# Creating and Teaching Case Studies in a Web Design Project

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# Purpose

In this exercise, students create studies that examine hydrologic issues in a way that incorporates both the societal significance of these problems and the science involved in trying to solve them. Such an approach reinforces the utility and necessity of hydrologic study.

By presenting individual case studies, students learn hydrology by explaining and teaching it. Compiling and presenting data in a variety of forms encourages students to think critically about how to make data accessible. By using a web-based approach, students make connections

(http://www.edwardsaquifer.net/).

the data and the scientific and social issues of their cases. The data collection process pushes students to consider how they access data. In creating structured lab exercises, students consider how to work with and understand the

various types of information that hydrologists work with on a regular basis. Students can model

their sites after such exemplary case study sites as Gregg Eckhardt's Edwards Aquifer home page

vater in the san juan islands

Benjamin Drummond | Hydrology | March 2002

The San Juan Islands are a small archipelago in the coastal waters off Washington State and between Seattle and Vancouver. <u>SEE MAP</u> An increasingly popular place to work and play, the islands host a growing number of year-round and seasonal residents, including a few small-scale farms. During the summers, visitors inundate the islands to sea kayak, whale watch, and sight-see. This case study focuses on the islands that comprise San Juan County: the main islands are San Juan

The islands' increasing population relies heavily on groundwater for its freshwater supply, as there are no permanent streams on any of the islands and only a few lakes. The groundwater is slowly recharged by precipitation, eighty-five percent of which falls during a seventh month period. Most residences—and wells—are located along the shoreline creating problems with seawater intrusion. The islands also do not have a central sewer system and most residences rely on septic tanks that have the potential to contaminate the water supply

The primary difficulty in managing the water supply of the San Juans is a **lack of information**. The geology of the acquirer is extremely complex and does not behave as a single aquifer system so that wells in close proximity to one another may have drastically different yields. The aquifer is also highly susceptible to contamination

Example of title page presenting background information and links to relevant figures (Drummond).

The Process

## 1) Select a newsworthy site or problem.

2) Determine if sufficient information to write a case

study is available. 3) Collect and connect data (published maps and

papers, USGS records, GIS data, news stories, etc.) 4) Determine hydrologic principles that can be demonstrated in case study.

5) Create and present a case study lab exercise that integrates diverse data.

6) Use web capabilities to compile and link data with student writing (final products were copied to CD, not posted to the Web).

# The Product

Case studies compiled by hydrology students can be used in a variety of other classes, including introductory and environmental geology. Subsequent classes can review, update, and improve earlier case studies. One student's 2002 case study on hydrologic implications of coal-bed methane extraction proved valuable to the lead author in reviewing a grant proposal in 2003. Finally, the model outlined here can be used for many other topics, both within earth sciences and beyond. One such application is in connecting teaching resources with pedagogical techniques and educational research.

Lessons Learned

This project emphasizes two ways in which the web is an important educational resource:

#### 1) Connectivity

Framing a case study in the webdesign format emphasizes the connections between types of data, data collection and analysis, and the relevancy of this analysis. Web pages can easily link newspaper articles about the economic issues of a case with a groundwater flow model and geochemical data of the area in question. Information regarding the collection methods of data can easily be included with the data itself.

Draw flow lines on these potentiometric surface maps of the Pheasant Branch watershed and dentify the possible source area contributing to Fredrick Springs.

Example of lab exercise that uses simple mapping techniques to understand groundwater flow (Hunzicker).

#### 2) Learning how to find data

Many types of available data are relevant to hydrologic study; however, locating these data is often complicated. The process of data compilation required students to search for web resources, books, articles, maps and government reports. Students must determine what types of data are necessary for understanding the case at hand. For example, most students were able to locate either well data or potentiometric surface maps from USGS Water Investigations Reports or USGS on-line water data. They learned how to locate and use library resources as well as how to search effectively for on-line data. They also learned how to write metadata for end-users of the case studies.

# Branson, Missouri: Entertainment, Country Music, and Hydrology?

Elizabeth Clark Geology 340, Carleton College



picture from ->http://branson.com/branson/tour/brntur1.htm

- Purpose of this study Hydrogeologic Setting
- Water Issues Structured Lab Exercise

pages (Clark).

Overview of Salt Water Intrusion:

as salt water intrusion (citation).

