

To Dam Or Not To Dam: An Insight Into The Environmental Politics Of Rivers

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ABSTRACT

In today's highly charged climate of environmental politics, decisions about building dams are extremely hard to make. Simply put, those who have the authority to make such decisions are damned if they dam and are also damned if they don't! There is no easy answer to many of the questions related to dam construction. No matter what the advantages of damming a river are, there are always some disadvantages that can derail the project. Dams may be built to achieve one or more of several goals such as reducing or eliminating the hazard of floods, regulating water flow in a turbulent river, storing water for drinking or irrigation purposes, generating hydropower, creating an artificial lake for recreational activities, or establishing a new habitat for fish, birds, and animals. Historically, dam building has always been controversial. Currently, arguing about building a new dam and studying its impact can take years. Dam construction is impacted by technical, political, economical, environmental, and cultural factors. The construction of a new dam may also result in the displacement of thousands of people and in a change in their lifestyle. This could be a depressing experience for those who cannot smoothly adjust. A new course has been developed to explore all of the above issues. China's Three Gorges Dam is used as a case study due to its mammoth size and enormous impact. Students are offered views of the pros and cons of each of the above factors. They are asked to examine the issues carefully, and to evaluate the positive and negative aspects of dam construction. Students are expected to make a case to dam or not to dam based on the evidence presented. The course teaches and promotes an educated and informed approach to decision making. Students will recognize that real world problems are never black and white and appreciate the need to judiciously weigh factors that fall within a gray zone.

INTRODUCTION

Many of the issues related to the environment today are resulting from man-made activities. Dam construction is one of the major undertakings that not only impacts the water flow in a river or waterway but also impacts the surrounding environment. In the early part of the twentieth century no attention was given to the environmental impact of dam construction on the environment, as this was not even considered an issue worthy of studying. The effect of dam building on the environment was usually an after thought. It is worth noting that at that era, the effect of the environment on dam construction was the overbearing concern, rather than vice versa. This, however, changed in a very significant way. It was nothing short of a U-turn. In today's highly charged climate of environmental politics, and with the scarcity of water resources, dams may not be constructed without a well-detailed environmental impact study. Studies of this nature usually examine factors that are important to both the engineers and the non-engineers. Dam design and construction is not only about the technical aspects related to the building of the dam, but is also about the effect of the dam on the livelihood of people, and the welfare of wildlife, animals, and birds. One of the major impacts of dam construction is the formation of a large lake in the upstream side of the dam, which, in addition to displacing people, results in the flooding and inundation of areas with cultural or historical significance. This, unfortunately, is a non-reversible effect that erases from the face of the earth monuments and places associated with events that are culturally important.

It is worth noting that dams are not built only for the sake of building them. The thought of building a dam originates as a result of a need. Those who get themselves into promoting dam building know,

probably more than others, the negative impact of dams. They also know that dam building is a very controversial subject that will never receive unanimous approval. The question governments are faced with then becomes, what course of action should be taken in light of the fact that they will be damned if dam and they will be damned if they don't. The decision concerning building dams is not one that can be a simple yes or no. Ultimately a decision will be made to go ahead and build a dam or shelf the plan to build one. However, aside from being an analytical decision that requires careful weighing of the pros and cons, the issue is influenced by an undeniable weight of emotions. There are those who feel one way or another about dam construction and have already made up their minds about the issue even before listening to any argument for or against construction. This is exactly the type of people that, by definition, should not be involved in the decision making process. Their bias will render the entire exercise of examining the real issues useless.

