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An environmental systems analysis of hydropower and its effects upon indigenous settlements in Karnataka, India

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AN ENVIRONMENTAL SYSTEMS ANALYSIS OF HYDROPOWER AND ITS EFFECTS UPON INDIGENOUS SETTLEMENTS IN KARNATAKA, INDIA

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Abstract

Hydroelectricity is a very common method of energy production. Large dams are constantly being introduced to the river landscape in areas all over the world. There are definite benefits to hydropower, but the drawbacks may be even more evident. As modernization and development expand across developing nations like India, indigenous populations are often subject to the highest ration of negative impacts and consequences. This research explores both the costs and benefits of hydroelectricity, while using specific examples of dam construction projects to analyze aspects of the cumulative effects of a hydropower project. The Kabini Dam in southern Karnataka, India is used to exemplify a specific example of indigenous displacement due to a dam construction.

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Introduction

In the midst of energy crises, there becomes an urgent need to produce the required power to sustain the energy demands of a growing population. Producing energy requires the use of resources, whether that is a renewable source or a non-renewable one. One of India's greatest environmental concerns is their production of energy to sustain their enormously growing population. According to the World Bank (2012), the population of India was 1.241 billion in 2011, and Mumbai, with a population of almost 21 million, is one of the four most populous cities in the world ("World City Information," 2012). Cities in India are densely populated and ample resources for such a population are not available within the confines of an urbanized city, no matter the size. Because of this concentration of individuals, outside resources must be used to ensure that energy demands are met.

Hydroelectric power has long been a source of energy for most areas in the world. It is a source of "renewable energy," making it a provocative natural resource because it does not get consumed. Even 2,000 years ago, cascading water was used to aid in wheel turning in Greek civilization (Kallis, 2010). Hydropower is preferred because it can produce large amounts of energy, and is also used for irrigation purposes. There is a lot of pressure to produce dams, as they are a part of the Clean Development Mechanism (CDM), and hydropower is the type of CDM project most sought after (Fletcher, 2010). The CDM is a part of the Kyoto Protocol, which occurred in the United Nations Framework Convention on Climate Change (UNFCCC). The goal of this protocol and the participating nations was essentially to decrease the amount of human interference to the climate system through the emission of greenhouse gases. The CDM, defined by the Kyoto Protocol, promotes usage and expansion of clean energy by providing certified emission reduction (CER) credits to those countries that follow their regulations. One

CER credit represents one ton of CO_2 reduction due to the clean energy emphasis. The CDM aims toward CO_2 emission reduction in developing countries in order to promote sustainable development ("Clean Development Mechanism," 2012). At a glance, hydropower becomes a common solution to utilizing cleaner energy, especially in developing regions. However, hydropower is not necessarily a universally sustainable energy source. There are numerous costs and drawbacks, including displacement of people, high costs, biological diversity reduction, water quality reduction, erosion, flood threats, habitat alterations, and soil quality diminishment, among even more shortcomings (Fletcher, 2010). Decision makers considering a hydroelectric power project should take each of these things into account before work on the project begins. India seems to be in constant battle over hydropower construction projects, because while hydropower offers many benefits, there are also many clear drawbacks.

Large-scale energy developments are often controversial projects with economic, social, environmental, political and physical disruption as consequences of their creation. There are typically disruptive effects to the area near construction and to all the people that this development may affect. While sustainable energy projects are meant to benefit the general good of people, impacts on the welfare of other people and other parts of the earth may not be taken into consideration. The consequences that occur in many of these large development projects is rather similar in each case, even in locations as different as the Tucuri Dam in Brazil (Fearnside, 1999), and the proposed Silent Valley Dam in Kerala, India (Balakrishnan, 1984). The Kabini Dam in Karnataka, India exemplifies the variable response to hydroelectric power development in terms of the costs and benefits to constructing a dam, including the dam's purpose of creation, its displacement of local people and their changed lifestyles, the coinciding disruption of local ecosystems, and public opposition or support of the new dam construction.

Research Purpose

This research was meant to explore dam-building projects, using a systems theory-based analysis. A systems analysis is a way of thought that promotes an investigation of the interrelations of elements of a particular system, taking into account how each element vitally influences each other element within the system (Meadows, 2008). More specifically, the system to be explored in this case is hydropower, and each element that affects it or it is affected by. One particular case will be analyzed: a dam built on the Kabini River, affecting an indigenous community in the Mysore district of the state of Karnataka in southern India (Figures 1, 2, 3). The case of this tribe parallels those of countless other communities affected by dam-building projects all around the world, including the aforementioned Brazilians (Fearnside, 1999) and the Winnemen Wintu tribe in Northern California (Young, 2008), illustrating this recurring theme as an international phenomenon. The health and environmental consequences of building projects will be investigated to determine if such projects are always backed by focus toward the "general good," and the true definition of such a phrase.

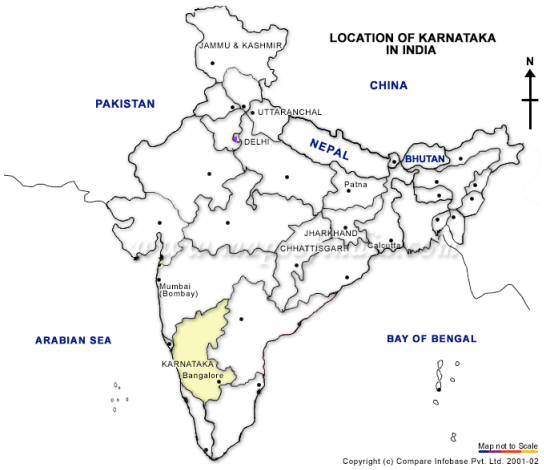

Figure 1: Map of India

Figure 2: Map of Karnataka, India

Figure 3: Map of Mysore, Karnataka

Research Questions to be Answered

The focus of this research was to discover the ways a community is both immediately and indirectly affected by a large-scale energy development project. Also, both obvious and unapparent health effects in relation to the effects of a dam construction were explored. When a group is relocated or is still living close to the site of a large energy plant (like a hydroelectric power plant), there can be many unforeseen health effects resulting from a changing water table, including changes in insect behavior and changes in chemical concentrations in sediments. For example, malaria has been encountered in post-construction areas (Fearnside, 1999). The tribal villages in southern Karnataka are fortunate to have had medical doctors working alongside them throughout the process of relocation, providing them with their medical needs.

As such an analysis on the social, economic, and environmental effects of hydropower development has not yet been published regarding the Kabini Dam and the recently affected community in the Karnataka state of India, this research was meant to explore the different ways in which the community and the environment are directly experiencing the effects from such a project. Research also noted how this specific situation relates to other circumstances around the world, including other cases in India (Balakrishnan, 1994), and also on the other side of the world in Brazil (Fearnside, 1999). The motives for such projects were explored in terms of the reasons for going through with a large-scale development project and the support or opposition that ensued because of a hydropower project.

Throughout the research process, there was extensive review on the purpose and said benefits of hydroelectric power. Much of the research focused on the negative aspects of these energy sources, but it is beneficial to also note the reasons that such a vast number of dams have been built as a “sustainable” source of energy. Despite frequent opposition by local people and

environmentalists alike, proposals and projects continue to be announced throughout the world, suggesting that there must be benefits for people that become more important than the notable drawbacks. Along with this, another key research question included how realistic hydropower is as a source of energy in its ability to conserve natural resources while providing populations with needed energy.

Aside from an extensive literature review of current dam critics and alternative energy sources, as well as information and research regarding hydroelectric power statistics, effects of hydroelectric power construction, and specific cases of groups affected by the construction of one of these projects, specific information was gathered in the form of informational interviews in the area of Karnataka, India, affected by the construction of the Kabini Dam. Interviews were conducted with the local doctors working and living in the community. Conversations with different people living in the tribal communities helped to realize first-hand knowledge and experiences from them, regarding personal views and opinions of the dam being built, current quality of life, difficulties both past and present in regards to all things dam-related, and all other effects the Kabini Dam may have had on their lives.

