ENVS 112 Natural Science and the Environment  
Spring 2010

Lecture: Hillcrest 103, MWF 9:05 – 9:55  
Labs: MBH 309 (sections W, X, Y, Z), 1:30 – 4:15 on M, T, W, or Th

Instructors

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Office Hours: by appointment & W 11-12  
and Th 11-12

Fundamentals

Welcome to the Environmental Studies Program's course on environmental science. ES 112 is one of the three introductory-level courses offered by the ES Program. In it, we explore in detail the science that underlies the principles of sustainability, focusing on concepts from biology, chemistry, geology, physics, and quantitative systems analysis. Topics covered will emphasize the dimensions of sustainability, particularly human population growth, agriculture, energy production, pollution, and ecosystem functions and services. You will also gain experience with the scientific method, tools for critical analysis, and systems modeling. This material is designed to complement other introductory environmental studies courses on social sciences (ES/PS 211) and humanities (ES 215), but our focus will be first and foremost on the natural sciences.

Science as a broad set of disciplines has characteristic conventions, features, and tools that often go unspoken, but are very important and used every day by practicing scientists. Citizens are bombarded daily with scientific and sometimes seemingly scientific environmental information in newspapers, on radio, TV, and the Internet. It can even be difficult for practicing Ph.D. scientists to make sense of information they read about other fields of science! In order to sift through and distinguish the reliable information from the unreliable information it helps to understand how scientists gather, validate, interpret, and report data. Some important features of current scientific practice include 1) external peer-review, 2) source validation and citation, and 3) the use of multiple pieces of evidence to support proposed explanations. You will learn about and try your hand at some of these practices in the course of studying several issues in environmental science.

The interdisciplinary nature of most environmental science often distinguishes it from traditional sciences such as biology, chemistry, geology, and physics. It draws on many aspects of the traditional sciences to examine issues that range from population analysis and contamination of natural environments to climate and land-use change. To truly understand the impacts of soil contamination, for example, we need to understand sources of contamination, geological and chemical transport and uptake, plant-related transport and uptake, food-web interactions, microbial activity, solid-liquid-gas phase relationships, and the potential for vapor production and atmospheric contamination. Clearly, knowledge of chemistry, geology, plant physiology, ecology, microbiology, and physics plays an important role in environmental science.

Environmental studies is even broader and more interdisciplinary in scope than environmental science, and includes perspectives from other disciplines, such as policy, philosophy, economics, and literature. If you choose to take additional courses in the Environmental Studies Program at Middlebury College, you will focus on some of these other perspectives and gain further insight into the relationship between humans and the environment.
Course Objectives

We hope that each of you will choose to participate actively and conscientiously in this course. This includes preparing for class, contributing respectfully to discussions, raising thoughtful questions, and seeking help when you need it. If you do so, by the end of the course you will:

- understand the relationship between sustainability and natural systems on Earth;
- use knowledge of current science practices to evaluate environmental information and to construct scientific arguments;
- connect specific concepts across multiple topics to support broader themes in environmental science;
- feel comfortable developing and interpreting conceptual models of how environmental systems function;
- communicate science effectively in written work and oral discussions; and
- critically read and evaluate several formats of scientific writing, including peer-reviewed literature, popular science writing, and environmental journalism.

Course Structure

The broad theme of this course for both lecture and lab relates to the science that underlies society’s search for sustainable practices. Our exploration of this theme will lead us to focus on a number of general environmental issues that are of both global and local concern and simultaneously to explore the scientific principles governing important human-environment interactions:

<table>
<thead>
<tr>
<th>Human population growth</th>
<th>Soils &amp; agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystem functions and services</td>
<td>Energy</td>
</tr>
<tr>
<td>Water resources &amp; pollution</td>
<td>Climate change</td>
</tr>
</tbody>
</table>

These issues will be linked through the concept of sustainability, the conversion of energy and matter by people today in ways that do not jeopardize the abilities of people to meet their needs in the future.

The lecture portion of this course is intended to cover material that is typically more global in nature and therefore less amenable to laboratory investigation. In contrast, laboratory sessions will investigate environmental science issues from an experiential and hands-on basis with a greater emphasis on local manifestations of global issues. Both lecture and laboratory are intended to provide intellectual and scientific background.