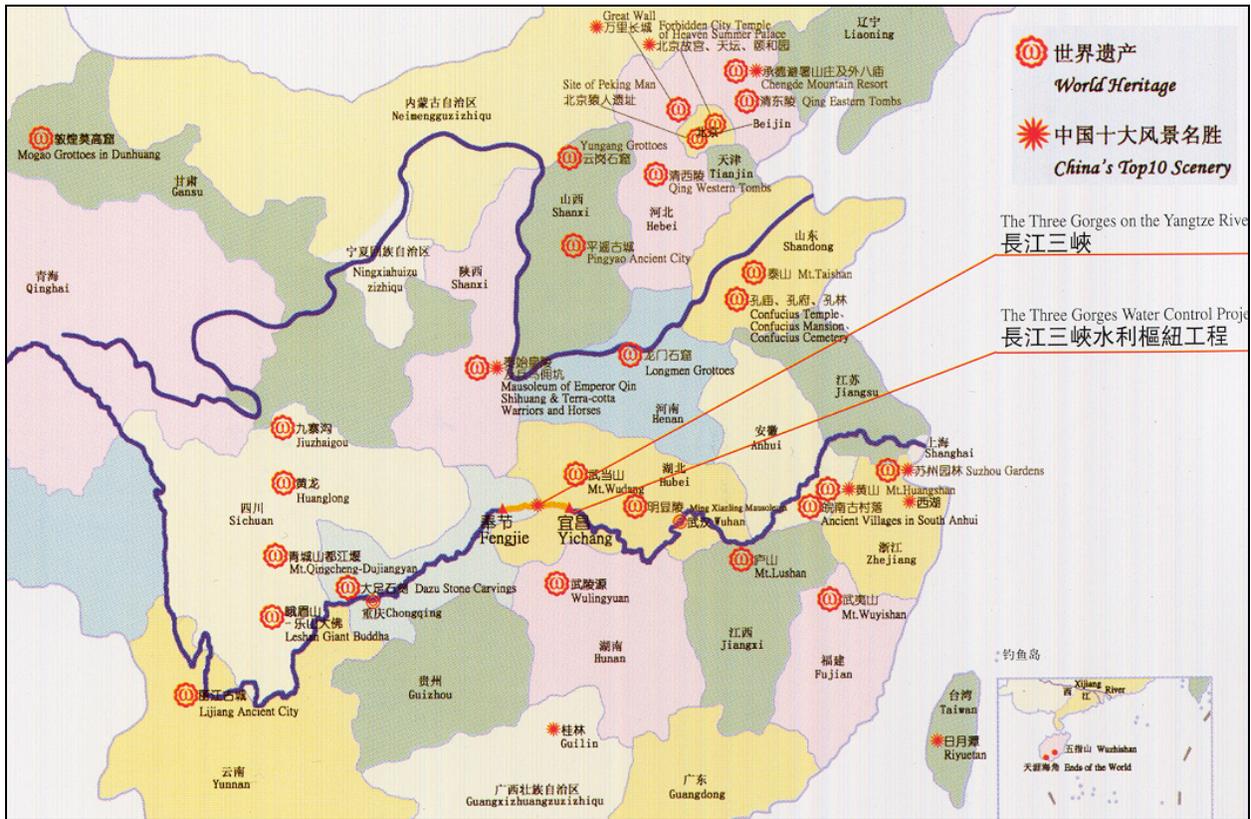


Figure 1. Map of China showing the Yangtze River and the location of the Three Gorges Dam (1).

The decision to dam or not to dam must be rational and justifiable. Despite the negatives, dam construction should not be given the green light without ensuring that the positives outweigh the negative impact. This is a very complex issue that the new course the writers developed attempted to address. This course is entitled *The New Wall of China*. This title plays on the familiar Great Wall of China theme since both structures were meant to block and protect. As the Great Wall of China was designed to protect China and block the path of a Mongolian invasion, the New Wall of China is the Three Gorges Dam (3GD) constructed to block the natural path of the Yangtze River (Figure 1) and to provide protection to the valley from the danger of floods. Both structures are massive in size and vast in scope, and both required the commitment of huge human and financial resources to accomplish. The new course teaches and promotes an educated and informed approach to decision making. Students will recognize that real world problems are never black and white and appreciate the need to judiciously weigh factors that fall within a gray zone.