Background. Karnataka, India is a state about the size of Illinois, home to 70,201,204 residents in their 2012 census ("India's Population 2012," 2012). The town of Sargur is very near the location of the dam construction and relatively near to the local villages that utilize this small town for many of their needs. Sargur's population is 10,983 ("Population of Sargur," 2012), and many people from the local villages commute by bus daily to work in this town. Sargur is home to a hospital that was constructed by a group of doctors in 1982-1984 in an effort to provide medical care to a people group with little to no monetary resources, suffering from multiple displacements. One of these doctors, Dr. Balasubraminyum, says these words, "I would try and

start a movement, which would usher in 'ethical, rational and cost-effective' medical care in rural India for people who will be seen as 'people' and not mere sufferers of diseases waiting for treatment" (SVYM Documentary). Thus was born the Swami Vivekanada Youth Movement (SVYM). This organization has been integrated into the lives of many tribal villages and people throughout the state of Karnataka. They began doing work in the tribal villages and with rural poor in order to provide help to people suffering with relocation and no provisions, living on the edge of Bandipur National Park. Prior to the establishment of Bandipur National Park, the land within the park boundary, as well as land flooded by the Kabini Dam, was home to at least five tribal communities that exist to this day. SVYM organized to provide assistance to the tribal communities, and assist with health and welfare impacts as a result of displacement from the forest to the rural, agricultural uplands. SVYM has played a critical role in providing for these people groups and for making their story known.

From very small beginnings, this organization has grown very large, and its impacts are far-reaching. "Swami Vivekananda Youth Movement today is a large organization running more than 60 projects all over Karnataka. More than 450 people in SVYM today are reaching out to nearly 6 million people directly or indirectly" (SVYM Documentary). These tribes in India were displaced from their indigenous, migratory homeland and relocated to a single plot of agricultural land so that the river could be impounded by a new dam and hydroelectric facility. The community was not only affected by the physical displacement and relocation, but a complete shift from a hunter-gatherer lifestyle to conventional, modern agricultural operation. This transition was subjected to the tribal community with no guidance or instruction as to how to implement subsistence agriculture (Mr. Ramesh, personal communication, May 2012). To date, existing tribal communities continue to farm the land adjacent to the river. The water both

above and below the location of the dam is used for drinking, bathing, and washing clothes. Although each tribal group maintains unique characteristics they do share basic similarities. A typical tribal village consists of clustered small huts made from mud and cow dung with tin roofs to repel the monsoon rains. The main source of income is through agriculture. Common crops are cotton, sugar cane, vegetables, herbs and ornamental flowers used for many religious ceremonies. As an alternative income source, SVYM has established self-help groups for tribal women who are leveraging micro-finance mechanisms. Each tribal community may consist of over one thousand individuals, and SVYM provides services to around 40,000 members of the general tribal community. A documentary produced by SVYM includes an interview with a tribal individual who states, "People from the forest department promised us land and made us leave the forest. We used to be people of the forest, then were not allowed to go back there. Our goal is to give our children a better life." This "better life" is being intensely pursued in this region, through the work of SVYM in all aspects of life: health, education, development, technology, and the environment.

While there is much work being done to better the conditions of the tribal people by SVYM, there are many areas where additional research and information would be helpful to gain further knowledge that could in turn affect the conditions of both the environment and the people living in the region of southern Karnataka. The quality of the drinking water and ground water has not been tested extensively, and there has been little published previously on the water condition in this area. Both the watershed and the water collecting reservoirs have changed substantially since the creation of the dam because of the alteration of the river, so groundwater is being used more frequently than surface water. There are current known problems in southern Indian with excessive fluoride contamination in the water, suggesting a possible contamination

in this area as well. Other water collection options are being explored in the tribal villages as well to encourage water conservation; one of these options is rainwater collection and cistern storage. Therefore, because of the drastic change in the water source, additional water testing was essential so that the components of the water could be classified and the health of individuals using these water sources could be better monitored. Preliminary water testing was done for this project to see how the quality of their water has been impacted. The levels of fluoride were carefully tested in the water sampling along with other basic water quality descriptors such as pH, water hardness, nitrate and nitrite levels, and ammonia levels.

Literature Review

Systems Analysis

Many sources of literature guided the direction of this research. First, and possibly most importantly, is Donella Meadows' book, *Thinking in Systems.* The purpose of this research falls under the category of systems thinking and analysis of these systems. Meadows' book is meant to be a sort of guide through the process of thinking in systems. Her book is useful in realizing the basics of systems analysis and its usefulness in analyzing almost any situation in our world. There are many basic ideas behind systems that are fairly easy to understand. Systems themselves contain the structures present for change, but are often manipulated by some outside force that either promotes or prohibits change. Meadows and her editor, Dana White, present the following definition of a system: it is an "interconnected set of elements that is coherently organized in a way that achieves something" (Meadows, 2008). According to Meadows, this system has much potential and many capabilities. Most importantly, all the parts included in a system must be taken into account in order to achieve any sort of analysis on the system. As mentioned above, a system is made up of its elements, interconnections, and a purpose or function. All are essential characters in how the system actually works. Without going into too much detail, Meadows book shows the general way of thinking for this research project. Although there are a lot of parts and categories of the topic of hydroelectric dam building that may be taken into account, it is important for the systems analyst to view the parts making up the whole in order to get a clearer view of the whole.

In the case of the southern Indian tribe, the systems analysis strives to understand the reasons behind building a hydroelectric dam on this particular river. A few of the elements investigated were: current water quality conditions near the dam and in areas surrounding the

river, physical health of tribe members, costs and benefits of dam development, reasons behind such a project in the particular area, and present feelings from current tribe members. Although there were countless interconnections and elements in play in this situation, the systems analysis may help to simplify the problem to determine its roots (Meadows, 2008), in hopes that this and similar situations may be dealt with in an improved manner.

Another important source of literature was Daniel Bromley's article, *The Commons, Common Property, and Environmental Policy*. While the concept of the "Tragedy of the Commons" may be broad in scope, the overall impact on both natural resources and local economies are evident and important to acknowledge. Bromley lays out the definitions and different types of property that exist, and what the social convention of property actually signifies. As this research project has much to do with the act of taking land from one group for use by a larger group, the patterns were made clearer based on the type of land that was taken. The reasoning behind much of the conflict between land exchange lies behind the belief of some that property is a natural human right, and a belief by others that land exists as property only when others recognize it is property (Bromley, 1992). This research will have much to say about the allocation of resources, and which peoples or groups are in charge of these resources to either distribute or to use them. The idea of the environment as a non-renewable resource plays much into this idea. Tribal community members shared a common resource of the ancient forest, while modern society quantifies the value of the area based on kilowatt hours generated by hydroelectric generation. Such a conflict results in both environmental and economic challenges based on decisions related to natural systems.

Hydroelectric Projects

In this project, several case studies of hydroelectric projects have been reviewed. This has shown correlations in projects in different locations of the world. Samantha Young recalled the story of the Winnemen Wintu tribe that lived near Lake Shasta in northern California. Their sacred land was destroyed by the building of a large hydroelectric dam in 1945, and they are now facing the plans of enlargement of the dam in order to fulfill an increasing demand for water from the Californian population (Young, 2008). The planned enlargement will flood the remaining fraction of land this now very small tribe still possesses. Although this tribe was promised compensation and other lands in return for their initial taking of their land, they never received this land. Young also stated that the indigenous populations should not be the only ones concerned with the planned construction. The dam to be built will have widespread affects on the surrounding environment, especially the trout and salmon residing in the water. Many cases of hydroelectric power construction show eerie similarities, and all cases of hydropower construction affect more things than just the energy or water supply.

Philip M. Fearnside reviewed a dam-building situation in Brazil in his report, *Social Impacts of Brazil's Tucuruí Dam*. The importance in this is to show the amount of similarity that exists in each case of an energy development project. The Tucuruí Dam flooded 2,430 km^2 of land, with part of this land being an Indian reserve. Individuals affected by the dam are unhappy with their new settlements, while people living downstream have undergone disastrous effects of a devastated economy. Brazil still has many more plans for increasing their hydroelectric power development. While many plans seem great in theory, Fearnside stated, "large areas of indigenous land would be flooded by dams made 'necessary' by an initial structure…that would appear highly attractive if viewed in isolation" (Fearnside, 1989).

