CIEE Global Institute - Monteverde

Course name:	Principles of Environmental Science (Lab course)
Course number:	(GI) ENVI 2401 MOCR
Programs offering course:	Monteverde Open Campus Block: STEM and Society
Open Campus track:	STEM and Society
Language of instruction:	English
U.S. semester credits:	4
Contact hours:	45 lecture and 45 laboratory/field
Term:	Spring 2020

Course Description

This course introduces students to the basics of environmental science. It will focus on energy flows in nature and human ecosystems; atmospheric processes such as climatology and the carbon cycle; water cycle and water resource management; and the interaction between humans and their ecosystems. All concepts will be enclosed in the overarching theme of ecosystem resilience. The course will use local and regional features as points of departure to talk about local global environmental science topics. Throughout, students will consider the impact of the environment on culture and society.

Learning Objectives

Upon completion of the course students will:

- Apply the scientific method to environmental problems
- Explain complex adaptive systems and their application to Environmental Sciences
- Articulate and apply major themes in the Environmental Sciences
- Use ecosystem resilience as a basis to understand connections in the environmental sciences.
- Describe the hydro/litho/bio/atmo/sphere and related biogeochemical cycles
- Employ basic metrics for measuring water and air quality
- Demonstrate the importance of nature in providing ecosystem services to humans
- Trace the workings of artificial wetlands and biodigestors for soil and waste processing
- Contrast renewable and nonrenewable energy sources for their economic viability and lasting impacts on the environment
- Detail the role of remote sensing as a tool for monitoring the environment
- Communicate current local and global sources of environmental challenges and possible solutions

Course Textbook

Enger, E. & Smith, B.F. (2016) Environmental Science. McGraw-Hill Education

Course Prerequisites

None

Methods of Instruction

Students will attend lectures and related lab and field activities. Lectures will be complemented by experiential learning and critical thinking. Students will read and analyze current literature as well as monitor technological trends in the internet. Students will spend time in the field collecting field data to complement theoretical aspects of the course. During the course students will be engaged in student-led seminars to discuss trends and technologies related to global change.

Assessment and Final Grade

Participation and Engagement	20 %
Weekly Quizzes	15 %
Lab Projects	20 %
Perspective Essays	15 %
Final Exam	30 %

Course Requirements

Participation

Participation is valued as meaningful contribution in the digital and tangible classroom, utilizing the resources and materials presented to students as part of the course. Meaningful contribution requires students to be prepared in advance of each class session and to have regular attendance. Students must clearly demonstrate they have engaged with the materials as directed, for example, through classroom discussions, online discussion boards, peer-to- peer feedback (after presentations), interaction with guest speakers, and attentiveness on co- curricular and outside-of-classroom activities.

Weekly Quizzes

Each week, students will take a quiz on the previous week's course material, including lectures, labs, activities and readings. Quizzes may be in-class activities with True/False, Multiple Choice, calculations, filling in blanks and short answer questions, or they may be take home essay assignments. Quizzes will cover only new material, but similar questions to those on the quizzes will be seen again on the comprehensive final exam.

Lab Projects

These will consist of projects related to each topic. They will include field work or research and a final lab report or presentation due at the end of the assigned time period.

Perspective Essays
Students will be asked to write a 1500-word essay on key topics. Students will frame the issue with data from outside resources. They will extrapolate data to explore potential environmental impacts. Students are expected to include multiple points of view, tackle not only the environment, but politics, governance, economics, human health and other related issues. They must espouse a thoughtful point of view tethered to sound environmental science principles.

Final Exam
At the end of the course, students will take a final exam covering all previous material. As with quizzes, the final exam will have a variety of question formats, including True/False, Multiple Choice, calculations, filling in blanks, essay and short answer questions.

Class Attendance
Regular class attendance is required throughout the program, and all unexcused absences will result in a lower participation grade for any affected CIEE course. Due to the intensive schedules for Open Campus programs, unexcused absences that constitute more than 10% of the total course will result in a written warning.

Students who transfer from one CIEE class to another during the add/drop period will not be considered absent from the first session(s) of their new class, provided they were marked present for the first session(s) of their original class. Otherwise, the absence(s) from the original class carry over to the new class and count against the grade in that class.
For CIEE classes, excessively tardy (over 15 minutes late) students must be marked absent. Attendance policies also apply to any required co-curricular class excursion or event, as well as to Internship, Service Learning, or required field placement. Students who miss class for personal travel, including unforeseen delays that arise as a result of personal travel, will be marked as absent and unexcused. No make-up or re-sit opportunity will be provided.

