

SOS 6932 Water Resource Sustainability
3 credits/Spring Semester

Course Description

This course describes the effects of human impacts on hydrologic ecosystems (aquifers, watersheds, coastal zones, lakes, and wetlands) with quantitative measures of impacts and mitigation/attenuation efforts. Case studies from around the world will be used to illustrate both the detrimental effects of unsustainable resource utilization and the benefits of implementing sustainable resource management strategies.

Instructor:

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Office hours will be following class lecture or by appointment.

Objective

There is demand for expanding freshwater resources to provide drinking water for the growing population, while at the same time preventing pollution and leaving enough water for natural ecosystem functions. These combined pressures define the need for sustainable water resource management. This course is intended for graduate students interested in the interactions between human civilization and hydrologic systems and should be of interest to agricultural and environmental scientists and engineers, and natural resource managers.

Course Formats and Requirements: 3-credit course taught Spring semester with two lectures and one discussion period per week.

Textbook: Cech, T.V., 2003. *Principles of Water Resources: History, Development, Management, and Policy*. Wiley: NY.

A CD-ROM will be available with required course materials (including several items from the Supplemental Reading list below).

Class Attendance: Highly encouraged. Note (below) that class participation counts for 10% of your grade.

Grading System: Mid-term exam (30%), final exam (30%), class participation—including periodic oral presentations (25%), final presentation and report (15%)

Grade Scale >90=A, 86-90=B+, 80-85=B, 75-79=C+, 70-74=C, 65-69=D+, 60-64=D, <60=E

There are no late assignments or make-up exams. In the event of unavoidable conflicts, arrangements must be made with the instructor in advance.

Oral and Written Assignments

Your success as a professional will be based, in large part, on your ability to effectively communicate your ideas in both written and verbal forms. We all need practice to develop and improve these technical communication skills.

The final project will require a 15-minute in-class presentation/demonstration and a short written report (maximum of 10 pages). You will choose your topic from a list provided by the instructor. You will research the topic, prepare visual aids (we will discuss options in class), and practice before the actual presentation. You will be judged on the content and organization of your talk.

Academic Honesty

As a result of completing the registration form at the University of Florida, every student has signed the following statements: "I understand that the University of Florida expects its students to be honest in all their academic work. I agree to adhere to this commitment may result in disciplinary action up to and including expulsion from the University."

UF Counseling Services

Resources are available on-campus for students having personal problems or lacking clear career and academic goals which interfere with their academic performance. These resources include:

- 1. University Counseling Center, 301 Peabody Hall, 392-1575, personal and career counseling;*
- 2. Student Mental Health, Student Health Care Center, 392-1171, personal counseling;*
- 3. Sexual Assault Recovery Services (SARS), Student Health Care Center, 392-1161, sexual assault counseling; and*
- 4. Career Resources Center, Reitz Union, 392-1601, career development assistance and counseling.*

Accommodation for Students with Disabilities

Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.

Software Use

All faculty, staff and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate.

We, the members of the University of Florida, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.

LECTURE TOPICS

I. Sustainability of Natural Resources

Definition of terms and contextual framework.

II. Historical and Geographical Background

Fundamental concepts: Discussion of the hydrologic cycle, how humans interact with the hydrologic cycle (i.e., this is what we mean by ‘water resources’), and introduction to the importance of sustainable water resource management, including a summary of worldwide water resource quantities, demands, and impact levels.

History: Discuss the link between the development of human civilizations and water resources, how natural climate and ecosystem changes have impacted humans (climate changes and other natural events have been impacting humans since prehistoric times), and how humans have impacted natural ecosystems: unsustainable resource management has contributed to the demise many great civilizations.

III. Groundwater

Why should we care about groundwater? Importance of groundwater in terms of both water quantity and quality. Discussion of groundwater utilization trends in different regions.

Human impacts: Discuss effects of subsidence, contamination (petroleum, chlorinated compounds, MTBE; natural contaminants: arsenic, saltwater). What are appropriate management responses to mitigate these effects and minimize future impacts?

Case studies: San Joaquin Valley, High Plains Aquifer, Long Island, South Florida; What has been or is being done in these areas?

IV. Watersheds

Watershed basics: watershed definitions, and descriptions of watersheds and river systems of the world.