Information Acquisition Beyond the Lectures and Labs: reading, viewing, listening

The textbook will provide a concise primer on each topic we will cover. In particular, it provides background on important concepts and themes in environmental science and introduces terminology and quantitative problem-solving approaches. We also want to emphasize the acquisition of information through multiple media that will connect you with current thinking and current events. These media will include (1) current journal articles and related articles, and (2) on-campus seminars.

1. Readings.—These will include journal articles, book chapters, newspaper articles, web sites, and any other form as is useful. These will be made available to you in a variety of ways, including:


- **ENVS0112A Handouts Folder on the Classes Server:** many readings will be deposited in the handouts folder; so be sure you know how to access this.
• **E-mail to Class List:** some readings will show up as file attachments in your E-mail Inbox. You are responsible for information and material sent to your college email address, so be sure to check your e-mail daily.

• **Internet:** some readings will be accessible on web sites, for which we will send you the URLs.

• **Hand-outs:** occasionally, photocopies will be handed out in class or lab.

Readings will fall into one of three categories: (a) background information like that provided by the textbook, (b) current news, and (c) research reports from the scientific literature. These readings are provided because they present the bases for in-class discussion, data analysis, and a deeper appreciation for the importance of environmental science to you as a citizen. They also include many of the styles of publications in science, including peer-reviewed journal articles, textbooks, newspaper and magazine articles, government documents (e.g., EPA and USGS publications), and various types of web dissemination. If you choose to print these materials for reading and review, we recommend that you get a three-ring binder to keep them organized.

We have noted in the syllabus (see below) as many of the readings we will want you to do during the semester as possible. However, new information is being published all the time and current events are reported in the news every day. Therefore, new reading assignments will be added throughout the semester. You are responsible for keeping track of these readings.

We cannot overemphasize the importance of doing the readings in this class. Reading these materials critically will make the difference between active engagement and passive boredom. To this end, for a number of reading assignments for lecture we will ask you to turn in a one-page reading report, and for lab there will be occasional reading questions for which we will ask you to write brief answers. The exact day on which these are due will be announced in class. The format for the reading reports is very important, and is described in detail on the last page of this handout. Articles that will require a reading report are noted in the syllabus with an asterisk, and will be further noted in class. Lab reading questions will be emailed during the week prior to the assignment date.

2. **Seminars.**—The College brings onto campus numerous speakers who present topics of relevance to environmental science. They also maintain a large digital library of seminars that have been presented in the past. As relevant, we will assign you to attend or view a seminar.

### Course Grading and Assignments

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Date/Period</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Exams (2)</td>
<td>March 19th &amp; during Finals Period</td>
<td>40%</td>
</tr>
<tr>
<td>Lab reports (3)</td>
<td>See schedule</td>
<td>35%</td>
</tr>
<tr>
<td>Lab exercises</td>
<td>See schedule</td>
<td>15%</td>
</tr>
<tr>
<td>Reading reports / participation</td>
<td>Periodically / in lecture &amp; lab</td>
<td>10%</td>
</tr>
</tbody>
</table>

**Grade Assignment:** Grading is based on a straight percentage scale: 90-100% is an A, 80-89% is a B, 70-79% is a C, 60-69% is a D, and less than 60% is an F, with high and low points within those ranges being given + or - grades.

**Exams:** A midterm exam (March 19th; 15%) and a final exam (during Finals Period; 25%). Each exam will build on information, skills, and concepts developed to that point in the course. The final exam will emphasize material covered in the 2nd half of the course but will also draw on material from the 1st half and should, therefore, be considered a cumulative exam. Exams will include qualitative and quantitative questions and will mainly cover materials from lecture and related readings and assigned seminars, but also will incorporate pertinent concepts or examples from lab.

**Lab Reports:** You will write three lab reports. The topics will be our legume nodulation experiment, our water quality and land use study, and our forest carbon analysis. Among the objectives of writing lab reports are 1) to give you an opportunity to analyze and interpret data, 2) to concisely describe the global and local context of the study, and 3) to discuss the broad implications of our results. For some of the lab reports you will be required to include
information from peer-reviewed papers that we have not had assigned in class (i.e., you will conduct your own literature searches). More details will be provided in lab.

**Lab Exercises:** We will have a number of small assignments, which will include a worksheet related to renewable energy and a presentation on an aspect of energy, a farm-systems model, and a wetlands worksheet. Brief responses to reading questions will be required for a selection of readings; questions will be distributed by email.