Attendance policies also apply to any required class excursion, with the exception that some class excursions cannot accommodate any tardiness, and students risk being marked as absent if they fail to be present at the appointed time.

Unexcused absences will lead to the following penalties:

Percentage of Total Course Hours Missed	*Equivalent Number of Open Campus Semester classes*	*Minimum Penalty*
Up to 10%	1 content classes, or up to 2 language classes	Participation graded as per class requirements
10 – 20%	2 content classes, or 3-4 language classes	Participation graded as per class requirements; **written warning**

More than 20%	3 content classes, or 5 language classes	Automatic **course failure**, and possible expulsion

Weekly Schedule

NOTE: this schedule is subject to change at the discretion of the instructor to take advantage of current experiential learning opportunities.

Week 1 Environmental Science - Basic Concepts

Session 1.1: Introduction to Environmental Science. Students will review and extend basic environmental science concepts, discuss their relationships to one another, to the environment and to human wellbeing. Students will explore the nature of environmental science, its interrelatedness, its relation to natural ecosystems but also to human political and economic issues. Students will relate environmental science to maintaining functional ecosystems, food security, environmental governance, human health and security. They will explore how environmental science at local levels sums up to global challenges. Students will also examine environmental ethics, discuss three philosophical approaches to environmental ethics and explore environmental attitudes of development, preservation, conservation and sustainable development. They will also investigate how environmental science impacts environmental justice, corporate environmental ethics, individual environmental ethics and the ethics of overconsumption.

Due: Students will be asked to write an essay on their personal environmental ethics.

Readings: Chapter 1 Environmental Relationships and Chapter 2 Environmental Ethics Schlosberg, D. (2007) Defining Environmental Justice. Theories, movements and Nature. Oxford Press. PP 3- 11.

Laboratory 1.1 Evaluating Sustainable Practices (Lab 1) and The Scientific Method (Problem Set 1). Students will use the CIEE Global Institute or similar nearby organization granting student access to identify and evaluate specific examples of sustainable practices on site. Students will prepare a technical report of their findings. In small groups, students will then choose to study a nearby site using the scientific method. They will make initial observations, formulate hypotheses and articulate an appropriate experimental design.

Due: Students will hand in their community assessment with recommendations.

Week 2 Framing the Environment: Science, Economy and Culture

Quiz 1

Session 2.1: Matter, Energy and Environment. Students will work in groups to educate one another on basic concepts in ecology related to matter, energy and environment. Students will be assigned portions of Chapters 4, 5 and 6 of their text to report back on basics of environmental chemistry, principles of energy, natural selection and evolution, species interactions, community and ecosystem interactions, major biomes, ecological restoration and population ecology. Students will augment information in their text using online resources. They will distill the most important scientific aspects of their topic and apply science to related environmental issues. Students will present their findings to one another

Due: Student essay on how science and society interact.

Readings: Chapter 3 Risks, Economics and Environmental Concerns, and select portions of Chapters 4-6

Lab Session 2.1: Experimental Design: Environmental Contamination (Lab 8) and Ecosystem Diagram (Problem Set 4). Students conduct a review of key scientific literature related to soil contamination. They then design and conduct an environmental experiment involving the effect of contaminated soil on plants. They will set up the experiment on seed germination and plant growth with different soil conditions. 14 days later, they will use basic statistics to analyze potential differences. Students then describe the potential adverse environmental effects of contaminated soils and plants. Students will take information from Session 2.1 and review concepts by choosing a local ecosystem and constructing an ecosystem diagram.

Due: Student presentations on basic ecological concepts and how they related to environmental challenges

Session 2.2: Populations: Characteristics and Issues. Students will examine population growth of species with and without limiting resources. They will use data to generate a growth curve for the human population in their region. Students will compare human population growth on a global scale to other key environmental metrics, like land transformation, biodiversity loss, carbon enrichment in the atmosphere and others. Students will discuss the Great Acceleration and its importance to global impacts of the human population on the environment. They will also explore if and where human populations will stabilize in the future. Students will consider the roles of culture and economics in human population growth in different countries and regions.

Readings: Chapter 7 Populations: Characteristics and Issues.

- *Complexity Labs. (2017) Complex Adaptive Systems* *https://www.youtube.com/watch?v=jBgq9eS6t_I&list=PLsJWgOB5mIMCiKZu61rKFT_-TncWzylN8&index=3*

- *Walker, B. & Salt, D. (2006). Resilience thinking: Sustaining ecosystems and people in a changing world. (Chapters 1, Ch 2, and Ch 6 (Pages 145-148).*

Lab Session 2.2: Human Survivorship Changes (Lab 29) and Recognizing Human Impacts (Problem Set 7). Students examine human population using survivorship data. They will describe how human mortality and survivorship have changed in the last 200 years. They collect population data and generate mortality and survivorship curves with Excel. They then compare populations over time and from different cultures to see how survival has changed. Next, students work in groups to calculate how environmental degradation is a function of population size, affluence (consumption) and technology. Using demographic data provided for the U.S., students will find similar online data for their host country and compare the two.