Dams also impact the health of individuals. Fearnside noted a changed level of different malaria vector mosquitoes after the Tucuruí Dam was built, including species that were previously nonexistent in the area. Along with this, an increase in mercury concentration has been found in sediments and fish in the reservoir and plants in the forest near the dam. Researchers have found that mercury concentration in the hair of individuals fishing from the reservoir is higher than those that are not (Fearnside, 1999). There are a few other health problems that are a concern only for this particular area affected by the Tucuruí Dam development, but it is still a beneficial comparison to those concerns, which may also exist within the tribal communities of Karnataka. Similarities with other hydroelectric dam developments provide key information to the side effects that may occur from a dam-building project.

Displaced Individuals

Some of the often-overlooked pieces of dam development are the populations affected by dam construction. Entire lifetimes can be devoted to studying the phenomenon of development in regards to indigenous individuals, but it is a very relevant part of this research, and must be considered, although briefly. As society evolves, developments take place that end up altering the state things once were in. Indigenous people are those "whose social, cultural and economic conditions distinguish them from other sections of the national community, and whose status is regulated wholly or partially by their own customs or traditions or by special laws or regulations" (International Labor Organization, 1989). These tribal groups have a determination to preserve who they are as people. In modern society, there are several different views of indigenous peoples: exotic, exploiting of resources, or savages (Dove, 2006). Throughout the past, and looking into the future, there have been countless indigenous rights conflicts, and what

Dove calls “indigenous rights movements” (Dove, 2006). However, he notes that indigeneity itself is a concept that only persists when there is something more developed than it. Therefore, “modernity makes indigeneity possible” (Dove, 2006). At the same time, as Dove (2006) relates, “…examples of modernity making possible articulation of indigeneity and indigenous conservation at the very time as it renders actual achievement of these things impossible.” Indigeneity itself has a certain definition legally, and thus only covers specific people groups. Many other groups of people aside from just the “indigenous” have been affected by relocation and other impacts of modernity. There are many criticisms of the title, Indigenous, and the genuine motivation for wanting to have this title or to fight for those who have that title. Indigeneity itself is a very clouded picture because of so many ulterior motives laced deeply throughout the history and politics of indigenous peoples (Dove, 2006).

Apart from indigeneism itself, there is a lot to be learned about indigenous knowledge. Dove (2006) relates JC Scott’s 1998 report on the State’s failed attempts to improve the human condition, “The twentieth century’s high-modern, global discourse of development was dismissive of local knowledge, including knowledge of the environment.” As modern society began to enter in to places of indigenous life, there was apathy toward learning what they know from living on the land. However, they failed to recognize the possibility of obtaining important knowledge from indigenous groups that could aide in a more effective development strategy (Dove, 2006). As scholars and researchers begin to realize the great depths of knowledge unknown to modern day academics, there becomes a strong pull toward learning more from these indigenous peoples about the uses of flora and fauna in the area (especially those with possible medicinal value), and their sustainable living and conservation strategies (if this is something the indigenous group actually intends to practice). Their knowledge then becomes a

sort of commodity, and the question over rights to their knowledge continues to be controversial (Dove, 2006). As land once occupied by indigenous communities is claimed for modern use, the opportunity for exploring how indigenous knowledge may be integrated is threatened, if not hindered or entirely lost.

Instead of focusing solely on development and not on conservation, the United Nations Environmental Program realized the importance of joining the two issues, as both are necessary today. Thus, Integrated Conservation and Development Projects (ICDPs) were created to commit to respect of the land needing to be developed, with plans set on how to conserve it in the meantime. This method has been very difficult to implement, and many development projects could not or did not want to participate. Along with this, community-based natural resource management (CBNRM) was initiated, which emphasizes utilizing the local community to partake in decisions regarding how best to confront developmental issues (Dove, 2006). Many CBNRM principles, participatory in nature, have been utilized by nongovernmental organizations (NGOs) in order to build trust and relationships to make matters easier during a certain project.

Hydroelectric Power

"*When Environmental Issues Collide: Climate Change and the Shifting Political Ecology of Hydroelectric Power*" by Robert Fletcher provides an interesting view into how climate change affects the building of dams, and how dams can in turn affect climate change. Using the example of a dam on the Río Pacuare in Costa Rica, it is evident the different forms of capitalist development competing over what is important environmentally and socially. In places like Costa Rica, where environmental sustainability is of increasing importance, hydroelectric power is examined as one of the better methods of energy development (Nizami, et al., 2011). While

Fletcher does not deny that hydroelectric power may be "less bad," he notes that it may not be as great of an energy source as it is often made out to be, as "…it may hold unforeseen and potentially negative consequences for particular environmental concerns" (Fletcher, 2010). This is very important from a systems analysis perspective, as it is essential to look from all sides at the costs, benefits, and reasons behind each element of a system.

Climate change concerns seem to correlate with an increase in use of hydroelectric power. Benoît Mayer also writes about this, from the perspective of indirect effects of climate change on human rights. Dams are viewed as a source of sustainable energy, but still do emit greenhouse gases. This is for the most part "…by the anaerobic decomposition of organic matter in lands flooded by the Reservoir" (Mayer, 2011). Mayer questions the true interests behind hydroelectric development, very similar to a systems analysis perspective. As this is a general overview of all hydroelectric development, this paper was a very important background in this research project.

Water Monitoring

The Kabini River is a tributary off of the Cauvery River, located in the states of Kerala and Karnataka, India, and is the location of a large hydroelectric dam construction in Karnataka. This river is part of the watershed that is utilized by many small tribes in the Mysore district of Karnataka. The reservoir created by the dam is a source of drinking or cooking water for people, and it is a part of the water cycle in their region. A study was done to test the amount of heavy metal pollution in sediments from the Kabini River. It was found that heavy metals were indeed present in the water, and these metals originated from both natural and anthropogenic factors (Hejabi, Basavarajappa, Saeed, 2010). It was found that the heavy metals discovered within the sediment were sometimes at toxic levels for both the environment and for human ingestion or

consumption. This pollution has increased in recent years due to industrial and urban activities, especially industrial chemicals, agriculture and sewage, which is substantially worsening the water quality of this water source. The study determined also that in certain metals, for example, copper, it is acceptable to have small quantities of the substance. When the concentration of metal gets larger, it can become very harmful. Along with this, groupings of different substances can have different effects than just a substance alone could have; while one metal may be heavily studied in confinement, it is often unpredictable what substances could do when they are together.

Similar to the United States, India does have national laws and policies regarding water monitoring requirements and protocols to maintain proper, uniform analysis of water quality around the country. As a large and exponentially growing population, there is an increasing need for water use in the areas of irrigation and also in consumption by both humans and industry (Bhardwaj, 2005). Fortunately, India has the provision of plenty of water resources, but the quality of it has been substantially depleted due to untreated sewage and industrial waste, quickly reducing the actual supply of usable water resources. In his account of water quality characteristics of the main rivers in India, Bhardwaj explained that water samples are currently tested for metals, pesticides, physic-chemical properties, and bacteria levels. Generally, organic pollution by means of manure and sewage in the water increases decomposer levels, which in turn deplete oxygen levels in water. Correspondingly, excessive nutrient levels in the water will increase plant growth in water, also decreasing oxygen supply. These phenomenon are very important in the viability of life in said water areas. Other concerns in water quality occur in the subsurface water: natural degradation, over-extraction of water, insanitary conditions in rural areas, fertilizers, pesticides, levels of nitrate, arsenic, salinity, micro pollutants, and pathogenic

pollution (Bhardwaj, 2005).

The Kabini River is a tributary of the larger Cauvery River, which is a common water source for many south Indians. Bhardwaj labels the Cauvery River as “grossly polluted”; it contains comparatively high levels of biochemical oxygen demand (BOD) and total coliform bacteria and fecal coliform bacteria colonies. In combination of all of the stretches of river in India, the Central Pollution Control Board through its Global Environmental Monitoring System labeled 6,086 kilometers of India rivers as “grossly polluted,” 8,691 kilometers as “moderately polluted,” and 30,242 kilometers as “relatively clean” (Bhardwaj, 2005). Although these reports may seem dismal, there is evidence that the water quality in India is changing for the better. The monitoring of water has been evolving to include more contemporary concerns, including pesticide levels in water.