**Reading Reports:** Reading reports, as described earlier, are associated with some of the required readings.

**Participation:** One additional way to display that you are involved with and understand the materials in this course is to ask informed questions and participate in Q & A.

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**General Policies**

**Late Assignments:** In order to ensure that grading is uniform and fair to all students, all assignments are due at the beginning of the lecture or lab period (as appropriate) unless otherwise noted. Late assignments will be penalized 5% if they are turned in after the designated time on the day it is due, and 20% per day for each day after that. This means that if an assignment is due on Thursday at the start of class, it will be penalized 5% if you turn it in on Thursday afternoon, and it will be penalized 25% if it is turned in on Friday. The exceptions to this are reading reports and reading questions, which will be penalized one point if it is turned in after the designated time on the day it is due and one point per day for each day after that.

**Assignment Formatting:** All assignments should be typed and printed double-sided. And STAPLED! Assignments that are not stapled will be automatically penalized 5%. Graphs should be completed with a computer program such as Excel. On homework assignments, you are welcome to hand in calculations written out by hand. All literature citations must be in the format specified for this class (one of many science-writing formats); see last page of syllabus and lab report guidelines for details.

**Laboratory Attendance:** Due to constraints on equipment availability and van sizes, you must attend the lab session in which you are registered. Missed laboratory sessions must be made up, which involves communicating and planning with Marc in advance.

**Lecture Attendance:** Attendance is required at all lectures. Your final grade will be reduced by a third of a grade (e.g., B+ to B) for every three unexcused absences. In this class, the lectures are interactive, and you should come to each class prepared to ask questions, and to be called upon to answer questions about the reading and lecture material. You are responsible for all material presented in lecture, reading, and for all assignments and exercises.

**Field Lab Attire:** We will spend about ½ of our time outside. Please come to lab prepared for any weather. You will need warm, waterproof gear and comfortable footwear. Do not wear sandals for field labs, except for the day we collect and sample stream water. If you do not have access to appropriate gear for being outdoors on foul-weather days, let us know ahead of time, and we will do our best to help you out. Inadequate preparation is NOT a valid excuse for missing a lab.
# Syllabus: schedule of topics, locations, readings, and assignments (subject to amendment)

## Week 1 (February 8-12)

<table>
<thead>
<tr>
<th>Lecture topics</th>
<th>Introduction to sustainability; human population; sources of energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab topic</td>
<td>Foundations of sustainability</td>
</tr>
<tr>
<td>Lab activity</td>
<td>Small group and individual explorations</td>
</tr>
<tr>
<td>Lab location</td>
<td>MBH 309</td>
</tr>
</tbody>
</table>
| **Reading**    | **LECTURE:**  
|                | TEXT: Ch 1; Ch 4 (pp. 81-86), Ch 6  
|                | **LAB:**  
|                | Lab handout for Week 1                                       |

## Week 2 (February 15-19)

<table>
<thead>
<tr>
<th>Lecture topics</th>
<th>Energy (continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab topic</td>
<td>Renewable electricity</td>
</tr>
<tr>
<td>Lab activity</td>
<td>Measuring electrical parameters from wind and solar generation</td>
</tr>
<tr>
<td>Lab location</td>
<td>MBH 309</td>
</tr>
<tr>
<td>Lab assignments due / Exams</td>
<td>None—do research for lab presentations</td>
</tr>
</tbody>
</table>
| **Reading**    | **LECTURE:**  
|                | TEXT: Ch 3 (pp. 49-59), Ch 15, Ch 16.  
|                | **LAB:**  
|                | Lab handout for Week 1                                       |

## Week 3 (February 22 – 26)

<table>
<thead>
<tr>
<th>Lecture topics</th>
<th>Climate system, history (e.g. ice cores), projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab topic</td>
<td>Hydroelectric and nuclear technologies</td>
</tr>
<tr>
<td>Lab activity</td>
<td>Student group presentations</td>
</tr>
<tr>
<td>Lab location</td>
<td>MBH 309</td>
</tr>
<tr>
<td>Lab assignments due / Exams</td>
<td>None</td>
</tr>
</tbody>
</table>
| **Reading**    | **LECTURE:**  
|                | TEXT: Ch 14, 15, 16  