Due: Complex Adaptive Systems Worksheet

Week 3 Energy

Quiz 2

Session 3.1 Energy and Civilization. Students begin with the history of energy consumption: biological energy sources, wood, fossil fuels and the industrial revolution, automobiles and growth in use of natural gas. They explore the process of extracting raw materials for each energy source, as well as processing and waste produced in using each energy type. Students compare how energy is used residentially, commercially, industrially and in transport. They examine how energy can be saved at home and will apply these saving ideas to what will and will not work locally. Students will examine energy consumption trends: growth in energy use, available energy sources and political and economic factors.

Readings: Chapter 8 Energy and Civilization: Patterns of Consumption

Lab Session 3.1. Landscaping for Energy Conservation (Lab 9) and Carbon Footprints and Sustainability (Problem Set 8). Students identify design practices for energy conservation and efficiency, considering wind, temperature, shade, compass direction and other variables. They then make recommendations for lowering energy consumption. Using online resources, students will track energy consumption for their city, country, region and globally. They will look at differences in energy use trends for industrial and developing nations. Students will interview local people to assess how energy use has changed in their lifetimes. Students will look at the current global population and assess how many people use a variety of energy sources. Students will then link this to their environmental footprint and footprints of the U.S. and their host country. Students will discuss the role of culture and geography in energy consumption.

Due: Energy Assessment Worksheet and Commentary

Lecture 3.2: Nonrenewable Energy. Students compare major nonrenewable energy sources for their degree of environmental impact. They will quantify sizes of reserves, current use and extrapolate to when these energy sources are likely to run out. They will study the geology of how coal, oil and natural gas were formed. They will also compare how coal, oil and natural gas are used. They will examine fracking and its current environmental and economic impacts. Students then explore nuclear energy: the nature of the nuclear chain reaction, nuclear fission reactors, fuel cycles, biological effects of ionizing radiation, nuclear waste disposal and safety. Students will discuss the ethical use of each energy source.

Readings: Chapter 9 Nonrenewable Energy Sources.

Lab/Field Session 3.2. Oil Consumption and Future Availability (Problem Set 9) and Renewable Energy. Students will investigate local, regional and global oil use. They will visit or investigate local sources of renewable energy and compare costs. Students will see how solar, geothermal, wind and hydropower are generated. They will assess each in light of their host country's domestic energy use and compare that to the United States. Students will also explore local sources of biofuels, sources of local biofuels and the case of African Oil Palm. They will use online resources to investigate how environmentally friendly each renewable energy source is and compare impacts to nonrenewable sources of energy. Students will select one alternative energy and write a data-driven report on its source, its sustainable development potential, and its environmental impact compared to a nonrenewable energy source of their choice.

Due: Environmental Impact of Renewable vs. Nonrenewable Energy Sources report

Lecture 3.3: Renewable Energy. Students begin by taking stock of renewable energy sources: what are they and how much are they likely to generate in different contexts? Among other renewable energy sources, students will intensively investigate biofuels, hydroelectric, solar, wind, geothermal and tidal power. Students will also discuss energy conservation and efficiency of use. Students will see how their host country ranks in renewable energy production and explore cultural reasons for similarities and differences with other regions or countries. Students will discuss how even renewable energy has important environmental, economic and social impacts.

Due: Essay on Individual Decisions vs. Governmental Policies and the student's personal energy use.

Readings: Chapter 10 Renewable Energy Sources

Week 4 Biodiversity, Land Use and Ecosystem Services

Quiz 3

Session 4.1 Biodiversity. Students are introduced to the distribution of ecosystems on the planet as well as the wealth of species they contain. They use Holdridge's Life Zones or other means of classifying ecosystems as a tool for understanding the influence of the geophysical world on biological systems and organisms. The distribution of ecosystems according to precipitation, bio-temperature, latitude and elevation will be seen in detail. The host country and region will be used as an example. Students will examine drivers of biodiversity loss, which species are most extinction prone, loss of genetic diversity and the impact of each on the ecosystem. Students will go on to explore what is currently begin done to protect biodiversity and will discuss what more is needed.