Methodology

The majority of the work for this thesis project was completed through extensive literature analysis, qualitative interview, and quantitative environmental monitoring, through the systems analysis perspective of looking at all the different aspects of a situation to determine how the system as a whole (indigenous communities and hydropower construction) functions. Since the topic considers global issues, much of the study included learning specific stories in hydroelectric power development from around the world. Field research was done through water collection and water quality testing of water sources in south India. Various water samples were collected, including surface water, tap water, and filtered drinking water.

Capstone in India

Much of the research on the specific case of the Kabini Dam was gathered in India in the month of May, 2012. University of Northern Iowa's capstone class, Indigenous Knowledge, Natural Resources and Health: Perspectives from Southern India was held in Karnataka, India, and the data collection occurred during this time. The duration of this class was spent learning first-hand how an indigenous population lives today amidst the impacts of urbanized society. This class helped to increase knowledge on the history and facts of this particular community in the state of Karnataka, while learning of the types of challenges they face post-relocation from the hydroelectric construction project on their previous forest dwellings. Water collection efforts were also explored to determine the status of their water post-dam construction.

Water Testing Methods

The simple water testing conducted served to obtain a general picture of the quality of water available to the relocated individuals in the tribal villages of the southern Mysore district. Some areas of South India encounter fluoride contamination, so both high and low frequencies of

fluoride were tested in each water sample using electronic fluoride readers (ref). Test strips were used to determine levels of pH, nitrate, nitrite, water hardness, and ammonia. The locations for water sampling were determined through observation of local people and conversation with community leaders to discover the areas most commonly utilized for water collection. Therefore, the sites chosen to sample water from were primarily in locations frequented by locals for use as drinking water, cooking water, and bathing water. Water was sampled from a few different sources, including groundwater bore wells, water purification systems, and untreated ground water. Other methods of water collection utilized by locals were also observed, including rainwater harvesting. However, these alternative methods were not tested, as they are not commonly used by the general population at this time.

In the bore well water sampling (Figure 4), the water was collected from the taps connected to the wells. The water was let to run for several seconds, and was then collected into clean plastic containers. The same procedure was utilized for collecting drinking water from the water purification systems. The water collected from the backwaters of the Kabini Dam (Figure 5) was sampled from a location that a woman collected a vat of water to take home with her. The water was sampled several feet from the shore, and was taken below the surface of the water but not from the bed of the lake.

Figure 4- Hosahalli Bore well
Picture taken by Amy Joens, May 2012

Figure 5- Backwaters of Kabini Dam
Picture taken by Amy Joens, May 2012

The simple water tests were done two times on each sample to ensure the correct results were obtained. These water tests were used to develop a general picture with basic water quality characteristics. Using test strips, the following parameters were measured on each of the water samples: pH, nitrate, nitrite, ammonia and hardness. The tests for levels of fluoride in the water were done using the electronic fluoride readers, making these tests a bit more accurate. A control vial of distilled water was used to calibrate the device prior to inserting each vial containing the test fluid.

Informational Interview Methods

While in India, information was also gathered by shadowing doctors in the community affected by relocation. The doctors had been with the community since its relocation, so they were knowledgeable about the politics behind the dam construction project. Through qualitative interview and conversation, these leaders of Swami Vivekanada Youth Movement (SVYM) were also able to provide critical information in order to understand the changes that have occurred in their area through all aspects of life due to the construction of the Kabini Dam: environmentally, socially, physically, and economically. Since the doctors had been present through the entire

process of relocation, they have an adequate grasp on the general types of medical and health needs of the community both before and after the dam construction. They provided information on the health of the tribal communities, the evolution of health through the relocation and adaptation process, measures of education to the tribal communities- especially in health-related areas like proper sanitation, hurdles they have faced in being a part of the SVYM organization, and current issues in India, especially the water crisis.

Other local leaders in the SVYM organization were utilized to obtain more information specific to their community in order to realize how all aspects of life are affected by the construction of dams in these communities. The SVYM leaders and executives provided tours of important locations in their villages along with instructional classes on the history of India, non-governmental organizations (NGOs), water, organic farming and education. This information was helpful to gain local perspectives on the topic, along with obtaining first-hand experience in the areas of influence of the dam. Also, SVYM leaders are heavily involved in all aspects of these tribal communities, including public policy and how the government has interacted with the villages and the NGO.

Conversations with local people were utilized as informal, informational interviews in order to obtain further facts from tribal members. Their sentiments toward the building project and their view on the current conditions in their community were noted, and they gave information on their current lifestyles. The level of integration into society the community has experienced was noted, along with how their focus is similar to and different from the common urban culture. Spending time both in the tribal villages and the nearest large city of Mysore helped to gather observations about how lifestyles and daily routines differed between people living in the two areas. Their occupations, modes of transportation, family lives, education, food

preparation, types of homes, sanitation, hygiene, levels of technology, and religious devotion were all aspects that were comparatively observed between Mysore city and the villages of Hosahalli and Kenchanahalli and the nearest small town of Sargur.

Results and Discussion

Southern Karnataka Tribal Villages

Health.

The health needs of a tribal community or a rural village may differ substantially from an urbanized, crowded city. These needs are often augmented by the challenges of adapting indigenous lifestyles to the demands placed upon individuals and communities as a result of modernization. Such challenges are then compounded by the construction of a dam. New diseases introduced when the river system was modified may now accompany previous, common health risks. Drinking sedentary waters in the backwaters of a dam could lead to several potential health risks. Reduced flow may increase mosquito populations near and within the water source, increasing the potential incidence of malaria. Also, chemical concentrations in dam waters may be increased due to the stillness of the water, and from the flooding of the land, which could contain chemicals in the soil and sediments. The chemical concentrations of a water source greatly affect the wildlife that calls the water body home, also. So, if there is an increase in chemical concentration in the water, it will likely have an effect on fish populations and fish tissue due to acute and chronic exposure to certain toxins. Individuals who consume these fish and other aquatic life may then be affected by the chemicals concentrated within the food they eat. Cattle and wildlife share the drinking water source, and also introduce bacteria to surface water through open defecation. Coliform bacteria may also pose serious health risks to humans who consume water from this area (Rebecca Kauten, personal communication, November 2012). Lastly, worsened conditions in tribal housing and migrant worker housing can greatly affect the health and standard of living of these individuals (Fearnside, 1999).

In 1982-1984, when the group of medical students from Mysore College began the initial plans for SVYM, healthcare was the primary concern of the doctors. The doctors relocated

themselves so as to be in a location closer to the tribal people, and where they live, eat, sleep, breathe, and work. The first hospital created by the doctors of SVYM was finished in 1987 in the town of Sargur, helping both tribals and non-tribals alike in the area with a blend of Ayurvedic and western (allopathic) medicine (Dr. Balasubraminyum, personal communication, May 2012). Later, a purely Ayurvedic hospital was created in the village of Kenchanahalli, and a mobile health unit was created. Both of these advances were meant to increase contact with tribal members, and to ensure local needs were met. SVYM discovered that some tribal individuals are hesitant about receiving health care. A mobile health unit encourages the doctors to become somewhat integrated, localized, and therefore more accepted into the lives of the tribe members. The mobile health units go weekly to eleven to twelve tribal villages, and they see 80-90 patients each visit. The hospital also practices HIV/AIDS prevention education and rehabilitation. During our visit to the Ayurvedic hospital in May, 2012, Dr. Dennis provided a basic analysis of a few diseases in the area. In the villages, diabetes and hypertension levels are actually quite low, despite the fact that India leads the world in its levels of diabetes. Malaria is not seen as often in most areas, except for the Manya district. In Kenchanahalli, around 45 patients are seen daily, commonly with skin diseases, common sicknesses, and pesticide poisoning (leading to ensuing cases of cancer, as well.) Another issue within the non-tribal groups is suicide and alcoholism, due to bank loans and debt incurred by agriculture and crop failures. The occurrence of fatal cases of diarrhea sickness due to water usage have decreased substantially in the area, because of an increase in education to the tribal villages about what water to drink and how to prepare it. The doctors noticed the reappearance of certain medical conditions (for example, diarrhea), and they looked into further developmental needs, like education (Dr. Dennis, personal communication, May 2012).