## Week 4 (March 1 - 5)

<table>
<thead>
<tr>
<th>Lecture topics</th>
<th>Climate, soils, agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab topic</td>
<td>Food production and the environment</td>
</tr>
<tr>
<td>Lab activity</td>
<td>Farm visit</td>
</tr>
<tr>
<td>Lab location</td>
<td>VAN PICKUP LOCATION</td>
</tr>
<tr>
<td>Lab assignments due / Exams</td>
<td>None</td>
</tr>
</tbody>
</table>
| **Reading**    | **LECTURE:**  
|                | TEXT: Ch 7.                  |

**LAB:**
Lab handout for Week 4

### Week 5 (March 8 - 12)

<table>
<thead>
<tr>
<th>Lecture topics</th>
<th>Soils, agriculture, nutrient cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab topic</td>
<td>Nitrogen management for sustainable agriculture</td>
</tr>
<tr>
<td>Lab activity</td>
<td>Nodulation experiment</td>
</tr>
<tr>
<td>Lab location</td>
<td>MBH 309</td>
</tr>
<tr>
<td>Lab assignments due / Exams</td>
<td>Farm system sketch model due at start of your lab</td>
</tr>
<tr>
<td><strong>Reading</strong></td>
<td><strong>LECTURE:</strong></td>
</tr>
<tr>
<td></td>
<td>TEXT: Ch 3 (pp. 65-69).</td>
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<tr>
<td></td>
<td><strong>LAB:</strong></td>
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<tr>
<td></td>
<td>Lab handout for Weeks 5 &amp; 6</td>
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</tbody>
</table>

### Week 6 (March 15 - 19)

<table>
<thead>
<tr>
<th>Lecture topics</th>
<th>No class Monday, Wednesday review, <strong>Friday Midterm</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab topic</td>
<td>Nitrogen management for sustainable agriculture</td>
</tr>
<tr>
<td>Lab activity</td>
<td>Data analysis of nodulation data</td>
</tr>
<tr>
<td>Lab location</td>
<td>Computer labs: W, X, Z — SDL IL3; Y — MBH117</td>
</tr>
<tr>
<td>Lab assignments due / Exams</td>
<td><strong>Midterm Friday in class</strong></td>
</tr>
<tr>
<td><strong>Reading</strong></td>
<td><strong>LECTURE:</strong></td>
</tr>
<tr>
<td></td>
<td>Review notes, readings from weeks 1-5.</td>
</tr>
<tr>
<td></td>
<td><strong>LAB:</strong></td>
</tr>
<tr>
<td></td>
<td>Nodulation lab report and data analysis guidelines</td>
</tr>
</tbody>
</table>
### Week 7 (March 29 – April 2)

| Lecture topics | Rain, surface water and aquifers: Natural systems, human modifications. |
| Lab topic | Water pollution |
| Lab activity | Water quality and land use study: land use analysis using GIS |
| Lab location | Computer labs: W, X, Z — SDL IL3; Y — MBH117 |
| Lab assignments due / Exams | Nodulation experiment lab report due April 2, 4p.m. to Marc’s office |
| Reading | **LECTURE:** TEXT: Ch 12, 13  
**LAB:**  
Lab handout for Weeks 7-9  
Lake Champlain Basin Program. 2008 State of the Lake and Ecosystem Indicators Report-2008. LCBP, Grand Isle, VT. *pages 4-10, 16-17*  
| LAB assignments due / Exams |  |
| Reading | **LECTURE:** TEXT: Ch. 12, 13 (cont)  
Kerr, R.A. 2009. Northern India’s groundwater is going, going, going … *Science* 325: 798.  
**LAB:**  
Lab handout for Weeks 7-9  

### Week 8 (April 5 - 9)

| Lecture topics | The hydrologic cycle, air and water resources. |
| Lab topic | Water pollution |
| Lab activity | Water quality and land use study — water sampling |
| Lab location | VAN PICKUP LOCATION |
| Lab assignments due / Exams |  |
| Reading | **LECTURE:** TEXT: Ch 12, 13 (cont)  
Kerr, R.A. 2009. Northern India’s groundwater is going, going, going … *Science* 325: 798.  
**LAB:**  
Lab handout for Weeks 7-9  

### Week 9 (April 12 - 16)

| Lecture topics | Toxic organic compounds, environmental toxicology.  
No class Friday (Student Research Symposium) |
| Lab topic | Water pollution |
| Lab activity | Data analysis of water and land use data |
| Lab location | Computer labs: W, X, Z — SDL IL3; Y — MBH117 |
| Lab assignments due / Exams |  |
| Reading | **LECTURE:** TEXT: Ch 10.  
Cristol, D.A. et al. 2008. The movement of aquatic mercury through terrestrial |

