

Comparative Analysis of Capacities and Vulnerabilities for Dam-Induced Flooding: The Case  
of Akosombo Dam in Ghana and the Mactaquac Dam in Canada

By

David Tanoh Aduhene

Submitted in Partial fulfillment of the requirements for the degree of Master of Development  
Economics

at

Dalhousie University

Halifax-Nova Scotia

August 2024

Dalhousie University is located in Mi'kma'ki, the  
ancestral and unceded territory of the Mi'kmaq.

We are all Treaty people.

© Copyright by David Tanoh Aduhene, 2024

## TABLE OF CONTENT

<b>TABLE OF CONTENT</b> .....	ii
<b>List of Tables</b> .....	iv
<b>List of Figures</b> .....	v
<b>ABSTRACT</b> .....	vi
<b>List of Abbreviations Used</b> .....	vii
<b>Acknowledgment</b> .....	viii
<b>Chapter 1: Introduction</b> .....	1
<b>Chapter 2</b> .....	4
Comprehensive Approaches to Regional Development: The TVA Model and Influence of the Big Push Theory of Industrialization .....	4
Implementation of the TVA and the Big Push Agenda.....	4
Critical Evaluation and Lessons Learned from the TVA and the Big Push Strategy.....	7
<b>Chapter 3</b> .....	9
Influence of the TVA Model in a Developing Country: The Akosombo Dam Project .....	9
Background to the Volta River Project-Akosombo Dam.....	9
Political Economic Factors during the Volta River Project in Ghana .....	11
Financial Resources for the Volta River Project .....	12
Akosombo Dam Floods .....	16
Economic Impact of the Akosombo Dam Floods.....	17
Destruction of Infrastructure.....	17
Effects on Livelihoods.....	18
Health Impact.....	18
Social Impact of the Akosombo Dam Floods .....	19
Critical Evaluation and Lessons .....	19
Lessons from the Volta River Project.....	20
<b>Chapter 4</b> .....	21
Regional Development in Canada: The Influence of TVA on the Mactaquac Dam Project .....	21
Regional Development in Canada .....	21
The Atlantic Development Board (1962-1969).....	24
The Agricultural Rehabilitation and Development Act .....	24
The Fund for Rural Economic Development.....	25
The Mactaquac Regional Development Plan .....	26
The Mactaquac Dam Project financing .....	28

The environmental and social costs associated with the Mactaquac Dam Project .....	30
Mactaquac Dam Flood.....	31
Effect on Infrastructure .....	32
Effect on Agriculture.....	33
Effect on Healthcare .....	33
Evaluation and Lessons from the Mactaquac Dam .....	33
Lessons from the Mactaquac Dam.....	34
Section II: Opportunity Cost of Dam Construction-Akosombo Dam and the Mactaquac Dam .....	35
Summary of Chapter .....	37
<b>Chapter 5 .....</b>	<b>39</b>
Early Warning Systems and Economic Mitigations for Disaster Victims .....	39
Components of Early Warning System.....	40
Insurance as an Economic Incentive for Disaster Victims.....	41
Lessons for Ghana on Early Warning System and Flood Insurance.....	42
Summary of section.....	42
Section II: Capacities and Vulnerabilities Analysis of Disaster Victims .....	43
Categories of Capacities and Vulnerabilities .....	44
Physical or Material Capacities and Vulnerabilities.....	44
Social or Organizational Capacities and Vulnerabilities .....	44
Motivational and attitudinal capacities and vulnerabilities .....	45
Physical/ Material Capacities and Vulnerability .....	47
Social/Organizational Capacities and Vulnerabilities .....	47
Motivational/Attitudinal Capacities and Vulnerabilities .....	48
Section III: Discussion and Insights and Lessons .....	48
Useful Lessons for Future Projects based on the Akosombo and the Mactaquac Dam construction.....	50
Comprehensive Evaluation of Projects before implementation .....	50
Adequate financial Resources before commencement .....	51
Comprehensive Evaluation of Projects .....	51
Renewable Energy for Future Projects .....	51
<b>Chapter 6 .....</b>	<b>53</b>
Conclusion and Discussion.....	53
Policy Recommendations.....	55
<b>REFERENCES.....</b>	<b>57</b>

### **List of Tables**

Table 3. 1: Cost of construction of the Akosombo Dam	25
Table 4.1: Cost of Construction of the Mactaquac Dam	30
Table 5.1: Capacities and Vulnerabilities Matrix	48

## **List of Figures**

Figure 3.1: The Volta River Project-Akosombo Dam	17
Figure 3.2. Submerged Mepe Township from the Akosombo Dam Spillage in Ghana	18
Figure 4.1: Map of New Brunswick with Mactaquac Dam located over St. John River	36
Figure 4.2 Mactaquac Dam floods	47
Figure 5.1: Elements of warning chain based on Werner (2011) and Carsell (2004)	40

## **ABSTRACT**

The Tennessee Valley Authority Project was the first integrated and comprehensive development plan undertaken by the Tennessee Valley Authority as part of the effort to develop the Tennessee Valley basin by the US government. Historically, the Akosombo Dam Project and the Mactaquac Development Project can be traced to the Tennessee Valley Authority which is a large-scale multipurpose river development project initiated in 1933 in the Tennessee River Basin. This project was unique not only in size but the fact that it incorporated the development of other sectors of the economy to attain a greater output from the physical and social changes in the livelihoods of the people caused by the dam's construction. Notwithstanding the benefits associated with such large-scale infrastructure projects such as dam construction, there are challenges related to such dams. While the cost of such infrastructure projects may be considered to be high at the initial stage, other challenges such as dam floods leading to the displacement of downstream communities are also recognized as some of the dangers associated with such large-scale infrastructure projects. The Akosombo Dam and the Mactaquac Dam have both experienced floods since their construction in 1965 and 1968, respectively. However, the Mactaquac Dam Project Authorities have been successful in handling such disasters since their last floods in 1970 while that of the Akosombo Dam has occurred more than ten times since its construction. The study focuses on exploring the useful lessons that can be drawn from the two projects which were influenced by the Tennessee Valley Project based on their weakness of flooding. The study revealed that while flooding has become a major challenge for the construction of these two dams, future projects should engage in a comprehensive analysis of the whole project before its implementation. It is also useful for future projects to make use of renewable energy sources rather than relying on such dam construction which has the possibility of flooding due to climate change.

**Keywords-Tennessee Valley Authority, Akosombo Dam, Mactaquac Dam, Floods, Renewable energy sources**

## List of Abbreviations Used

ADA	Area Development Act
ADB	Atlantic Development Board
ADF	Atlantic Development Fund
ADP	Atlantic Development Program
ALCAN	Aluminium of Canada Ltd
APEC	Atlantic Provinces Economic Council
ARDA	Agricultural Rural /Rehabilitation and Development Act
BACO	British Aluminium Company
CIC	Community Improvement Corporation
DREE	Department of Regional Economic Expansion
EEC	European Economic Community
FRED	Fund for Rural Economic Development
GDP	Gross Domestic Product
TVA	Tennessee Valley Authority
EWS	Early Warning System (EWS)
U.S.	United State of America
VALCO	Volta Aluminum Company
VRP	Volta River Project
EXIM	Export-Import Bank
PFRA	Prairie Farm Rehabilitation Act and the
MMRA	Maritime Marshland Rehabilitation Act

## **Acknowledgment**

I wish to thank my supervisor, Professor Ian McAllister, who inspired me and has provided valuable suggestions on this academic journey of pursuing the thesis option of this academic program. I also thank Professor Dozie Okoye for his advice and useful comments as well as suggestions for this thesis and Professor Wimal Rankaduwa for motivating me to push on to complete this project.

