Large Dams in India

Large Dams in India:

The Missing Dimension of Science, Technology and Society (STS)

By

Thounaojam Somokanta

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Dedicated to

My Late Father, Thounaojam Shantikumar

(1950-1991)

My Mother, Sanjembam Binokumari Devi

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Thounaojam Somokanta

ABBREVIATIONS

ACTIP	Action Committee Against the Tipaimukh Project
AD	Anno Domini
AFCL	Agricultural Finance Corporation Limited
CATD	Committee Against the Tipaimukh Dam
CCDD	Citizens Concerned for Dams and Development
CCP	Churachandpur District
CEA	Central Electricity Authority
CORE	Centre for Organizational Research and Education
CWC	Central Water Commission
DSO	Dam Safety Organization
DVC	Damodar Valley Corporation
EI	Elevation
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FAC	Forest Advisory Committee
FIPAG	Forum for Indigenous People Association, Gender and Children
FRL	Full Reservoir Level
GoM	Government of Manipur
ICOLD	International Commission on Large Dams
INR	Indian Rupee
JVC	Joint Venture Company
KW	Kilowatt
MoP	Ministry of Power
MoU	Memorandum of Understanding
MPRVD	Multipurpose River Valley Project
MW	Megawatt
MWL	Maximum Water Level
NEEPCO	North Eastern Electric Power Corporation Limited
NH	National Highways
NHPC	National Hydro Power Corporation Limited
NWUM	Naga Women's Union Manipur
SIA	Social Impact Assessment
SJVN	Sutlej Jal Vidyut Nigam Limited
ST	Scheduled Tribe
STS	Science, Technology and Society

TD	Tribal Development
TML	Tamenglong District
TVA	Tennessee Valley Authority
USD	United States Dollar
WCD	World Commission on Dams
WRC	Wet Rice Cultivation

CHAPTER ONE

INTRODUCTION

The field of Science, Technology and Society (STS) is interdisciplinary in nature. It draws on "a variety of disciplines including history, philosophy, sociology of science and technology, anthropology, cultural studies, critical theory, feminist theory, gender studies, and postmodern philosophy" (Van House 2004: 3). It may also be defined as "an interdisciplinary field that is creating an integrative understanding of the origins, dynamics, and consequences of science and technology" (Hackett et al. 2008: 1). This field emerged in the 1960s and 1970s.

STS programs were established in Western universities during the 1960s: Robert Merton developed a program in the Sociology of Science at Columbia University; Derek de Solla Price was appointed Professor of the History of Science in 1960 at Yale University; Thomas Kuhn worked at the University of California Berkeley from 1961 to 1964; the Science, Technology and Society Program was set up in 1969 under the directorship of Frank Long at Cornell University; David Edge founded the Science Studies Unit in 1966; Michel Callon was the Director of the Centre for the Sociology of Innovation from 1982 to 1994. The Science Dynamics Group was set up in 1982 in Amsterdam under the leadership of Stuart Blume and the Centre for Science and Technology Studies was established at Leiden University and led by Anthony van Raan in the 1980s (Martin et al. 2012).

STS has become a well established professional discipline through the formation of academic bodies and associations. The Society for Social Studies of Science (4S), the oldest and largest scholarly society, was founded in 1975 with an international membership of over 1,200. It aims to bring together those interested in understanding science and technology in societal contexts.[1] The European Association for Studies of Science and Technology (EASST) was founded in 1981 with the aim of bringing

[1] http://www.4sonline.org/

together the diverse fields of natural science, engineering, and the social sciences.[2] Specialist STS journals, such as Social Studies of Science, were launched in 1971 with a focus on a wide range of fields, including political science, sociology, economics, history, philosophy, etc.[3] In 1976, Science, Technology and Human Values was launched with the aim of disseminating cutting-edge research in the field of science and technology studies.[4] The publication of the first handbook of STS in 1977 was a historical landmark. The second handbook was published in 1995. Similarly, the Asia Pacific region has a long history of STS networks.

