691-15761-0.

Other Readings (specific chapters to be assigned):

1. Langmuir, C.H. and Broecker, W., *How to Build a Habitable Planet (Revised edition).* Princeton University Press, 2012. ISBN 978-0-691-14006-3.
2. Sobel., A., *Storm Surge: Hurricane Sandy, Our Changing Climate, and Extreme Weather of the Past and Future.* HarperCollins, 2014. ISBN 978-0-06-*230476*-6.
3. Bloomberg, M., and Pope, C., *Climate of Hope: How Cities, Businesses, and Citizens Can Save the Planet.* St. Martin's Press, 2017. ISBN 978-1-250-14207-8.
4. Sachs, J.D., *The Age of Sustainable Development.* Columbia University Press, 2015. ISBN 978-0-231-17315-5.
5. Cohen, S., *Sustainability Management.* Columbia University Press, 2011. ISBN 978-0-231-15259-4.
6. Zolli, A., and Healy, A.M., *Resilience: Why Things Bounce Back.* Simon and Schuster, 2012. ISBN 978-1-4516-8381-3.

Resources

Columbia University Library

Columbia's extensive library system ranks in the top five academic libraries in the nation, with many of its services and resources available online: http://library.columbia.edu/.

SPS Academic Resources

The Office of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: http://sps.columbia.edu/student-life-and-alumni-relations/academic-resources.

Programming
Students should be familiar with standard Microsoft Office / Google Workspace software to support their completion of course assignments.

Course Requirements (Assignments)

Class Participation (15%) (L1, L2, L3, L5)

Class participation, including oral and written communication, exercises important job skills. Weekly readings must be completed before class and will help contextualize class discussions which hone your ability to talk about the role of climate and climate predictions in sustainability practices. We will assign weekly readings and we will start each class collecting questions from the students to get us started. Please come to class having read the material, having written down one or more questions, and ready to participate in classroom discussions. Classroom participation makes up 15% of your final grade. Most importantly, it gives us a window on your interests and grasp of the material.

Midterm Paper (35%) and Final Paper / Presentation (50%) (L1, L2, L3, L4, L5)

Students will write a short midterm paper and prepare a paper or presentation on a semester-long project. The midterm paper will be in the form of a brief (approximately five page) project proposal which will be developed further as the final project. A typical project would comprise the identification of a problem faced by a particular client (private sector enterprise, government agency, community group); an assessment of the science illuminating the issue; recommendations on a potential technical or policy solution; and an implementation strategy. Students will prepare both a written description of the project results (approximately 20 pages plus references and figures) and a formal oral presentation (approximately 15 minutes) delivered to the class.

Evaluation/Grading

Participation (15%)

Participation will be graded on a scale of 0-100. Participation includes class attendance, contribution of written questions, and active discussions in class. The students are expected to show critical thinking, respectful interactions with classmates and a positive attitude towards learning and freely discussing the topics proposed. Students are encouraged to share the critical questions from their assignments with their peers.

Midterm Paper (35%)

The midterm paper will be judged on a scale of 0-100, and will be evaluated as a project proposal. The project proposal should state the subject and hypothesis, the relevance to sustainability science, and the data, analysis or other resources required for completion. Approximately one-third of the evaluation will be based on the clarity of

the written work. Students are encouraged to discuss potential topics with the instructor(s) beforehand. Instructor comments will be returned with the graded work and should be incorporated in the final project paper and presentation. Deficiencies in the midterm paper that are corrected in the final paper will yield an improved grade on the midterm paper.

Final Project Paper and Presentation (50%)

Both the written final project report (two-thirds of the final project grade) and the class presentation (one-third of the final project grade) will be graded on a scale of 0-100. The written report will be graded based on completeness (i.e., including background and motivation, methods, results, conclusions and references) and correct interpretation of the results. The class presentation will be graded based on clarity, quality of the presentation materials, finishing in a timely manner, and responses to audience questions.

The final grade will be calculated as described below:

FINAL GRADING SCALE

Grade	Percentage
A+	98–100 %
A	93–97.9 %
A-	90–92.9 %
B+	87–89.9 %
B	83–86.9 %
B-	80–82.9 %
C+	77–79.9 %
C	73–76.9 %
C-	70–72.9 %
D	60–69.9 %
F	59.9% and below

ASSIGNMENT	% Weight
Participation	15
Midterm Paper	35
Final Project / Presentation	50

Course Policies

Participation and Attendance

You are expected to come to class on time and thoroughly prepared. The instructors will keep track of attendance and look forward to an interesting, lively and confidential discussion. If you miss an experience in class, you miss an important learning moment and the class misses your contribution. More than one absence will affect your grade.