Readings: Chapter 11 Biodiversity Issues

Lab/Field Session 4.1: Local and Regional Ecosystems. Students will identify and investigate three different ecosystems within their host country or region area to illustrate the effects of climate and geography on biodiversity. Students will amass a series of abiotic and biotic data from online sources that describe the physical and ecological features of the region. Students will write a report on similarities, differences and possible reasons behind them. The report will also explore changes to ecosystems and physical geography with climate change.

Due: Report on Ecosystems

Session 4.2: Land Use. Students begin by discussing the need for land planning. They analyze historic forces shaping land use, including waterways, roads, rural to urban trends in population and patterns of urban and suburban sprawl. They will explore if these trends hold true for the industrialized and developing world. Students take these lessons and apply them to problems associated with unplanned urban growth. They will learn about Land Use Planning Principles and how they are practiced. Students apply this to greener cities, sustainability and overall regional zoning.

Readings: Chapter 12 Land-Use Planning

Lab/Field Session 4.2: Carbon and Land Use. Students will quantify infiltration and carbon sequestration. This field session will compare the ability to infiltrate water and sequester carbon of a cattle pasture, a coffee plantation and a primary forest. This will be done using standard protocols used in Costa Rica for these purposes.

Due: Group Presentations on Ecosystem Services

Session 4.3: Ecosystem Services. This lecture will introduce students to the concept of ecosystem services: carbon storage, biodiversity, water infiltration, river flow regulation, erosion control. Students will investigate how each is valued economically, as well as non-economic values. Students will discuss the paradigms of land sharing and land sparing in light of maintaining essential ecosystem services.

Readings:

- Chan K.M.A. et al. (2006) Conservation Planning for Ecosystem Services. PLOS Biology. October 31, 2006. https://doi.org/10.1371/journal.pbio.0040379
- Subrendho, K. et al (2010) Show me the money: Do Payments Supply Environmental Services in Developing Countries? Review of Environmental Policy and Economics, Vol.4, No. 2. pp 254-274.
- Mace, G.M. et al. (2012) Biodiversity and ecosystem services: a multilayered relationship. Trends in Ecology and Evolution, January 2012, Vol. 27, No.1. doi:10.1016/j.tree.2011.08.006

Week 5: Soils, Agriculture and Water Management

Quiz 4

Lecture 5.1: Soils. Students will study soil science, geological processes at work to build and maintain soils, soil properties and will compare temperate and tropical soil profiles, understanding the underlying causes for their differences. They will study soil erosion and soil conservation processes. They will compare traditional, modern and innovative ways to use soil for agricultural output. They will study the value of soil as a carbon store. They will also investigate soil conservation on non-agricultural lands. Students will investigate ways of restoring contaminated soil, including bioremediation.

Readings: Chapter 13 Soil and Its Uses

Lab/Field Session 5.1: Soil Characterization (Lab 21). Students will describe the process of digging a soil test pit. They identify soil horizons in the stratigraphy of a soil test pit from various global locations using online research. They describe local solils suing a color and texture guide and identify the components in a soil report. They visit a local farm or talk with a farmer or agricultural engineer about best practices for maintaining soil fertility with limited inputs. Students also compare different land uses and their soil fertility using a variety of soil science methods.

Due: Worksheet comparing land use and soil fertility.

Lecture 5.2: Agriculture. Students will investigate if we really make grow enough food for the world's current population. They will see that agriculture is as much about the price of food as supply. Students investigate the history of agriculture and how different innovations have led to different environmental challenges. They will explore the use of agrochemicals and their environmental and human health impacts. Students will discuss alternatives to conventional agriculture along with the economic, social and cultural aspects of more sustainable agriculture.

Readings: Chapter 14 Agricultural Methods and Pest Management

Lab Session 5.2 Municipal Wastewater Treatment (Lab 18). Students visit or virtually visit a local wastewater treatment plant. They describe the basic processes in treating sewage, industrial wastewater and stormwater runoff. Students will then produce a technical report that describes the facility, its capacity and discusses current and future challenges facing municipal wastewater treatment facilities here and elsewhere.

Due: Report on municipal wastewater treatment.

Session 5.3 Water Management. Students will examine our global water challenges. They will learn the hydrological cycle and human influences on it. They will see how humans use water for domestic, agriculture, industrial and municipal uses. They survey types and sources of water contamination, including runoff from agriculture, industry, thermal pollution, marine oil spills, and groundwater pollution. They examine water-use planning issues, like wastewater treatment, salinization, fossil water use and water use in national parks and other protected areas. They work in groups to complete Problem Set 10 in their lab manual: Water Quality and Consumer Choice.