STS research is more developed in Western countries. The field has recently been established in developing countries, including India. The landscape of STS seems to be a missing dimension in India. STS programs in India are still in their infancy. Universities like Central University of Gujarat, Jawaharlal Nehru University and Central University of Hyderabad offer STS programs. Many faculties and research students are working on diverse themes in STS, trying to expand STS knowledge in India.

This interdisciplinary area is an emerging field of research and study in Indian universities. The Central Government of India had taken important steps towards introducing interdisciplinary courses at undergraduate and postgraduate level. In 2001, the University Grant Commission (UGC) launched a new scheme for the establishment of new centers and institutes of excellence in study and research in various interdisciplinary areas in the sciences and humanities. Dr. Manmohan Singh urged that by "making interdisciplinary research and innovation the salient agenda of the university system, we can hope to improve our ranking amongst the top universities of the world."[5] His statement reflects the urgent need for interdisciplinary research in India to compete with other world class universities. From this brief overview, the picture of STS research in India emerges as a new pathway of research and teaching in India.

The book applies the interdisciplinary approach of STS to the context of large dams in India, particularly the proposed Tipaimukh dam project in Manipur. In the existing STS literatures, water has become a critical focus of scholarly engagement. STS scholars have also increasingly engaged

[2] http://easst.net/about-easst/
[3] http://sss.sagepub.com/
[4] http://sth.sagepub.com/
[5] https://www.ugc.ac.in/pdfnews/7938259_Annual-Report-2013-14.pdf

with questions of water (Alatout 2009; Bijker 2007; 2012; Helmreich 2011). The STS literatures in India focused on the analysis of the political economy of colonial hydraulic technology during the British rule in India, symbolizing the larger momentum of capitalism (D'Souza 2003; 2006). However, it has been exposed that the rise of capitalism during the colonial rule for 200 years had severely declined the national economy from 23 % to just over 3 %. The simple reason was, India was governed for the benefit of Britain (Tharoor 2016: 4).

After independence, Jawaharlal Nehru had committed to the development of large dam projects with the hope of fostering national economy from colonial backwards. Nehru's famous statement, "Dams are the Temple of Modern India" reflects the techno centric approach of development depicting the symbols of power, national empowerment and technocratic governance (Klingensmith 2007). Another STS scholar argues that the traditions of large dams execution in the post independent era have led to the transboundary water conflicts and geo-political tensions with lower riparian country like Bangladesh. In this connection, Somokanta (2012; 2014) has applied STS and Environmental Sociology theory to understand the transboundary water conflicts with Bangladesh as well as risks and politics of large dams in India by analyzing a case study of the proposed Tipaimukh dam project in Manipur.

Research Context

One of the greatest benefits of large dams is the generation of hydroelectricity, which remains a key driver for improving living standards. In developing countries, rapid urbanization and population growth will lead to increased demand for electrical power in the decades to come. Energy planners in many developing countries will continue to see hydroelectric dams as reliable sources of renewable electricity. Many countries rely upon hydropower for a substantial portion of their electricity.

Recently, international initiatives, including the World Summit on Sustainable Development in Johannesburg in 2002, the World Water Forum in Kyoto in 2003, the World Commission on Dams from 1997-2002, and the Dams and Development Project of the United Nations Environment Program, have reaffirmed the commitment of many governments and international agencies, including the World Bank, to hydropower development, but in a manner reflecting modern environmental concerns.

In this context, it is important to note that large hydroelectric dams are not all alike in terms of the scale of ecological hazard. Large hydroelectric projects vary tremendously in their environmental and social impacts. For example, the 500 MW Pehuenche Hydroelectric Project in Chile flooded only about 400 hectares of land with minimum damage to forest and wildlife resources and has had no water quality problems. By contrast, the Brokopondo Dam in Suriname inundated about 160,000 hectares of biologically valuable tropical rainforest and is known for its serious water quality and aquatic weed problems while providing relatively little electricity generation of 30 MW (World Bank 2003). This indicates that the risk dams present does not depend on size and capacity, but may depend rather on the quality of the Environmental Impact Assessment (EIA) and location of the dam. The above World Bank working paper illustrates that large dams are a reliable source of electricity to fulfil demand and address the power supply gap.