I wish to thank my family who always gave me emotional support and made education a priority, my colleagues from the MDE program for making this program interesting as we share insights, and God for the strength to push on to complete this program successfully.



## **Chapter 1: Introduction**

The Tennessee Valley Authority Project was the first integrated and comprehensive development plan undertaken by the Tennessee Valley Authority as part of the effort to develop the Tennessee Valley basin by the US government. It was considered to be a multi-purpose development project aimed at improving the economic conditions of people living in the Tennessee Valley area through industrialization and the provision of cheaper electricity.

Historically, the Akosombo Dam Project and the Mactaquac Development Project can be traced to the Tennessee Valley Authority which is a large-scale multipurpose river development project initiated in 1933 in the Tennessee River Basin. This project was unique not only in size but the fact that it incorporated the development of other sectors of the economy to attain a greater output from the physical and social changes in the livelihoods of the people caused by the dam's construction (Liel, 2011; pp. 2320-2331). The Tennessee Valley Project later became a model for similar river developments around the world and resulted in its influence on the Akosombo Dam in Ghana and the Mactaquac Project in New Brunswick in their earlier stages of construction.

Both the Volta River Project and the Mactaquac Dam project were somewhat influenced in their early days by the Tennessee Valley project and the Big Push strategy and theories that underpinned that development approach. Notwithstanding the benefits associated with such large-scale infrastructure projects such as dam construction, there are challenges related to such dams. While the cost of such infrastructure projects may be considered to be high at the initial stage, other challenges such as dam floods leading to the displacement of downstream communities are also recognized as some of the dangers associated with such large-scale infrastructure projects (Costa, 1985; pp. 1-2). Because these large-scale projects insert millions of financial resources into their local economies and the projects themselves, they are often

touted as successful and beneficial to the regions that host them. The replication of such projects not only becomes acceptable, but they are sometimes perceived as an altruistic act by those involved in its planning, financing, and project implementation (Tilt, Braun, & He, 2009; pp. 249-257). The ability of these infrastructure projects to provide local industries and households with a power supply for production and household consumption is often mistaken for success and interestingly, most development and infrastructure projects are planned and assessed under this assumption (Turner & Xue, 2018; pp. 783-805).

The Akosombo Dam and the Mactaquac Dam have both experienced floods since their construction in 1965 and 1968, respectively. However, the Mactaquac Dam Project Authorities have been successful in handling such disasters since their last floods in 1970 while that of the Akosombo Dam has occurred more than ten times since its construction (Perera et al., 2021; pp. 11-25). What useful lessons can the Volta River Project management take from the successful management of the Mactaquac Dam? For example, while the Mactaquac Dam Project has effective early warning systems for detecting the occurrence of potential floods and providing the necessary information for downstream communities, the Akosombo Dam Project has no effective early warning system to detect the occurrence of floods leading to the devastating impact of floods on downstream communities (Mioc et al., 2015; pp. 183-202). Can the Akosombo Dam Project also provide useful lessons for the Mactaquac Dam Project based on Capacities and Vulnerabilities Analysis of affected communities downstream? What are the opportunity costs associated with the construction of the Mactaquac and the Akosombo Dam? What lessons can these two projects provide for the future development of such projects in other jurisdictions?

Based on the problems identified above, this study focuses on the influence of the Tennessee Valley Authority on the construction of the Mactaquac Dam Project and the

Akosombo Dam. The study also provides useful lessons that these two infrastructure projects can take from each other in building resilience among downstream communities.

Chapter 2 provides a brief history of the TVA project and the Big Push Strategy that underpinned the use of that development approach. It further outlines some lessons to be learned from the use of the Big Push strategy of industrialization as well as its associated strengths and weaknesses of this development approach.

Chapter 3 outlines the influence of the Tennessee Valley Authority (TVA) on the construction of these two mega projects. The differences in financing of these large-scale projects between the Akosombo Dam and the Mactaquac Dam projects are also compared in this chapter. The breakdown in the allocation of financial resources for these two projects is outlined with the help of Tables.

Chapter 4 provides an overview of the influence of the Tennessee Valley Authority on the construction of the Mactaquac Dam and the challenges associated with the project such as flooding and its impact on the livelihoods of people downstream.

Chapter 5 provides the role of Early Warning Systems in disaster management and the role of economic incentives in flood. The opportunity costs of such infrastructure projects are assessed in this chapter. Useful lessons of Capacities and Vulnerabilities are assessed in this chapter with a focus on Ghana and Canada based on the experiences of downstream communities. The chapter also presents useful lessons for future projects based on the experiences of the Akosombo Dam and the Mactaquac Dam.

Chapter 6 provides a summary of the whole study and the lessons that can be learned from each project based on the successes and failures associated with them. The chapter also provides conclusions based on key points in the study as well as policy recommendations for future projects.

## Chapter 2

### Comprehensive Approaches to Regional Development: The TVA Model and Influence of the Big Push Theory of Industrialization

The installation of Franklin D. Roosevelt as the President of the United States at the beginning of 1933 led to the move to immediately demonstrate the Federal government's commitment to helping the many Americans who had become unemployed due to the Great Depression. Based on this need for development, the Tennessee Valley Authority (TVA) was chartered within the first 100 days of the Roosevelt administration (Johnson, 2017; pp. 2-4). The TVA was hailed as having "accelerated and intensified a scientific approach to agricultural and forest management", the development of a river basin, and the conservation of natural resources (Rechichar & Fitzgerald, 1984; pp. 223-248). The TVA became the model that inspired the planners and advocates of the development of the Volta River Project in Ghana and the St. John River in New Brunswick. Despite the differences between the Volta River Project and the Mactaquac Development Project from the Tennessee Valley Project, all three projects share a similar weakness in that they failed to generate much of the promised industrial linkages for which they were purposely established (Neuse, 1983; pp.491-499). The current chapter provides an overview of the Tennessee Valley Authority and how it was influenced by the Big Theory of Industrialization as well as the strengths and weaknesses associated with this theory of industrialization.

#### Implementation of the TVA and the Big Push Agenda

The primary purpose of the Tennessee Valley Authority was to produce electricity to supply the seven surrounding states. These states included Parts of Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia. Additionally, the TVA mandate in 1993 was to "improve the navigation of water flow and to provide flood control of

the Tennessee River; to provide for reforestation and the efficient use of marginal lands in the Tennessee Valley; to provide for national defense through the creation of a corporation for the operation of Government property at Muscle Shoals in Alabama” (Bradshaw, 1988; p. 126).

The TVA was implemented as a result of economic indicators that demonstrated that the region required sustainable development activities. The Southern Appalachia hills were inhabited by poor white farmers with an average family income of less than 44% of the US average (Lilenthal, 1953; p.36). The region suffered from severe soil erosion due to the combination of steep slopes and outdated farming methods. The region also lacked alternative employment opportunities, while economic development was retarded by high electricity practices and poor transportation, healthcare, education, water and sewerage facilities (Moeller, 1976; pp. 308-312).

