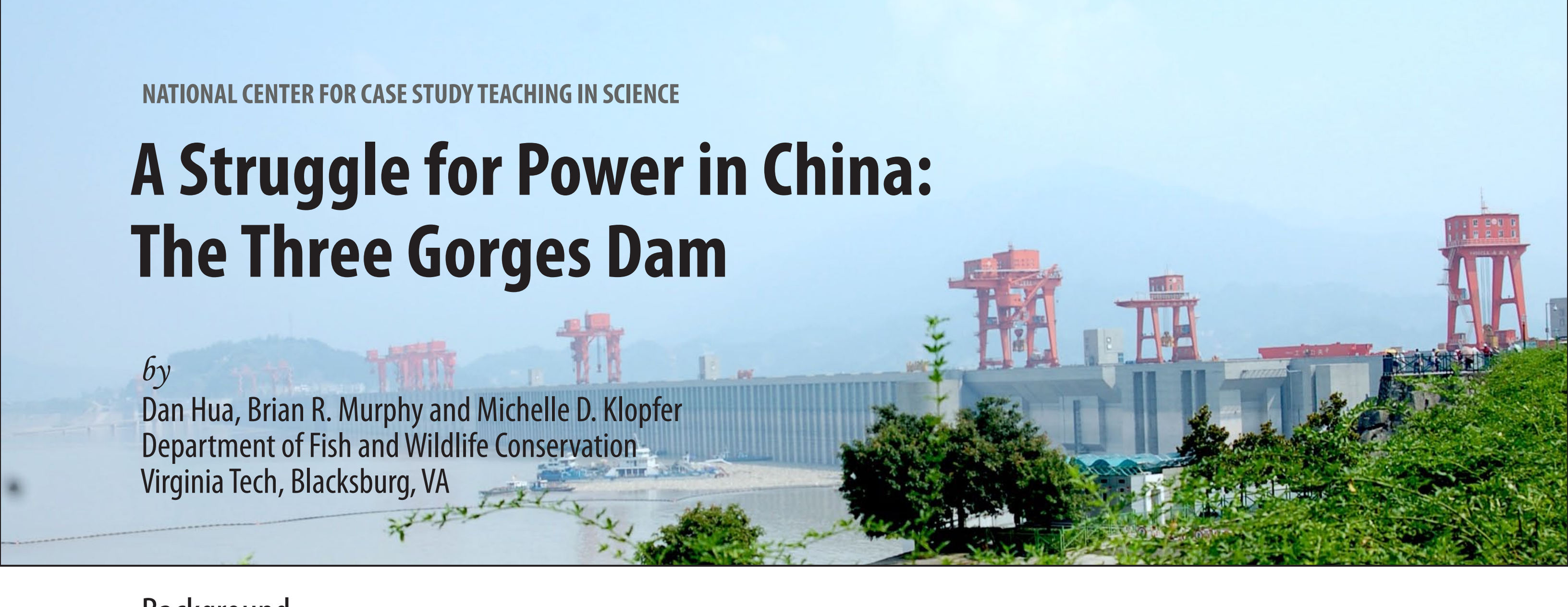

NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

A Struggle for Power in China: The Three Gorges Dam

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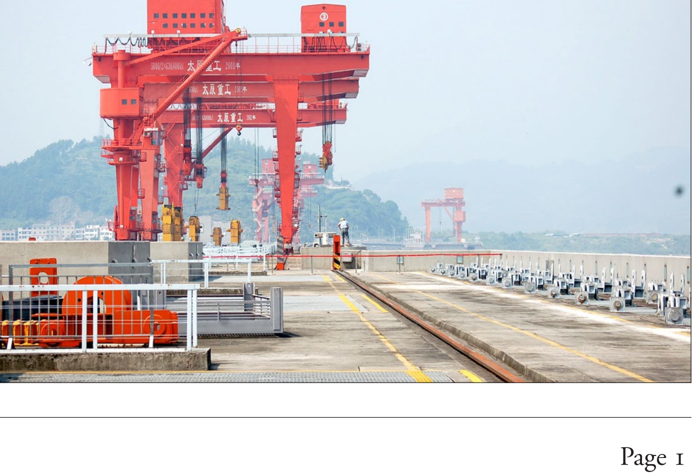
Background