Land reparation. After relocation, the individuals affected by the dam should have been properly compensated for the land that they lost due to the dam construction. Initially, the tribal people were not given proper reparations, and were forced to squat on land outside of the forest and on the land of others nearby. As SVYM began to join in with the tribal groups to help them in different ways, they decided to legally defend the tribal people who had lost land. The tribal people were submissive in response to the government's interactions with them, and they were not given proper compensation for the land which was taken away. They did not have the resources nor the knowledge to know how to be able to argue with the government for the right to their land, and so were left somewhat defenseless. An eight-year lawsuit with the Indian government resulted in a 500-acre plot of forest land allocated to SVYM for use by tribal communities and their respective organization. After this lawsuit, each family that had been displaced was to be given one hectare of land as repayment from the Indian government for the construction of the dam, along with a house, minimal agricultural resources and food rations. Currently, none of the groups actually live in the forest, even the least-developed Jane Kourdeba tribe lives just on the fringes of the forest (Mr. Ramesh, personal communication, May 2012). In addition, the area is seeing further expansion and modernization. In 2009-2010, a modern tourist resort was constructed on the opposite side of the impoundment from the SVYM property. Road construction is underway near the tribal villages. During our stay, we witnessed traffic consisting of both Indian and non-Indian tourists traveling to the area. Boats on the water and jeeps on the land take paying tourists to see wild elephants, crocodiles, wild boars and monkeys along the lake-forest fringe. Meanwhile, bare skeletons of age-old trees peek out from the lake waters to remind visitors of the ancient forestland below.

Water quality. Although an extensive water testing program was beyond the scope of this research project, a few samples of water were obtained to generally depict water quality conditions in some key locations to the tribal groups and their supporting organization, SVYM, in southern India. After a dam is built, the existing water can be changed drastically in terms of its physical and chemical characteristics because of the decreased flow in the river water and the composition of sediment accrued in the water due to flooding active photosynthetic organisms, human dwellings, and countless other possibilities. The items tested for in this analysis were chosen because of their relative ease to test, and to get a basic idea of the components of the water (Table 1). An attached file is included in the appendix that lists India's levels for drinking water standards.

In many ways, the water tested in this analysis did not deviate greatly from the drinking water standards in India (view India Standard Specifications for Drinking Water in this document's appendix). There are higher levels of water hardness than are acceptable, and pH levels are on the higher end in every case tested.

Table 1- Water quality testing in tribal villages in southern Karnataka

Location	Date Collected	pH	Hardness	Nitrite	Nitrate	Ammonia	Fluoride HR	Fluoride LR	Details
Hosahalli bore well	May 19th, 9:00 am	8 to 9	425 ppm: very hard	0 ppm	20-50 ppm	0-0.25 ppm	0	0.39	Village residents collect drinking and cooking water daily from this well (outdoor tap area)
Backwaters of Kabini Dam (surface water)	May 19th, 6:00 pm	7 to 8	50-100 ppm: soft	0 ppm	0 ppm	0-0.25 ppm	0	0.03	Villagers visit this area frequently, for recreation, water collection, or cleaning (open water)
Kenchanahalli bore well	May 20th, 11:00 am	9	425 ppm: very hard	0 ppm	10-20 ppm	0.25 ppm	0	2	Villagers and hospital use this water for cleaning and other uses, usually not drinking (indoor tap)
Kenchanahalli drinking water	May 20th, 12:00 pm	9	425 ppm: very hard	0 ppm	10-20 ppm	0 ppm	0	0.55	Villagers and hospital use this water for drinking (water purification system)
Hosahalli drinking water	May 20th, 7:00 pm	8	425 ppm: very hard	0 ppm	40-50 ppm	0.25 ppm	0	0.15	Villagers use this water for drinking (water purification system)
Mysore drinking water	May 22nd, 10:00 am	9	400-425 ppm: very hard	0 ppm	10 ppm	0.25 ppm	0	2	People living in dormitories use this water for drinking (jugs)

Unfortunately we were unable to test the samples for bacteria, heavy metals, pesticides, or phosphorous. Should UNI send another group to this area, bacteria testing and further nutrient analysis may be a means of further assessing water quality. This research will hopefully be a base in the water testing protocol that may follow when other UNI Capstone groups or SVYM volunteer groups return to these sites, so that the water can be properly monitored and care can be taken to assure that the water lies in the parameters of India's water quality specifications.

The areas of most concern in this water quality assessment are: the Kenchanahalli bore well, the Kenchanahalli drinking water, and the Mysore drinking water. In each of these cases, there was an elevated pH level of 9, and all were under the category of "very hard" in terms of water hardness. Along with this, the Kenchanahalli bore well and the Mysore drinking water portrayed levels of elevated fluoride content, which could be a potential danger in excess. However, as stated, these water samples are just a small sample of what could be studied, and many more samples should be taken to produce definitive results.

Other Examples of Hydroelectric Power Development Projects

As previously stated, there could be extensive analysis about each dam development project, showing the interconnections and relationships between the individuals displaced by the dam, the land, and the local ecosystems present in the construction area. India is full of examples of hydropower conflicts. Due to the first-hand experience and knowledge gained by traveling to the site, only the Kabini Dam is explored in the greatest detail in this report. Dam constructions do not just occur in India though; they are in fact very widespread throughout the world. Latin America has had many dam-building situations, both initiated by their own governments, and also by outside governments. Further information on the Silent Valley Dam in India and the

Tucuri Dam in Brazil follow below, in an effort to show connections between dam construction projects thousands of miles and huge cultural stretches apart.

Silent Valley Movement. The Silent Valley Movement to oppose the creation of a dam on the Kuntipuzha River "marked the fiercest environmental dispute in India and established a precedent wherever a major development project, specifically a dam, threatened ecological balance" (Karan, 1994). This case is a representation of how a conservation problem can move through to completion using various tools, and how a notable conservation success can emerge.

Silent Valley is today a protected area in the state of Kerala in southern India. In 1984, around the time of the proposed dam construction in the area of Silent Valley, there were 8,952 hectares of land in the reserve, and 40,000 hectares of connected forests when including the forests that border Silent Valley on all sides (Balakrishnan, 1984). One of the reasons this area is so valuable in terms of conservation is because it is a largely undisturbed natural habitat of moist evergreen forest, unlike many areas of forest surrounding it. In his study of mammals in this area, Balakrishnan stressed that India does not have many locations of untouched rainforest remaining, making Silent Valley very important in the sense of its biome, and because this type of forest is extremely diverse in its species composition.

Biodiversity and public outcry framed the outcome of the Silent Valley dam project. The study done by Balakrishnan focused on disturbance the mammal wildlife present in Silent Valley and the connecting forests, in order to make a prediction of the possible impact a dam development would have in the area. Strikingly enough, Balakrishnan states that at that point in history, there had not been any previous assessments done of wildlife and habitats in India on a hydroelectric power development project, despite the constant recurrence of projects of this sort. Balakrishnan found in his study that Silent Valley had almost all of the types of mammals found

in the rest of India, and three of these species were endangered while some were vulnerable and some were rare. Those endangered include the tiger, the lion-tailed macaque and the Nilgiri tahr. After observing the species, this study found that three of the five different troops of the lion-tailed macaque, an endemic species only viably breeding in Silent Valley and another near forest, occurred in the area the dam would submerge, and the other two troops were in very close proximity to the area that would be submerged. Along with this, the fruit comprising most of this species' diet was plentiful only in the area to be submerged. The largest conservation concern for the Niligiri tahr was the threat of poaching that had caused this other endemic species to be nearing extinction. With their location in the forest only about four kilometers from the dam, the threat of human contact with these species would greatly increase. Lastly, India is well-known in the conservation world for their efforts to save the populations of endangered tiger species. The markings and droppings of tigers found in this study were all located around the area where the dam would be constructed, so the habitat of a very important mammal in the food chain would be disrupted.