Idealists in the Regional Planning Association of America proposed to the Federal government during the 1920s to plan for the social and economic development of rural areas, to reduce the effects of the expansion of the unhealthy and overcrowded urban-industrial centers of the North. Some of the ideas centered on using the Tennessee River basin as a unit for organizing an integrated regional development for the states in the TVA area and had been adopted by many early sponsors of the individual TVA projects (Bradshaw, 1988; p.127). The political need and opportunity for action, the means of dealing with the problem, and the practical technological and political factors, all came together as the government envisaged economic and social growth on a large and expanding scale. TVA was, at the time, considered to be a beginning.

The TVA was however faced with controversies at the beginning due partly to the fact that it was imposed on the region by the US Congress and that it did not consider the needs of the local farmers making them defensive and conservative in their attitudes, especially when

some of the best fertile lands were being drowned. This constituted a weakness in the Big Push Theory of Industrialization in the Tennessee Valley basin. Another challenge associated with the Tennessee Valley Project was the appointment of the three-member board of directors directly by the president- a decision-making structure that left the public without a say in the actions of the Authority and this constituted a major weakness in the use of the Big Push Theory of Industrialization in assessing the TVA Project (Ansar, 2018; pp. 385-395).

The TVA construction and operations were originally financed by Congress with appropriate funds. The TVA enjoyed the extraordinary liberty of self-authorization power despite being funded on annual congressional appropriations. This exonerated the TVA from the political constraint of having first to obtain authorization and appropriations from Congress as other US agencies do. However, there was an oversight of the TVA activities by appropriation committee members (Barbour, 1937; pp. 393-405). The TVA entered its major phase of growth and its contribution to economic change within its basin became important in the 1940s. The TVA concentrated on providing cheap electricity and improved navigation, rather than on the whole set of social and economic possibilities which had been opened up by the 1933 legislation. This became a weakness of the TVA model and the concept of adopting this strategy of industrialization where the social needs of the population are ignored (Auty, 1994; pp. 11-26). Also, there was the diversion of resources to the war effort in 1941 leading to financial constraints for the continuation of other dams.

Despite these weaknesses identified with the TVA model using the Big Push approach to development, the TVA model provided cheap electricity for the establishment of munitions plants at first, which was later converted into fertilizer manufacturing plants to produce more food. A new munition plant was sited near Huntsville, Alabama for the production of aluminum. An initial center for research on the atom bomb was established at Oak Ridge near Knoxville, Tennessee (Bradshaw, 1988, p.131).

By 1950, 80% of the farms in the Valley had access to electricity compared to 3% in 1933 and 28% in 1945 (Bradshaw, 1988, p.131). The population of the TVA area rose from 3 million in 1933 to over 7 million in 1980 with average income also rising to 80% of the US average by 1980. The increasing population and affluence led to an increase in the use of electricity despite the lack of new industries to use large quantities of electricity produced. TVA became an innovator and initial entrant in the field of nuclear energy in the late 1960s (Owen, 2014; pp.23-28). With rising energy costs in 1973, TVA planned to double its output of electricity by building larger nuclear power stations but was hit with rising costs imposed by higher fuel prices and the need to make modifications to its coal-fired plants to meet environmental legislation. This was not considered in the initial plan of the TVA projects despite its contribution to the reforestation projects, agricultural extension services, fertilizer research, and development of the Tennessee Valley Basin (Neuse, 1983; pp. 491-499).

#### Critical Evaluation and Lessons Learned from the TVA and the Big Push Strategy

The TVA power generation program has according to various assessment schemes, been both successful and a failure as a way to industrialize. The TVA project was recognized as a major participant in the area of energy development in the Clinch River breeder reactor. The TVA has also made great contributions to the area of research through the National Fertilizer production, including the development of the basic process used to make three of today's most important fertilizers (Chandler, 1984; p.10). The TVA research, development, and demonstration programs have shown the value of government education programs in helping the market to work more efficiently. It also demonstrates the use of fertilizers, crop rotation, and soil conservation, and serves as a model for large-scale government-sponsored education programs (Selznick, 2011; pp. 23-35).

The TVA experiment suggests that when resources are allocated by the government which has no consideration for the project's beneficiaries but focused on industrialization, they

may not be allocated efficiently. Such was the case in Ghana and the Mactaquac Dam where the Volta River Project and the St. John River Project were implemented without substantive control from the Ghanaian Government and with virtually no commitment to the inhabitants of the area affected.

Also, the political decisions that involve displacing one group to provide for another, stripping one family's land against their will to provide slightly cheaper power to another, or constructing power plants against the will of people who have no voice in the decision is a major setback to the Big Push development approach. The TVA's approach to river development has been copied in Ghana, Canada, Mexico, Brazil, and Russia since the TVA has been espoused as a model for industrialization and regional development (Selznick, 2011; p.19). The building of the Akosombo Dam in Ghana and the Mactaquac Dam in New Brunswick were influenced in the early stages by the TVA's water projects based on the significant contribution of the TVA to regional economic growth. Though the TVA achieved the industrialization agenda to a large extent, replicating such projects should be accompanied by a comprehensive analysis of the benefits and shortfalls such as potential floods that accompany such projects.

The TVA experience shows that decisions that affect the lives of many cannot always be left to the experts who are focused on economic growth without consideration for the social and environmental costs of such large-scale projects. Furthermore, it demonstrates that politicians and administrators should be more cautious about the replication of large-scale projects that have not received a comprehensive evaluation.



### **Chapter 3**

#### **Influence of the TVA Model in a Developing Country: The Akosombo Dam Project**

The Volta River Project involved the construction of a dam over the largest river in Ghana. The original intent was to implement a multipurpose development that included a comprehensive aluminium industry for Ghana. This industrialization agenda was supposed to develop Ghana's bauxite resources and allow the diversification of the Ghanaian economy through spin-offs and linked industries (Miescher, 2022; pp.1-19). The review of aspects of the implementation of the Volta River Project in this current chapter illustrates some of the complications of instituting a multipurpose river development project in a developing country like Ghana without fully considering such aspects of the projects as the possibility of flooding, and social and environmental costs. Despite the influence of the Tennessee Valley Authority style of development for Ghana, the Volta River Project was reduced to a megaproject that displaced over 80,000 residents downstream who were considered some of the poorest people while the project benefitted multinational corporations and only certain segments of the Ghanaian society (Hange, 1967; p.4).

#### **Background to the Volta River Project-Akosombo Dam**

The Government of Gold Coast developed the idea of developing the Volta River as long as 1915. Commercial investigations for the development of the river began in 1938 but plans for its development were postponed due to the influence of the Second World War (Hange, 1967; p.6). Following the War, West African Aluminum Ltd was formed to continue the planning while the Government of Gold Coast with the assistance of the UK government continued to assess the potential value of the Volta River to the Ghanaian economy. In 1951, the reports recommended that a) a dam and power plant be placed at Ajena, b) an aluminium

smelter close-by in Kpong, c) extracted bauxite be transported on new railway lines from Aya-Yenahin areas, and d) a new port should be constructed at Tema (Chambers, 1970; pp. 14-45). The reports from the Commission formed by the Gold Coast government favoured the development of the river basin as a whole.

