

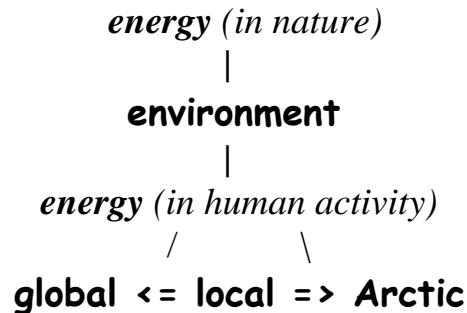
H A&S 222d Introduction to Energy and Environment (Life Under the Pale Sun)

Spring 2009

Tues-Thurs 10.30-12.20 Mary Gates Hall 284

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Abstract:

1. Energy: an organizing principle for studying Nature
forces: electrostatic, electromagnetic, gravitational
energy: mechanical, thermal, chemical, electromagnetic;
energy production, flux, storage, transformation
the ultimate energy source: the sun
flow of energy through the Earth
 water and heat
 atmosphere
 ocean
 biosphere
conversion, storage
‘physics’ of biology: photosynthesis, carbon cycle
2. The global environment:
earth, air, fire, water
circulation of atmosphere and ocean
global biosphere: its relation with circulation, energy and nutrient supplies
the end of Nature?
3. Humans and their energy use
global population and its ‘footprint’
global energy resources
the great debate over oil
 alternative fuels
relation to global change, global warming
4. Life at the rim of the Arctic: people and ecosystems
interaction with energy: human use
energy resources in the far North
native culture and its relation to energy issues
global change and its Arctic amplification

An underlying environmental ethic, and a practical strategy for success, both require an understanding of the place of humans among ecosystems of the Earth. A part of this

understanding comes from scientific observation and analysis...which requires familiarity with some of the underlying principles of natural science, coming from physics, chemistry, and biology.

Week 1: 26/30 March 2009

Note taking: We will put a lot of the ideas and observations on the class web-site and in some handouts, but taking good lecture notes is still a very good idea. A strategy is to buy one of those hard-bound lab books (with lines) and use it for both class notes, homework drafts and essay drafts.

Assignment: Check your computing resources:

- ability to download, save and organize Adobe PostScript files
- email organization and storage
- class website found and explored

(www.ocean.washington.edu/courses/as222d)

- confirm your email address and tell us how good your web access is:
 - all the time, easy
 - I have to go to a UW computing lab
 - I can't access the Web at important times like

evening/weekends

modem or
-My access is low-speed (telephone modem), high-speed (cable-modem or better)

(brief) Essay #1: A Vivid Outdoor Memory

out: Tues 31 March 2009

due: Thurs 2 April 2009 (i.e., the 2d meeting of class)

On one page describe an outdoor place that you remember as being exceptionally beautiful, peaceful, interesting or inspiring. Frame your discussion in terms of your emotional or artistic reaction to this place. You might ponder *why* you reacted so strongly, making yourself a part of the picture.

On a second page describe the same place in terms of its function: for example if it were a waterfall you could discuss why it is there, where the water originates, how it has affected the geology (rocks) and ecology (plants and animals) of the area; if there are plants and animals you could think about who is doing what to whom. Are humans involved in its function (or, potentially will they affect its future)?

Reading week 1: McNeill *Something New Under the Sun:*

on energy: preface xxi-xxvi

Ch. 1 Peculiarities of a Prodigal Century 3-17

Smil *Energy* Ch 1. Energy in our minds

plus a handout

Thoughts about your writing.

A page is about 450 words, say 30 lines of 15 words each; if using Microsoft Word, use 1.5 line spacing and a 12 pt font like Times New Roman with about 1" margins. Your word count is easily checked. But we are happy if you don't use Microsoft Word. In a way it is sad to see everyone on Earth using the same writing tool.

Writing is an essential part of this course, both in several essays (2-week assignments) and continuous keeping of a journal, using *Google Documents*. The journal will be shared between you, the instructor and TA.

Good writing will get you far. We can easily imagine another course in which you looked at the environment in literature, in the poetry of Emily Dickinson and Robert Frost. Or a course on representation of environment in great paintings. But scientific writing and other kinds of prose or poetry differ. We are a science-based course, though with an important component of humanities. We wonder, for example, "How do people and ecosystems relate to and react to the winds and currents around them?" Tersely focused writing is taught, for example by Strunk & White's classic little book *The Elements of Style*.