Late work
Work that is not submitted on the due date noted in the course syllabus without advance notice and permission from the instructor will be graded down 1/3 of a grade for every day it is late (eg., from a B+ to a B).

Citation & Submission
All written assignments must cite sources and be submitted in person or to the course website (not via email).

School Policies [Include all school/university policies as written below]

Copyright Policy
Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity
Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at https://sps.columbia.edu/students/student-support/academic-integrity-community-standards. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Accessibility
Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website: http://health.columbia.edu/services/ods/support.

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Course Schedule/Course Calendar

NOTE: Some topics may be covered by Guest Lecturers, including practitioners from outside Columbia

Date	Topics and Activities	Readings (due by class time) * = required	Assignments
9/6	General definitions of sustainability, adaptation, mitigation and resilience. Overview of sustainability science and sustainability management	*Matson, P., Clark, W.C., Andersson, K. *Pursuing Sustainability: A Guide to the Science and Practice.* Princeton University Press, 2016. ISBN 978-0-691-15761-0. Ch. 1, pp. 1-13 Cohen, S., *Sustainability Management.* Columbia University Press, 2011. ISBN 978-0-231-15259-4. Ch. 1, pp. 1-19 Zolli, A., and Healy, A.M., *Resilience: Why Things Bounce Back.* Simon and Schuster, 2012. ISBN 978-1-4516-8381-3. Introduction, pp. 1-24	
9/13	Frameworks for sustainability analysis	*Matson, P., Clark, W.C., Andersson, K. *Pursuing Sustainability: A Guide to the Science and Practice.* Princeton University Press, 2016. ISBN 978-0-691-15761-0. Ch. 2, pp. 14-51	
9/20	The structure and dynamics of natural systems	*Langmuir, C.H. and Broecker, W., *How to Build a Habitable Planet (Revised edition).* Princeton University Press, 2012. ISBN 978-0-691-14006-3. Ch. 1, pp. 1-26	
9/27	Natural Climate System, Human Impacts on the climate system	*Langmuir, C.H. and Broecker, W., *How to Build a Habitable Planet (Revised edition).* Princeton University Press, 2012. ISBN 978-0-691-14006-3. Ch. 18 – 20, pp. 539-648. (Skim pp. 567-596)	
10/4	Coupled Human-Natural systems	*Matson, P., Clark, W.C., Andersson, K. *Pursuing Sustainability: A Guide to the Science and Practice.* Princeton University Press, 2016. ISBN 978-0-691-15761-0. Ch. 3, pp. 52-82	
10/1	Extreme events	Lecture notes Sobel., A., *Storm Surge: Hurricane Sandy, Our Changing Climate, and Extreme Weather of the Past and Future.* HarperCollins, 2014. ISBN	

		978-0-06-*230476*-6. Ch. 6,7, pp. 39-54, Ch. 11, pp. 75-94.	
10/18	Introduction to risk: identification, assessment, perception, management	Lecture notes	**10/20 Midterm Paper due**
10/25	Management and governance for sustainability	*****Matson, P., Clark, W.C., Andersson, K. *Pursuing Sustainability: A Guide to the Science and Practice.* Princeton University Press, 2016. ISBN 978-0-691-15761-0. Ch. 4, pp. 83-104 Bloomberg, M., and Pope, C., *Climate of Hope: How Cities, Businesses, and Citizens Can Save the Planet.* St. Martin's Press, 2017. ISBN 978-1-250-14207-8. pp. 19-40, 131-146.	
11/1	Observation, Data and Information for Sustainability: Frontier observational technologies and database interrogation strategies	Lecture Notes	
11/8	University Holiday - No class		
11/15	Case Study: TBD		
11/22	Case Study: TBD		
11/29	Case Study: TBD		
12/6	Wrap-up discussion	*****Matson, P., Clark, W.C., Andersson, K. *Pursuing Sustainability: A Guide to the Science and Practice.* Princeton University Press, 2016. ISBN 978-0-691-15761-0. Ch. 5-6, pp. 105-142.	
TBD	**Final Presentations**		**12/20 Final Paper due**