With the recent increased focus on renewable energy sources, hydroelectric dams are being constructed at a record pace. Worldwide, there are more than 45,000 large hydroelectric dams, plus countless smaller dams built for navigation, flood control, and other uses (Duflo and Pande, 2007). Currently, more than half of the world's rivers contain at least one dam; major rivers often contain multiple dams (Duflo and Pande, 2007). The amount of energy generated from these dams is impressive. Hydroelectric dams produce more than 3400 terawatt-hours of electricity annually, which is more than 16% of worldwide electricity production (Worldwatch Institute, 2013). For comparison, 41% of electricity is produced from coal, 22% from natural gas, 13% from nuclear reactors, 5% from oil, and 3% from other sources (OECD, 2013). Hydroelectric energy accounts for 92% of renewable energy production, with wind (6%), geothermal (1.8%), and solar energy (0.2%) making up only a small portion of renewable energy (OECD, 2013).

Although the developing world's per-capita energy consumption is still lower than that of industrial countries, rapid development means rapidly increasing energy demand. As a result, many of the new hydroelectric dams are being constructed in developing countries that are trying to meet ever-increasing energy needs. From 2005 to 2011, global energy consumption increased by 12.8%; China's energy use increased by 56.6% during that period. The U.S. Energy Information Administration (EIA) projected that world energy use will increase 53% by 2035, and China alone accounted for 40% of that increase (EIA, 2011). Currently, the Asia-Pacific region generates approximately a third of all hydroelectric power (Worldwatch Institute, 2012). China leads the world in the number of hydroelectric dams, having more than 22,000 large dams (Wu et al., 2004); the United States has the second-largest number of dams worldwide, with about 8100 major dams (USACE, 2013). China's hydroelectric dams produce 721 terawatt-hours of energy annually, providing 17% of the nation's energy (Worldwatch Institute, 2012).

Figure 1. The top of Three Gorges Dam, China (Photo by D. Hua).



Perhaps the most well-known of China's dams is the Three Gorges Dam (TGD; Figures 1 and 2), located on the Yangtze River between Chongqing and Yichang City, Hubei province in south-central China (Wu et al., 2004) at the coordinates 30° 49′ 23″ N, 111° 00′ 12″ E (Wikipedia, 2013b). Initial plans for the dam began in 1992 and construction began in 1998. The dam began operating in 2003 and was operating at full capacity by 2012 (Wu et al., 2004). TGD is 175 m high and flooded 632 km^2 (156,000 acres) for the reservoir. The TGD power station produces 84 terawatt-hours of electricity annually, which is more than four times the energy produced by the largest U.S. dam, the Grand Coulee. China currently has plans to add more hydroelectric capacity in upcoming years, building dams equivalent to seven dams the size of TGD (Worldwatch Institute, 2012).

The TGD project was not without controversy. The reservoir created by the dam flooded 156,000 acres of land (Figure 3, next page), and more than one million residents were forced to relocate and find new homes and new jobs (Wu et al., 2004). The price of building a dam is never cheap; the construction of Hoover Dam cost around $49 million in 1931, which is equal to $811 million in 2013 dollars (Wikipedia, 2013a). However, the cost to build TGD was nearly 13 times greater than that, reaching $10.4 billion (Wikipedia, 2013b). This is an enormous amount of money for any country, but it is an unfathomable cost to Chinese citizens, who earn an average of less than $5000 per year (World Bank, 2013).

