SCIENCE

An Introduction to Environmental Science

I. FOUNDATIONS OF ENVIRONMENTAL SCIENCE 20%
   A. What Is Environmental Science?
   B. Environmental Indicators
      1. Biological Diversity
      2. World Human Population
      3. Food Production
      4. Resource Consumption
      5. Global Temperatures and Greenhouse Gases
      6. ENVIRONMENTAL SCIENCE CASE STUDY: MEASURING GREENHOUSE GASES IN ICE
      7. Air and Water Pollution
   C. The Scientific Method
      1. An Illustration of the Scientific Method
      2. The Role of Repetition in Science
      3. Understanding How to Interpret Scientific Studies
   D. The Limitations of Environmental Science
      1. The One Earth Problem
      2. Inconsistent Units of Measure for Energy
      3. Subjectivity
      4. Unpredictable Consequences of Preferences and Policies
   E. Environmental Systems
      1. System Dynamics
      2. Matter and Energy Exchange
      3. Open and Closed Systems
      4. The Human Component of Environmental Systems
      5. Inputs, Outputs, and Flux
      6. Steady State
      7. ENVIRONMENTAL SCIENCE CASE STUDY: MONO LAKE—AN INPUT–OUTPUT SYSTEM ANALYSIS
      8. Mean Residence Time
      9. Accumulation and Depletion
      10. Feedbacks
      11. Overshoot
      12. Regulating Population Systems
      13. ENVIRONMENTAL SCIENCE CASE STUDY: HUMANS AND ELEPHANTS IN AFRICA—FEEDBACK AND REGULATION IN INTERACTING POPULATION SYSTEMS
      14. ENVIRONMENTAL SCIENCE CASE STUDY: RED SPRUCE IN THE NORTHEASTERN UNITED STATES—AN ENVIRONMENTAL SYSTEM IMPACTED BY THE INTERACTION OF NATURAL AND HUMAN-CAUSED FACTORS
      15. ENVIRONMENTAL SCIENCE CASE STUDY: MANAGING ENVIRONMENTAL SYSTEMS IN THE FLORIDA EVERGLADES

II. BIODIVERSITY: FROM LOCAL TO GLOBAL 30%

A. Biodiversity
   1. What Is Biodiversity and Why Does It Matter?
   2. The Value of Biodiversity
   3. Genetic Diversity
      a. Expressions of Genetic Diversity
      b. Species Diversity

B. Evolution
   1. Adaptation through Natural Selection
   2. Adaptation to a Changing Environment
   3. Nonadaptive Evolutionary Processes
   4. The Pace of Evolution

C. Changes in Environmental Conditions and Extinctions
   1. The Fossil Record
   2. Mass Extinctions
   3. Estimating Extinction Rates from Habitat Loss

D. Human Activity and Biodiversity
   1. Habitat Fragmentation
   2. The Introduction of Exotic Species

E. Linking Biodiversity and Evolution to Ecology
   1. The Ecological Perspective
   2. Environmental Conditions
   3. Resources

F. Population Ecology
   1. Density-Dependent Growth
   2. The Logistic Growth Model
   3. ENVIRONMENTAL SCIENCE CASE STUDY: THE CHALLENGE OF MANAGING POPULATION GROWTH
   4. Density-Independent Growth
   5. Metapopulations
   6. Populations and Biodiversity

G. Community Ecology
   1. Interspecific Competition
   2. Predation
   3. Mutualism

H. Ecological Communities
   1. Food Webs
   2. Keystone Species
   3. Succession
   4. ENVIRONMENTAL SCIENCE CASE STUDY: A SIMPLE ECOSYSTEM—ORGAN CAVE

I. Productivity
   1. Primary Productivity
   2. Energy Transfer Efficiency

J. Major Aspects of Ecosystems
   1. Ecosystem Boundaries

2. The Biotic Components of Ecosystems
3. The Impact of Ecosystem Change on Its Biotic Components

K. Biomes
1. The Global Climate and Biomes
2. Biomes and Global Biodiversity

L. The Cycle of Elements within the Biosphere
1. The Elements on Earth
2. Biogeochemical Cycles
3. The Hydrologic Cycle
4. The Carbon Cycle
5. The Nitrogen Cycle

III. THE HUMAN IMPACT ON NATURAL RESOURCES 30%

A. The Human Population
1. Growth Rate
2. Lower- and Higher-Income Countries
3. Population Size and Resource Use
4. Factors Affecting Population Growth
   a. Fertility
   b. Life Expectancy and Infant Mortality
5. Age Structure