The Preparatory Commission was set up in 1953 and was chaired by Commander Rover Jackson. The stakeholders of the Commission were the United Kingdom and the Gold Coast governments, Aluminium of Canada Ltd (ALCAN), and the British Aluminium Company (BACO) (Killick, 1966; p.390). In the period of all these preparations, the country was moving towards independence with a highly political climate (Hange, 1967; pp.12-17). The report of the Preparatory Commission was published in 1956 and recommended the development of a multipurpose river scheme that covered every aspect of the project, including power supply, bauxite development, aluminium production, and aspects of the river basin development such as fishing and resettlement schemes (Killick, 1966; p.392). The multipurpose development arrangements of the Volta River Project were based on the examples set by the Tennessee Valley Authority which by 1960, had been visited by over 50 officials from Ghana (Tweedale, 1967; pp. 234-245). Despite the multipurpose nature of the Volta River Project, no commitment for implementation was to be made until the independence of the Gold Coast.

By 1957, other political and economic factors began to influence the development of the Volta River Project. While there was a decline in the demand for aluminium, the price also experienced a fall. This economic condition made companies reluctant to invest in the projects, unlike the Tennessee Valley Project which was approved by Congress through the appropriations commission. Ghana gained a new government under Kwame Nkrumah after independence in 1957. The unpredictable attitude and international political leanings of Kwame Nkrumah also affected the financing of the project, unlike the Tennessee Valley Authority project where financial resources were readily available (Siekman, 1961; p.129)

## Political Economic Factors during the Volta River Project in Ghana

Dr. Kwame Nkrumah developed a great interest in the project for many reasons. Politically, the Volta River Project offered the surest way of consolidating power with the promise of new industrial development and improved living conditions (Siekman, 1961; p. 129). Additionally, the Volta River Project was recognized as a major step in the development of the resources of the country. A Development Commission was used to replace the Preparatory Commission but remained under the direction of Commander Jackson. The Government began to seek financial resources for the construction of the Volta River Project in 1957. Following the Big Push theory of development approach, the Volta River Project as recommended by the Jackson Commission was focused on having a substantive impact on the advancement of the Ghanaian economy and the welfare of its people.

Ghana was interested in broadening its economic base as it had a rapidly increasing population. The population of the country as the development of the Volta River Project has nearly tripled in the last fifty years, increasing from 3.5 million in 1937 to 10.2 million people in 1987 (Population Reference Bureau, 1987; p. 67). The project was therefore expected to make a substantial long-term contribution through the development of an integrated aluminium industry that would create an infrastructure to allow for the development of other metal and chemical industries. Following the Tennessee Valley Authority, it was agreed that the Volta River Project was expected to make available cheap electricity that would trigger the establishment of new industries and businesses that would create employment and assist in Ghana's economic growth and development (Ghana Information Service, 1960; p.30). Also, the Volta River Project offered the possible establishment of irrigated agriculture, a water transport industry, a tourism industry, and an expanded fishing industry. The fishing industry was expected to supply an amount of fish equivalent to the fish imported into the country in

1962 (Killick, 1966; p.407). It was expected that local entrepreneurs would be involved in the tourism industry created by the new scenic river basin.

Despite these benefits that were expected to be associated with the Volta River Project, Ghana lacked the financial resources, skills, and technical knowledge necessary to engage in the planning, construction, and operation of an integrated aluminum industry and the development of a multipurpose river project, without foreign assistance (Hance, 1977; p.12).

#### Financial Resources for the Volta River Project

The Finance Minister of Ghana in 1957, Komla Agbeli Gbedemah (MP) was charged with the responsibility of searching for financial resources for the construction of the Volta River Project (Killick, 1966; p. 407). As part of the search for financial resources, he paid a visit to both London and Washington. While in Washington, the finance minister, and his secretary suffered racial abuse in Maryland, which attracted the attention of the U.S press and resulted in a breakfast meeting between President Eisenhower, Vice President Nixon, and Finance Minister, Gbedemah. The president of the U.S attention was brought to the project where there was a promise to provide financial assistance for the construction of the Volta River Project. In 1958, Dr. Kwame Nkrumah officially requested aid from the United States by stating that the project was key in implementing development plans for Ghana.

Within the same period, international political factors were of concern to the United States. Ghana represented the first African country to attain independence. This made the United States responsive to the needs of Ghana (Miescher, 2014; p.14). In addition, the acceptance to support Ghana was influenced by the financial support of the U.S.S.R towards the Aswan Dam in Egypt. Henry J. Kaiser Engineering Limited of America was selected to investigate the feasibility of the construction of the Volta River Project. Its report was submitted a year later. As part of the report, it was recommended that the construction of the dam should

be shifted from Ajena to Akosombo since the Volta River was narrower at that point, and construction expenditure would be minimized with operating capacity becoming greater and more efficient. It was also recommended that the aluminum smelter be built at Tema instead of Kpong (Hance, 1956; p.10). This was recommended to save costs on transportation and avoid the construction of a new town site. However, the report took no cognizance of the establishment of the river basin or the resettlement program. The original multipurpose development plan for the Volta River Project was reduced in scope to make the project feasible for international investors. Recommendations for a transmission system to serve the main cities, towns, and mining towns in southern Ghana were also made under this proposal but with little development efforts (Montalvo, 1991; p.3).

The report on the feasibility of the project, which was presented to Dr. Kwame Nkrumah, led to the requisition of Kaiser Aluminium and Chemical Corporation to form an aluminum company in Ghana. This was later founded as the Volta Aluminium Company (VALCO) and was charged with the responsibility of aluminum smelter and making the entire project a possibility. VALCO hoped that other companies would take part in the venture but unfortunately, ninety percent of the financial capital required for the project was provided by Kaiser Aluminium and Chemical Corporation. Reynold's Metal Company provided the rest of the capital requirement. The Export-Import Bank (EXIM) Bank of the United States provided large loans and official development assistance. The support from the United States in the establishment of VALCO Limited was based primarily not only on economic reasons provided by Nkrumah's administration to raise living standards in Ghana but also on political considerations such as the worsening political conditions in Ghana and Africa in general (Killick, 1987; p.13).

As part of efforts to raise enough financial resources for the commencement of the project, a delegation of the parliament of Ghana visited Moscow in search of aid for the project

but received reactions from the Western countries leading to the rejection of the offer in 1960 (Hance, 1967; p. 92). Nkrumah's quest to see the Akosombo Dam completed on time led to a tour of the Soviet Union blocks in July 1961. The U.S president, Kennedy sent him a personal assurance that the loan from the U.S. government would be completed shortly. It was reported in the New York Times that the U.S. would be providing a loan amount of \$133 million to Ghana to finance the Volta River Project. The total amount was to be released in stages before all funds were expended on the project (Kanter, 1972; p.129).

Four (4) major components were finally agreed on during the construction of the Project. The first component focused on a dam that required the resettlement of an estimated 80,000 people during its construction. The second component focused on a transmission mechanism of length 500 miles aimed at serving the Southern part of Ghana. Valco Aluminum smelter was the third component to be established at Tema. The final component involved the construction of a power station at Kpong. The estimated cost of the project was equivalent to USD 196 million as of 1965.

The implemented Volta River Project held only the skeleton features of the Jackson proposals that envisioned a comprehensive multipurpose river development which was influenced by the Tennessee Valley project. Though the Volta River Project started based on economic reasons for industrialization and as an avenue to improve the living conditions of the poor, it became a political product of the Cold War. Shaped by the ideas and inspirations of modern technocrats, the Volta River Project (Akosombo Dam) construction became the most successful parastatal in Ghana. Ghanaians perceived the Volta River Project as one of the projects with the most significant impact on the development of Ghana's industrialization agenda. It provided housing and transportation needs for the population through the construction of affordable accommodation and railway systems (Miescher & Tsikata, 2009).