However, no matter how beneficial it is, each technological project brings its own ecological and social risks. Although the Tehri Dam irrigates 600,000 hectares of agricultural land and provides 270 million gallons of drinking water per day to Uttaranchal, Uttar Pradesh and Delhi, the Status Report of the Public Works Department of Tehri of 2002 estimated that the Tehri Dam would displace12,547 families, as well as cover the homes and lands of around 100,000 indigenous people. Landslides are also a common feature of the steep slopes that surrounded Tehri's reservoirs (International Rivers Network 2002).

Patrick McCully states that large dams[6] are "expressions of the dominant ideology of the technological age: icons of economic development and scientific progress" (McCully 2001). In other words, although dams remain an important option for economic development and act as symbols of technological advancement, they can also displace millions of indigenous people from their homelands and create ecological hazards. Powerful countries have a tendency to harness water resources for the generation of hydropower and this involves the exercise of forms of power and authority.

The commodification and privatization of water by constructing large dams has huge potential for generating ecological hazards. Many corporate

[6] The International Commission on Large Dams (ICOLD) defines large dams as "'those having a height of 15 meters from the foundation"; there are approximately 45,000 large dams worldwide.

sectors have invested large amounts of capital in dam construction. Although dams have positive aspects, they often run the risk of violating fundamental and human rights and entail geological and seismic risks.

It is clear that development projects such as dams bring prosperity to countries, but questions of benefit and profit sharing remain. Who benefits and who does not? Why are most large dams built in tribal areas? It is therefore necessary to explore the environmental and social aspects of large dams in global and national context.

Large dams are associated with negative impacts on ecosystems and it is estimated that they have had negative environmental impacts on 67% of the locations in which they have been built. Large dams have led to the loss of a number of animal species and the loss of forests and wildlife habitat. The Aral Sea previously supported 24 species of fish and a population of 10,000 people living in fishing communities. This inland sea lay between Kazakhstan in the north and Karakalpakstan, an autonomous region of Uzbekistan, in the south. Dams were constructed on the sea for irrigation and cotton cultivation. In 1960, its water volume was reduced to about 25%, increasing salinity and wiping out fish populations. The environmental damage caused has been estimated at 1.25 billion USD annually.

By the end of the twentieth century, the world's governments had built more than 45,000 large dams. The overwhelming majority of these, around 40,000, were constructed after 1945. These dams, and the reservoirs behind them, have displaced somewhere between 40 and 80 million people from their homes and lands. There are dams on approximately 60% of the world's rivers and nearly every large river has at least one large dam.

The social risks of large dams include risks to people's livelihoods, cultures, displacement, and the violation of fundamental and human rights. Displacement may involve both physical removal from land and the removal of livelihoods. Physical displacement is involuntary and involves coercion, while livelihood displacement brings an emotional toll for the people affected. Sometimes, physical displacement leads to killings. About 376 Maya Achi people were killed during their eviction from the Chixoy Dam site in Guatemala. Physical displacement has occurred in 68 out of 123 dams, which constitutes 56% of cases (WCD 2000).

Large dams have had devastating social impacts on people and livelihoods in Asia, Africa and Latin America, where river systems have a long history

of supporting the economies, cultures and ways of life of large numbers of people and diverse communities (WCD 2000: 102).

From 1950 to 1990, in India and China large dams displaced between 26 and 58 million people. Tribal populations constituted 40% to 50% of people displaced by development projects in India. Over the past 50 years, 3,300 big dams have been built in India. In 1991, an estimated 180,000 people were displaced by the Hirakud Dam and 20,500 people by the Sardar Sarovar Dam (Pattanaik, Das and Mishra 1987).

