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Introduction to Environmental Science

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Sources

UCCP AP Environmental Science Course, WikiBooks - Applied Ecology

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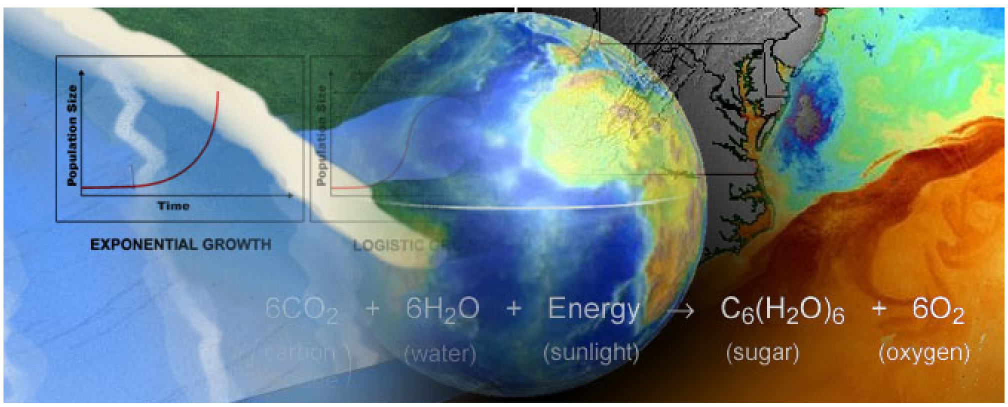
Introduction to Environmental Science



1.1 Introduction

The environmental conditions of earth, including the climate, are determined by physical, chemical, biological, and human interactions that transform and transport materials and energy. This is the "earth system" that humans rely upon for survival and life. Understanding current environmental issues requires having a critical eye to all information read and found online. **Remember: Junk In = Junk Out.** If you start with false and incorrect information, you will end with false conclusions. Obtaining reliable and credible information is one of the most important steps in evaluating current environmental issues.

Chapter Objectives

- Describe what is Earth System Science.
- Explain recent developments that have changed our view of Earth.
- List the critical thinking methods used to evaluate online sources for credibility.

1.2 Definitions

Environmental Science is the study of ...

The Earth behaves as a system in which oceans, atmosphere and land, and the living and non-living parts therein, are all connected. (Steffen et al, 2004). This **earth system** is a highly complex entity characterized by multiple nonlinear responses and thresholds, with linkages between disparate components. (Jickells, et al, 2005).The Oxford English Dictionary defines a system as:

> A set or assemblage of things connected, associated, or interdependent, so as to form a complex unity; a whole composed of parts in orderly arrangement according to some scheme or plan.