Something important has happened to science writing in the past few years. It has become much better, more effectively channeling information and ideas between scientists and non-scientists (yes, both ways). People with Ph.D. degrees in physics have become full-time writers of articles in magazines and of books. A good example is Phillip Ball, author of *H₂O – The Matrix of Life: a Biography of Water*. By combining hard science with an understanding of its impacts on humans—you might call this philosophy of science—writers like Ball give us a deep understanding of things that matter. Sometimes they fool us into thinking that we really understand the essence of a difficult scientific idea (as in *Genius—the Life and Science of Richard Feynmann*, a biography of the physicist by James Gleick). But, as in this course, they can succeed by using some results of science (not derived or demonstrated) and from these, showing an important result (for example, if we are given the amount of sulfur put into the atmosphere each year by human activity, and the observed concentration of sulfur in air we can calculate the average lifetime of a sulfur atom—how long it resides in the atmosphere before being rained out. And, in a way that is what scientists all do; they understand some parts of a complicated system, far less than they would like, and yet deduce something important about it.

Other authors are highly successful scientists who also like to write. For example Prof. Brownlee of UW Astronomy has written in '*Rare Earth*', about the chance of finding life elsewhere in the Universe. Fred Hoyle, the most prominent astronomer in England for many years, wrote wonderful science fiction (*The Black Cloud*, *October 1st is Too Late*). In the book *A For Andromeda (1961)* Hoyle imagines a radio signal arriving in Scotland from far outside the solar system. It is decoded, and turns out to be a computer program, together with instructions for assembling the computer. When the program is run it contains the DNA sequence which produces a beautiful alien named Andromeda. Of course her mission is to invade the Earth, but Hoyle, writing just 8 years after Crick & Watson's discovery of the DNA molecules helical structure (the 'physics' of life), sees how, all of a sudden, life has in a sense become a computer program and aliens could transmit themselves rather than ride spaceships. Science fiction is one of the few activities in which writers are imagining humanity's future.

On the other hand, non-science (almost rhymes with nonsense) authors like Gretel Ehrlich (*This Cold Heaven*, about Greenland) write as artists infatuated with Nature, and seeing

scientific ideas in their own way. They have much to teach scientists about what's important. And so we will read excerpts from her book.

Make a conscious effort to study science writing in a variety of media: news magazines, nature magazines (like *Audubon Magazine*), 'popular' science magazines (*Discover*, *Smithsonian*, and yes even *Popular Science*), and more intense publications like *Scientific American* (famous for its obscurity). Each Tuesday the *N.Y. Times* has a science section which is good and readable. The journals *Science Daily* www.sciencedaily.com and *Science News* www.sciencenews.org both are very readable sources of what's happening, including coverage of the environment.

One of the reasons for all these good books and news sources on science is that they manage to communicate its beauty and power, and yet (most) science is real, unlike the deluge of fiction and fantasy that surrounds us.

These ideas may help you to think of your audience as you write: are they well-educated non-scientists, school children in 8th grade, or rocket scientists? As you go through drafts of your essays, you can try them out on a friend.

A good example of multiple viewpoints in this field is seen in the terrible floods that engulf Bangladesh, which is a low-lying country, essentially a river delta, tucked in between India on the west and Burma (Myanmar) to the east. Bangladesh is hit by tropical cyclones (hurricanes) quite frequently and there is great loss of life. Scientists look at this as a prediction problem (giving warning), a prevention problem (building dykes), yet an economist (in this case Amartya Sen, a Nobel Prize winning 'social economist') may argue that it is more important to look after people in the weeks, months and years following a devastating flood: loss of employment, infrastructure, and family stability may be as important, or more important than, the immediate loss of life. A variant of this continuing tragedy occurred with hurricane Katrina, which devastated New Orleans (August 2005). Before Katrina I taught this course and spoke of hurricanes as causing some economic damage in the USA but little loss of life here. Yet with Katrina we saw at least 1600 people die and, as Amartya Sen argues, the lives of 100s of thousands of people totally dislocated by the storm and the inadequate levee. Even now the recovery is incomplete in New Orleans and the much larger Gulf Coast coastal region with much of the population permanently dislocated. At that earlier time, fall 2004, I also noted that hurricane Andrew in 1992 was the most damaging storm economically and that if it had hit Miami directly it would have done \$100B of damage; yet that is close to the estimate of Katrina's actual damage (uncertain yet greater than \$75B). (Note that 1992 dollars and 2005 dollars differ due to inflation and need to be reconciled.)

The big numbers of the environment make it difficult to learn: they are difficult to remember and 'sense'. This is something to address in your writing: ways to make the enormity of the environment understandable. Whether it's the size of Greenland, the number of barrels of oil consumed per day (about 90M ..90 million), global population or tragic events, like the 1600 deaths in hurricane Katrina; more than 18,000 deaths in hurricane Mitch which sat over Nicaragua/Honduras in 1998; 3000 in the terrorist attacks of 11 Sept. 2001; tens of thousands in the Iraq war and hundreds of thousands in the decade of economic sanctions before that war.