India saw strong initiatives for dam construction taken after independence. Jawaharlal Nehru showed his commitment to building a new, powerful, postcolonial nation through the modern technology of dams as a means of generating hydropower and increasing irrigation. In the first five year plan, dams were the central point of discussion. Nehru was a modern man who believed in science, modernization and rationalization as keys to development. He laid the foundation stones for dam projects including Hirakud, Bhakra Nanga and Tehri (Klingensmith 2007).

In India, the setting up of the Damodar Valley Corporation (DVC), modeled on the Tennessee Valley Authority (TVA), was an important achievement. In the context of Northeast region of India, the Government of India put great effort into converting the northeast into a powerhouse by utilizing its hydropower potential (Hussian 2008). The region is known as a hotspot of biodiversity. The region has huge potential for hydropower as the Brahmaputra and Barak rivers flow through the region.

In this book the case study of the proposed Tipaimukh Dam in Manipur has been selected to understand the linkages between science, technology, politics and environmentalism.

Research Problem

There are two levels to this research problem. One is at the practical and the other is at the theoretical level. The problem at the practical level deals with the current debates and controversies over the Tipaimukh Dam. The lack of theoretical insight from STS and the sociology of risk into the issues of the dam is the primary research problem. The Tipaimukh Dam is not just a massive concrete entity—political interests revolve around the dam. The risks and politics of the dam is the core of this research. This dam will lead to the marginalization of indigenous people. It will increase

the likelihood of fundamental and human rights violations, increase the risk of earthquakes, and damage biodiversity.

The dam will permanently submerge an area of 275.50 km^2 of land and displace 1,461 Hmar families in Manipur. It will further violate the human rights of the Zeliangrong and Hmar tribes by displacing them from their land and depriving their right to life and the enjoyment of their cultural heritage. National Highway 53, which is a major transport artery through Manipur and two major bridges over the Barak and Makru rivers, will be submerged (AFCL 2004).

The dam site is located in a high risk earthquake zone (Ranjan 2003). As far as environmental risks are concerned, the dam will submerge the habitat of the Bengal tiger and harm many endangered species. The dam will also affect the Zeilad Wildlife Sanctuary and the habitat of the Akhoipuina (Red legged falcon), a migratory bird that visits the Barak River annually.[7]

Rationale of the Study

Interdisciplinary research from an STS perspective opens up a new field in India. STS, in an academic sense, is a discipline that India urgently needs, but has yet to access (Visvanathan 2000: 1). The STS perspective aims to develop a deep understanding of the changing relationship between technology, society and the environment.

There has not yet been appropriate research undertaken under the STS framework in the context of technological projects like dams, industry, and nuclear power plants. STS is a challenging discipline in India in which the problems and issues of research can be analyzed from a novel perspective. This book analyzes the Tipaimukh Dam from the perspective of STS and the sociology of risk.

Using the combined perspective of STS and the sociology of risk is an original research procedure with new research outcomes. My analysis of the Tipaimukh Dam is positioned in the framework of Beck's risk society, Langdon Winner's work on politics and artifacts, and Andrew Feenberg's democratization of technology. These combined perspectives provide the rationale of this book.

[7] Memorandum Submitted to the Prime Minister of India, New Delhi, dated 27th November 2006 by Member of Parliament, Outer, Manipur Government of India.

Research Questions

1. What are the environmental and social risks of the Tipaimukh Dam?
2. What roles do politics and stakeholder participation play in the dam?
3. What are the roles of civil society and environmentalism in opposition to the dam?