- Annotated Bibliography (including links to other internet resources)

This title page outlines web site structure and includes

links to all sections. Most student case studies included

similar sections, and many had additional links to data

In coastal areas, if the aguifer is connected to the ocean, a boundary between fresh and salt water will

Excessive withdrawal of groundwater under these circumstances can lead to the upward and landward

migration of the boundary - sometimes causing coastal wells to pump salt water - in a condition known

groundwater (density = 1.0 g/cubic cm) "floats" on top of seawater (1.025 g/cubic cm). The position of

exist in the aquifer. The boundary is not vertical - it dips toward the mainland because the fresh

the boundary varies with sea level, groundwater flow rates and the position of the water table.

set in the past five years, creates empathy with the central characters, includes quotations, is relevant to the reader, serves a pedagogical function, requires that dilemmas be solved, has generality, and is short." (ref. 1)

"A good case tells a story, is

# Case Studies from 2002

Chetel, Lauren M., Saltwater in the Mississippi River, a threat to the drinking water of New Orleans, Louisiana: A case study.

Clark, Elizabeth, Branson, Missouri: Entertainment, country music, and hydrology?

Drummond, Benjamin, Water in the San Juan Islands (Washington).

Gendaszek, Andrew, Yucca Mountain, Nevada: A hydrologic case study.

Gittings, Hilary, Saline intrusion at Hilton Head Island, SC. Hall, Melissa, Bemidji (Minnesota) Toxics Project: USGS National Research Program in the hydrologic sciences.

Hunzicker, David, Pheasant Branch Marsh (Wisconsin): Surface water - groundwater interactions and the possible effects of urbanization.

Nemitz, Eric, Saltwater intrusion on Cape Cod (Massachusetts): Threats to a coastal aquifer.

Nickerson, David, What's the story on coal-bed methane (CBM) in Wyoming's Powder River Basin.

"...the case method involves learning by doing, the development of analytical decision-making skills, the internalization of learning, learning how to grapple with messy reallife problems, the development of skills in oral communications, and often teamwork" (ref. 2)

In 1983, the Minnesota district of the USGS proposed the Bemidji site for consideration as a research site for a USGS groundwater and toxic waste program began in 1982. This program is now known as the National Research Program in the Hydrologic Sciences. The Bemidji site was chosen due to a number of features. 1. The groundwater hydrology was assumed to be relatively simple. The main hydrologic unit being glacial deposits. 2. The local discharge drained into a single lake. 3 There were no wells drawing water from the aquifer, and no houses within a mile of the site of the spill. As a result, a number of institutions and agencies set up equipment to analyze the evolution of thecrude oil within the aquifer over time. This data collection has occurred from 1983 through 2001.

In 1999 new Minnesota state legislation required that further remediation take place in this area, to remove existing liquid phase crude oil contaminating the aquifer. Results of this remediation are at this point unknown, although will have serious implications for the long term research projects that were being completed in the area.

Historical photos and a narrative description of the case introduce this historical case study. This project explores the remaining effects and issues surrounding an oil pipeline accident that occurred in 1979 (Hall).

# USGS 07374525 MISSISSIPPI R @ BELLE CHASSE, LA Plaquemines Parish County, Louisiana Latitude 29°51'25", Longitude 89°58'40'

# References

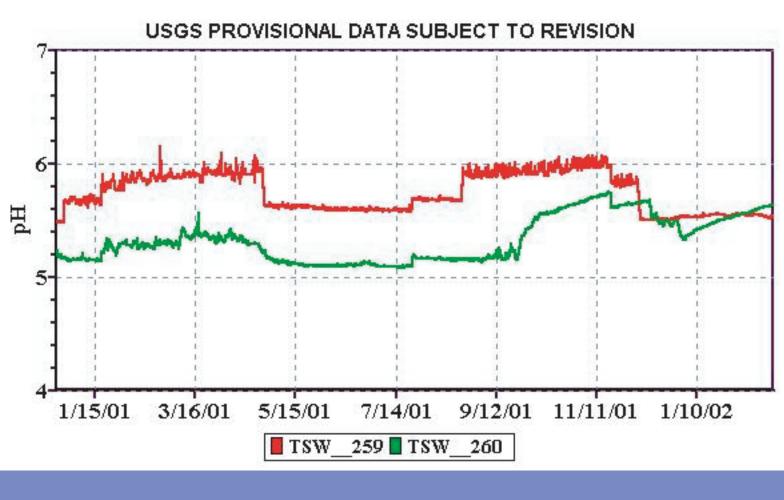
Herreid, C.F., 2000, Cooking with Betty Crocker: A recipe for case writing, Journal of College Science Teaching: 29(3), 156-8.

