# COMBINING DIGITAL TECHNIQUES AND FIELD DATA TO TEACH INTERDISCIPLINARY COASTAL STUDIES

Rosanne W. Fortner, Carolyn J. Merry, Shiue-Shian Lin, Hongxia Duan

## BACKGROUND

Science is a study of the Earth, and engineering is a study of how to make human existence better. Both subjects relate to the natural environment, but the approaches and end goals of the disciplines differ. In the current educational system, college students in engineering and science are frequently bound by disciplines, taught multitudes of reductionist facts endemic to those disciplines, and evaluated by competitive measures. Such training can limit students' ability to adapt to modern working environments that frequently require interdisciplinary, creative and cooperative action.

In 2001-2 the Division of Undergraduate Education of NSF funded a proposal for a classroom innovation that would bring together some traditionally disparate groups of students – those in civil engineering and environmental sciences – and provide instruction combining the hands-on methods of the field scientist with the digital and geospatial tools becoming available through public sources. The goal was to deliver a course that focused on studies of the Earth system, emphasizing relationships among the hydrosphere, atmosphere, lithosphere and biosphere as those relations are demonstrated in the environments of coastal and offshore areas. The course would thus bring environmental education to a new audience with introduction of a range of useful tools for study and some interpersonal processes for dealing with natural resource issues and decision making. Course instructors Fortner and Merry represented the University's Natural Resources and Engineering programs, respectively. The course was taught in a five-week summer term at the University's field station on Lake Erie, F. T. Stone Laboratory.
The objectives of the project were to

- Apply an Earth systems approach to interdisciplinary science and engineering studies,
- Identify, access and use available data on characteristics and issues of coastal environments,
- Demonstrate advantages of combining digital and field techniques, and
- Analyze the strengths and weaknesses of problem-based collaborative learning and alternative assessment techniques for studies in science and engineering.

## COURSE PREPARATIONS

Conceptually the course followed accepted approaches toward problem solving, beginning with problem definition, followed by hypothesizing and preliminary study, data acquisition and organization, analysis, results and discussion. At each step after the problem was identified, both digital and field techniques, applied to physical and biological relationships, were demonstrated through labs and discussion.

### Available Data Sets

Data prepared for this project included remotely sensed imagery, geographic information system (GIS) data in the public domain, and archival data from research groups: Landsat-5/7 imagery, USGS data, Census 2000 data, state data on soils and land uses, and NOAA bathymetry. The Landsat-5/7 imagery was particularly important. Over 30 years of archived Multispectral Scanner (MSS) data are available to provide great opportunities to study changes in the Earth's surface environments. Landsat images are collected for a given area every 16 days from an altitude of 705 km, so two new images arrived during the five week class, a valuable check and comparison for field data collection.

Other datasets were accessed on line as students needed information for completion of projects and labs. Extensive use was made of the following sources:

- Great Lakes Forecasting System (Physical conditions of the Great Lakes)
- NOAA's MAROBS (buoy data)
- National Marine Fisheries Service (species harvest data)
- US Army Corps of Engineers (water level in the Great Lakes)
- USEPA (Toxic Release Inventory)
- Great Lakes Information Network (GLIN – multiple resource types and syntheses)
- Library resources.

**Pedagogical Aspects of Course Development**

The course was designed to foster student-centered learning, assuming students with varied and complimentary expertise. Lab activities were designed to bring in the application of concrete level skills and abstract thinking, exploration of methods (design of research) and collaborative group processes. Lectures were kept to a minimum and were illustrated and web archived to accommodate different learning styles, backgrounds, and assimilation speeds.

As for the subject matter, Earth systems education advocates learning locally and applying globally, a skill set that should precede the standard EE mantra of thinking globally and acting locally. Thus the topic areas were first approached in the Lake Erie coastal environment, then examples from the global ocean compared. In all aspects of the class, interactions and relationships within the subject matter were stressed. This was reinforced through students' development of concept maps.

## CONTENT OF CLASS ACTIVITIES

**Science Topic Areas and Principles**

To address the Earth systems focus, the science topics chosen were related to the lithosphere (coastal erosion), biosphere (fisheries decline), and hydrosphere (anoxia and eutrophication). An over-arching theme of global climate change (atmosphere) completed the categories of information to be studied.