**Table 3. 1: Cost of construction of the Akosombo Dam as of 1965**

Cost of Construction of the Mactaquac Dam	Millions of Dollars (USD)	Percentage (%)
Aspect		
Dam and Generating Equipment	102.8	52.45
Engineering, administration, and contingencies	74.6	38.06
Compensation and flooding damage	18.6	9.49
Total	196	100

Source: Miescher, 2022: *A dam for Africa: Akosombo stories from Ghana*.

**Figure 3.1**

**The Volta River Project-Akosombo Dam**



## Environmental and Social Costs of the Volta River Project

Though the Volta River Project has been lauded as beneficial to the Ghanaian economy, most authors do not mention the effects of including river basin development in the project. While the project is considered one of the greatest engineering projects on the entire continent, the evaluation never considered the impact of dam overflow on downstream communities.

The highest social and environmental cost of the Volta River Project was incurred by the people displaced by it. The resettlement program efforts were inadequate compared to those of the Tennessee Valley Authority, where the project was focused on skills and capacity development of the affected Tennessee Valley basin. This means that an overall assessment of the impact of the Volta River Project such as flooding was not incorporated into the planning and construction of the Volta River Project. The next section focuses on the analysis of the impact of the Akosombo Dam floods as a weakness of the Akosombo Dam project.

### Akosombo Dam Floods

The most recent flood of the Akosombo Dam occurred in October 2023 leading to the displacement of 30,000 people. The spillage of the Akosombo Dam since its construction is not peculiar to a specific year, as this has occurred over the past five decades. Flooding from the Akosombo Dam occurred in 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1974, 1991, and 2010 (Miescher & Tsikata, 2009; pp.15-53). During the above-listed years, an average of 10,000 people were displaced with properties such as farms, and buildings, and human life was lost. Unfortunately, the low-lying areas of the Akosombo Dam course such as Meper, Battor, Sogakope Mafi, Adidome, Ada, and others have suffered the devastating impact of the floods.



Figure 3.2.

Submerged Mepe Township from the Akosombo Dam Spillage in Ghana



Source: Ghana Broadcasting Corporation, 2023

Economic Impact of the Akosombo Dam Floods

Despite the economic contribution of the Akosombo Dam construction to the economy of Ghana, there are several economic challenges associated with the construction and the floods caused by the Dam spillage. The Volta Lake creation has led to the loss of the total land area of 8,502 square kilometers equivalent to the loss of 3.6 percent in Ghana (Gyau-Boakye, 2001; pp.17-29). This includes forest reserves that could be a source of minerals for export. The loss of land also led to the reduction in agricultural land for farming activities. Some of the major identified economic impacts of the Akosombo Dam flooding are outlined below:

Destruction of Infrastructure

The Akosombo Dam spillage over the past five decades has led to the destruction of infrastructure usually categorized into commercial properties and residential properties. Commercial properties such as industries including hotels, restaurants, pubs, and corn milling facilities have been destroyed following the dam spillage (Miescher & Tsikata, 2009; pp.15-53). These infrastructures tend to create employment opportunities for many of the youths who are engaged in their activities. Residential facilities, which include houses, have also been destroyed over the years leading to the creation of temporary shelter homes for the many displaced people because of the flooding.

#### Effects on Livelihoods

The Akosombo Dam spillage has also resulted in the worsening of livelihoods for the majority of people who used to reside in the downstream areas of the dam. Dam spillage usually leads to the sweeping of farming communities leading to the displacement and relocation far away from their farmlands. This often results in negative shocks to the household's livelihoods and results in poverty among the household members. Food insecurity is recognized as one of the major negative impacts of flooding the communities closer to the Akosombo Dam due to the destruction of the farmlands (Miescher, 2021; pp.124-142).

#### Health Impact

Malaria and bilharzia are recognized as some of the common negative health impacts resulting from the dam spillage over the past years. The release of water from the dam usually causes stagnant water in most downstream communities leading to the outbreak of malaria and bilharzia due to children swimming in these water bodies. The cost of healthcare and the loss of income because of days off from work also affect the living standards of people residing in the flooded areas due to the Dam spillage (Balana, Mul, & Mante, 2017; pp. 277-301).

### Social Impact of the Akosombo Dam Floods

The flooding of the Akosombo Dam has destroyed the social and cultural fabric of the communities closer to the dam. Due to the relocation and resettlement of some communities closer to the dam, the level of social integration and cultural values that used to exist in these communities have broken down. The resettlement of communities means that not all people would like to move to the newly developed downstream communities (Kanyagui, 2008; p.13). This tends to affect the social and cultural stratifications within these communities. The displacement of 80,000 people across 739 communities due to the fear of spillage has also affected the social structure of the people along the course of the Volta Lake. The breakdown of traditional laws and order has also been a significant resultant factor of the Akosombo Dam floods (Gyau-Boakye, 2001; pp.17-29).

### Critical Evaluation and Lessons

The implementation of the Volta River Project which was under the influence of the Tennessee Valley Authority (TVA) displays the complexities associated with large-scale development projects in an unstable international economic and political environment. The Cold War led to tensions in the financing of the Akosombo Project leading to multiple delays and changes to the original plan. This chapter has shown that though Ghana envisaged developing the Akosombo Dam in a multipurpose fashion as influenced by the Tennessee Valley Project, the country could not acquire the resources needed to implement the multipurpose development of the river basin.

Also, the lack of comprehensive evaluation of the project affected the overall objectives of the Akosombo Dam Project especially, the environmental and social cost of the project. The effects of floods from the Dam such as economic impact, environmental impact, distortion in the social stratification of downstream communities, and health impact of the Akosombo Dam

construction were all not considered. This means that despite the benefit of providing cheaper electricity to the Ghanaian population, the residents displaced by the dam are yet to acquire improved living conditions with compensation remaining unpaid to date.

#### Lessons from the Volta River Project

The Volta River Project presents useful lessons for the development of future projects with adequate comprehensive evaluation before the projects are implemented. This means that the development of the Akosombo Dam should serve as a precedent in gathering the needed financial resources before the commencement of such projects. This will ensure the avoidance of delays in the implementation of future projects.

Also, another lesson from the Akosombo Dam Project is the use of comprehensive techniques in assessing the costs and benefits associated with such Projects. The cost assessment should include the social and environmental costs before the project is implemented. This means that those affected by the project can be fully compensated without delays.

Future projects may also consider the use of renewable energy sources such as solar panels and Wind energy for electricity generation. This may reduce the space they occupy and provide the needed energy without much environmental impact. These renewable energy sources may be cost-effective as well compared to the \$196 million that was sunk into the Volta River Project.

## **Chapter 4**

### **Regional Development in Canada: The Influence of TVA on the Mactaquac Dam Project**

This current section focuses on a brief background of regional development programs that helped in the implementation of the Mactaquac Development Project. The section also focuses on the influence of the Tennessee River Authority (TVA) project on the planning and development of the Mactaquac Project and how it differs from the Volta River Project in Ghana. The different sectors incorporated into the development of the Saint John River are also outlined in this section.

### **Regional Development in Canada**

Differences in the level of economic development among the various regions and provinces have existed in Canada for several decades since the formation of the nation. Their existence in Canadian history has dominated the political agenda between the poorer provinces and the Canadian Federal government. The practice of regional development as part of the government's concerted efforts to bridge the regional disparities dates to the period of 1957 to 1960 (Springate, 1972; p.12). Before these efforts, the Federal government had introduced the Prairie Farm Rehabilitation Act (PFRA) and the Maritime Marshland Rehabilitation Act (MMRA) in 1935 and 1948 respectively to focus on assisting rural peasant farmers only.