Readings: Chapter 15 Water Management, Magana et al. 1999. The Midsummer Drought over Mexico and Central America. American Meteorological Society

Due: Essay suggesting solutions to local soil, agriculture and water solutions.

Week 6 Climate Change, Solid Waste, Solutions

Quiz 5

Session 6.1: Air Quality and Climate Change. Students learn basic chemistry of the atmosphere, the source of different pollutants and their impact on the environment and human health. They investigate photochemical smog, acid deposition, ozone depletion, control of air pollution, air pollution in the developing world, indoor air pollution and noise pollution. Along the way, students examine sources, impacts and solutions to air contamination. They extend these lessons to climate change, linking it to greenhouse gases and human activity. They explore consequences of climate change, including disruptions in the hydrological cycle, rising sea level and health effects. Students will also see local changes to biodiversity and ecosystems from climate change. Students will discuss global responses to climate change and if they are sufficient to assure a sustainable future.

Reading: Chapter 16 Air Quality Issues and Chapter 17 Climate Change: A 21st Century Issue

Lab/Field Session 6.1: Climate Change and Sea Level Rise (Experiment 22). Students create a working example of the greenhouse effect. They then explore the connection between global warming and sea level rise. They describe the role of modeling in assessing vulnerability to sea level rise. Students in groups investigate a nearby location facing potential negative impacts from sea level rise.

Due: Climate Change and Sea Level Rise report.

Lecture 6.2: Solid Waste. Students delineate kinds of solid waste, their sources and implications for the environment and human health. They examine how municipalities deal with solid waste, including landfills, incineration and composting. They look at recycling and repurposing solid wastes and examine the economics of why recycling is often impossible or subsidized. They discuss will calculate how many plastic water bottles are sold in Monteverde and how many are recycled.

Readings: Chapter 18 Solid Waste Management and Disposal, and Medina, M. (2010) Solid wastes, poverty and the environment in developing country cities: Challenges and opportunities. Working paper // World Institute for Development Economics Research, No. 2010,23. http://hdl.handle.net/10419/54107.

Due: Worksheet: Disposal Water Bottles in Monteverde

Lab Session 6.2: Environmental Regulation and Policy. Students will use the textbook and online resources to investigate and report on environmental regulations of hazardous substances and wastes. These will include how hazardous wastes are characterized, controlled, managed, how they enter the environment, regulatory responses and management choices. Students will define and discuss environmental policy in the U.S. and Costa Rica, as well as International Environmental Policy.

Due: Student Presentations on Environmental Regulation and Policy

Final Exam

Course Materials

Course Textbook

Enger, E. & Smith, B.F. (2016) Environmental Science: A Study of Interrelationships. 14th edition, McGraw-Hill Education

Wagner, T. and Sanford, R., (2018) Environmental Science: Active Learning Laboratories and Applied Problem Sets. 3rd edition, Wiley

Readings

Chan K.M.A. et al. (2006) Conservation Planning for Ecosystem Services. PLOS Biology. October 31, 2006. https://doi.org/10.1371/journal.pbio.0040379

Complexity Labs. (2017) Complex Adaptive Systems https://www.youtube.com/watch?v=jBgq9eS6t_I&list=PLsJWgOB5mIMCiKZu61rKFT_-TncWzylN8&index=3

Keith D.K. (2000) Geoengineering the Climate: History and Prospect. Annu. Rev. Energy Environ. 2000. 25:245–84

Mace, G.M., Norris, K. and Fitter, A.H., (2012) Biodiversity and ecosystem services: a multilayered relationship. *Trends in ecology & evolution*, *27*(1), pp.19-26

Magaña, V., Amador, J.A. and Medina, S., (1999) The midsummer drought over Mexico and Central America. *Journal of Climate*, *12*(6), pp.1577-1588

Medina, M. (2010) Solid wastes, poverty and the environment in developing country cities: Challenges and opportunities. Working paper // World Institute for Development Economics Research, No. 2010,23. http://hdl.handle.net/10419/54107

Schlosberg, D.(2007) Defining Environmental Justice. Theories, movements and Nature. Oxford Press. PP 3- 11

Subrendho, K. et al (2010) Show me the money: Do Payments Supply Environmental Services in Developing Countries? Review of Environmental Policy and Economics, Vol.4, No. 2. pp 254-274

USGS (2014) National Field Manual for the Collection of Water-Quality Data (NFM). https://water.usgs.gov/owq/FieldManual/

Victor D.G. et al (2009) The Geoengineering option. Foreign Affairs , March/April 2009

Walker, B. & Salt, D. (2006). Resilience thinking: Sustaining ecosystems and people in a changing world. (Chapters 1, Ch 2, and Ch 6 (Pages 145-148)