Sources: solving problems more than collecting facts

A major challenge in studying the environment is finding 'facts', 'data' (lots of facts), as well as finding ideas. The Web is where we go, more often now than the library. Louise Richards' (UW Oceans librarian) will give us a lecture on web searching related to environmental literature.

For our Arctic studies, simply going to e-journals in the library website (on www.washington.edu) and searching for 'polar' or 'arctic' brought up many resources. Learning of general environmental journals and the research database on this site was also valuable. One stumbles on remarkably good 'big' resources like the Arctic Climate Impact Assessment www.acia.uaf.edu a very recent large book (downloadable in .pdf) from a US study of environment and human impacts in the region. Ms. Richards will show how to explore the quality of a reference article by hunting down the history of the authors...their other publications, professional connections and societies, citations referring to them, all build a picture of reliability or the opposite. In the global warming debate, for example, many debaters are not successful scientists, and many are receiving money from industries with their own interests at heart.

Sometimes the Web is described as "a mile wide and an inch deep". Of course it's better than that, as we saw above, but when we limit our searching to Google, we may not find the one person in the world who really understands a problem we need to solve. That person might have written a book or a journal article, and others will know of him or her. There is still a wealth of ideas in books and journals, inaccessible on the Web. A sort of 'grapevine' of communication will develop where one smart person hears a good idea and passes it on. Someday the Web will work this way but not yet. Look for smart people and ask them.

Another remarkable resource is Wikipedia, the great experiment in collecting on one site the information of all mankind that has some kind of lasting value. It is a volunteer-driven, contribution-funded, living encyclopedia written by its users (you can write or comment on an entry).

http://en.wikipedia.org/wiki/Main_Page

and see what you think of it. To me it is a wonderful resource yet also brings up questions: "Do we really want all of human experience to be collected in one place?" Just as, "Do we want to be in one room with everyone else on Earth?", which is what modern communication is beginning to achieve.

For those interested in this spin-off question from this course, you may want to read about Wikipedia and its founder, in *Atlantic Monthly*, 2006

<http://www.theatlantic.com/doc/200609/wikipedia>

The crucial question, "How is quality maintained in Wikipedia entries?" is answered by its founder. 'A thousand pairs of eyes' watching Wikipedia's articles tend to push them toward the truth (the users revise the articles, and the history of the revisions is visible). There is some rather loose control by the people running Wikipedia, but quality seems to be quite high.

For this course you might begin a Web search by visiting

<http://www.arctic.noaa.gov/peoples.html>

from the US National Oceanic and Atmospheric Administration, our principal government organization devoted to the ocean and atmosphere environment.

This is to say that individual creativity and competence are still of the highest importance in scholarly or artistic activity. But the Web, which places so much information at our fingertips, can change our idea of creativity. It is so easy to cut-paste paragraphs to produce an essay with learned appearance: possibly without the cutter-paster having even read it! Obviously you must stick rigorously to citation rules (quotation marks when appropriate, avoiding the technique of changing a few words and dropping the quotation marks, including web addresses, book references... in the full), and these should help you to maintain your own 'voice' in writing. Really, the rapid growth of the Web has caught all of us off balance, and we need to think about what creativity means, in the face of all of the world's knowledge. Try to make it a 'feature'

rather than a 'problem': we have this infinite library and can now advance to the next step by solving some real-world problems with it.

Resources

This course is taught by an oceanographer/atmospheric scientist (P.B.R.) and a molecular biologist (M.E.). Our GFD (Geophysical Fluid Dynamics) laboratory engineer/instructors Eric Lindahl and Bob Koon, will be in evidence even though we cannot regularly schedule labs. We are all researchers, working on different parts of the atmosphere/ocean system. Some of our aims involve basic questions like the origin of life beneath the seafloor, and before photosynthesis became the main agent of life. Or, the fundamental physics (or 'dynamics') behind the circulation of the atmosphere, ocean and atmospheres of the planets. PBR is working on high-latitude climate and climate change, using theory, lab experiments, computer models, and field observations near Greenland, Iceland, and Norway. Contrary to what you may have heard, scientific research is a tremendous aid in teaching. Any good teacher is constantly questioning his or her material, trying to find better and simpler understanding of something even though it's in the textbook. This means that they are, in essence, researchers. An object of research is to *simplify* and find organizing principles behind complex-looking natural phenomena. A complicated explanation doesn't have legs, and like as not will be forgotten quickly. Well, there are limits. It may have been Einstein who said we must "explain science in the simplest possible terms, but no simpler." This is sometimes known, obscurely, as 'Occam's Razor' (www.wordiq.com/definition/Occams_razor), or K.I.S.S. (keep it simple, stupid).

Finally research helps in teaching because students can join in, and discover something, possibly important, surprisingly quickly.