Conservation India, a non-profit organization striving to maintain wildlife biodiversity in India, shares the story behind the dam project in Silent Valley. The following timeline of information comes from Shekar Dattatri's article on Conservation India: *Silent Valley – A People's Movement That Saved A Forest.* In the year 1970, the state of Kerala proposed a dam to be constructed in Silent Valley, utilizing the Kunthipuzha River. According to initial plans, the reservoir of this dam was supposed to inundate 8.3 square kilometers of this intact and untouched forest, and would cost approximately five million US dollars. The purpose of this dam was to provide a source of vital electricity for the state of Kerala, irrigate nearby districts, and would consequently positively affect the economy by employing workers during the construction

project. As scientists began to study the area prior to dam construction, there began to be concerns about the project and how it would affect the wildlife in the region. Six years after the initial proposal, a task force was employed by the National Committee on Environment Planning and Coordination that would focus on the environmental concerns in relation to the project. Although it was recommended that the project be abandoned due to these concerns, the state of Kerala chose to employ safeguards to reduce damage from the project, and stated that there would be only ten percent total damage to the entire ecosystem as a result of the safeguards. Conservationists began to study the impacts the project may have, and began to spread this information throughout the entire state of Kerala. They argued (among many things) that there would be a far greater damage than ten percent to the ecosystem if the dam was constructed, the biodiversity of the lower valley would be completely destroyed by submersion, and that the Valley would be wrought with destruction due to construction work and constant human contact throughout the duration of the project. As the Kerala government proceeded with the project in 1979, conservation advocates filed multiple petitions that stopped work on the project. Awareness campaigns went into affect, and the tone of the newspapers shifted from government support to ecological concerns. One published news report in The Hindu included the perspective of naturalist M. Krishnan, "In my lifetime I have seen many fine wildlife habitats demolished for hyd-el [hydroelectric] projects. Silent Valley is more important than them all- the last authentic sizeable evergreen forests left" ("Conservation India," 2011). 1981 marked the declaration of protection of Silent Valley by the Indian Prime Minister Indira Gandhi, however the area involved in the hydroelectric project was left out. Finally, in 1983, the government withdrew completely from the Silent Valley Hydroelectric Project, fully protecting the area.

The complexity of this conservation focus exists because of polarized opinions about

conservation. It is not realistic to say that energy production is not a valid need humans have from the environment, however, it is something that needs to be considered and undertaken wisely so that needs may be met, especially in an overpopulated area like India. The Silent Valley Movement was not the only conservation effort in a hydroelectric power project in India. In fact, in just 2004, there was another attempt to build a dam in the same area in Silent Valley- a mere 3.5 kilometers away from the old site. Conservation India recounts these attempts, and this dam was also not continued to completion. The Save the Narmada Movement from the 1980s and 90s is another conservation attempt against the creation of a huge water project: the construction of thirty large dams and many others along the Narmada River and its tributaries (Karan, 1994). This conservation attempt was not as effective as the Silent Valley Movement; since it was a much larger project, there was not as much room for compromise with the government. There are many other stories of attempted conservation in the midst of hydroelectric power project developments that are unsuccessful, because energy production trumps all else in the eyes of many.

When facing a hydroelectric power project proposal, it would be of first importance to validate or disprove all environmental claims made by the proposal. On top of this, extensive research should be done on the proposed location of the project prior to begin work, and it should not be cut short because of haste to begin project. There should be mandates in place requiring certain specifications be met in regards to conservation before, during and after construction of the dam, and to ensure that biodiversity will be maintained. Especially, there should be heightened importance placed on endangered species in the location of dam development. Because hydropower is such a destructive generator of energy, (despite the fact that it is labeled as a “clean” energy), all other energy-producing options should be considered prior to

development of a dam. If no other option remains viable, then the least disruptive method of construction should be sought after, and the least amount of damage or impact to the natural environment in the dam's location should be pursued.

The story of Silent Valley is admirable because it illustrates how conservationists, naturalists, environmentalists, and even common people in a society can join together to influence the outcome of an undesirable development project. It shows that grassroots and local action can be both powerful and effective, and that when all the evidence points toward conservation, dam projects can be turned down. Most importantly, it shows that even in an extremely populated country of the world, there are still alternatives to exploiting every bit of natural resources that occur in the area, and that there is a lot of value to leaving the land as it is. Despite the pressures to obtain the energy from the dam that would have been built in the Silent Valley, an alternative was obviously found, and hopefully this alternative was more sustainable and offered better protection of biodiversity than the dam construction project.

Tucuruí Dam in Brazil. The Tucuruí Dam in Brazil is a well-known example of a conflict over hydroelectric power development. The created dam affected many people, and its consequences were far-reaching. Brazil, like many other developing nations, has implemented many plans for hydropower development as an energy source. Currently, 80 percent of their energy needs come from large dams, and there have been no plans to cease these construction projects ("International Rivers," 2012). Brazil has also had a history in dam development of severely underestimating the financial costs of dam construction and the amount of people to be influenced and displaced by the construction projects. The Tucuruí Dam was supposed to be created in two phases: Tucuruí-I and Tucuruí-II. Built as a source of hydroelectricity mostly intended for industrial use, the first phase, Tucuruí-I was built in 1984, and it generates 4000

MW of energy from its power station. The second installment would have just as much energy developing capacity, increasing the dam's power output to 8000 MW. After blocking the Tocantins River, 2,430 km^2 of land was flooded, pouring out over the Parkanã Indian Reserve. Funding for this project was actually not accrued by the World Bank, unlike many other dam construction projects. It's funding came mainly from Electronorte, along with many other small organizations in Brazil and other nations (Fearnside, 1999).

There have been many people in Brazil affected by dam constructions. Many Brazilians are highly opposed to the idea of new dam creations, as it has had such an incredible effect on so many Brazilian people. An organization was created in Brazil for the sole purpose of fighting against dam constructions affecting people, and to provide resources for those that have been affected by dam constructions. The Movimento dos Atingidos por Barragens (MAB), or Dam-Affected Peoples Movement, can identify 16 human rights violations that occur in the construction of a dam. These violations, in their estimations, have affected one million Brazilians over the course of history throughout the construction of dams in this country. Also, like many other situations of displacement due to dams, a majority of the displaced individuals were not properly compensated for the land and living that they lost. MAB estimates that 70 percent of these dam-displaced individuals would fit in this category ("International Rivers," 2012). Residents that lived in close proximity to the proposed Tucuruí Dam were actually very proactive in fighting against the dam to be created. They complained loudly, and they protested for two years at the entrance to the Electronorte construction site (Fearnside, 1999).

The dam construction went through to completion, and Electronorte's modest estimation that 15,000 people would have to be moved because of the construction was completely exceeded. The number rose to 23,871 people after the dam was built, and it was calculated that

32,871 more individuals were dislocated, along with the already displace indigenous people (Fearnside, 1999). Proper resettlement sites were also not provided for many of the people, especially the groups that were moved to areas near the dam's reservoir that seasonally flooded.

Many individuals were not directly affected by relocation, but they were affected because of their proximity to the dam and their reliance on the river for many of their needs. As the dam had a dramatic effect on the life in the river on both sides of the dam, the livelihood for many of the downstream residents was greatly affected. There was a huge decline in fish catch and shrimp harvest following dam construction (Fearnside, 1999). Along with this, the filling of the reservoir prompted the arrival of many *Anopheles* mosquitoes, which are vectors for the disease malaria in the Amazonia. Other mosquito species are in such abundance now that there are areas where humans cannot comfortably live due to mosquito swarms. Yet another health concern is the heightened concentration of mercury in dam reservoirs, which can be directly evidenced in the mercury concentrations in human populations eating fish present in this reservoir.

Hydroelectric Power Costs and Benefits

Hydroelectric power is often a contentious public utility source due to the potential for as many, if not greater costs than benefits for the community at large. There is clear evidence of hydropower's positive effect on modernization and rural development. However, there is also strong evidence of hydropower's negative effects on ecosystems and opportunity costs related to land use. Inherently, we may assume people in general would not support displacement of communities or a destruction of the environment for no defined or just cause. Therefore, the proposed benefits for such actions should be clearly defined and relatively secured prior to taking such action.