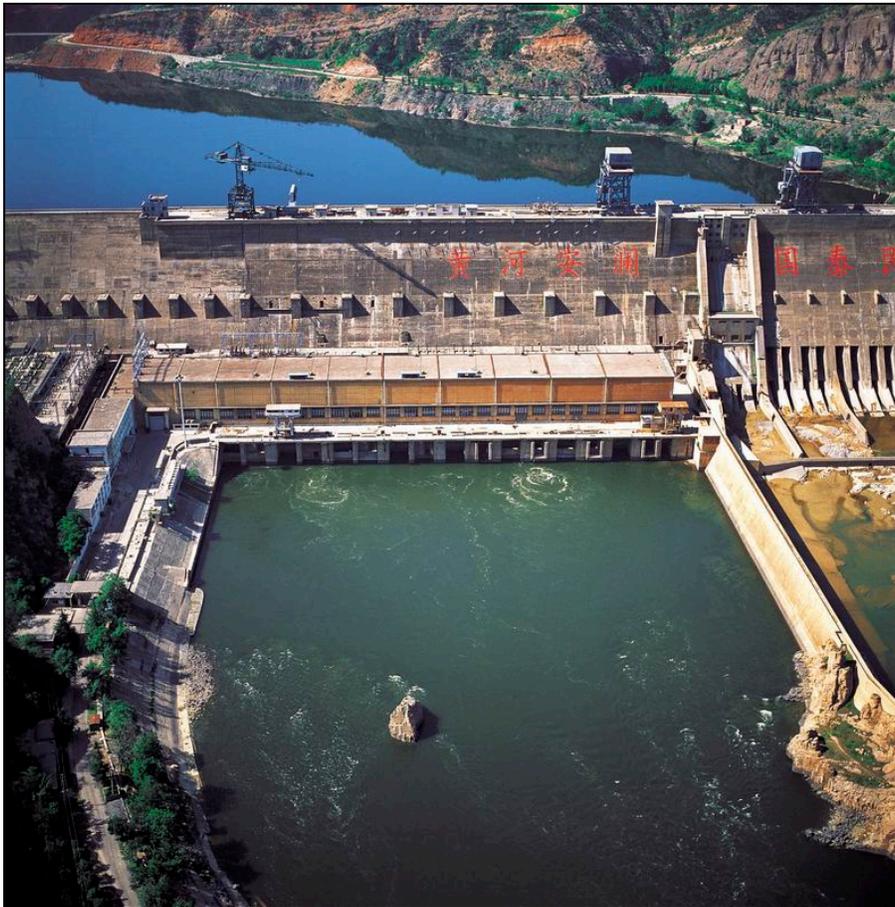


Figure 2. A partial view of the Three Gorges Dam from the downstream side (2).

COURSE DEVELOPMENT

The back and forth arguments about the construction of the Three Gorges Dam (Figure 2) go back over a hundred years before the construction of the dam actually began in 1990. One can rightly expect a variety of opinions about the construction of a dam across the river since such a dam will have a profound impact on a huge number of people. The path of the Yangtze River extends for 3915 miles (7) and courses through nine provinces. It is the second longest river in the world. It originates at the Tibet heights in the west and runs all the way to Shanghai in the east. The average water discharge in the river exceeds a million cubic feet per second and the area of its basin is almost 700 thousand square miles. The population living within the valley of the river is almost 450 million people (8). The Yangtze River has played an appreciable role in the development of all forms of life along its banks for thousands of years.

There have been over a thousand floods between 206 BC and 1949 AD at a frequency of almost a major flood every two years (7). Some of the most destructive floods are those of 1911, 1931, and 1935. The most notable flood was the one on the middle and lower reaches of the Yangtze River in 1931, inundating more than 3.3 million hectare of farmland, affecting 28.5 million people, and causing 145 thousand deaths (Figure 3). This devastating flood intensified an ongoing fierce debate between those that supported building a dam to control and regulate the water of the Yangtze River and those that resisted the damming of the river. Both camps argued their cases in eloquent fashions and offered evidence to support their point of view. The ensued debate addressed many technical and non-technical issues and sincere attempts by both groups to win over the other. The disastrous 1935 flood that left death and destruction in its wake fueled the debate further. The close follower of the debates concerning dam construction cannot help but

notice the passion displayed in expressing various viewpoints. One must also admit that in absence of critical examination of all factors, it may never be possible to reach a convincing decision that can be accepted by a majority of the people.



