Science and Sustainability: An Introduction to Environmental Science

Chapter Objectives
This chapter will help students:

- Define the term environment and describe the field of environmental science
- Explain the importance of natural resources and ecosystem services in our lives
- Discuss the effects of population growth and resource consumption
- Characterize the interdisciplinary nature of environmental science
- Understand the scientific method and the process of science
- Diagnose and illustrate some of the pressures on the global environment
- Evaluate the concepts of sustainability and sustainable development

Lecture Outline

I. Our Island, Earth
   1. The astronaut’s view of Earth suggests that its systems are finite and limited.
   2. Increases in population, technological powers, and resource consumption alter our planet and damage the systems that keep us alive.
   
   A. Our environment surrounds us.
      1. Our environment consists of all the living and non-living things around us.
      2. It encompasses built environments – structures and living spaces – as well as natural components such as plants and animals.
3. The fundamental insight of environmental science is that we humans are a part of the natural world, not separate from it, and we are dependent on a healthy, functioning planet.

B. Environmental science explores our interactions with the world.
   1. **Environmental science** is the study of how the natural world works, how our environment affects us, and how we affect our environment.
   2. Environmental scientists study issues of central importance to our world and its future. Rapidly changing global conditions demand that we act now to solve problems.

C. We rely on natural resources.
   1. **Natural resources** are the various substances and energy sources we need to survive. Our island, Earth, is finite and bounded, and it places limitations on the availability of these resources.
   2. **Renewable natural resources**, such as sunlight, wind, and wave energy, are essentially inexhaustible while others, such as timber, water, and soil, can be replenished by the environment over periods varying from months to decades.
   3. In contrast, resources such as mineral ores and crude oil are formed more slowly than we use them and are considered to be **nonrenewable natural resources**. Once we deplete them, they are no longer available.
   4. Renewability is a continuum. Some renewable resources may turn nonrenewable if we deplete them too drastically. Pumping groundwater from underground aquifers faster than it can be restored is an example of this.

D. We rely on ecosystem services.
   1. Earth’s natural systems provide **ecosystem services** such as air and water purification, climate regulation and plant pollination. We could not survive without these processes.
   2. We have degraded nature’s ability to provide these services by depleting resources, destroying habitats, and generating pollution.

E. Population growth amplifies our impact.
   1. Two phenomena triggered remarkable increases in the Earth’s population, from less than a million people for most of its history to over 6.9 billion today.
   2. The **agricultural revolution** occurred around 10,000 years ago as humans transitioned from a hunter-gatherer lifestyle to an agricultural way of life.
   3. The **industrial revolution** began in the mid-1700s. It was a shift from rural, agricultural life to an urban society provisioned by mass-produced manufactured goods and powered by **fossil fuels**.
4. Environmental science tries to answer the question of whether the natural systems of the planet can sustain current and future populations.

F. Resource consumption exerts social and environmental pressures.
   1. The “tragedy of the commons.”
      a. Garrett Hardin analyzed how people approach resource use.
      b. Resources that are open to unregulated exploitation, the “commons,” will eventually be depleted. Hardin called this the tragedy of the commons.
      c. He disputed the economic theory that individual self-interest, in the long term, serves the public.
   2. Our ecological footprint.
      a. Mathis Wackernagel and William Rees developed the concept of the ecological footprint. It expresses the environmental impact of an individual or a population by the cumulative amount of land and water required to provide the raw materials they consume and to recycle the waste they produce.
      b. The ecological footprint is the sum of the amount of Earth’s surface “used” once all direct and indirect impacts are totaled.
      c. Wackernagel and his colleagues used these calculations to determine that we are depleting our resources about 30% faster than they are being replenished. Overshoot describes the actions of humans surpassing the planet’s productive capacity.

G. Environmental science can help us avoid past mistakes.
   1. Most great civilizations have fallen after degrading their environments, leaving devastated landscapes behind.
   2. The stakes are higher than ever today. If we cannot forge sustainable solutions, there will be global societal collapse.

II. The Nature of Environmental Science
   1. Scientists seek to understand how Earth’s natural systems function and how we are influencing those systems.
   2. Solutions are applications of environmental science.

A. Environmental science is an interdisciplinary pursuit.
   1. Environmental science is an interdisciplinary field, drawing techniques from multiple disciplines and bringing their research into a broad synthesis.
   2. An interdisciplinary approach to addressing environmental problems can produce effective and lasting solutions.
   3. Environmental science is broad because it encompasses both the
natural sciences and the social sciences. The term environmental studies is often used to describe programs that incorporate the social sciences extensively.