Research Objectives

1. To explore the environmental and social risks of the Tipaimukh Dam. This includes broad issues of lost biodiversity, increased seismic risk, displacement, and the violation of human rights.
2. To examine the political dimensions, decision making processes and stakeholder participation related to the dam. This highlights the political interests of the Manipur government and proponents of the dam who are in favor of the dam, aiming to enhance economic growth of the state. This book examines negotiation between the Joint Venture Company (JVC) of the Tipaimukh Dam, civil society, and affected stakeholders.
3. To examine the role of environmentalists in the democratization of technology. Environmental activists have arisen as a democratic means to promote sustainable development. This covers the environmental movement and civil society organizations in Manipur, which seek alternative forms of development.

CHAPTER TWO

LITERATURE REVIEW

A literature review has the aim of reviewing the current state of knowledge on various aspects of dam research and this book attempts to fill a gap in this research. This literature review focuses on the work of McCully, Scudder, Cernea, Cummings, and Caine at the global level; and Klingsmith, D'Souza, Nayak, Pathak, Baviskar, and Khagram at the national level.

McCully traces the history of the WCD to assess the rate of dam building in a global context. He finds no reliable or up to date data on changes in the annual rate of dam building since the mid 1990s. The WCD has used the International Commission on Large Dams' (ICOLD) data to show the rate at which large dams have been commissioned at regional and global levels. According to these figures, the worldwide rate of commissioning per decade peaked in the 1970s at more than 5,400 and has since fallen to just over 2,000 (McCully 2001).

According to McCully, massive or large dams are much more than simple machines to generate electricity and store water. They are concrete, rock and earth expressions of the dominant ideology of the technological age and act as icons of economic development and scientific progress: he presents them as expressing the relationship between power and water (McCully 2001: 2-3). Dams have been potent symbols of patriotic pride and of the taming of nature through human ingenuity. President Franklin D. Roosevelt, paraphrasing Julius Caesar at the inauguration ceremony of the Hoover Dam on 30th September 1935, said "I came, I saw and I was conquered" (McCully 2001: 1).

McCully assessed the human impacts of large dams in terms of health, community, and tradition, and ecological impacts in terms of disturbances to food chains, flooding, and habitat destruction. McCully examines the challenges and experiences of ancient and modern dam building. He also tackled the complex array of technical and sociological factors of dam operation (Lanza 1997). McCully found that dams have had massive negative impacts on society and nature. He also found that their benefits

have been exaggerated and could often have been produced by other less destructive and more equitable means (McCully 2001).

Scudder's work (2005) examined river basin residents impoverished by large dam projects. He offers positive practical recommendations, centering on adherence to the WCD's "seven strategic priorities" in those cases where dam construction is proposed. These include: gaining broad public acceptance through transparent, participatory decision making processes; consideration of a broad range of alternatives to meet perceived needs; maximizing the potential of existing structures before starting new large-scale projects; giving weight to design features that protect riverine systems while assuring sustainable livelihoods for basin occupants; sharing the benefits of dam operation in equitable ways among all segments of affected populations; ensuring compliance with commitments made at the initiation of projects; and sharing river water equitably among riparian nations.

Scudder (2005) reviewed historical disputes over large dam projects after World War II. He critically examines the views of Gamal Abdel Nasser Hussein and Jawaharlal Nehru on dams. Nasser, the second president of Egypt, considered a large dam to be "a new pyramid for the living," serving as a symbol of progress and prestige for a developing country. Similarly, Nehru considered dams to be "the temples of modern India," providing reliable water supplies, electrical power, flood control, and fisheries. Scudder focuses on the processes of nation building in Egypt and India through generating hydropower as a means to enhancing their economies. He also found there to be a lack of institutional commitment and capacity among governments and responsible authorities to address complex resettlement issues.

Scudder proposed a theoretical model of a successful resettlement process. This is comprised of a four-stage temporal framework: a lengthy pre-settlement period; the initiation of physical removal—living standards are likely to drop as people become risk-averse; the post-settlement period of community formation, greater risk-taking, and economic development; and the handing over to the second generation of settlers with full integration of the population into the political economy of the affected region.