Hazard mitigation may also be considered a benefit of dam construction. Hydroelectric dams may provide a reduced risk of flooding. A dam can reduce flooding potential by reducing the flow of water and impounding a defined volume of water prior to discharging downriver. In cases where regions experience excess of water from snow runoff, a dam can slow down the water that potentially could have flooded the land downstream. However, an argument that counters this is that during dam construction, a huge majority of the land is flooded anyway (Thakkar, 1999). Damming up a river creates an obvious blockage in the way of the normal current, which creates a reservoir causing the water to pool behind the dam. In many cases of large dam development, this submerged land can be many square kilometers of flooding. This flooding, unlike the flooding of a river that ebbs and flows, does not go away; it is there for the duration of the dam's existence.

Another reason that dams are an attractive construction project is because of their irrigation benefits to arid regions. Water is conveyed from one part of the river to other areas unable to use surface or groundwater, often for agricultural use. This source of agricultural water is important because it provides a constant flow of water to the crop area, allowing less pressure to be placed on the need for rain to grow food (ISID). If rainwater does not satisfy the demands of crops and livestock, the farmer no longer needs to be concerned about the water provided by the sky because their water source through dam irrigation has already met their needs. In an age of ever-increasing populations worldwide, more efficient ways of increasing food production are necessary (Thakkar, 1999). Since food requires water to grow, it makes sense that an increased food need would require an increase in water supply as well.

The energy production industry often refers to hydroelectric power as a renewable source of energy, and is known as "clean energy". This is because it does not burn fuel to function, it

instead uses the energy generated by the renewable resource of water. There are reports of carbon dioxide being released into the atmosphere during dam constructions, due to the flooding of photosynthetic plants and their subsequent decomposition and excretion of CO_2. However, because no smokestacks exist to emit greenhouse gases, the perception by many is there are no environmental impacts. The "natural" source of energy keeps it "clean".

The costs and benefits of a dam construction have not always been properly weighed out before construction begins. This is evident in both the proposed Silent Valley Dam construction project in India, and the Tucuruí Dam in Brazil. Both of these projects will be elaborated on later in this paper. In both cases, the construction began on the dam prior to complete research done on the possible effects. Sometimes, also in both of these cases, so-called "required" assessments are not completed prior to construction per the company or government interest. The assessments that do occur can be rushed, deeming them more inconsequential than they actually may be. Often, the dams seem appealing when studied in isolation (Fearnside, 1999), but like anything else, they highly affect and are affected by other systems. For instance, a dam further on down the river will affect the other dams along the river. Also, the individuals living downstream from a dam are completely affected by a dam construction, although they may not have to be relocated.

Outsourcing water. With incredibly large groups of people concentrated in one area, it is impossible to utilize only the resources in the area where the people are located to fulfill their energy demands. Resources for food, water, and energy need to come from other locations in order to support the vast needs of such a population. As previously stated, India is a nation overwhelmed with people, most times concentrated in cities. An ongoing issue in India's history has been in controlling the water resources in the country in order to reap the benefits of the

extensively endowed river system running through India. Dams can be utilized to bring water resources from a far away location to a location of extremely dense population where the need for drinking water or water for other needs is extremely high.

Development-induced displacement. History is laden with examples of people being displaced by development projects to promote modernization. Large building constructions, agricultural endeavors and road developments have all been a part of displacement of people. Hydroelectric power projects especially require a substantial amount of land in their construction, and will oftentimes flood extensive expanses of previously dry land. Because of this, many people have been displaced from their original dwellings when a development project ensues.

Who really has the right to the land? There are several different types of property regimes, each defining the corresponding rights that people have to the land. Property is not a tangible object rather it is a concept or social norm measuring the value of ownership against other values. State property, individual property, common property and open access regimes all uniquely describe the rights and duties associated with a specific plot of land (Bromley, 1992). The type of regime that the land is defined by affects how the resources of these lands can be made use of, and who controls the land.

Property is defined by "collective perceptions regarding what is scarce (and hence *possibly* worth protecting with rights), and what is valuable (and hence *certainly* worth protecting with rights)" (Bromley, 1992). Property represents a benefit stream, which is the possible future value in the land. In his article on the Tragedy of the Commons, Bromley (1992) says that a successful property regime means, "that the natural resource has not been squandered, that some level of investment in the natural resource has occurred, and that the co-owners of the

resource are not in a perpetual state of anarchy." For a piece of property to be successful, it is imperative that the land is being used to benefit the best interests of all affected by the property. When selfish ambitions or exterior pressures are placed on the property, it can negatively affect the intact system of the property. Oftentimes, the best interests of those currently living on the land to be used are not placed in the highest importance.

Indigenous people have long been affected by developmental needs of urbanized culture. There are many different definitions of "indigenous," but all stress the idea that indigenous people are determined to conserve who they are as people, separate from other parts of society (Dove, 2006). Indigenism is a relatively new idea, though; being created as human civilization morphs into more and more advanced technological versions of itself. It proves true that "…the concept of indigeneity was a reaction to modernity's delocalizing impacts" (Dove, 2006). Indigeneity would be non-existent if it were not for its modern counterpart. As populations of humans continually change and become more complex and sophisticated, the older, more natural ways to live are looked at as primitive and inferior. It is much less difficult to declare dominion over those that are seen as inferior, making it equally as simple to further the needs of the more important and influential group of people dominating the area. Rejecting modernity, indigenous people are without an understanding of how the "civilized" society works, leaving them particularly vulnerable to attack of the outside world. "They encounter tremendous odds in dealing with the market economy. Their unfamiliarity with modern technology and skills coupled with official indifference to their entry into the mainstream economy pushes a majority of tribals into conditions of servility and bondage" (Ray, 2000). Tribal people, or indigenous populations, are some of the most often affected individuals of a development project. Although they consist of only 8 percent of the total population of India, they are over 40 percent of the

displaced population, while the rest of those affected are mostly comprised of rural poor individuals (Ray, 2000). Because of their economic status, those affected are often unable to effectively defend against the displacement.

Individuals affected by dam construction are often not properly remunerated for the land and resources that have been taken from them. They are often blatantly ignored throughout the construction planning process, and afterward they continue to be overlooked. There have been many cases of multiple displacements of indigenous populations; after a dam construction project, the government may have some other reason to again relocate them. The Kabini Dam has multiple examples of this phenomenon. One tribal community within the Kabini Dam are, the Jane Kourdeba, has been relocated five times by the Indian government. The rest of the Soliga tribals were displaced originally by the dam construction and forced to squander on the remaining edges of their original forest land because they were not given adequate reparations for their displacement. Following this, the Indian government decided to establish the forest they were dwelling in as a Rajib Gandhi National Park, forcing them out once again, with no resources. Even more astonishing is the case of the Singrauli tribe displaced by the Rihand Dam, who was successively displaced five additional times in only five decades, all due to development and urbanization projects (Ray, 2000). In both instances, the tribal community members were unable to object or counter the displacements due to both eminent domain practices within the country, as well as their inability to fully participate in the decision-making process.

So often, the people being affected by the construction of a dam are not the ones benefiting from the existence of the dam. “Build a dam to take water *away* from 40 million people. Build a dam to pretend to *bring* water to 40 million people” (Roy, 1999). The resources

of the native population are taken from them so that water or energy produced by water can be relocated to a perhaps more dense, “advanced,” “evolved,” “civilized” group of people. The displacements are justified by the dire need of this type of construction, although alternatives are not often pursued (Thakkar, 2001). Such instances are not unique to areas only outside American borders. In the United States, the Shasta Dam in Northern California submerged most of the Winnemen Wintu tribe’s sacred ceremonial grounds in 1945. The dam was originally built to provide irrigation to farmland in the Central Valley of California. Looking to increase the size of the dam, Californian federal officials would approve of flooding the remainder of the historic tribal lands of the Winnemen Wintu. Their reasoning for the increase in size of the dam was in order to make available additional hydropower, reduce flooding, and increase the storage of water in the dam for further water to be used in irrigation. The tribe will supposedly be consulted about the project, but their dwindling population will likely not have much influence over the construction plans. In 1941, the tribe was promised land in the form of a reservation for the land that was taken from them in the initial dam construction. This land was never given to them (Young, 2008). This one example of dam construction and subsequent indigenous displacement is reflective of the picture of dam constructions around the world. Dam constructions are justified by the utilitarian philosophy of the thing that will provide the most overall benefit, rendering everything else to be affected by the construction as inconsequential.