B. People vary in their perception of environmental problems.
   1. A person’s age, gender, class, race, nationality, employment, and educational background can all affect whether he or she considers an environmental change a “problem.”
   2. In other cases, people from different cultures and homelands may vary in their awareness of problems.
   3. Economic status can affect both your knowledge of risk and how you react to that knowledge.

C. Environmental science is not the same as environmentalism.
   1. Environmentalism is a social movement dedicated to protecting the natural world from undesirable changes brought about by human choices.
   2. Environmental science is the pursuit of knowledge about the environment, how it works, and our interactions with it.

III. The Nature of Science
   1. Modern scientists describe science as a systematic process for learning about the world and testing our understanding of it.
   2. Knowledge of science and technology is increasingly important as our society becomes more dependent on it for the crucial elements of transportation, communications, medicine, and agriculture.
   3. This knowledge is important because it allows society to make informed decisions.

A. Scientists test ideas by critically examining evidence.
   1. Scientists make observations, take measurements, and design tests to determine if ideas are supported by evidence.
   2. An explanation that resists attempts to disprove it is accepted as a true explanation.

B. Science advances in different ways.
   1. Most scientific work is observational science or descriptive science based on information gathering.
   2. If enough is known about a subject, scientists pursue hypothesis-driven science, trying to answer specific questions.

C. The scientific method is the traditional approach to science.
   1. The scientific method is a technique for testing ideas with observations. It includes several assumptions and a series of interrelated steps.
2. The assumptions are:
   a. The universe functions in accordance with fixed natural laws.
   b. All events arise from some cause and, in turn, cause other events.
   c. We can use our senses and reasoning abilities to detect and describe natural laws.

3. The steps of the scientific method are:
   a. Make observations.
   b. Ask questions. Determining which questions to ask is one of the most important steps in the investigation process.
   c. Develop a hypothesis. A hypothesis is a statement that explains a phenomenon or answers a scientific question.
   d. Make predictions. A prediction is a specific statement that can be directly and unequivocally tested.
   e. Test the predictions. An experiment is an activity designed to test the validity of a hypothesis; it involves manipulating variables, or conditions that can change. The independent variable is the variable that the scientist manipulates, while the dependent variable is the one that depends on the first variable. Scientists conduct controlled experiments by controlling for the effects of all variables except the tested one. Often, controlled experiments have a treatment area that is manipulated and another that is not, called a control.
   f. Analyze and interpret results. Scientists record data from their studies and analyze the data using statistical tests to see if the hypothesis is supported. If the results disprove a hypothesis, the hypothesis is rejected and a new one may be proposed. If the repeated tests fail to reject a particular hypothesis, it will ultimately be accepted as true.

D. We can test hypotheses in different ways.
   1. A manipulative experiment is an experiment in which the researcher actively chooses and manipulates the independent variable.
   2. When variables cannot be manipulated - climate change is an example of this - a natural experiment is performed. In such experiments, researchers test their hypothesis by searching for correlation, a statistical relationship between variables.
   3. Natural experiments provide evidence that is weaker than manipulative experiments but can still make for strong science.

E. The scientific process does not stop with the scientific method.
   1. Peer review. Research results are submitted to a journal for
publication. Other scientists who specialize in the subject area are asked to provide comments and critiques and judge whether the work merits publication. This process is known as peer review.

2. Conference presentations. Scientists frequently present their work at professional conferences and receive informal comments on their work prior to publication.

3. Grants and funding. Most scientists spend considerable time writing grant applications to private foundations or government agencies for support of their research. These applications are also usually subjected to peer review. Conflicts of interest sometimes arise when results are in conflict with the interests of the funding agency. This has occurred in the case of private industry funding. Government agencies have also occasionally suppressed findings to avoid policy implications.

4. Repeatability. The careful scientist may test a hypothesis repeatedly in various ways before submitting it for publication. After publication, other scientists will attempt to reproduce the results in their own analyses.

5. Theories. If a hypothesis survives repeated testing by numerous research teams, it may be incorporated into a theory. A theory is a widely accepted, well-tested explanation of one or more cause-and-effect relationships that has been extensively validated by a large amount of research. In science, a theory is not speculation or hypothesis.

6. Applications. Knowledge gained from scientific research may be applied to help fulfill society’s needs and address society’s problems. A correct social response may still be difficult even when the scientific information is clear, however.