In addition, Scudder's model provides an important mechanism for assessing when dams are an acceptable option and when they are not: how the decision-making process should be structured and should a dam be

found to be a good option, how to work out a planning, implementation and asset handling process that ensures the majority of resettled persons become project beneficiaries (Howe 2005).

Scudder (2005) performed a statistical survey of 50 resettlement cases for which accompanying data on social and economic conditions could be found. This analysis offers a major extension of research into resettlement and highlights how few the successes are in comparison to the failures. The major causes of failure of resettlement may be found in: failure to involve those to be displaced in the planning process; failure to provide real opportunities for improvement in living standards for displaced populations; insufficient funding, lack of resettlement staff expertise and experience; and lack of political will by government and project authorities to follow through on resettlement plans and promises.

In a few cases where resettlement has been properly implemented, it has become the largest single component of project cost. Monetary compensation for settlers has often been used as a means to move them and competition often arises between intended settlers and more aggressive immigrants attracted to the new reservoir and settlement facilities (Scudder 2005). Scudder analyzed mechanisms of resettlement in detail and explored how project authorities address the issues of resettlement and rehabilitation policy.

Scudder (2005) looked at the benefits to river basin communities from resettlement in terms of irrigated agriculture and reservoir fisheries. The resettlement of indigenous people into urban areas and the resettlement of large urban populations (as with the Yangtze) were found to be problematic. He gave detailed assessments of the Mahaweli Project in Sri Lanka, Kariba in Zambia, Sardar Sarovar in India, the South Okavango Integrated Water Development project in Botswana, and the Grande Baleine Project in Quebec.

He discovered that common shortcomings in these cases included: the failure of donor organizations to intervene when project intentions and promises were not kept; failure to provide for independent project monitoring and evaluation; failure to include major stakeholder groups; inadequacy of current guidelines followed by bilateral and multilateral agencies; the absence of proper post-analyses of projects. Risk analyses concerning flood risks, health risks, impacts on drawdown agriculture, and the failure of irrigation during drought are seldom carried out. Strong criticisms have been leveled against the World Bank, the United States

Army Corps of Engineers and other international organizations in connection with these shortcomings (Howe 2005).

Scudder (2005) sees large dams as "flawed yet still necessary development options"—flawed because of their often ignored negative social and environmental impacts, but necessary in meeting short and medium term human needs. Dams provide irrigation for farmers and electricity and drinking water for cities. In countries like Nepal and Laos, large dams act as sources of foreign exchange by allowing the export of excess hydroelectricity (Mathur 2008). For Scudder, dams remain an important development option, but should only be built in limited numbers and within a strong institutional framework (Scudder 2005).

Michael Cernea (1991) considers forced population displacement as a result of dam construction to be the most serious social consequence of water resource development (Cernea 1991). He states that development-induced displacement causes more refugees globally than wars and natural disasters (Cernea 1996: 18). Human dislocation, impoverishment and community rehabilitation are perhaps the gravest concerns surrounding dams in developing countries (Cernea 1991).

The impoverishment of displaced people is often a primary result of involuntary population resettlement. To counter this risk, protecting and reconstructing the livelihoods of displaced people is a central requirement for an equitable resettlement program. Cernea's "Risk and Reconstruction model" is based on the following eight general sub-processes that lead to the rapid onset of impoverishment: landlessness; joblessness; homelessness; increased morbidity and mortality; food insecurity; marginalization; loss of access to common property; and community disarticulation (Cernea 1991).

Cummings (1990) conducted research on hydroelectric developments in the Amazon. He chose two regional cases: Manaus and the Balbina hydroelectric dam in Amazonas; and Altamira and the proposed hydroelectric complex on the Xingu River in Para. The example of the Amazon serves to highlight key aspects of the conflict surrounding conservation, people, power, heritage, and modernization. Cummings' three month field study raised questions on the resolution of these conflicts in favor of the native peoples and environments of the Amazon. He examines the techniques used by Amazonian peoples to stop industrial development and to strengthen the rights and values attributed to Amazonia and Amazonians (Cummings 1990).