Figure 3. The disturbance floods cause to the lives of people living along of the Yangtze River banks (2).

In the development of this new course, the writers heavily dwell on combining engineering and the liberal arts to show the students that each exerts some influence on the other. The technical factors related to the design of dams include engineering design, safety, method of construction, materials used, flood control, environmental impact including greenhouse gas emission and health effects, hydropower generation, sedimentation and erosion problems, water salinity, fertility on farmland in the downstream, loss of farmland in the upstream, navigation in the waterway, economical factors, finance issues, construction of new communities for displaced people, and compliance with codes and regulations (7). The non-technical aspects include history, culture, disturbance to people's lives due to displacement and resettlement, effect on the social fabric in the area, quality of life in the basin of the river, recreation and tourist activities, effect on wild life and fisheries, and the effects on the area's ecosystem. The engineering and non-engineering factors are greatly intertwined. It is almost impossible to address any of them in absence of the others. This is what makes the decision to dam or not to dam extremely complex. However, it is also a fascinating problem where students can clearly see that cooperation between professionals with various backgrounds and expertise is the only way to reach a meaningful conclusion. They also appreciate the contribution each makes toward the common goal of reaching a better understanding of the problem at under consideration.

In the consideration of the technical factors, in addition to the 3GD, examples of the design and construction of other mega dams are considered. These include an example of a major dam from each continent except for Australia. The following are the examined dams and their location: Grand Coulee Dam, USA, North America; Tucurui Dam, Brazil, South America, Kariba Dam, border of Zambia and Zimbabwe, Africa; Glomma & Lagan River Basin development, Norway, Europe, Tarbela Dam, Pakistan, Asia. The 3GD, China serves as the ultimate case study in this course. These examples are true eye opener because they show that every project has a special character and a set of requirements. Dam construction has never been and will never actually be a routine job that one can accomplish by using a

formula or a recipe. It is about the use of logical and thoughtful criteria to first make a decision to dam or not to dam then to implement it in a manner that is consistent with the nature of the specific project.

In terms of social and historical factors in dam construction, students examine both primary and secondary documents that shed light on the roles individuals, aid agencies, and governments play in determining the development principles of a project. Students also learn about Chinese conceptions of human relationship with nature, the principles of good governance, and the factors that precipitated China's embrace of Western-influenced modern development. That is, the belief in the power of science and technology over nature.

COURSE THEMES

The instructors that co-teach the New Wall of China course are an engineer and a liberal artist. Course themes are equally divided between the two. Although the engineering faculty used, in addition to the 3GD, examples of several other mega dams from all over the world, the liberal arts faculty concentrated on China and on the basin of the Yangtze River. The rich heritage and long history of this area provide abundant sources of information to demonstrate the closely-knit and inter-woven relationships between the people and the river.

Engineering and Environmental Themes

General background on dams: Dams are massive structures constructed across waterways to regulate the flow of water. The control of the water flow can be used to generate hydropower, prevent or reduce the hazard of floods, and provide water during times of drought. In this module, it is intended to cover different aspects related to different types of dam structures, method of construction, and the functions dams serve.

Technical and engineering: The technical and engineering aspects of dam design are extremely complex. The design of dams must include safety features to ensure that the dam will not experience structural distress. Dam failure can result in the release of an extreme destructive force that can sweep everything in its way. Hence, dam design is always associated with the use of the latest, state of the art, engineering theories and technical tools. In this module, emphasis will be placed on the importance of theoretical and physical modeling to predict, with the maximum possible accuracy, the behavior of the actual dam after construction.

Hydroelectric power: One of the great features of large hydraulic structures such as dams is the ability to generate clean power. Energy generated from dams is renewable and results in no pollution to the environment. The principle used in power generation from dams is simple. Obstructing a waterway, such as a river, with a dam leads to a significant difference in water levels between the upstream and the downstream sides of the structure. Allowing the water to fall from the high water level to the lower one produces mechanical energy. The mechanical energy is converted to electrical energy using a magnetic field installed in power generators. The height of waterfall and the amount of water released from the upstream to the downstream are the two major factors that control the amount of energy generated.