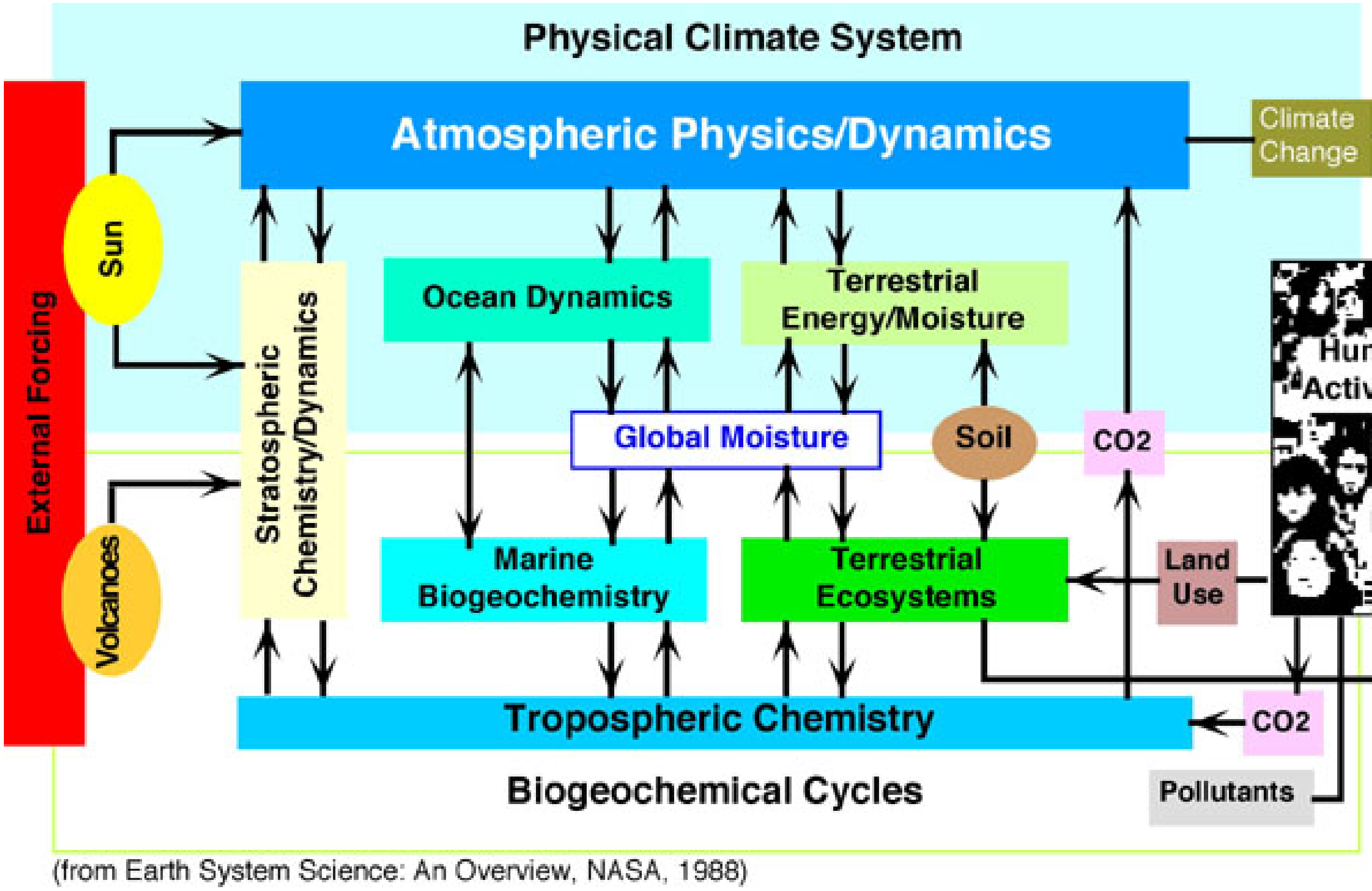
The earth system is composed of interacting physical, chemical, and biological processes that move and change materials and energy on earth. The system provides the conditions necessary for life on the planet. For example, plants, which are part of the living system, use solar energy to change carbon dioxide into organic carbon. Less carbon dioxide in the atmosphere helps cool the planet. Winds and ocean currents move heat from the tropics to higher latitudes, helping to warm the higher latitudes.

Earth systems interact through feedbacks. Positive feedbacks lead to instability. They speed up change in the system. Negative feedbacks lead to stability. They reduce change in the system. Until the beginning of the Anthropocene, or the human era on Earth, the systems were all natural. Now humans have begun to influence the planet, changing the operation of many systems. Because all systems are interconnected, a change in one system influences all other systems.

> ”The goal of earth system science is to obtain a scientific understanding of the entire earth system on a global scale by describing how its component parts and their interactions have evolved, how they function, and how they may be expected to continue to evolve on all timescales” (Earth System Science Committee, 1986, p. 26).

History of Earth System Science

Earth system science began in 1983 when the NASA Advisory Council established the Earth System Sciences Committee, which published their revolutionary report Earth System Science: A Program For Global Change in 1988. The committee, chaired by Francis Bretherton, showed for the first time how the many systems interact. The term ”earth system science” was first used by Moustafa Chahine of the NASA Jet Propulsion Laboratory, during a meeting with Bretherton. Chahine noted scientists had studied the solar system for many years, now it was time to study the earth system.



A schematic diagram of the earth system proposed by the Bretherton committee, 1988.

Organizations Studying Earth Systems

The NASA report complements work by many groups that have organized programs to study earth. The primary international groups are:

1. The World Climate Program, established in 1980 under the World Meteorological Organization, theInternational Council for Science, and, since 1993, the Intergovernmental Oceanographic Commission, seeks to develop the fundamental scientific understanding of the physical climate system and climate processes needed to determine to what extent climate can be predicted and the extent of human influence on climate.
2. The Intergovernmental Panel on Climate Change, established in 1988 under the World Meteorological Organization and UNEP, seeks to assess scientific, technical and socio- economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation.
3. The International Geosphere Biosphere Program, established in 1987 under the International Council for Science, studies the interactions between biological, chemical and physical processes and human systems. IGBP collaborates with other programs to develop and impart the understanding necessary to respond to global change.

Each of these large organizations has many sub-panels working on various aspects of each program. Overall, tens of thousands of scientists contribute to earth-system studies.

