

Using Documentaries for Earth Science Education

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With the success of *An Inconvenient Truth*, a movie about former U.S. vice president Al Gore's campaign to educate the public on global climate change, long-form documentaries, particularly those concerning environmental issues, are enjoying a renaissance. These films can be a powerful educational tool because they create teachable moments by heightening students' interest in environmental topics. Successful documentaries engage the audience emotionally and tell a compelling story, with heroes and villains. Often films touch on some scientific concepts and may even contain graphics and animations that are useful in explaining processes. However, they generally do not provide a balanced exposition of the science and technical issues that underlie the environmental problems described. Documentaries may advocate a particular policy position.

Using advocacy documentary films in an educational setting not only demonstrates the social relevance of science but also provides an opportunity to impart critical thinking skills to students. Are the claims made by the film consistent with scientific knowledge? What aspects are technical and what aspects are social? Is the position espoused by the filmmaker the only "correct" position, or does the other side have legitimate reasons for pursuing a different approach?

Researchers involved with the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI), have developed a formula for using documentaries to promote education. Their program, called "Let's Talk About Water," focuses on water issues through a format that consists of viewing the documentary with a carefully selected (and prepared) panel and having a question-and-answer (Q&A) session following the film. Several "Let's Talk About Water" events have been successfully presented on multiple college campuses thanks to this easy-to-follow formula, which serves to maximize the effectiveness of Q&A sessions after films.

Setting Up a Documentary Film Event and a Panel of Speakers

CUAHSI developed its approach after attending many events where the Q&A formats after movies generally did not work well. Panelists often gave extended speeches that did not directly address topics raised by the film and failed to connect the dots between events depicted in the film and issues relevant to the audiences' lives.

The "Let's Talk About Water" format addresses these problems with thoughtful preparation and careful execution of the event. There are four important steps to prepare for these events.

First, identify and attract a specific audience. CUAHSI specifically targeted lower division undergraduates to teach them about the importance of water science and attract them to water science careers. For example, a multicampus event in Boston, involving the University of Massachusetts Boston, Northeastern University, and Tufts University rotates annually among the campuses to expose undergraduates to these different campuses and their graduate programs. For the past 4 years, CUAHSI staff have worked with instructors in entry-level Earth science, engineering, and public health courses to offer extra credit to students who attend the "Let's Talk About Water" events. This has helped to attract audiences of about 200 students to each film viewing and subsequent discussion.

Second, "build the buzz." Advertise in student newspapers and local media outlets. Generally, science writers for local newspapers are happy to include the events in their paper's calendars and mention them in columns. To promote "Let's Talk About Water," CUAHSI has used student clubs to develop posters and generate student interest in the event.

The documentary films featured in "Let's Talk About Water" events have included *Flow: For Love of Water* (a film about businesses exploiting water resources through privatization and manipulation of pollution regulation); *After the Flood* (a film set in the future, after levees in the Netherlands have

failed, that interweaves this fictional telling of the future with factual presentation of climate change impacts); and *Gasland* (a film about natural gas extraction through hydraulic fracturing). Additionally, CUAHSI has shown dramatic Hollywood films during the week leading up to the event to build an audience: *Chinatown* (inspired by California's notorious water disputes of the early twentieth century) was shown at the University of California, Irvine, and *A Civil Action* (based on a true story about industrial pollution of water supplies in a small Massachusetts town) was shown at Boston's multicampus event. Such films localize the problem and motivate students.

Third, get a headliner to add star power to the panel. If the budget allows, get a big name on the panel. Jan Schlichtmann, the real prosecuting attorney in the case featured in *A Civil Action*, appeared on the Boston panel for a fraction of his usual fee due to his interest in education. His insight was invaluable—his experiences really connected with students. Including heads of local water management agencies and other "real-world" entities adds dimension to the discussion and credibility to discussions of career options. Many may be willing to participate at no cost.

Fourth, prepare the panel. This is probably the most important step. All panelists should view the film in advance. Get the panelists together (perhaps over dinner the evening before) to get them discussing the film before the event. If the panelists meet and learn about one another's interests and viewpoints, then they will be more comfortable with one another and engage in a livelier discussion. For CUAHSI's events, staff encouraged the panelists to share their experiences and how they became engaged in the water discipline. Water is a serious topic, but it is important that participants have an enjoyable and fun experience at these events. Adding the human dimension helps to engender that feeling.

Successfully Running the Event

Three elements are critical in executing the event:

First, actively manage the discussion. Avoid long introductions and statements by panelists by having the moderator introduce the panelists and move immediately

to the audience's questions. To speed things up, have the audience write questions on index cards. Then collect and organize them so the moderator can pose questions. The moderator has to actively manage the discussion to keep panelists on point, to solicit alternative viewpoints from the panelists, and to simplify responses that contain too much jargon. Roving microphones can help the moderator keep the discussion moving and can pick up questions from the audience on a topic as it is discussed.