Human impacts: dams and flow diversions, desertification, contamination (nutrients, endocrine disruptors, sediment, heat).

Case studies: Colorado River, Mississippi River, Nile River, Yellow River, Murray/Darling Basin, and other local-scale watersheds. Implementation of TMDLs as a mitigation strategy.

V. Coastal Zones and Wetlands

Description: Why these areas are relevant as water resources.

Human impacts: erosion, overfishing, land use change, coral reef damage, eutrophication, exotic species. Discuss historical trends in these impacts, and whether these trends are improving—or getting worse.

Case studies: Florida coastline, New York coastline, Global coral reefs, Everglades, Illinois wetlands

IV. Cross-boundary Impacts

Hydrologic compartments: compartmentalization into groundwater, surface water, wetlands, etc. is an artificial construct. Impacts are felt on many scales.

Human impacts: Climate change, acid rain, hypoxia, deforestation; Scale issues: political constraints increase as the scale of the problem increases, local-scale processes in relation to larger-scale issues. Case studies: Glaciers worldwide, Mediterranean Sea, Gulf of Mexico.

REFERENCES AND SUPPLEMENTAL READING

References thematically grouped, and listed chronologically within each theme. ** Indicates included in electronic format on course CD-ROM.

I. Sustainability

The State of the World - "Pessimistic"

- 1) Brown, L.R. et al. 2001. *Vital Signs: The Trends That Are Shaping Our Future*. Worldwatch Institute, Norton: New York. [*Vital Signs 1984 through 2001* and *State of the World 1984 through 2001* are available].
- 2) Meadows, D.H. et al., 1972. *The Limits to Growth*. Universe Books: New York.
- 3) World Commission on Environment and Development (Brundtland Commission), 1987. *Our Common Future*, Oxford: Oxford University Press.

The State of the World - "Optimistic"

- 4) Bolch, B. and H. Lyons, 1993. *Apocalypse Not: Science, Economics, and Environmentalism*, Cato Institute: Washington, D.C.
- 5) Bailey, R., 1993. *Eco-Scam: The False Prophets of Ecological Apocalypse*. St. Martin's Press: New York.
- 6) Lomborg, B., 2001. *The Skeptical Environmentalist: Measuring the Real State of the World*, Cambridge University Press: NY.

Natural Resources and Sustainability

- 7) Youngquist, W., 1997. *GeoDestinies: The Inevitable Control of Earth Resources over Nations and Individuals*. National Book Company: Portland, OR.
- 8) **USGS, 2000. *World Petroleum Assessment 2000— Description and Results*, U.S. Geological Survey World Energy Assessment Team, <http://energy.cr.usgs.gov/WEcont/world/woutsum.pdf>
- 9) **WRI, 2000. *World Resources 2000-2001 People and Ecosystems: The Fraying Web of Life*, United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), World Bank, and World Resources Institute (WRI).
- 10) Deffeyes, K.S., 2001. *Hubbert's Peak: The Impending World Oil Shortage*, Princeton University Press: Princeton, NJ.
- 11) Wolfe, D.W., 2001. *Tales from the Underground: A Natural History of Subterranean Life*, Perseus Publishing: Cambridge, MA.
- 12) **Heinz, 2002. *The State of the Nation's Ecosystems: Measuring the Lands, Waters, and Living Resources of the United States*, The H. John Heinz III Center for Science,

- Economics, and the Environment, Cambridge University Press: NY.
- 13) **Graedel, T. E. and Klee, R.J., 2002. Getting serious about sustainability, *Environ. Sci. Technol.*, 36 (4), 523-529.

II. Historical Background

Development of Human Civilizations Linked to Water

- 14) Sprague de Camp, L., 1963. *The Ancient Engineers*. Ballantine: New York.
- 15) Smith, N., 1976. *Man and Water: A History of Hydro-Technology*. Peter Davies: London.
- 16) **Held, J.E., 1998. *The Canal Age*, Archaeological Institute of America, <http://www.archaeology.org/online/features/canal/index.html>
- 17) Landels, J.G., 2000. *Engineering in the Ancient World*, 2nd ed., University of California Press: Berkeley.
- 18) **CPL, 2000. *Down the Drain: The Historic Development of an Urban Infrastructure*, Chicago Public Library (CPL) Digital Collections, <http://www.chipublib.org/digital/sewers/intro.html>
- 19) **Gleick, P., 2000. *World Water Conflict Chronology*, Pacific Institute for Studies in Development, Environment, and Security, <http://www.worldwater.org/conflictIntro.htm>