F. Science may go through “paradigm shifts.”

1. A paradigm is a dominant view regarding a topic, based on the facts and experiments known at that time.

2. Thomas Kuhn argued that science goes through periodic revolutions in which one dominant view is abandoned for another as more information becomes available.

IV. Sustainability and the Future of Our World

A. Achieving a sustainable solution is vital.

1. The primary challenge in our increasingly populated world is how to live within our planet’s means. This is the challenge of sustainability.

2. We have been drawing down Earth’s natural capital, its accumulated wealth of resources, 30% faster than it is being replenished. This cannot be sustained.
B. Population and consumption drive environmental impact.
   1. The ways we modify the environment have been influenced by the steep and sudden rise in human population.
   2. Our consumption of resources rises even faster than our population.
   3. Large differences in the benefits of rising affluence exist among the world’s nations. The discrepancies in income lead to large differences in the ecological footprint of citizens from different nations.

C. We face challenges in agriculture, pollution, energy, and biodiversity.
   1. Advances in technology have enabled us to grow more food per unit of land. Extensive use of chemical fertilizers and pesticides, and their resulting runoff and pollution, along with the widespread conversion of natural habitats, are some environmental costs of conventional agriculture.
   2. Synthetic chemicals pollute land, water, and air. Pollution causes the death of millions of people and significant loss of wildlife.
   3. Our most pressing challenge might be the looming specter of global climate change. Our use of fossil fuels in concert with deforestation has increased the amount of carbon dioxide and other gases in the atmosphere, bringing warming to its highest level in at least 800,000 years.
   4. Overharvesting, the introduction of nonnative species, and habitat alteration cause serious problems with biodiversity -- the number and diversity of living things -- which is declining dramatically, as well as on other ecological systems. The Millennium Ecosystem Assessment clearly states that we have degraded many environmental systems.

D. Our energy choices will influence our future enormously.
   1. Our reliance on fossil fuels, while bringing us material affluence, has intensified virtually every impact that we have on the environment.
   2. In addition to the environmental problems caused, we will soon have to deal with the depletion of these fuels and the energy crisis that this could precipitate.

E. Sustainable solutions abound.
   1. Renewable energy and efficiency efforts are gaining ground.
   2. Legislation and technological advances are decreasing pollution in wealthier countries.
   3. Advances in conservation biology enable scientists and policymakers to work together to protect habitat and organisms. Soil conservation, irrigation, and organic methods are improving agriculture.
4. Steps to reduce greenhouse gas emissions are increasing.

F. Are things getting better or worse?
   1. Some environmental thinkers, whose views are characterized as **Cornucopian**, claim that the quality of human existence is improving.
   2. Others prophesize imminent doom. These people are often called **Cassandras**.
   3. What questions do we need to ask to discover the likely realities?

G. Sustainable development involves environmental protection, economic well being, and social equity.
   1. Our civilization cannot exist without an intact natural environment. Portrayals of environmental protection as threatening people’s economic and social needs fail to account for the importance of environmental quality. It is also the poorest members of our society who suffer most from the degradation of the environment.
   2. Development in an economic sense describes the use of natural resources for economic advancement. **Sustainable development** is the use of these resources in a manner that does not compromise the future availability of resources. Otherwise, future generations may not have the present quality of life.
   3. Interpretations of the phrase **sustainable development** vary. To meet the goals of the original United Nations definition, we need to satisfy a **triple bottom line**, which encompasses economic advancement, environmental protection, and social well-being.
   4. Environmental science holds the key to answering the question of whether we can develop in a sustainable way.

V. Conclusion
   A. Finding effective ways of living peacefully, healthfully, and sustainably on our diverse and complex planet will require a thorough scientific understanding of both natural and social systems.
   B. Identifying a problem is the first step in devising a solution to it.
   C. Science in general, and environmental science in particular, can help efforts to develop balanced and workable solutions to the many challenges we face and to create a better world for us and our children.
Key Terms

agricultural revolution  
biodiversity  
Cassandras  
control  
controlled experiment  
Cornucopian  
correlation  
data  
dependent variable  
descriptive science  
ecological footprint  
ecosystem services  
environment  
environmentalism  
environmental science  
environmental studies  
experiment  
hypothesis  
hypothesis-driven science  
independent variable  
industrial revolution  
interdisciplinary  
manipulative experiment  
Millennium Ecosystem Assessment  
natural capital  
natural experiment  
natural resources  
natural sciences  
nonrenewable natural resources  
observational science  
overshoot  
paradigm  
peer review  
prediction  
probability  
renewable natural resources  
science  
scientific method  
social sciences  
sustainability  
sustainable development  
theory  
tragedy of the commons  
treatment  
triple bottom line  
variables

Teaching Tips

1. Begin class by asking students to define the term environment in their own words. Ask them to respond on a note card and collect the note cards. At the end of the semester, return the note cards to the students and ask them to redefine the term based on what they learned during the course. Lead a discussion about how their definitions changed.