7
Week 10 (April 19-23)

| Lecture topics | Ecosystem components, functions, services |
| Lab topic        | Sustainable forest management |
| Lab activity     | Exploring forest management |
| Lab location     | VAN PICKUP LOCATION |
| Lab assignments due / Exams | Water quality and land use lab report due April 23, 4p.m. to Marc’s office |
| Reading          | **LECTURE:**  
|                  | TEXT: Ch 3 (pp. 57-59), Ch 4, Ch 5  
|                  | **LAB:**  
|                  | Lab handout for Weeks 10 & 11  

Week 11 (April 26 - 30)

| Lecture topics | Biodiversity, invasive species, biodepletion and extinction |
| Lab topic        | Forests and the carbon cycle |
| Lab activity     | Forest carbon sampling |
| Lab location     | VAN PICKUP LOCATION |
| Lab assignments due / Exams |  
| Reading          | **LECTURE:**  
|                  | TEXT: Ch 4, Ch 5 (cont), Ch 8  
|                  | **LAB:**  
|                  | Lab handout for Weeks 10 & 11  
|                  | TBA…  

Week 12 (May 3 - 7)

| Lecture topics | Natural science, environmental policy and management of natural resources: selected case studies |
| Lab topic        | Ecosystem functions and services |
| Lab activity     | Wetland functions |
| Lab location     | MEET AT BASEBALL FIELD on South Street |
| Lab assignments due / Exams | Forest carbon lab report due, May 7, 4p.m. to Marc’s office |
| Reading          | **LECTURE:**  

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**foodwebs. Science 320: 335.**

Additional reading TBA.

**LAB:**

Water quality and land use study lab report and data analysis guidelines

TBA…

**LAB:**
Lab handout for Week 12
Vermont Wetland Rules [1-page excerpt]

<table>
<thead>
<tr>
<th>Week 13 (May 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture topics</td>
</tr>
<tr>
<td>Lab topic</td>
</tr>
<tr>
<td>Lab activity</td>
</tr>
<tr>
<td>Lab location</td>
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<tr>
<td>Lab assignments due / Exams</td>
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<tr>
<td>Reading</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Finals Period (May 12-18)</th>
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</thead>
<tbody>
<tr>
<td>Lab assignments due / Exams</td>
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</tbody>
</table>
For an article or a pair of articles to be announced as the semester proceeds, you will be required to submit a reading report for the lecture portion of the class. **Due dates will be announced in class.**

### What is in a report?

- Your name, followed by a blank line.
- The citation for the reading, using the correct style (see below), followed by a blank line.
- The first author’s professional affiliation, i.e. where they work (e.g., Department of Biology, Middlebury College, U.S. Fish and Wildlife Service), followed by a blank line.
- In a separate paragraph, summarize the main points of the reading.
- In another separate paragraph, describe (a) the major strengths of the paper’s arguments, (b) the major weaknesses of the paper’s arguments, and (c) your overall evaluation of the reading in 2-3 sentences each. In other words, critically analyze the authors’ arguments. Be sure your writing **clearly** distinguishes the strengths, weaknesses, and overall evaluation.
- In a final separate paragraph, state why you think the reading was assigned. In other words, summarize what you think this article contributes to your education in this course.

### What is the format for a report?

Printed, single-spaced, normal margins, normal font size, normal font type. Use proper English. No summaries should be more than can fit on one printed page (double-sided if necessary).

### How will they be graded?

On a scale of 0 to 4, based on content, style, grammar, proofreading, and adherence to specifications:

- 0 = unacceptable job (= not showing evidence of actually having read the article carefully)
- 1 = inadequate job (= incomplete or **not meeting the specifications** [I’m serious about this so you should read the “What is in a report?” section very carefully!])
- 2 = acceptable job (= basically complete but nothing special)
- 3 = very good job (= complete, generally well written, with some evidence of critical thinking)
- 4 = excellent job (= complete, very well written, and clear evidence of very good critical thinking)

Reading reports turned in late for any reason will automatically be penalized one point, with additional penalties of one point for each subsequent day it is late.

### Correct style for a Reading Report citation

The following are examples of the proper style for citing a journal article. Note the correct use of initials, punctuation, and capitalization.