Impacts of Natural Climate and Ecosystem Changes on Humans

- 20) Wigley, T.M., Ingram, M.J., and G. Farmer (eds.), 1981. *Climate and History: Studies in Past Climates and Their Impact on Man*. Cambridge, UK: Cambridge University Press.
- 21) Stommel, H., and E. Stommel, 1983. *Volcano Weather: the Story of 1816, the Year Without a Summer*, Seven Seas Press: Newport, R.I.
- 22) Grove, J.M., 1990. *The Little Ice Age*, Routledge: NY.
- 23) Lamb, H.H., 1995. *Climate, History, and the Modern World*, 2nd ed. Routledge: New York.
- 24) **Wohletz, K., 2000. *Were the Dark Ages Triggered by Volcano-Related Climate Changes in the 6th Century? (If so, was Krakatau volcano the culprit?)*, Los Alamos National Laboratory LA-UR 00-4608, <http://geont1.lanl.gov/Wohletz/Krakatau.htm>
- 25) Caviedes, C.N., 2001. *El Nino in History*. University Press of Florida: Gainesville.

History of Human Impacts on Hydrologic Systems

- 26) Reisner, M., 1986. *Cadillac Desert: The American West and its Disappearing Water*, Penguin Books: NY.
- 27) Outwater, A., 1996. *Water: A Natural History*, Basic Books: NY.
- 28) Postel, S., 1999. *Pillars of Sand: Can the Irrigation Miracle Last?*, W.W. Norton: New York.

III. Groundwater

- 29) **Alley, W.M., Reilly, T.E., and O.L. Franke, 1999, *Sustainability of Ground-Water Resources*. United States Geological Survey Circular 1186, USGS: Denver, CO. <http://water.usgs.gov/pubs/circ/circ1186>
- 30) USGS, 2000. *Ground Water Atlas of the United States*. USGS: Washington, D.C. <http://capp.water.usgs.gov/gwa/gwa.html>
- 31) Freeze, R.A., 2000. *The Environmental Pendulum: A Quest for the Truth about Toxic Chemicals, Human Health, and Environmental Protection*, University of California Press: Berkeley.
- 32)**Alley, W.M., Healy, R.W., LaBaugh, J.W., and T.E. Reilly, 2002. Flow and storage in groundwater systems, *Science*, 296, 1985-1990.

Case Study

- 33) NRC, 1995. *Mexico City's Water Supply: Improving the Outlook for Sustainability*, National Research Council (NRC), National Academy Press: Washington, D.C. <http://www.nap.edu/books/0309052459/html/index.html>

IV. Watersheds

- 34) Gleick, P.H., ed., 1993. *Water in Crisis: A Guide to the World's Fresh Water Resources*. Oxford: New York.
- 35) Revenga, C., 1998. *Watersheds of the World: Ecological Value and Vulnerability*. Worldwatch Institute: Washington, D.C. <http://wri.igc.org/watersheds>
- 36) **WCD, 2000. *Dams and Development: A New Framework for Decision-making*, the Report of the World Commission on Dams (WCD). <http://www.dams.org/report/contents.htm>
- 37) **Klement, K.D., Heitschmidt, R.K., and C.E. Kay, 2001. *Eighty Years of Vegetation and Landscape Changes in the Northern Great Plains: A Photographic Record*, United States Department of Agriculture, Agricultural Research Service, Conservation Research Report No. 45. <http://www.ars.usda.gov/is/np/eightyyears/eightyyearsintro.htm>

Case Studies

- 38) **Goolsby, D.A., and Battaglin, W.A., 2000. *Nitrogen in the Mississippi Basin-Estimating sources and predicting flux to the Gulf of Mexico*, United States Geological Survey Fact Sheet 135-00. <http://wwwrcolka.cr.usgs.gov/midconherb/hypoxia.html>
- 39) PBS, 2002. *Sinking City of Venice*, Public Broadcasting Service (PBS), <http://www.pbs.org/wgbh/nova/venice>
- 40) Vollmann, W., 2002. Where the ghost bird sings by the poison springs, *Outside Magazine*, February. http://outsideonline.com/outside/environment/200202/200202where_the_ghost.adp