The data on the exact amount of people that have been displaced due to development projects is actually unknown, as there has been few attempts to collects this information throughout the world, especially in India; India as a country ranks third globally for dam building, having over 4,000 dams built or being built (Ray, 2000). This does not deny the fact that these interactions do occur. Hydroelectric power development is laden with examples of

confrontation with indigenous territories. Ray also notes a World Bank review stating that 13,000 people are displaced on average per large dam created. The World Bank has assisted in loaning funds for development projects to nations all over the world; they are one of the leading proponents of dam development. They have formed a World Commission on Dams (WCD), which joins all parts of the debate on hydropower in order to determine the effectiveness of hydropower and dam development in terms of benefits to overall development (Thakkar, 2001). Himanshu Thakkar also presented that although only 26.6 percent of the projects causing displacement that the World Bank funds are large dams, large dams constitute 62.8 percent of the total amount of people displaced in World Bank projects causing displacement (Ray, 2000). Also according to Ray (2000), the numbers of displaced people are generally much smaller than the immense amount of people affected by the construction but not displaced.

Conclusion

With today's energy needs, there is no doubt that forms of clean energy are essential to a sustainable future for humans and the earth's environment. Hydroelectric power is an attractive source of clean energy because of its ability to utilize the natural resource of water in many different ways, not only for energy production. While there are many benefits to hydropower, there are many drawbacks as well. These drawbacks are exemplified in the analysis of different hydropower projects; a closer look at the long-term effects of a dam construction shows that in many cases, an alternative to hydropower may be more beneficial with all things taken into account.

The Kabini Dam in southern Karnataka, India links together many different effects of a dam construction. While the energy- as well as some of the water from the Kabini River will ultimately service Bangalore, Karnataka, the people affected by the construction of this massive structure continue to live with the first-hand consequences of such a development project. Indigenous groups were relocated, local ecosystems were changed, and an entire new social structure needed to be learned and implemented so as to encourage sustainable development in a population unaware of how to integrate into modern, "civilized" society. The scar of the Kabini Dam construction will ever be with these people. Despite how successful the efforts of Swami Vivekanada Youth Movement have been in aiding these people to provide for their own needs and to be able to acclimate to modern culture, there will forever be a memory of the past, and how life used to be. That life is now submerged, with only the Kabini Dam left to tell the story.

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Appendix

INDIAN STANDARD SPECIFICATIONS FOR DRINKING WATER IS: 10500

S.NO.	Parameter	Requirement desirable Limit	Remarks
1.	Colour	5	May be extended up to 50 if toxic substances are suspected
2.	Turbidity	10	May be relaxed up to 25 in the absence of alternate
3.	pH	6.5 to 8.5	May be relaxed up to 9.2 in the absence
4.	Total Hardness	300	May be extended up to 600
5.	Calcium as Ca	75	May be extended up to 200
6.	Magnesium as Mg	30	May be extended up to 100
7.	Copper as Cu	0.05	May be relaxed up to 1.5
8.	Iron	0.3	May be extended up to 1
9.	Manganese	0.1	May be extended up to 0.5
10.	Chlorides	250	May be extended up to 1000
11.	Sulphates	150	May be extended up to 400
12.	Nitrates	45	No relaxation
13.	Fluoride	0.6 to 1.2	If the limit is below 0.6 water should be rejected, Max. Limit is extended to 1.5
14.	Phenols	0.001	May be relaxed up to 0.002
15.	Mercury	0.001	No relaxation
16.	Cadmium	0.01	No relaxation
17.	Selenium	0.01	No relaxation
18.	Arsenic	0.05	No relaxation
19.	Cyanide	0.05	No relaxation
20.	Lead	0.1	No relaxation
21.	Zinc	5.0	May be extended up to 10.0
22.	Anionic detergents (MBAS)	0.2	May be relaxed up to 1
23.	Chromium as Cr^{+6}	0.05	No relaxation
24.	Poly nuclear aromatic Hydrocarbons	--	--
25.	Mineral Oil	0.01	May be relaxed up to 0.03
26.	Residual free Chlorine	0.2	Applicable only when water is chlorinated
27.	Pesticides	Absent	--
28.	Radio active	--	--

DRINKING WATER SPECIFICATION: IS: 10500, 1992
(Reaffirmed 1993)

TOLERANCE LIMITS

S.No	Parameter	IS: 10500 Requirement (Desirable limit)	Undesirable effect outside the desirable limit	IS: 10500 Permissible limit in the absence of alternate source
		Essential Characteristics		
1.	pH	6.5 – 8.5	Beyond this range the water will effect the mucous membrane and / or water supply system	No relaxation
2.	Colour (Hazen Units), Maximum	5	Above 5, consumer acceptance decreases	25
3.	Odour	Unobjectionable	--	--
4.	Taste	Agreeable	--	--
5.	Turbidity, NTU, Max	5	Above 5, consumer acceptance decreases	10
	Following Results are expressed in mg/l :			
6.	Total hardness as $CaCO_3$, Max	300	Encrustation in water supply structure and adverse effects on domestic use	600
7.	Iron as Fe, Max	0.30	Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures, and promotes iron bacteria.	1.0
8.	Chlorides as Cl, Max	250	Beyond this limit tast, corrosion and palatability are effected	1000
9.	Residual, Free Chlorine, Min	0.20	--	--
		Desirable Characteristics		
10.	Dissolved solids, Max	500	Beyond this palatability decreases and may cause gastro intentional irritation	2000
11.	Calcium as Ca, Max	75	Encrustation in water supply structure and adverse effects on domestic use	200

12.	Magnesium as Mg, Max	30	--	100
13.	Copper as Cu, Max	0.05	Astringent taste, discoloration and corrosion of pipes, fitting and utensils will be caused beyond this	1.5
14.	Manganese as Mn, Max	0.1	Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures	0.3
15.	Sulphate as SO_4 Max	200	Beyond this causes gastro intentional irritation when magnesium or sodium are present	400
16.	Nitrates as NO_3	45	Beyond this methanemoglobinemia takes place	100
17.	Fluoride, Max	1.0	Fluoride may be kept as low as possible. High fluoride may cause fluorosis	1.5
18.	Phenolic compounds as C_6H_5OH, Max	0.001	Beyond this, it may cause objectionable taste and odour	0.002
19.	Mercury as Hg, Max	0.001	Beyond this, the water becomes toxic	No relaxation
20.	Cadmium as Cd, Max	0.01	Beyond this, the water becomes toxic	No relaxation
21.	Selenium as Se, Max	0.01	Beyond this, the water becomes toxic	No relaxation
22.	Arsenic as As, Max	0.05	Beyond this, the water becomes toxic	No relaxation
23.	Cyanide as CN, Max	0.05	Beyond this, the water becomes toxic	No relaxation
24.	Lead as Pb, Max	0.05	Beyond this, the water becomes toxic	No relaxation
25.	Zinc as Zn, Max	5	Beyond this limit it can cause astringent taste and an opalescence in water	15
26.	Anionic detergents as MBAS, Max	0.2	Beyond this limit it can cause a light froth in water	1.0
27.	Chromium as Cr^{6+}, Max	0.05	May be carcinogenic above this limit	No relaxation
28.	Ploynuclear aromatic hydrocarbons as PAH, Max	--	May be carcinogenic	--

29.	Mineral Oil, Max	0.01	Beyond this limit undesirable taste and odour after chlorination take place	0.03
30.	Pesticides, Max	Absent	Toxic	0.001
31.	Radioactive materials a) α emitters Bq/1, Max b) β emitters Pci/1, Max	-- --	-- --	0.1 1
32.	Alkalinity, Max	200	Beyond this limit taste becomes unpleasant	600
33.	Aluminum as Al, Max	0.03	Cumulative effect is reported to cause dementia	0.2
34.	Boron, Max	1	--	5

Data from the Himachal Pradesh State Pollution Control Board