Dams are built for human needs and desires, but their negative impacts are notable. Decline of native fishes and riparian vegetation, sedimentation and related flooding, degradation of habitat, and changes to downstream temperature and flow are all related to dam operation (Collier et al., 2000). Additionally, dams can increase disease and toxic substances, reduce productivity and biodiversity, induce salinization in estuaries, and cause water loss due to greater evaporation (Helfman, 2007).

Figure 2. View from the top of Three Gorges Dam, China (Photo by D. Hua).

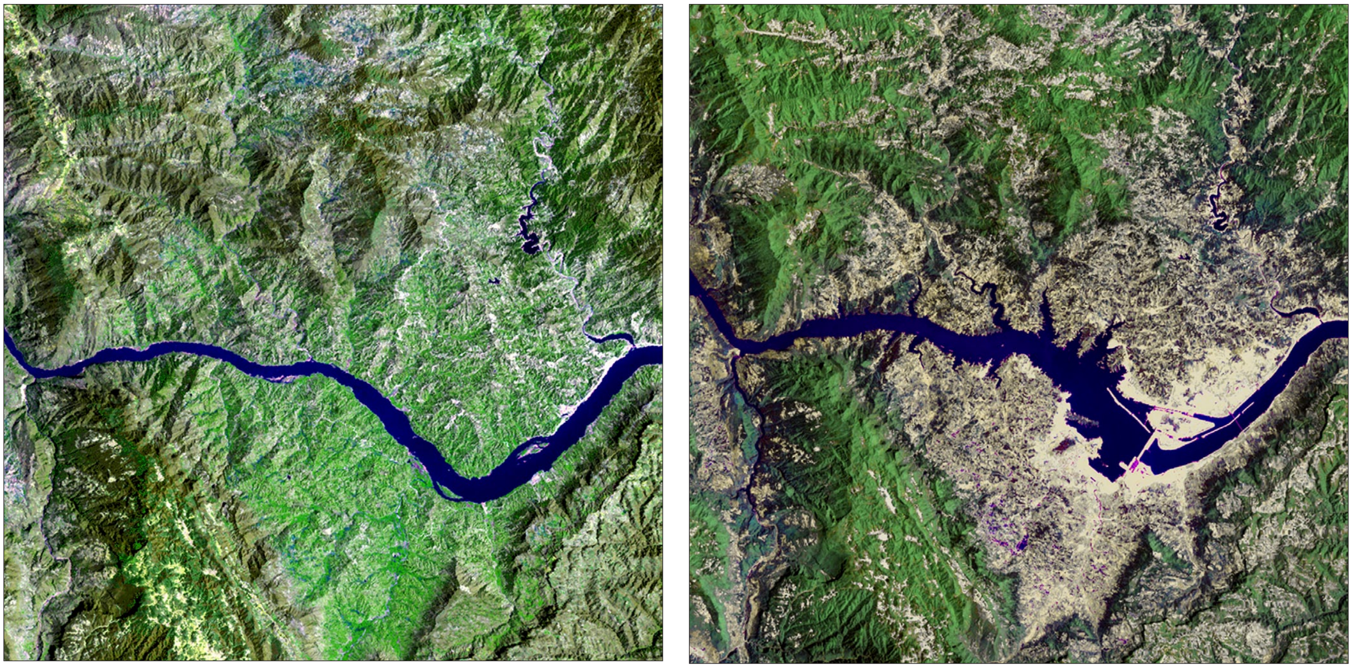
The construction of the TGD caused dramatic ecological changes to the area. Many of the fish, wildlife, and plant species that lived on or near the river were not suited to the new flow, temperature, or depth of the reservoir and dammed river (Wu et al., 2003). For example, the Chinese river dolphin (baiji; *Lipotes vexillifer*)—a 30-million-year-old species unique to the Yangtze River—became critically endangered after the construction of TGD (Lei, 1998).