V. Coastal Zones and Wetlands

Beaches, Coastal Zones, and Fisheries

- 41) **UNEP, 1995. *Global Programme of Action for the Protection of the Marine Environment from Land-based Activities*, United Nations Environment Programme (UNEP).
- 42) NOAA, 1998. *State of the Coast*. National Oceanographic and Atmospheric Administration (NOAA) <http://state-of-coast.noaa.gov/default.html>
- 43) **NOAA, 1998. "Ecological Effects of Fishing" by Stephen K. Brown, P.J. Auster, L. Lauck, and M. Coyne. *NOAA's State of the Coast Report*. Silver Spring, MD: National Oceanic and Atmospheric Administration (NOAA).
http://state-of-coast.noaa.gov/bulletins/html/ief_03/ief.html
- 44) Dean, C., 1999. *Against the Tide: The Battle for America's Beaches*. Columbia University Press: New York.
- 45) NRC, 1999. *Sustaining Marine Fisheries*, Committee on Ecosystem Management for Sustainable Marine Fisheries, National Research Council (NRC).
<http://www.nap.edu/catalog/6032.html>
- 46) Nordstrom, K.F., 2000. *Beaches and Dunes of Developed Coasts*, Cambridge University Press: NY.
- 47) **AIMS, 2002. *Status of Coral Reefs of the World*, ed. C. Wilkinson, Australian Institute of Marine Science (AIMS).
<http://www.aims.gov.au/pages/research/coral-bleaching/scr2002/scr-00.html>

Wetlands

- 48) USGS, 1999. *National Water Summary on Wetland Resources*, U.S. Geological Survey Water-Supply Paper 2425, <http://water.usgs.gov/nwsum/WSP2425/index.html>
- 49) **Dahl, T.E., and G.J. Allord, 1999. Technical Aspects of Wetlands: History of Wetlands in the Conterminous United States, in *National Water Summary on Wetland Resources*, U.S. Geological Survey Water-Supply Paper 2425, <http://water.usgs.gov/nwsum/WSP2425/history.html>

Case Study

- 50) NPS, 1999. *History of Everglades National Park*, National Park Service (NPS), <http://www.nps.gov/ever/eco/history.htm>
- 51) LOC, 2002. *Reclaiming the Everglades: South Florida's Natural History, 1884-1934*, Library of Congress (LOC), <http://memory.loc.gov/ammem/award98/fmuhtml/everhome.html>

VI. Cross-boundary Impacts

Regional Issues

- 52) Murakami, M., 1995. *Managing Water for Peace in the Middle East: Alternative Strategies*, United Nations University Press: New York, <http://www.unu.edu/unupress/unupbooks/80858e/80858E00.htm>

- 53) NRC, 2002. *Riparian Areas: Functions and Strategies for Management*, Committee on Riparian Zone Functioning and Strategies for Management, Water Science and Technology Board, National Research Council (NRC), National Academy Press: Washington, D.C. <http://www.nap.edu/catalog/10327.html>

Climate Change

- 54) **Johnson, R.G., 1997. Climate control requires a dam at the Strait of Gibraltar, American Geophysical Union, *Eos*, Vol. 78, No. 27, July 8, 1997, pp. 277,280-81. http://www.agu.org/sci_soc/eosrjohnson.html
- 55) **Gleick, P. et al., 2000. *Water: The Potential Consequences of Climate Variability and Change for the Water Resources of the United States*, The Report of the Water Sector Assessment Team of the National Assessment of the Potential Consequences of Climate Variability and Change, U.S. Global Change Research Program, <http://www.pacinst.org/naw.html>
- 56) McGuire, B., 2002. *A Guide to the End of the World: Everything You Never Wanted to Know*, Oxford University Press: NY.