Second, provide a free lunch. CUAHSI has typically held "Let's Talk About Water" events on Saturdays. The documentary is shown around 10:00 A.M. and finishes between 11:30 and noon. The index cards on which the students write their questions are collected when they exit the auditorium for lunch. This gives organizers about an hour to group questions into general themes to guide the discussion. The discussion begins about 1:00 P.M. and runs to between 2:00 and 3:00 P.M. Engaging the audience again after a lunch break has not been a problem in CUAHSI's experience.

Indeed, discussions have been lively, perhaps because audience members have full stomachs.

Third, segue into relevant topics. As the discussion of the science issues winds down, moderators have segued into discussion of career options for students in a range of water-related careers, including consulting, research, resources management, policy, and law. This gives an opportunity for panelists to tell their personal story and for students to ask questions directly relevant to them, for example, Where are the jobs?

Using this approach, CUAHSI has sustained lively discussions for more than 90 minutes at all events. Students rated the events highly, and some even found internships at the event with the panelists.

Events have typically cost about \$10,000 including the cost of room and film rental, speaker fees, catering, and other organizational costs. Most campuses have departmental and other funds that are available to support public events.

The hope is that this formula will guide others interested in educating students

through documentary films on how to run a successful event. Resource materials and further information on films are at <http://www.cuahsi.org/ltaw.html>.

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—RICHARD HOOPER, CUAHSI, Medford, Mass.; E-mail: rhooper@cuahsi.org; LINDA LILIENTHAL, Creative Consultant, Washington, D. C.; and JENNIFER ARRIGO, CUAHSI, Medford, Mass.

Scientific Network to Decipher Crustal Evolution of the Arctic

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The tectonic evolution of the regions in and around the Arctic remains highly debated due to a lack of geologic knowledge, the region's geologic complexities, and the logistical difficulties of working at extreme latitudes. For example, the northward continuation of Paleozoic (~545- to 250-million-year-old) mountain belts is predicted yet unrecognized, and the tectonic development of the Canada Basin—which defines the nature of the crust in and around the Arctic—is still debated, partly because few research projects are regional in scope or link the submarine and subaerial environments. This has led some to speculate, for example, that oceanic crust underlies the entire Amerasian Basin, whereas others indicate a much more limited extent within the Canada Basin.

A contributing factor in the development of such conflicting hypotheses is the traditional segregation of land- and marine-based researchers: Over the past several decades, Arctic campaigns have conducted marine, aerogeophysical, and geological investigations [e.g., *Lawver et al.*, 2010], but few of these have integrated onshore and offshore environments. To address this shortcoming, a new multinational, multidisciplinary science network called the Circum-Arctic Lithosphere Evolution (CALE) project seeks to integrate onshore geology with offshore geophysics in the Earth's northernmost regions.

The likely reduction of sea ice due to global warming, societal pressure for natural

resources, and the United Nations Law of the Sea Treaty, combined with technological advances in geophysical data acquisition, have created the incentive and means to accomplish paradigm-changing advances in Arctic geoscience knowledge. With this in mind, CALE, scheduled to run from 2011 through 2015, focuses its research efforts on the overarching goal of understanding the evolution of Arctic lithosphere in space and time.

Scientific Themes

About 40 researchers are involved in CALE, hailing from Canada, Denmark, Germany, the Netherlands, Norway, Russia, Sweden, the United Kingdom, and the United States. CALE researchers have identified seven geographic regions (see Figure 1 for locations) where questions related to three themes can be addressed.

The first theme concerns circum-Arctic lithosphere and plate tectonics. Tectonic processes created the ridges and basins of the Arctic Ocean, modifying their internal structure and architecture over time. The Lomonosov Ridge is clearly a continental sliver rifted from the Barents Sea/Kara Sea continental margin, but the origin and therefore the crustal structure and composition of other ridges (e.g., the Alpha-Mendeleev) and the older Amerasian Basin are highly debated (see Figure 1 for locations). Mapping of the deep Arctic Ocean, collecting multichannel seismic reflection data and other geophysical

data, and sampling the sedimentary record by drilling are the primary means to determine the strength, evolution, deformation, and response to surface processes of the Arctic Ocean lithosphere. CALE seeks to initiate new geological and geophysical data acquisition campaigns so that the necessary advances required for understanding the tectonic development of Arctic lithosphere can be made.

Another theme involves the evolution of circum-Arctic sedimentary basins such as the Amerasian Basin and the Eurasian Basin. Sedimentary basins of the onshore and shelf regions of the circum-Arctic are important because their petroleum resources sustain local communities and society. As global demand for these resources expands, it is necessary to ensure that Arctic resource abundances are well defined so that communities can make informed public policy decisions, ensure economic development, and facilitate environmental protection. Understanding the tectonic evolution of circum-Arctic sedimentary basins requires linking basin architecture to underlying (deep) structures in the crust and upper mantle. CALE will combine bathymetry, potential field data, seismic reflection and refraction data, and core sampling with geological mapping and field studies to understand the sedimentary, structural, thermal, and magmatic histories of these basins.

A final theme concerns the geoscience of global change. Diverse observations indicate that a complex suite of interrelated atmospheric, oceanic, and terrestrial changes are under way in the Arctic. Arctic climate records depend to some extent on tectonic evolution, for example, the development of Arctic "gateways" like the Bering and Fram straits, which allow water to circulate into and out of the