Altering river flow could also directly affect biodiversity and productivity in wetlands and lakes downstream of a dam (Tullos, 2009). For instance, Poyang Lake basin provides critical habitat to many migratory birds and is a major wintering ground for rare crane species, including the highly endangered Siberian crane (*Leucogeranus leucogeranus;* Tullos, 2009). Changes in turbidity and water depth caused by TGD affected the primary food of Siberian cranes, the submerged aquatic plant *Vallisneria spiralis* (Kanai, 2002). Similarly, Dongting Lake hosts 41 globally significant species that could be impacted by changes in water level (Tullos, 2009). Changes in flow can also affect fisheries by reducing the productivity of algae and plankton: reduction of water flow from TGD led to an 86% decrease in primary productivity and a 55% decrease in sediment loading (Tullos, 2009).

Proponents of the TGD project contend that these costs are outweighed by the tremendous benefits from the dam. Obviously, the large amount of energy generated is the main benefit, but the dam also improved navigability of the river to aid shipping. In addition, the disastrous floods of the past are less likely to occur again, thanks to the flood-control mechanisms of the dam. Furthermore, the water controlled by the dam is used for irrigation; nearly a third of irrigated acres worldwide rely on dams (Duflo and Pande, 2007). Also, TGD attracts hundreds of thousands of tourists annually. As visitors line up to see one of the new "Wonders of the World," they bring much-needed money to the region.

Do the benefits from the dam outweigh the ecological, economic, and social costs? Answering this question is difficult, since the benefits and costs are not directly comparable. How do you compare the loss of endemic species to the increased safety from flooding? How do you weigh a relocated family's social and economic costs in comparison to the

Figure 3. The Yangtze River, China, before damming (left, 17 April 1987) and the Three Gorges Dam and reservoir after damming (right, 9 May 2004). Data available from the U. S. Geological Survey. http://landsat.usgs.gov/images/gallery/77_L.jpg.



benefits of a sustainable and renewable energy source? These controversies are present in nearly all dam construction projects, and your answer—to dam or not to dam—depends on your evaluation of the information available, within the context of your own personal value system.

Your Assignment

Working in teams, you will investigate the costs of and benefits from the Three Gorges Dam in greater depth, focusing on ecological, economic, or social impacts. After you collect information, your group will weigh the pros and cons to decide whether, as a group, you support or oppose the construction of the TGD. As a group, you will prepare a persuasive presentation (3–5 minutes) based on your research of the ecological, economic, or social impacts; try to avoid discussing issues related to the other topics. Your goal is to convince the rest of the class to join you in either supporting or opposing construction of the dam.

Some Tips

- Search Google Scholar for journal articles and reports related to the topic. Use websites only when you cannot find peer-reviewed sources.
- Get the full citation for each reference you use, whether it is a journal article, website, or report. Cite all information that you obtain from other sources on the slides you prepare and in a Literature Cited document you will turn in.
- When information about TGD is not available, try to find information about another dam. Be sure to identify the dam you are using for comparison, and discuss how you would expect this information to be related to what is/was occurring in the TGD system.

Some Topics to Get You Started

Ecological:

- Direct and indirect impacts to aquatic and terrestrial plants and animals: common, endemic, threatened, keystone species, used for food, etc.

- Impacts to the ecosystem: food web, ecosystem services
- Habitat changes due to damming: feeding areas, breeding areas, natal habitat

Economic:

- Direct costs of dam construction and maintenance, direct benefits of energy production
- Indirect costs for human relocation, ecosystem services, food species/habitat loss, etc.
- Indirect benefits from improved navigability, lowered flood risk, tourism, etc.

Social:

- Impacts of human relocation and career changes (locals were evacuated and forced to relocate, but the dam provides some jobs)
- Impacts to agriculture and food availability (irrigation vs. crops that require annual flooding)
- Other factors: flood safety, river navigation, aesthetic value, loss of archaeological sites
- Political and social factors related to site selection and treatment of the local people

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