Case Study

- 57) Levine, M., 2002. Tuvalu tootle-oo, *Outside Magazine*, December. http://outsideonline.com/outside/features/200212/200212_tuvalu_1.html

Other Web Resources

Water Resources of the United States	http://water.usgs.gov
USGS Publications: Circulars	http://pubs.usgs.gov/products/books/circular.html
USGS Earthshots: Satellite Images of Environmental Change	http://edcwww.cr.usgs.gov/earthshots/slow/tableofcontents
Global International Waters Assessment	http://www.giwa.net
Worldwatch Institute	http://www.worldwatch.org/topics/water.html
World Resources Institute	http://www.wri.org
The World's Water	http://www.worldwater.org
NOAA - Pressures on Coastal Ecosystems	http://state-of-coast.noaa.gov/topics/html/pressure.html
EPA Surf Your Watershed	http://www.epa.gov/surf
Global Warming Links	http://www.autobahn.mb.ca/~het/globalwarming.html
National Drought Mitigation Center	http://www.drought.unl.edu/index.htm
USGS - World Energy Resources	http://energy.cr.usgs.gov/oilgas/wep/index.htm
The Coming Global Oil Crisis	http://oilcrisis.com
Energy Crisis = World Dieoff	http://dieoff.com
Terraserver Home Page	http://terraserver.homeadvisor.msn.com
Dam-Reservoir Info & Impact Archive	http://www.sandelman.ottawa.on.ca/dams
International Dark-Sky Association	http://www.darksky.org/images/sat.html
The Ancient World (antiquity online)	http://www.fsmitha.com/h1/index.html
Inventory of Conflict and Environment	http://www.american.edu/projects/mandala/TED/ice

Notes for references (Most are classified as 'popular', 'journalistic', or 'scientific')

- 1) Environmental overview from quasi-political organization that advocates resource conservation.
- 2) Landmark, but controversial, study raising the question of how long natural resources will last.
- 3) Report that initiated the age of 'sustainable development'. Proscribes global development and resource management strategies.
- 4) Conservative response to 'arch' environmentalism written by an economist and a biologist.
- 5) Journalistic counterpoint to environmental "doomsayers".
- 6) Scientific treatment that argues that the current state of the environment is not bad at all, and that money would be better spent elsewhere. Notable for detailed notes and references.
- 7) Scientific, textbook-type treatment of sustainability of Earth's mineral resources.
- 8) Government report detailing petroleum reserves. Somewhat politically charged as some scientists have claimed that the results are influenced by the current administration.
- 9) Report on human impacts on several different types of ecosystems. Of specific interest are case studies in Chapter 3: New York watersheds and Florida Everglades). Also, the following Boxes in Chapter 1 are interesting: 1.1 Resources (pp. 6-7), 1.3 Water (p. 12), 1.6 Carbon Storage (p. 15), 1.12 Population (p. 28), and 1.13 Pollution (p. 29).
- 10) Popular presentation of theory of oil depletion, along with description of overall oil resource issues (for example: why oil is found where it is).
- 11) Popular description of importance of soil as a resource. Chapters on the Dust Bowl and extermination of prairie dogs.
- 12) This reference is similar to (9), except the emphasis is on developing quantitative indicators of ecosystem function and health.
- 13) Scientific economic analysis of resource depletion, with examples for minerals and water.
- 14, 15, and 17) Of interest primarily to history and engineering technology buffs. Describes, for example, how the Roman aqueducts were built and used.
- 16) Journalistic history of the use of canals for transportation in the US in the 1800s.
- 18) Journalistic history of linkage between development of Chicago and water resources.
- 19) Journalistic summary of importance of water in conflicts and wars.
- 23) The definitive text from the world authority on history and climate change.
- 24) Scientific discussion of background material from popular book "Catastrophe" by D. Keys.
- 26) Classic journalistic story of water resource exploitation linked to development of the U.S. West that was the basis for a PBS documentary.
- 27) Popular book that is largely anecdotal, including description of extermination of beavers.
- 29) Scientific discussion of groundwater sustainability.
- 31) Balanced discussion of groundwater pollution issues in society written by a prominent groundwater scientist.
- 32) Review paper in a respected scientific journal.
- 46) Scientific textbook-type discussion of coastal geomorphology, landscape change, and human impacts.
- 54) Somewhat alarmist scientific paper written by a respected oceanographer.
- 56) Journalistic treatment of current environmental catastrophic scenarios. Chapters on global warming and the next ice age.
- 57) Popular case study of potential impacts of global warming on a South Pacific island nation.