The Federal government of Canada organized the Federal-Provincial Conference on Reconstruction in the mid-1940s as part of its effort to develop the country (Smiley, 1963: pp. 9-12). The period between 1945 and 1960 experienced an increase in federal government transfer payments to the provinces, primarily in the form of shared cost programs. Some of the shared cost programs included the funding of the Trans-Canada Highway, contributions to public healthcare and hospital insurance, old age financial assistance, welfare programs,

training in vocational skills, agriculture, and conservation of natural resources (Smiley, 1963; pp.9-12).

Technological advancements in the 1930s and 1950s reduced the level of unemployment rates in the primary industries while practically no expansion occurred in the Atlantic region's manufacturing industries within the same period. Following the Second World War, the Canadian economy experienced one of the greatest expansions historically but at the same time, the Maritimes and Newfoundland shared only to an extent in this prosperity. Though the Canadian economy enjoyed full employment levels by Canadian standards with unemployment ranging between 3 and 4.5 percent in the mid-1950s, the Atlantic regions experienced unemployment rates between 6.5 and 10.7 percent for the same period (Springate, 1973; p.19). The economic structures of the Atlantic Provinces prevented them from realizing the full benefits of the economic growth that occurred across the rest of Canada.

The provincial government created an office of economic development. Premiers Fleming of New Brunswick and Stanfield of Nova Scotia Atlantic Provinces formed the Economic Council (APEC) in 1956 to speed up the development pace of these provinces (Careless, 1977; p.123). The formation of APEC was to take a regional approach to the problems of poverty and underdevelopment in the Atlantic regions. The formation of APEC and other provincial statistical sources of development helped provide the Atlantic Provinces with the necessary information required to exert pressure on the Federal government for further funds to be provided in supporting the extended services (Smiley, 1963: pp. 9-12). An increase in the competency level of these provinces enabled them to table their needs before the federal government for immediate action through funding support.

The Federal government tasked the Royal Commission on Canada's Economic Prospects to report in 1957 on problems facing the various provinces rather than tax sharing.

The Commission chaired by Walter Gordon addressed the nation's economic potential and the problems of development in the poorer Atlantic Provinces. Based on the Commission's report, Canada's economy, and to be specific the poorer provinces, required structural changes. Part of the recommendations of the report also bordered on freer grants to the poorer provinces but warned that larger grants could not merely solve the problems of inefficiencies and incapacities of size, education, and skills (Careless, 1977; p. 123).

At the end of Walter Gordon's Commission report, a newly elected Prime Minister, Diefenbaker, still pledged to assist the poor provinces to achieve economic prosperity. He, however, diverged from the long-term and comprehensive development planning envisioned by the Gordon Commission to an ad-hoc intervention for short-term and immediate political gains (Careless, 1977; p. 123). Despite these efforts by the new government, the economic effects of the recession on the Atlantic Provinces increased the provinces' ability to articulate their needs. Four (4) major Federal programs were designed to assist the Atlantic Region. These include:

- ✓ The Atlantic Development Board (ADB)
- ✓ The Agricultural Rehabilitation/Rural Development Act (ARDA-1961)
- ✓ The Fund for Rural Economic Development (FRED)
- ✓ The Area Development Program (ADP)

These were created in 1961 to address the specific needs of the Atlantic Provinces including New Brunswick, Newfoundland, Prince Edward Island, and Nova Scotia. The first three programs contributed to the planning, funding, and implementation of the Mactaquac Development Project (MDP). This was recognized as New Brunswick's first comprehensive program of development (Harrington, 1960: p. 10).

### The Atlantic Development Board (1962-1969)

The Development Board of the Atlantic region represented the Federal government's major attempt to improve Eastern Canada in the 1960s. The recommendations of the Gordon Commission largely inspired the ADB as it focused on the weakness in infrastructure and social capital that existed in the Atlantic Provinces (Savoie, 1986; p.24). As part of efforts to bridge the infrastructural gap, the board spent CAD 143 million on highways, power, water, and industrial park projects (ADB report, 1969: p.4). Funding was made available for the construction of the Mactaquac Dam at CAD 20 million by the New Brunswick Electric Power Commission. This was part of the efforts to provide infrastructure to the province. Despite the lack of any comprehensive development plan or strategy for the region, it conducted a series of research studies on individual sectors.

The Board, however, did not provide significant assistance and support to attract private industries into the Atlantic regions (Savoie, 1986; p.42). Despite the non-existence of a properly structured program for attracting new industries into the Atlantic regions, it supported a water project that lured the St. Anne-Nackawic Pulp and Paper Company Limited to locate in Nackawic (Atlantic Development Board, 1969 report).

The ADB was however criticized for not providing enough financial support to the private sector. It was also faulted to have spent much financial resources for political reasons and not for economic reasons. Others also argued that the ADB lacked proper coordination efforts since it was never part of a comprehensive plan for specific spending targets.

### The Agricultural Rehabilitation and Development Act

A Federal funding program named the Agricultural Rehabilitation and Development Act was enacted in June 1961. The program focused on the use of land to "salvage lands as agriculture retreated from marginal areas" and was purposely designed to assist the rural poor



after advancement in technology at the global level reduced employment in the agricultural areas (Buckley & Tihany, 1967; p.18). Agriculture was expanded to include non-agriculture projects after it was renamed the Agricultural Rural Development Act. The program was purposely designed by the Federal government to reduce poverty in rural areas, despite the introduction of new programs designed to absorb surplus labour that was not involved in farming activity (Buckley & Tihanyi, 1967; p.18).

Notwithstanding its core objective, outside of farming, the Agricultural Rehabilitation and Development Act (ARDA) was involved in more comprehensive projects. Multi-purpose river basin development that was coupled with the construction of the Mactaquac dam had been conducted under the direction of the New Brunswick Agricultural Rehabilitation and Development Act Committee (Dickison, 2006; p.28).

Despite the recognition of the ARDA as the commencement of integrated regional planning, the programs associated with them were relatively small and not well coordinated with a comprehensive plan to develop an area (Buckley & Tihanyi, 1967; p. 18). The recognized shortfalls associated with the ARDA led to the formation of the Fund for Rural Economic Development within the Atlantic Provinces by the Federal government to speed up the economic prosperity within the Atlantic regions.

#### The Fund for Rural Economic Development

The Fund for Rural Economic Development (FRED) was established in 1966 to deal with the shortfalls within the ARDA geographic problem, by restricting its activities to identified regions only (Savoie, 1986; p.24). FRED was designed to provide an integrated rural development program in areas where poverty was severe as identified by the Federal government. The Federal government and the provincial governments chose five (5) areas in

four provinces including the Mactaquac area in New Brunswick. The Northeastern area of the province was also chosen for development (Savoie, 1986; p.24).

The Fund for Rural Economic Development focused on integrating programs like soil and water conservation programs provided by ARDA. According to Dickison (2006; pp.1-12), the main goals of the program were to raise levels of income and provide employment opportunities (through education, upgrading of skills, manpower mobility, resettlement, housing, and transportation). The Fund for Rural Economic Development also provided financial support to the Community Improvement Corporation in New Brunswick which was to coordinate the river basin development aspect of the Mactaquac Development Project (Dickison, 2006; pp. 2-14). The sectors targeted under the Mactaquac agreement were land acquisition, use and control, forestry industry development and conservation, agriculture, recreation, development of townsites, manpower planning and mobility strategies as well as training and extension services.