2. To teach the scientific method, present a situation to the class and ask students to work in groups to address the issue using the scientific process. For example: A farmer in South Carolina notices that the pond on his property contains an unusually high amount of algae. Because of the algal growth, his cattle will not drink from the pond. Ask students what is happening, and what could he do? Based on this information (the observation), ask students to formulate a hypothesis, make a prediction, and design an experiment.
3. To make environmental science more appealing, have students investigate local environmental issues so they can relate to them personally and realize that they can make a difference. One possibility is for students to look at the Environmental Protection Agency’s Superfund Sites in their state. The National Priorities List of sites in the United States can be found at: http://www.epa.gov/superfund/sites/npl/. From there they can choose their state or territory. They can click on any site shown on the state map to see names and locations. They then can click on the site name to go to a page devoted to that site, its description, cleanup approach, progress, potentially responsible parties, and many other site-related documents.

4. Ask students to conduct an Internet search on Easter Island. What is it like today? How many people live on the island? What are the main resources? Now tell them to research one of the success stories, the island of Tikopia, which lies in the Pacific Ocean east of Australia and New Guinea, west of Tonga and Fiji. They can look in Jared Diamond’s book Collapse (2005, Viking Press) or at some of the Internet sites devoted to the subject (such as Diamond’s lecture at: http://www.tannerlectures.utah.edu/lectures/documents/Diamond93.pdf)

Ask students to compare and contrast the stable culture that has lasted at least 3,000 years on Tikopia with the fallen and failed culture of Easter Island. What are the major differences in how the people approached the idea of sustainability?

5. Quick feedback: Use a technique known as “muddiest point” to assess student understanding of the material. During the last 5 minutes of class, pass out 3 × 5 cards (or have students use their own paper, but in a large class 3 × 5 cards will be faster to assess) and ask students, anonymously, to write down the one point from the lecture that they don’t quite grasp—the “muddiest point.” Students leave cards in a pile as they exit. You don’t need to read every one of them in a large class—a random sample of 20 will indicate whether there are a couple of concepts that many students find unclear, or whether most everyone understood most everything. The technique has two benefits: First, the students must engage in some higher-order thinking to quickly review the lesson and their notes, assessing for clarity; and, second, you will learn whether there are small, scattered misunderstandings or a single issue that needs to be revisited. (From Thomas A. Angelo and K. Patricia Cross, Classroom Assessment Techniques: A Handbook for College Teachers, 2nd ed., San Francisco, Josse-Bass Publishers, 1993).

6. Divide the class into six teams. Assign a chapter from Overshoot by William Catton, Jr. (see text reference below) to each team. Ask students to summarize the main points, analyze the information presented by the author, and explain if or how the text is relevant today. Encourage discussion about how issues raised in the text were addressed with legislation and action. Consider dividing students into small groups, each having responsibility for making an oral presentation during the semester. This chapter’s group might seek out the current research on carbon sequestration by the oceans, terrestrial capture by forests, or direct burial of CO₂ from power generation.
7. Consider dividing students into small groups, each having responsibility for making an oral presentation during the semester. This chapter’s group might investigate the ecological footprint of the community where the school is located and explore its sustainability issues. They might investigate whether there are identifiable groups impacted by current transportation or energy issues in the community.

8. Community Service: Ask students to brainstorm, individually or as a group, ways in which they might explore the issues of this chapter in their community and take action. A specific example might be to educate consumers about the use of phosphates in dishwashing detergents. If your course contains a community service component, some students might want to take an idea from this section as a project.

Additional Resources

Websites

1. NASA Spacelink Curriculum Support, NASA  

   This website provides educator guides for life science activities that integrate the scientific method.


   Information, documents, and publications related to sustainable development, as well as Agenda 21, can be accessed from this website.

3. U.S. and World Population Clocks—POPClocks, U.S. Census Bureau  
   (www.census.gov/main/www/popclock.html)

   This website provides the current total population of the world.

4. Fished Out: The Rise and Fall of the Cod Fishery, Canadian Broadcasting Corporation  
   (http://archives.cbc.ca/economy_business/natural_resources/topics/1595/)

   Archival video reports can be found here about the collapse of the cod fishery in the Grand Banks off the eastern coast of Canada.