Earth Science

The remainder of this page is taken almost entirely from the executive summaries of their reports, especially the report: Global Change and the Earth System: A Planet Under Pressure, IGBP Science 4 Report.

1. The earth is a system that life itself helps to control. Biological processes interact strongly with physical and chemical processes to create the planetary environment, but biology plays a much stronger role than previously thought in keeping earth's environment within habitable limits. Life, the carbon cycle, greenhouse gases in the atmosphere, and earth's surface temperature are all interrelated.
2. Global change is much more than climate change. It is real, it is happening now and it is accelerating. Human activities are significantly influencing the functioning of the earth system in many ways; anthropogenic changes are clearly identifiable beyond natural variability and are equal to some of the great forces of nature in their extent and impact. The changes are so large that we are entering a new geological age, the anthropocene.
3. The human enterprise drives multiple, interacting effects that cascade through the earth system in complex ways. Global change cannot be understood in terms of a simple cause-effect paradigm. Cascading effects of human activities interact with each other and with local- and regional-scale changes in multidimensional ways.
4. The earth's dynamics are characterized by critical thresholds and abrupt changes. Human activities could inadvertently trigger changes with catastrophic consequences for the earth system. Indeed, it appears that such a change was narrowly avoided in the case of depletion of the stratospheric ozone layer. The earth system has operated in different quasi-stable states, with abrupt changes occurring between them over the last half million years. Human activities clearly have the potential to switch the earth system to alternative modes of operation that may prove irreversible. Changes in the earth system can lead to abrupt climate change.
5. The earth is currently operating in a no-analogue state. In terms of key environmental parameters, the earth system has recently moved well outside the range of the natural variability exhibited over at least the last half million years. The nature of changes now occurring simultaneously in the earth system, their magnitudes and rates of change are unprecedented.

Table 1.1:

Left: Photograph of earth taken on December 7, 1972 by the crew of Apollo 17 from a distance of about 45,000 km, while traveling to the moon. This image revolutionized our concept of earth, and it is one of the most famous photographs ever taken. Image from NASA Earth Observatory.
Right: The Blue Marble floating in the void. earth as seen from space based on a montage of data from three satellites. Clouds were observed on September 9, 1997 by the Geostationary Operational Environmental Satellite (GOES) operated by NOAA. Land color is portrayed by a vegetation index calculated using data collected from September 9-19, 1997, by the Advanced Very High Resolution Radiometer (AVHRR) instruments carried aboard NOAA's Polar Orbiting Environmental Satellites. Ocean color data were collected in late September and early October 1997 by NASA's Sea-viewing Wide Field-of-view Sensor (SeaWiFS) satellite. Image from NASA Visualization Analysis Lab, Goddard Space Flight Center.
Global observation systems and fleets of satellites allow us to study the earth as a whole in ways that we could do before only on regional or local scales. We can now study earth as a system.

Recent Developments

Several developments have led to this dramatic change in our perception of earth:

1. **Earth seen from space:** The view of earth from space, a blue-green sphere floating in blackness, triggers emotional feelings of a home teeming with life set in a lifeless void. It also leads us to ponder that we are alone on a spaceship with limited resources. http://oceanworld.tamu.edu/resources/environment-book/Images/firstbluemarble.jpg
2. **Global databases** are now being collected and processed in a consistent way that allows us to compare and analyze processes on a global scale over many years.
3. **Research Advances:** Dramatic advances in our ability to collect data about environmental conditions hundreds to millions of years ago allow contemporary processes to be viewed as continuations

of past processes.

4. **Enhanced computing power** allows us to use theory and data together to study earth and the interactions among many different parts of the earth system.

Science has crossed the threshold of a profound shift in the perception of the human-environment relationship, operating across humanity as a whole and at the scale of the earth as a single system.

1.3 Environmental Issues

As earth's population increases, changes in the environment accelerate, leading ultimately to disasters.

> Wherever humans live at high population densities, making unsustainable demands on natural systems, ... you eventually see ecological breakdowns, unmet needs, and tensions that lead toward conflict. Look at Darfur. Look at Rwanda. Look at Zimbabwe (Quammen, 2005).

1.4 Using the Web

Making good environmental science choices starts with having a good critical eye about environmental science information. Beware what you read on the Internet: Anyone can post to the web. It does not mean they know anything about the topic. **Remember: Junk In = Junk Out.** If you start with false and incorrect information, you will end with false conclusions. Obtaining reliable and **credible information**, or information that is accurate, reviewed by experts, and as unbiased as possible, is one of the most important steps in evaluating current environmental issues.