B. The Elements on Earth
1. The Cycles of Calcium, Magnesium, Potassium, and Sulfur
2. Soil
   a. What Is Soil?
   b. Soil Horizons
   c. State Variables and Soil Formation
   d. Soil Degradation

C. Water Resources
1. The Long-standing Challenge of Accessing Clean Water
2. Water's Importance to Earth's Environmental and Human Systems
3. Groundwater and Surface Water: The Major Sources of Water for Human Use
4. Transport of Water
5. Desalination
6. Water Use
7. Water Shortages
8. Floods
9. Water Pollution
   a. Types of Water Pollutants
   b. Nonchemical Pollutants
   c. Ocean and Shoreline Pollution
   d. Solid Waste Pollution
   e. Wastewater Treatment
10. Improvements in U.S. Water Quality

D. Agricultural Resources
1. The Beginnings of Agriculture

2. Traditional Agricultural Methods
3. The Green Revolution
4. The Status of World Food Production
5. Food Insecurity—Hunger in the World
6. Conventional Land-Use and Planting Techniques
    a. Mechanization and Intensive Working of the Soil
    b. Irrigation
    c. Monocultures
    d. Chemical Fertilizers
    e. Chemical Pesticides
7. High-Density Farming of Animals
8. GMOs
    a. Genetic Engineering
    b. The GMO Controversy
9. Sustainable Agriculture

E. Fishery Resources
1. Overfishing and the Decline of Fisheries
2. The Scientific Management of Fisheries
3. Managing Fisheries for a Sustainable Future
4. An Economic Approach to Fishery Management
5. Integrating an Ecological Perspective into Fishery Management
6. ENVIRONMENTAL SCIENCE CASE STUDY: MANAGING AN ENDANGERED FISHERY

F. Forestry Resources
1. Principles of Forestry
2. Harvesting Methods
3. Intensive Forestry
4. Ecologically Sustainable Forestry
5. Forestry in the Tropics
6. ENVIRONMENTAL SCIENCE CASE STUDY: SELECTIVE LOGGING AND BUTTERFLY DIVERSITY IN BORNEO
7. North American Forests

IV. SCIENCE FOR A SUSTAINABLE FUTURE 20%

A. Air Pollution and Atmospheric Science
1. Major Air Pollutants
    a. Sulfur Dioxide
    b. Nitrogen Oxides
    c. Carbon Monoxide
    d. Lead
    e. Particulate Matter
    f. Ground-Level Ozone
2. Secondary Pollutants
3. Natural Sources of Air Pollution
4. Therman Inversion
5. ENVIRONMENTAL CASE STUDY: USING MODELS TO PREDICT POLLUTION

B. Energy Use and Sources

1. Units of Energy
2. Worldwide Patterns of Energy Use
3. The Current Fuel Mix in the United States
4. Energy Efficiency
5. Energy for Transportation
6. Finding the Right Energy Source for the Job
7. Generating Electricity
    a. The Power Grid
8. Nonrenewable Energy Sources
    a. Coal
    b. Petroleum
    c. Oil
    d. Natural Gas
    e. Hydraulic Fracturing
    f. Nuclear Power
        i. Nuclear Accidents
        ii. Radioactive Waste
9. Renewable Energy
    a. Direct and Indirect Solar Energy
    b. Passive Solar Energy
    c. Active Solar Energy
        i. Solar Water Heating
        ii. Solar Generation of Electricity
    d. Wind Energy
    e. Advantages and Disadvantages of Solar and Wind Energy
    f. Hydroelectric Power
        i. Run-of-the-River Hydro
        ii. Water Impoundment
    g. Biomass Around the World
    h. Modern Carbon vs. Fossil Carbon
    i. Ethanol
    j. Geothermal and Tidal Energy
10. Conservation and Efficiency
    a. Reducing Peak Demand

C. Human Environmental Impacts and Human Health Risks
1. Qualitative and Quantitative Risk Assessment
2. Environmental Risk Analysis
3. Risk Assessment
4. ENVIRONMENTAL SCIENCE CASE STUDY: RISK ASSESSMENT
5. Risk Acceptance
6. Risk Management

D. Global Climate Change
1. The Sun–Earth Heating System
2. Greenhouse Gases
3. Evidence of Temperature Change over Time
4. Indicators of Climate Change

5. Models
6. Feedback in the Global Greenhouse System
    a. The Temperature–CO_2 Feedback Loop
    b. The Temperature–Permafrost Feedback Cycle
    c. The Ice–Albedo Feedback
7. Effects of Global Warming
8. Predicted Future Effects of Global Warming