Despite the broad objectives of FRED, plans were never designed to encourage a large-scale secondary manufacturing sector. The inclusion of the large-scale manufacturing sector was over-ambitious given the generally underdeveloped and economic marginalization within the chosen provinces. With the introduction of the DREE, the Fund for Rural Economic Development was phased out.

### The Mactaquac Regional Development Plan

The Mactaquac Development Plan constituted a multipurpose river development that encompassed the construction of a hydroelectric dam, recreation and tourism facilities, a new town for residential settlement, consolidation of the labour force, and consolidation of agricultural farms (Gertler, 1969; p.48). The selection of a multipurpose development project was understandable due to the efforts by governments in the Atlantic Provinces and the role of

APEC in promoting a more comprehensive development project as part of the Big Push process of industrialization. Notwithstanding these efforts of the governments and the APEC, the multipurpose approach to the development of the St. John River was more deeply rooted under the influence of the Tennessee Valley Authority.

In the early 1960s and specifically in 1962, the University of New Brunswick hosted a Conference on the Multipurpose Development and usage of the St. John River. Many of the guests had experience in the multipurpose development of rivers through their work with the Tennessee Valley Authority (TVA) and most of the conference presenters spoke of the TVA project as a model for an innovative way of multipurpose development (Gertler, 1969; p.48). Mr. Reg Tweedale, the General Manager of the New Brunswick Electric Power Commission in a presentation submitted; “A river basin such as the St. John River should be chosen to establish a model for multipurpose resource development, as has been effectively done in the case of the Tennessee Valley Authority.” The call for the development of the multipurpose river was long overdue.

The government of New Brunswick authorized the construction of the Mactaquac Hydroelectric Dam in January 1964. The Provincial Government announced the adoption of a policy that encompassed multipurpose resource development in that portion of the river basin that was affected by the construction of the Mactaquac Dam (Gertler,1969: p.48). The Mactaquac Dam project was unprecedented in the history of the province, and its announcement was recognized as a province of a brighter future to the proponents of development in the province. The clustered projects around the river basin were named the Mactaquac Regional Development Plan.

‘Acres and Company Limited’ was authorized to provide social evaluation, to secure and analyze all economic and social information relating to the reservoir area. They were to

make recommendations about the development of a resource-based economic sector and to propose to the ARDA Committee, a program leading to a plan for the economic development of the St. John area (Acres and Company Ltd report, 1964). The whole operation represented an opportunity to put into motion a program of rehabilitation and resource development that was expected to place the Mactaquac region in constant and lasting economic development.

The project was generally focused on improving the economic well-being of the residents of New Brunswick. The energy produced from the Mactaquac Dam was thought to continue to assist the industrialization agenda of the province by increasing production through cheaper power supply. The government's involvement in the project was focused on creating an enabling environment that has the potential to attract private capital and enterprise. A Federal Agreement to spend US\$21 million in September 1966 was signed for 10 years. The financial commitment covered the operations of the CIC administration of an Integrated Rural Development Agreement with a clear goal of "increasing the level of incomes and the standard of living of the people presently in the area" (CIC report, 1966; p.24). The objective also focused on land use and adjustment, farm consolidation, recreation and tourism facilities, residential site development, rehabilitation, human resource mobility, training, and research facilities. The Mactaquac Dam construction, fish collection facilities, and the issuing of compensation to those affected by the flooding were to be separated under the management and funding of the New Brunswick Electric Power Commission.

#### The Mactaquac Dam Project financing

The Mactaquac Dam is located about 22 kilometers upstream of the City of Fredericton. The project constitutes a rockfill dam with two associated spillway structures, an intake structure, a powerhouse, and an installed capacity of 600 Megawatts. The first three generator units came into full operation in 1968 and units four, five, and six were added in 1972, 1979, and 1980, respectively (Federation & Giffin, 2016; p 12). Aside from the dam's construction,

ancillary works such as the relocation of the highway, railway, church buildings and cemeteries, a recreational facility complex, municipal services, a small airport, and the construction of the salmon hatchery were estimated to cost about \$30 million (Tweeddale, 1962: p.36). In all, 25 percent of the total expenditure of the six-unit development was spent on these accomplishments.

**Table 4.1: Cost of Construction of the Mactaquac Dam**

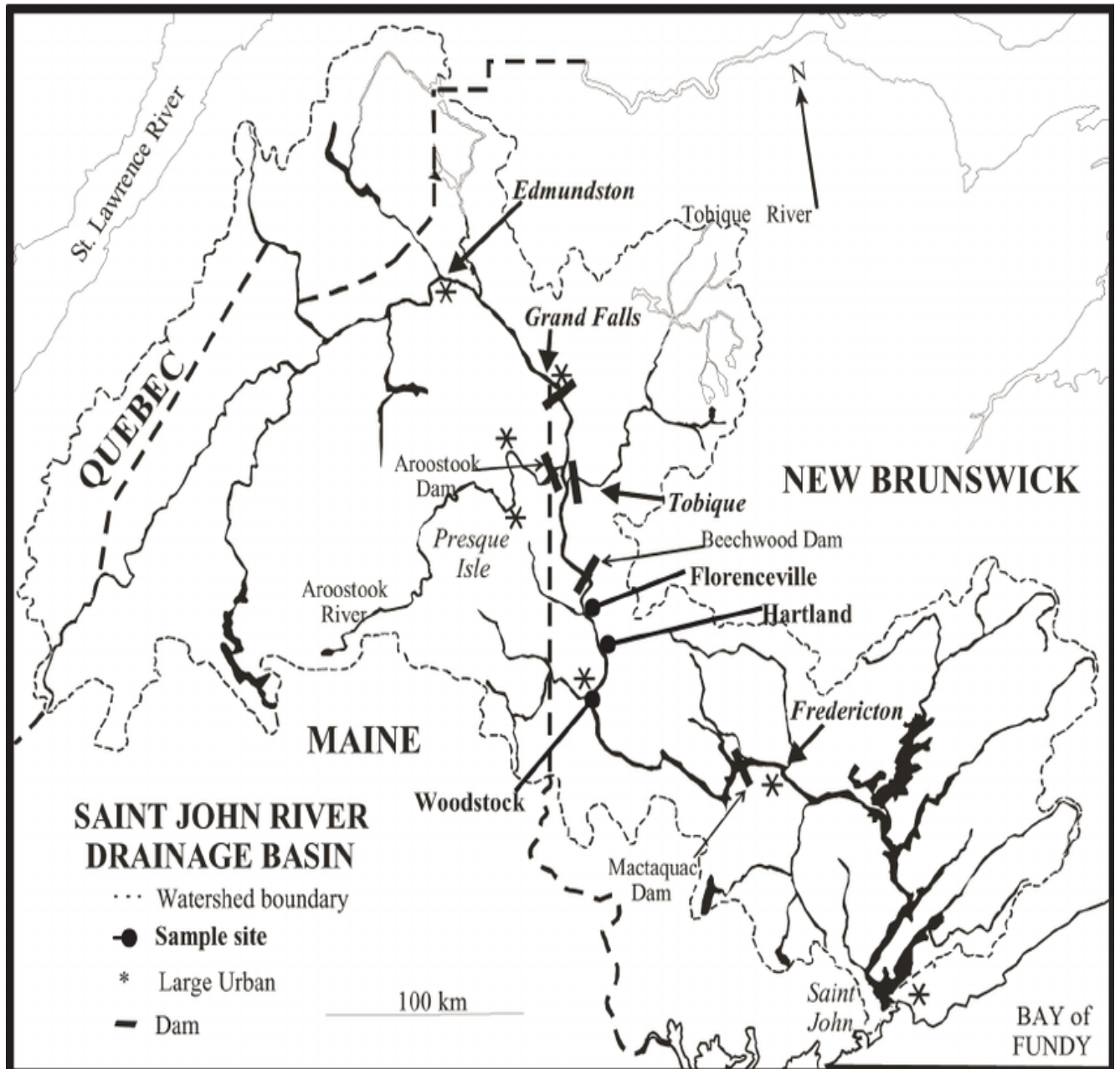
Cost of Construction of the Mactaquac Dam	Millions of Dollars (CAD)	Percentage (%)
Aspect		
Dam and Generating Equipment	64.7	70.09
Engineering, administration, and contingencies	13.6	14.73
Compensation and flooding damage	14	15.18
<b>Total</b>	<b>92.3</b>	<b>100</b>