Cummings (1990) employed three approaches to obtain information relevant to his research. Firstly, he gathered facts relating to Amazonian hydroelectric development from available resources. Secondly, he interviewed ecologists, human rights activists and some progressive politicians. As there were insufficient published resources on the Amazon dam projects, his research primarily depended on direct interaction with planners and the people affected. Thirdly, he visited the Balbania dam site and the affected areas twice: once on an "official" tour and once under the guidance of a social-work team.

Cummings (1990) suggested procedures for future developments undertaken in Amazonia. He considered an acceptable development policy to be one that offered benefits to the people directly affected and the maintenance and care of the environment. Cummings suggested several alternatives for national energy production and considered the replacement of imported petroleum to be essential to Brazil's economic development. Coal only has the potential to provide a small contribution to Brazil's national energy solution. Biomass could also supply a limited amount of energy (Cummings 1990).

Rosa and Schaffer (1998) considered firewood to be an important and viable source of rural fuel. Natural gas was seen as one of the sources of energy in Brazil with the most potential. Other options, such as solar energy, offer prospects for future energy production—the technologies for their full utilization are currently unavailable to Brazil (Rosa and Schaffer 1998). The development of small hydropower projects and energy conservation improvements are the most practical options to secure Brazil's energy supply. Rosa and Schaffer point out that small hydropower projects have lower costs of construction and shorter time requirements when compared to larger hydropower projects. Small hydroelectric projects may have only limited environmental impacts and may be considered appropriate technology (Cummings 1990).

Caine (2010) states that the story of the Aswan High Dam exposes the history of technology, the management of natural resources, the legacy of colonialism, and the politics of science (Caine 2010). White maintains that the Egyptian government had three reasons for building the Aswan Dam: to control flooding; to store water from periods of high flow for release in times of low flow; and to use released water to generate hydroelectric power (White 1988). The completion of the dam in 1970 had major impacts on the flow of the Nile, the geography of the Nile Valley and the

people of Egypt. The dam converted old methods of basin irrigation into perennial irrigation (Waterbury 1979).

A number of impacts were not adequately addressed by Nasser's government. The dam had three major environmental negative impacts: the trapping of the Nile's silt in Lake Nasser; water loss through evaporation and seepage; and the decline in water quality due to salinization, pollution, and increased runoff. On a human level, the dam had two major negative impacts: the displacement of Egyptian Nubians and the rise of disease amongst Egypt's rural population (Caine 2010). Waterbury suggests that historians and political scientists see Aswan High Dam as the physical manifestation of President Nasser's hegemonic rule over Egypt and material evidence of his consolidation of Egyptian power into a technocratic, centralized government (Waterbury 1979).

Caine (2010) suggests that environmental history has tended to frame the Aswan High Dam as a case study in the problem of "human exceptionalism," that is, the tendency of humans to view themselves as distinct from nature and capable of controlling it (Caine 2010). Understanding the capacity of large dams to serve symbolically as "shining monuments to progress and prosperity," Egyptian planners conceived of and promoted the Aswan High Dam as Egypt's one-way ticket to economic and technological modernity (McCully 2001)

He theorized the Aswan High dam within the framework of Bruno Latour's concept of "things"—this reframes dams as expansive sites of material and discursive practices rather than physically defined engineering structures. By understanding dams as "things" and approaching them as multifaceted, variegated entities, planners, policymakers, and engineers can begin to make better management decisions based on more complex, nuanced thinking (Caine 2010).