5. The Millennium Ecosystems Assessment,  
   (http://www.millenniumassessment.org/en/index.aspx)

   A comprehensive website containing reports and summaries of the commission’s work.
Audiovisual Materials

1. *Earth on Edge*, Bill Moyers Reports, 2001, distributed by Films for the Humanities and Sciences (www/shoppbs.com)
   In collaboration with the World Resources Institute, Bill Moyers assesses the state of the environment in interviews with scientists from around the world (2001).

2. *Scientific Methods and Values*, distributed by Hawkhill Video (www.hawkhill.com)
   This 35-minute program describes the history of the scientific method and explains how scientists use the technique.

   This video, narrated by David Attenborough, is the first in a three-part series that describes worldwide biodiversity and the human activities that are destroying it.

   This video is a 2-hour program that investigates social and environmental strains placed on the world due to rapidly increasing human populations.

5. *Planet Earth*, 2007, produced by the BBC. This series first aired on the Discovery Channel and captured the attention of very diverse viewers.
   The compelling footage highlights many interesting and rare species, their habitat preferences, and also projects the viewer into the future, inspiring one to ask, “What next? What will happen if these areas and creatures are not recognized and protected?” (www.pbs.org)

Suggested Texts

1. *People and the Land Through Time: Linking Ecology and History*. Emily Russell. Yale University Press, New Haven, 1997. For students who want an in-depth analysis of ecological issues based on human settlement patterns, this text provides valuable insights into the evolution of contemporary environmental issues. The author begins with geology, moves through disturbance features such as anthropogenic fire, and finishes with actual case studies grounded in historical ecology.

Weighing the Issues: Facts to Consider

Tragedy of the Commons

Facts to consider: Biologically-based resources are somewhat more resilient to exploitation, as populations of harvested animals are usually replenished year after year depending on environmental conditions. However, as more fishers enter an area and move further away from established fishing grounds, the reproductive adult lobsters that restocked the fished-out population are taken as well. Populations begin to decline as the number of reproductive adults decreases. With more fishers, more reproductive adults are taken until most of the lobsters harvested are small (one molt above minimum size). At this size, the lobsters are only 50% mature, and because they are harvested, these lobsters will never reproduce, further depleting the population of reproductive adults for the future. (http://www.nefsc.noaa.gov/sos/spsyn/iv/lobster/).

A real-life example of this scenario is the closing of the Grand Banks fishery off the east coast of Canada to commercial fishing. (See Additional Resources for a website link to archival television and radio reports about this topic.) Individual responses will vary about whether government regulation or private cooperative regulation would be more appropriate solutions.

Follow the Money

Facts to consider: A research scientist who is dependent on external funding is also generally dependent on the successful publication of his results to continue to receive funding. If the funding contract includes requiring review of the results prior to publication, the results may be suppressed. There are well-documented instances of this in tobacco research in this country, although this is still contested by the tobacco companies. For a well-documented discussion of this see: Brian Martin, “Suppressing Research Data: Methods, Context, Accountability, and Responses.” Accountability in Research, Vol. 6, 333-372, 1999.

During President George W. Bush’s administration, 2000-2008, a number of stories appeared documenting the editing for political purposes of internal scientific reports, particularly from the Environmental Protection Agency, by non-scientists.

Ecological Footprints

Facts to consider: The science behind the ecological footprint can be found in Wackernagel and Rees’ text, Our Ecological Footprint, New Society Publishers, 1996, and a number of footprint calculators can be found online. The answers to this question are clearly rooted in values, not in science, except that the authors make a strong case for our societal inability to continue to use resources at our current rate, the richer nations being responsible for the excess use.
The Science behind the Stories:
Thinking Like a Scientist

The Lesson of Easter Island

Observation: While presently denuded of large vegetation, examination of sediment cores from lakes, ancient nut casings, carbon-channels in the soil, charcoal, and analysis of ancient script all indicate that Easter Island once had a thriving palm forest.

Hypothesis: The forest was lost due to climate change.