Environmental issues: Dam construction alters the natural flow in waterways. It also results in the formation of a lake in the upstream side of the dam. In addition to the submersion effect towns and villages are subjected to, the formation of the lake results in elevating the amount of water evaporation and the heightening of the level of humidity in the air. This naturally results in a change in the ecosystem of the area where the dam is constructed. Another environmental aspect is the deprivation of the land on the downstream side of the dam from the settlements and deposits that come with every flood and provide the soil with rich nutrients, which keep it fertile.

Flood control: The most important reason behind a decision to build a dam is probably protection against flood. This is especially true in the case of the Three Gorges Dam. Floods are occurrences of devastating proportion to people, property, and the economy. Clearly, flood control is a significant aspect of dam construction; however, it comes with a number of side effects that must be studied carefully to minimize the negative impact of the dam on the area in which it is constructed (8).

Navigation: The blockage of waterway with a dam spells disruption to navigation in the river and delay for the transportation of people and freight. The problem can be remedied through the construction of a system of hydraulic locks as an integral part of the dam. Locks are structures that allow vessels to navigate between two different water levels through the use of a massive chamber in which the vessels is “locked” and the water level inside is raised or lowered as the need be. This topic will be addressed in details to show how these locks work and the factors that affect this operation.

Wildlife and fisheries: The construction of dams prevents the natural movement and migration of fish in the river. This may negatively impact the fish population in the river due to inability to reach natural habitat or breeding grounds. Furthermore, the formation of a lake in the upstream side of the dam may result in flooding vast areas of land that were once a refuge for animals and birds. Similar effect may also arise in the downstream side of the dam where the lowering of water level can force massive migration of animals and birds in search for a new land similar to what they are used to. Adjustment of wildlife to the new situation can take decades or generations.

Finance issues: Dam construction requires commitment of enormous resources. The most important point that must be addressed before a dam is constructed is that once construction begins, the dam must be completed. Dams cannot stand partially completed. They could be constructed on phases or stages, but each phase or stage must be brought to full completion within a known timeframe. This necessitates the lining up of resources and money to meet financial obligations during construction. Most of the projects with such gigantic scope require international aid or support from the World Bank. This is where the line between engineering, economics, and certainly politics becomes blurred. Governments are aware of this aspect and usually study all options to ensure that the project is brought to conclusion in a successful manner.

Economical and social issues: Dam construction usually results in an economic boom due to the increased flow of money into the local economy of the area where the project is built. It also leads to impacting the area of the project, as it becomes a tourist attraction or a recreational region. Other social impact includes the rise in the standard of living in the area of the dam due to the abundance of hydropower, which can be used in the establishment of new industries. These new industries employ thousands of people who move in with their families and establish new communities.

Displacement of people: This is an unintended aspect of dam construction. Areas flooded with water in the upstream side of the dam become uninhabitable. Before the complete blockage of the waterway with a dam, plans are made to relocate the people affected by the formation of the new lake. Plans are also made to relocate important monuments or artifacts that could be permanently lost under water. The displacement of people to new communities requires extensive planning of housing and services to ensure smooth transition without major disruption to people’s lives. The opposite is also true on the downstream side of the dam where a lower water level may negatively impact the agriculture activities and this can force the local population to flee their lands or focus on new pursuits (7).

World water and energy needs: Water is a basic ingredient of life for humans, animals, birds, and plants. Energy is what keeps the wheel of societal development and progress running. It has been evident for sometime that the world’s consumption of both water and energy is increasing at a rapid pace, and that the shortage in both materials is accelerating at an alarming rate. This segment intends to offer a

perspective on the distribution of fresh water and energy resources in the world's countries and territories. The main goal is to show that areas where there is a concentration of population are not necessarily those rich in water and energy resources. This unbalanced distribution of population and natural resources could be a major source for potential conflicts. This segment attempts to promote better management of natural resources and the greater role diplomacy can play in increasing understanding between nations.