The Kariba dam was constructed before independence, between 1955 and 1959, and is one of the largest dams in the world. The dam was constructed on the Zambezi River (WCD 2000). The construction of the dam displaced 57,000 Tonga farmers and flooded 5,580 square km of land (Hughes 2006). The Kariba dam exploited mineral and other resources for the benefit of industrialized Western nations so that they could maintain a high standard of living—developing countries often allow their environment to be exploited for short term gains. The indigenous people were promised effective irrigation, improved fish production and other benefits, but these remain unfulfilled (Balon 1978)

Muyambo, Lacroix and Euvrard (2003) analyzed the Ruti Dam, located in a semi-arid region of Zimbabwe, which has used technological innovation to promote sustainable development by providing irrigation facilities to local communities. Construction of the Ruti Dam was supported by the local people because improvement of access to water and poverty reduction were major local concerns. The heightening of the Ruti Dam offers an outstanding example of a successful project in its combination of innovative technical solutions with financial support from French and the willingness of the government of Zimbabwe.

The dam's technical constraints were solved by the use of a fuse gate system, which has led to a 20% increase in storage capacity without requiring any work to the dam embankment. The particularly long spillway necessitated the installation of 256 fuse gate units to form a watertight barrier on top of the existing spillway sills. This challenging project was completed within one and a half years. The additional storage will be used to extend the area of irrigated land around the dam and further downstream. It will also ensure a regular source of income to the local communities involved in the project. As such, the project promotes sustainable development (Muyambo, Lacroix and Euvrard 2003).

Klingensmith (2007) suggests that dams were built as political symbols of progress, technocratic governance, national empowerment and achievement. He studied the historical context of dams built in the 1940s, 1950s, and 1960s from a political perspective. The DVC, modeled on the TVA, was widely regarded as the paradigm for 'world reconstruction' and was perceived to be at the forefront of the struggle for 'development.' The TVA acted as a model for transformational development and was perhaps the first icon of development.

Klingensmith's work shows how American river control projects influenced thinking on development along the Damodar and documents how development policies and actions (the construction of dams, power stations, and irrigation canals) are linked to the ideological challenges posed by nationalism, liberal colonialism and post-war liberal modernism. After 1947, the anti-colonial, middle-class nationalism of India's colonially trained professional elite showed their enthusiasm for large dams. Klingensmith reviewed the role of technocrats in this, such as Nehru, Kholsa and Sain. The Congress party wanted to magnify their power and authority by undertaking big dam projects. Nehru's commitment to modern science was key to the success of dam projects in the post-

independence era and dams became important parts of the First and Second Five-Year Plans.

He explored the significant role that dams have played in the development efforts of the American and Indian governments. His work seeks to understand the political meanings attached to the building of dams and to explain how dams became nationalist icons. He traces how political cultures have intersected the flow of rivers, ecosystems and human communities. The politics of dam building is a result of overlapping discourses on development, nation, and modernity. Dams in the 21st century have been the result of national and transnational public policy conversations (Klingensmith 2007).

D'Souza (2003) traced the history of the emergence of multi-purpose river valley development (MPRVD) in India by examining the case of the Mahanadi River. The global model for MPRVD was pioneered in the United States in the early 1930s with the establishment of the TVA.

In the Indian context, he argues that the adoption of MPRVA was inextricably linked to the political economy of decolonization and nationalism. The decision to dam the Mahanadi River at Hirakud and the importation and adoption of MPRVD into British India was not just emblematic of a consensus between fledgling Indian industrial capital, the colonial government and certain sections of the nationalist leadership. More significantly, it was in sync with the larger momentum of capitalist restructuring during that period.

He attempts to offer a corrective to the notion that Jawaharlal Nehru's sense of monumentalism or personal attraction to the "modern" was the main vectors for large dam construction in post-independence India. He argues that MPRVD schemes were introduced in India in a political context where Indian capital and the colonial state were developing a new rhetoric of and paradigm for rule (D'Souza 2003).

Arun Kumar Nayak (2010) examined the movement against the construction of the Hirakud Dam in Orissa. In his work it is evident that the anti-Hirakud Dam movement was unsuccessful due to the lack of involvement of Non-Governmental Organizations (NGO), allied transnational advocacy networks, legitimized global norms on human rights, indigenous communities, and environmental lobbies (Nayak 2010). Domestic resistance to the Hirakud Dam was too weak politically to