Results: Evidence disproved this hypothesis, supporting an alternative hypothesis that the forest was lost due to human-caused environmental degradation. Archeological evidence indicates that, traditionally, the palms and other trees were used for fuel, for building materials for houses and canoes, and as fibers for clothing, and that the fruit was eaten. However, as tribes began to make and move massive stone statues, palms were harvested for rope and to use as rollers to move the statues. Pollen analysis of the lake sediment cores showed decreasing plant populations and plant species diversity until there was very little vegetation by A.D. 1400. Deforestation led to increased erosion, as revealed by the increasing depth of the lake sediment layers. Higher erosion rates decreased soil quality, resulting in smaller crop yields. Other evidence of forest loss can be seen in the decreasing diversity of animal species used as food, with early islanders eating many species of forest birds and marine animals and later islanders eating only domesticated chickens. Archeological evidence supports the conclusion that extreme scarcity of food led to intertribal warfare and collapse of the Easter Island society.

Answers to End-of-Chapter Questions

Testing Your Comprehension

1. Renewable and nonrenewable resources are categories of natural resources, the various substances and energy sources we need to survive. Resources replenished by the environment over relatively short periods of time are renewable resources. Sunlight and wind energy are examples. Those in limited supply and that are formed more slowly than we use them are nonrenewable resources. Oil and coal are examples.

2. The human population grew markedly as a result of both the agricultural and industrial revolutions. The agricultural revolution made it easier for humans to meet their nutritional needs; thus they lived longer and had more children. The industrial revolution brought improved sanitation and medical technology, and increased agricultural productivity fueled by fossil fuels and fertilizer. This significantly increased life expectancy, decreased mortality, and expanded the capacity to feed a growing population.

3. The “tragedy of the commons” refers to a situation in which resources that are open to unregulated exploitation will eventually be depleted. In a public pasture, each person whose animals graze there would benefit from grazing more animals. If each individual
makes the rational decision to graze more, eventually the pasture will be overgrazed and its value destroyed. In the case of an industry that pollutes waterways, publicly accessible fresh water is the “commons,” and pollution is analogous to overgrazing.

4. Environmental science seeks to understand how Earth’s natural systems function, how humans are influenced by them, and how we are influencing them. It includes the disciplines of ecology, earth sciences, economics, political science, demography, and ethics, among others.

5. Science is both the systematic process for learning about the world and the accumulated body of knowledge that arises from this process. It can be applied to the development of new technologies, such as electrical lighting, nuclear power, and antibiotics. It can also be applied to policy decisions and resource management strategies.

6. The scientific method includes making observations, asking questions, developing a hypothesis, making predictions, and testing those predictions, often through experiment.

7. In a manipulative experiment, a scientist actively chooses and controls the independent variable. In this type of experiment, causation can generally be shown because the change in the dependent variable can be measured as a direct result of the manipulated independent variable. In a natural experiment, a scientist measures and correlates the response of a system to naturally occurring variation in the independent variable, often because the process of interest is beyond the scientist’s ability to alter or control.

8. Before being published, a researcher’s results go through a process of peer review, which guards against faulty science contaminating the literature.

9. Major environmental problems in the world today include loss of biodiversity, increasing depletion and pollution of available freshwater resources, soil erosion, global climate change, and air pollution (among others). These may be caused directly or indirectly by human population growth and by increasing human consumption of natural resources.

10. Sustainable development is the use of renewable and nonrenewable resources to maintain or increase human living standards in ways that satisfy our current needs without compromising the resources’ future availability. Sustainable development will be necessary if we are to continue human civilization far into the future. The triple bottom line refers to three goals of sustainability: social justice, economic equity, and environmental health.
Calculating Ecological Footprints

<table>
<thead>
<tr>
<th>Nation</th>
<th>Ecological footprint (hectares per person)</th>
<th>Proportion relative to world average footprint</th>
<th>Proportion relative to world area available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>0.6</td>
<td>0.2 (0.6÷2.7)</td>
<td>0.3 (0.6÷2.1)</td>
</tr>
<tr>
<td>Tanzania</td>
<td>1.1</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Colombia</td>
<td>1.8</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Thailand</td>
<td>2.1</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Mexico</td>
<td>3.4</td>
<td>1.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Sweden</td>
<td>5.1</td>
<td>1.9</td>
<td>2.4</td>
</tr>
<tr>
<td>United States</td>
<td>9.4</td>
<td>3.5</td>
<td>4.5</td>
</tr>
<tr>
<td>World average</td>
<td>2.7</td>
<td>1.0 (2.7÷2.7)</td>
<td>1.29 (2.7÷2.1)</td>
</tr>
<tr>
<td>Your personal footprint (see Question 4)</td>
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</tbody>
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1. Bangladesh has a low per-capita income.
2. The United States has a high per-capita income.
3. Higher per-capita income suggests a higher consumption of goods, which require natural resources in their production. There is also a correlation between the use of energy resources, especially for transportation, and income.