Cultural and Social Themes

History and Culture in Ancient China: The Yangtze River is one of the seats of early Chinese civilization, with Chongqing, Wuhan, and the Lower Yangtze region comprising core regional areas of cultural and technological development. This segment presents an early historical overview of the development of Chinese culture in this region, paying attention to historical accounts and archaeological remnants. This segment shows the historical artifacts buried under the water.

Waterways and Architecture: The Sanyou Caves, Temple of the White Emperor of the Three Kingdoms period present examples of early Chinese architecture, where building structures, art, and technology coincide. This segment examines the role the waterways have played in commercial and cultural development. Attention is paid to the cultural life along the canals in the Lower Yangtze region (8).

Poetic Tradition along the Yangtze: From Qu Yuan to Song *ci* poetry, regions along the Yangtze represent the artistic talents of great poets and writers. This segment looks at the poetic history along the banks of the river, including influential Yangzhou poetry societies that influenced intellectual and cultural life in the Ming and Qing dynasties.

Painting along the Yangtze: This segment looks at Chinese aesthetics, perspective, and representation. Students will learn different ways of seeing the world through artistic representation of the Three Gorges.

Music: From *kunju* opera to Suzhou *pingtan*, this segment examines the rich musical tradition developed along the Yangtze.

Individual City Backgrounds and their Contributions to Chinese Culture: Nanjing as Ming dynasty court; Wuhan as seat of revolutionary government; Chongqing and wartime stories; Shanghai as port city.

China's Goals for Modernization: We will begin with Sun Yatsen's early 20th-century plans for the dam and his goals for a republican China as a means to understand what modernity meant to the Chinese and the role technology played in achieving this goal. Close attention is paid to China's drive to modernize an impoverished region. This segment takes a specific look at the Yangtze during the height of socialism in China.

Political History and the CCP Legacy: Building Another Great Wall. This segment compares the building of the Three Gorges Dam to another monumental technological feat, the Great Wall. While both endeavors reflect the political and historical conditions of the governments in power we will examine what precipitated the CCP's drive to create a modern legacy.

The CCP and Ecology: Mao's purported swim across the Yangtze River constitutes one of the most iconic images of China's modernization project: man conquering nature. This segment looks at the environmental impact the dam will have/is having on the region. It will explore CCP's environmental policies and the writings of Dai Qing, an outspoken activist against the dam. This segment considers questions about the possibility for dissent in the Party's plans, as well as for China's approach to nature in light of its modernization goals.

Population Migration and Displacement: Since the plan to build the Three Gorges Dam was announced, millions of peoples have been displaced or removed from their homes. This segment examines mobilization efforts and campaigns to move villages and relocate peoples, as well as citizen's protests and unrest over the move.

Visual Media: This segment examines cultural and social impact of the dam on Chinese culture and society. We will observe filmic representations about the displacement of people's along the Yangtze, as well as study the government's advertising campaigns in support of the dam.

Changes in urban culture along the Yangtze (Yichang, Chongqing, Nanjing, Suzhou, Shanghai): This segment traces the rapid development and expansion of the cities along the Yangtze. Long important cities along the river, each city's cultural, technical, economic, and political growth has been tied to the river. This segment looks at what each city gains and loses with the creation of the dam. Moreover, this segment considers the important role of tourism along the Yangtze.

ASSIGNMENT TOPICS

The course assignments are designed to get the students involved in addressing the major themes covered in the instructors' lectures. These assignments are intended to let the students express, in their own words, the impact various factors have on dam construction. Students were required to offer balanced viewpoints, avoid bias, be judicial, abandon emotion, and be rational. It is of interest to mention that students found it hard to fully comply with the above requirements. The majority felt one way or another about each of the assigned issues. It was evident in grading the first few assignments that the writer felt compelled to argue for or against dam construction without being fully informed. As the instructors stressed throughout the term that assignments are meant to discuss "both sides of the story", a considerable improvement became easily noticeable. This achieved one of the major goals in this course.