How do we know which pages on the web can be trusted?

1. Use Scirus to help find scientific articles published in journals and elsewhere: http://www.scirus.com/
2. Use Google Scholar, which only looks up peer-reviewed academic research: http://scholar.google.com/
3. Pay attention to the URL in Internet searches, ***do NOT*** just use the first item that comes up on the first page of Google. Just because it is the first item does not mean it is a reliable or credible source.
4. Use links that end in .edu (accredited educational institution) or .gov (such as Nasa.gov), etc., as opposed .com or .org, which would be a company or organization that may be a reliable source of information, but may not be as well. Just think of how the Tobacco companies hired their own researchers who falsified and hid data for the company so that they could claim that cigarettes were not harmful to one's health.

How do we know what material to trust? Ask these questions:

1. **Who produced the material?**
   - Material produced by an expert tends to be more trustworthy than material produced by others, but one should always review all material with a critical eye.
   - Is there material at the site describing the author's credentials or experience?
   - Is the writer anonymous? This is a bad sign when there is no author listed!
2. **Who uses the material?**
   - Is it cited by others?
   - Is it linked from trustworthy sites?
   - Has the site won awards? Beware of fake awards that some websites give themselves!
3. **Has the material been reviewed by peers?**
   - Journal articles on the web from respected journals are peer reviewed. **Peer review** is when an article or research is first reviewed by several other experts in the field to determine accuracy prior to publishing it. This helps alleviate errors and false data.
   - Some journals are better than others. The best are Science and Nature.
   - Some web pages are reviewed by portals such as the Digital Library for Earth System Education: www.dlese.org
   - Some data sets and information may have been described in published articles cited by the site.
4. **Who hosts the page?**
   - College, university, government, grammar school, commercial, or personal web site? Some domains such as .edu, .org, and .gov are good sources of scientific information.
   - Does the hosting organization have strong opinions? Most organizations are biased. This is neither good nor bad. We just need to be aware of biases. Greenpeace and the US National Marine Fisheries Service may have differing, but valid viewpoints.

5. **When was the web page last updated?**
   - Some sites are many years old.
   - Oceanography is changing rapidly, and often more recent sites have the best information.
6. **False Friends, web pages that mimic scientific sites.**
   - They may be hosted by a non-profit organization.
   - They appear to be written by an expert.
   - They have many references at the end of the article.
   - Yet the information is misleading or incorrect.
   - Sites offering medical advice, advice on diets or nutrition, or cures for common diseases sometimes fall into this category. They are written by medical doctors, they reference obscure journal articles, and they are hosted by the doctor's organization.
   - Consider the controversial topic of chelation therapy to cure clogged arteries. Compare the information on chelation therapy reviewed in an article in the American Heart Journal and a similar article by the American Heart Association with a bibliography of papers supporting chelation therapy by Dr. Elmer Cranton, Medical Director of Mount Ranier Clinic and his article on the Theoretical Mechanism... Who would you believe?
7. **Beware the Widely Quoted Statistic !!**
   - Some statistics are widely quoted by many different authors, yet they may be incorrect or misleading.
   - What is the original source of the statistic?
   - Was the original source reliable.
   - Consider this statistic: Children from low-income households average just 25 hours of shared reading time with their parents before starting school, compared with 1,000 to 1,700 hours for their counterparts from middle-income homes. These oft-repeated numbers originate in a 1990 book by Marilyn Jager Adams titled, "Beginning to Read: Thinking And Learning About Print." Ms. Adams got the 25-hours estimate from a study of 24 children in 22 low-income families. For the middle-income figures, she extrapolated from the experience of a single child: her then-4-year-old son, John. She laid out her calculations and sources carefully over five pages, trying to make clear that she was demonstrating anecdotally the dramatic difference between the two groups. In the 17 years since then, at least a half-dozen child-advocacy groups, including United Way, Kids in Common and Everybody Wins, have boiled down those five pages into a single sentence, repeated in various forms, often without attribution to the original source. As is typical for such numbers, the child-reading stats have taken on a life of their own through a game of media telephone, with news articles usually attributing the numbers to one of these advocacy groups or to various researchers or foundations that themselves got the numbers from the Adams book. For her book, Ms. Adams drew on a 1986 study by William Teale and colleagues of low-income families in Southern California. Using his findings about reading time per child, she extrapolated to their time before entering school and averaged the total. Prof. Teale, who now teaches education at the University of Illinois, Chicago, says his findings couldn't be generalized to the overall population, nor did he ever make that claim: "We had way too small a sample." From Bialik (2007).