2 Herreid, C.F., 1994, Case studies in science: A novel science education, Journal of College Science Teaching: 23(4), 221-229.

## Robowell

Robowell is an automated well monitoring system that allows hydrologists to gather real-time data quite efficiently. Provincetown on northern Cape Cod is one of the pilot programs for Robowell, which began in 2000. Hydrologists are using Robowell in two monitoring wells in Provincetown to help changes in the freshwater/saltwater interface by measuring pH and specific conductance. <u>Click</u> here to link to the Provincetiown project's home page, or look at the USGS Robowell Home

Here are examples of the real-time data from Robowell in Provincetown. Currently, the data is only presented in graphical form.



Example of data presentation including explanatory prose written by student, date-specific data and links to regularly updated data sources. Real-time water data and historic water levels were commonly selected data types (Nemitz).

### Coal-Bed Methane Presentation Outline:

"CBM is growing rapidly is Wyoming right now, but it is a boom different from ones we have experienced before. The difference is that each CBM well is hardly noticeable, but there are thousands of wells expected – one to several on many 80-acre tracts of coal. And the coal lies under several million acres. We are, in effect, platting the coal-rich portion of the PRB. In a sense, each "lot" has water, power, roads, and gas. The gas lines lead to compressors, one to every section or two in the developed area. Thus, in aerial extent, this kind of development is very different from the impact of a coal mine or a power plant. And surface use agreements guiding the terms of this development are being made in an information vacuum.

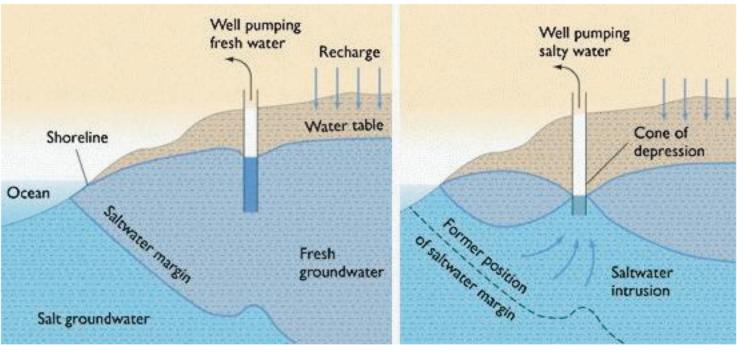
While the mineral rights are owned in large part by the Federal government (almost half), the surface rights are owned in large part by private parties, as many as several thousand. These private surface owners and the decisions they make with regard to their surface management as part of mineral development affect their neighbors, and in many cases neighboring counties and even states. Their decisions often have transboundary effects, that is, effects that pass beyond the boundaries of their property. Yet the private landowner does not have readily available the means to even identify, much less analyze and mitigate, the possible outcome of his land use management decisions with respect to CBM development. Resources that can be affected include surface and ground water, the coal and methane themselves, soils, air, wildlife, landforms, vegetation, and cultural resources. Despite the sweeping cumulative effects of individual decision-making, those decisions are often made with very limited information. This decision-making "in the dark" is probably the single large effect on the surface environment to grow out of the CBM development."

(Source: Mickey Steward's congressional testimony - Washington DC, September 6, 2001)

- a) Well picture b) Well head Picture
- c) Gas trucked to compressor plants
- d) Water pumped out of wells & flows away
- Sodium Adsorption Ratio (SAR)
- a) The ratio of sodium (numerator) to calcium and magnesium (denominator) b) Problems with viewing as a quantity not a ration
- c) Electrical Conductivity (as it goes up, so does sodium, i.e. light bulb experiment in high school) Total dissolved solids (refers to all of them)

Example of outline for class presentation. This case study uses a quotation to frame the issues. The outline includes links to data and structured lab exercises, as well as questions for discussion (Nickerson).

An example of metadata for streamflow data at a USGS station in Louisiana. Maps of the location of the gaging station and links to further data from this station are included (Chetel).



Porosity, rainfall and pumping rates all play a role in the nature of the saline intrusion. A <u>fun model</u> to use to demostrate the effects. (go to page 10 and click on HERE)

Example of background information including schematic diagram (Gittings).