There were seven assignments in this course. The final grade was based on these assignments in addition to a term project, midterm, and final exams. Assignment topics were made compatible with the themes already covered by the instructors. They are as shown below:

- Assignment (1):** Survey of different types of dams.
- Assignment (2):** Economical and political aspects of dam construction.
- Assignment (3):** Cultural and social aspects of dam construction.
- Assignment (4):** Environmental and ecological impact of dams.
- Assignment (5):** Decision making: positives versus negatives of dams.
- Assignment (6):** Renewable versus non-renewable energy: the hydro option.
- Assignment (7):** Violent and turbulent rivers: to dam or not to dam?

Each assignment consists of a three- to five-page paper on the assigned topic of the week. The paper may include pictures, graphs, charts, or tables, but it must contain at least three pages of text. In addition, students were made aware that they should be prepared to possibly make a class presentation using electronic media on the topic of their paper if they were randomly selected.

PROJECT DESCRIPTION

The course included a project, called *Chinamania*. Each student is asked to pick a subject of interest covered within the framework of the course and related to dam design and/or construction (Figure 4), and to write a research paper on that subject. Students are to post their projects on their respective websites for evaluation. While the project may also include pictures, graphs, charts, or tables, it must contain at least 10 pages of text. Grading criteria emphasize the strength and quality of the arguments made, grammar and style, organization, and content.



Figure 4. The main body of the Three Gorges Dam is shown under construction (2).

COURSE ASSESSMENT

This *New Wall of China* course was assessed in many ways. The two instructors in this course covered each week an engineering and a non-engineering theme. Students were required to write a weekly assignment on the themes covered in class and to use case histories to illustrate the points they were trying to make. This proved to be a successful exercise because it obligated the students to do an extensive amount of research in order to find materials that prove their thesis. In addition, randomly selected students were asked to make class presentation on the subject they addressed in the previous week's assignment. This kept the students up to date in their preparation and study of the materials covered. Class participation was also a major component used as an assessment tool in this course. Class time was not only for instructors' presentations, but it was also about asking students for their opinions about the issues being discussed and the instructors were pleasantly surprised to see the eagerness of the students to express their views and to argue against the views they deemed inconsistent with what they believed to be the best. Stakeholders' meeting was another component of assessment that proved to be highly successful. Students were divided into teams representing the government that made a decision to build a dam, dam authority corporation, displaced and resettled people, financing organizations, multinational engineering design firms, and organizations concerned about the health of rivers and the environment. The meeting started with various parties detailing their positions supplemented by what they viewed as supporting evidence. When the floor was opened for discussion between various entities,

it was as if “floodgates” opened. Students argued passionately and made every effort to convince other parties that their positions were the best for all. Few were willing to shift their positions and all appreciated the degree of difficulty associated with making decisions related to such complex issues. They also observed first hand how frustrating it could be to engage in negotiations with parties that have little consideration or appreciation for what one has to say.

The ultimate assessment tool in this course was the final project where the students were told that, considering all factors and weighing all options, a terminal decision must be made to dam or not to dam the river. It was a dilemma for many that got torn between the pros and cons and between the positive and the negative of dam construction. This was the perfect illustrative tool that showed the students what is waiting for them in the “real world”: difficult decisions based on very complex calculations. It taught them that a disciplined approach was the way to reaching such decisions. They also recognized that they needed to divorce their emotions and perceptions to make the decisions as rational and lucid as possible.

COURSE EXPERIENCE

The *New Wall of China* course was open to engineering and non-engineering students. A fourth of the class was engineering and computer science students. There were also freshmen, sophomores, juniors, and seniors. Students that took this course in its first offering came from over ten majors and minors. This was a very diverse audience that contributed to diverse viewpoints on all kinds of issues. It was certainly gratifying to observe the gradual change in students’ attitude between the first week and the last week of the course. In the beginning of the term students, in general, were fast in expressing their views and almost disliked to be bothered by conflicting opinions. As the course drew closer to the end, students showed more willingness to listen and took their time to appreciate conflicting views. This willingness to first digest opposing views before simply rejecting them out of hand was, in the writers’ opinion, a positive development in the students’ appreciation of the complexity of the issues under consideration. This was one of the major goals this course attempted to achieve, and evidence shows that this task has been reasonably and successfully accomplished.

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BIOGRAPHY

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