- Coastal erosion was studied with a time-series of aerial photos of an area of coastal Ohio. Erosion rates from 1954-1999 were calculated from a combination of image overlay measures and digital elevation maps, and current patterns with sediment flow were examined in Landsat images to find the relationship of current direction to erosion and deposition. Predictions of water level decline with global warming were discussed to consider if erosion might be exacerbated or reduced.
- Striped bass decline in the North Atlantic was the subject of Billy Joel's song Downeaster Alexa. Using on-line datasets the class plotted the commercial catch decline, and brainstormed a list of factors that might be responsible for the decreasing numbers caught. Similar data were accessed for the catch of walleye in Lake Erie. Students calculated a model for determining optimum sustainable yield of fish. They also examined literature related to thermal niches and the proposed changes in striped bass range with global warming.
- Field data were collected over the course term to identify the pattern of dissolved oxygen distribution in waters around the station. These data were combined with plankton densities, water transparency measures, conductivity, and nutrient levels for consideration of the relationships within eutrophic conditions. Students determined that reports of anoxia at depth were anomalous and Lake Erie was not approaching the conditions that led to its previous reputation as a "dead" lake.

**Digital Techniques**
The students learned basic skills for use of ArcView, GPS, image interpretation, and numerical data processing. The introductory labs prepared them to apply the skills in the science lab work, and with the area they selected for their final team project.

- Geographic Information Systems were introduced by developing a georeferenced GIS for Gibraltar Island (field station site). Students mapped the feature coordinates using GPS units and input the spreadsheet data as a GIS theme, overlaying contour lines.
- AVIRIS data were used to demonstrate the spectral responses of ground features, and to learn basic visual interpretation of remotely sensed images.
- Thermal bands of Landsat were converted to map the water surface temperatures of Lake images over the seasons and generalize about land and water thermal relationships.
- Data from field observations were converted into GIS layers.

**Culminating Projects**
Teams of students selected nearby sites for which environmental decisions were to be made. They met with resource people, reviewed documents, collected digital photos and georeferenced ground data, and prepared recommendations for agency consideration in future development. One group made suggestions for developments in a newly designated state park; another recommended sites for new erosion control structures for beach maintenance at an established park.

**DISCUSSION**

The pilot version of this experimental course had mixed success. Students' ability to work in a cross-disciplinary, collaborative environment was developed. During the five weeks, students worked together to combine their skills and knowledge bases. That learning experience is well demonstrated in the final projects.

The course illustrated some weaknesses of current curricula in both engineering and science. For engineering students, training seems to focus on more high-tech orientation and may lack basic science principles. A more restricted path toward problem solving is also evident in the attitude of engineering students. In contrast, science students tend to focus on the science principles and have a flexible attitude toward problem solving. They become frustrated by their own lack of high-tech skill.

Another important discovery was that most studies in the biology/fisheries/natural resource field focus on local ecosystems and do not look toward global applications. As a result, few studies record the location of events/subjects, and this is a great loss for those studying Earth changes. Geospatial databases in the biological sciences are critical to study environmental changes and their effects on global ecosystems.

Every new course has weaknesses. For this one some students misinterpreted course objectives. They tended to focus on the digital techniques and forgot that problem-solving relies on science principles. Within the digital techniques, they concentrated on images and neglected the importance of numerical data processing. Spreadsheet skills were underdeveloped.

Mixing groups of students has problems as well as opportunities. Engineering students focus on final solutions with less emphasis on causes and relationships. This can contradict science students who usually prefer to learn facts.

Overall the course provided extremely valuable experience in the study of interdisciplinary issues and collaborative learning across engineering and sciences. Future course offerings will account for the issues identified. In the meantime, course information and materials are accessible on the Internet for others to use (http://earthsys.ag.ohio-state.edu/nr797/) and metadata are being added to make the materials accessible through the Digital Library for Earth Systems Education (http://dlese.org).

Rosanne W. Fortner
The Ohio State University
2021 Coffey Road
Columbus, Ohio 43210 USA
Voice: 1-614-292-9826
Fax: 1-614-292-7432
Email: Fortner.2@osu.edu