Source: Canada, Mactaquac Area, Federal-Provincial Rural Development Agreement, 1970.

Table 4.1 highlights the cost of construction of the Mactaquac Dam project and the ancillary works associated with the Construction of the Dam. It can be observed from Table 3.2 that the Dam construction and its generating equipment cost CAD 64.7 million which was estimated to be 70.09 percent of the total expenditure in the development of the St. John River basin. The expenditure on engineering, administration, and contingencies associated with the construction of the Mactaquac Dam was estimated to be CAD 13.6 million. This was estimated to be 14.73 percent of the total expenditure associated with the development project. In terms of compensation and flooding damage due to the construction of the Mactaquac Dam, a total of CAD 14 million was spent on this category of items. This represents 15.18 percent of the total cost of construction for the Mactaquac Dam project.

**Figure 4.1**

**Map of New Brunswick with Mactaquac Dam located over St. John River**



**Source: Mactaquac Dam Project Directory, 2023**

**The environmental and social costs associated with the Mactaquac Dam Project**

The Mactaquac Development Plan which involved the development of a multipurpose river development project included the construction of a hydroelectric dam, recreation and tourism facilities, a new town, consolidation of the labour force, and consolidation of farms. This development was understandable based on the multipurpose development approach given

to the Atlantic provincial governments and the comprehensive development projects advocacy by APEC.

Despite the benefits associated with the Mactaquac Dam Project, one major challenge associated with this project is the flooding that occurred in 1970. The construction of the Dam did not envisage the occurrence of such a flood which had a devastating impact on the New Brunswick province.

### Mactaquac Dam Flood

The Mactaquac Dam is one of the largest hydroelectric dams constructed in Maritime Canada (Keilty et al., 2016; pp. 234-248). The Mactaquac Dam, which was built in 1967 overflowed its boundaries and flooded a 100km head-pond of agricultural land and farming communities. Since its construction, flooding has occurred just once in 1970 due to the release of ice from the Nashwaak River leading to a rise in the water level of the Mactaquac Dam. Following the floods, an estimated US\$3.3 million in damages were reported in the New Brunswick Province across various cities affected by the floods.

**Figure 4.2 Mactaquac Dam floods**



Source: CBC News

### Effect on Infrastructure

The heavy flooding from the Mactaquac Dam caused considerable damage to the New Brunswick province, particularly for towns within 50 50-meter radius of Fredericton. While several communities were completely isolated, many of the roads were completely submerged making transportation difficult for most of the parts of the towns affected (Keilty, Beckley & Sherren, 2016; pp. 234-248). Telephone infrastructure and power supply were also distracted for several days due to the Mactaquac Dam flooding that occurred. Based on the Department of Public Works report, 32 major structures were destroyed due to the flooding of the Mactaquac Dam.



### Effect on Agriculture

The Mactaquac Dam flooding resulted in the loss of livestock on various farmlands close to the dam (Zhong & Power, 1996; p.285-308). Barns and farm equipment such as plowing machines, tractors, and harvesters were destroyed. Fish cages on the various rivers were also destroyed leading to huge losses for the aquaculture industry. Damage was recorded at the fish hatchery in Florenceville when a portion of the damaged dam was washed away due to the flooding (Reilly & Adamowski, 2017; p. 2).

### Effect on Healthcare

The Mactaquac Dam floods resulted in the death of a motorist at Keenan Siding due to the washing away of a bridge across Morse Brook. The flooding also led to the destruction of health facilities in the New Brunswick Province. An estimated 100 families were affected by the flooding in the Glen Falls area leading to isolation and increased levels of depression among the family members (Stanke et al., 2012; p.12). There were reported incidents of psychological trauma due to the breakage in communication between the affected area residents and their family members living in other parts of the Province and Canada at large.

### Evaluation and Lessons from the Mactaquac Dam

Based on the information outlined in the chapter above, it is clear that the TVA provided a useful influence on the development of the Mactaquac Dam at its initial stage of construction. The TVA financiers argued that economic development was achieved from the project through investments in power generation, navigation, flood control, and fertilizer promotion of multipurpose development in comparison to the Mactaquac Dam and the TVA Projects. The Financing of the Mactaquac Dam was not a major challenge due to the Federal government's efforts and that of the New Brunswick Province. This makes sourcing finance for the

development of the project easier through various commissions and boards established to see to the fruition of the project.

Also, the Mactaquac Dam was associated with labour mobility training and educational amenities which was similar to the Tennessee Valley Authority which also involved the development of Research institutions from the project. This makes the Mactaquac Dam construction unique due to the establishment of labour mobility centers for the training of resettled residents. the affected communities in the Akosombo Dam construction were only left to their fate.

The TVA experience displays that the genuine decisions that affect the lives of many cannot be in the hands of experts who may be isolated from the scene and in not close contact to the local communities. The Mactaquac Dam Project carefully learned this lesson by ensuring that affected communities are compensated, unlike the Akosombo Dam which refused to consider compensation plans for the affected communities.

#### Lessons from the Mactaquac Dam

The Mactaquac Dam construction provides useful lessons for future projects such as the construction of multipurpose Dams in any part of the world. Some of the useful lessons to be drawn from this mega project are outlined as:

Adequate financial resources before the commencement of such projects are important to achieve the overall objectives of the project. This is important because it reduces the inability of the project managers to construct the project according to plan. This is also useful in ensuring that all aspects of the project are achieved based on the intended multipurpose nature of the project.

Also, comprehensive consultations from technocrats to the implementation of the project is a significant part of the Mactaquac Dam construction, unlike the Akosombo Dam. While the Mactaquac Dam was developed for the industrialization drive of the New Brunswick Province, the Akosombo Dam was developed for political consolidation which undermines the main purpose of the project. This provides a useful lesson for future projects to be designed based on technocrats' ideas and the formation of competent boards and commissions and not based on political ideologies.

Another important lesson drawn from the Mactaquac Dam case is the use of effective early warning systems and prompt payment of compensation to the affected residents and communities closer to the dam.

## Section II: Opportunity Cost of Dam Construction-Akosombo Dam and the Mactaquac Dam

Aside from the direct devastations caused by the floods from the dams under consideration (the Akosombo Dam and the Mactaquac Dam), there are opportunity costs associated with the Dam construction.

Despite the need for the big push industrialization agenda, the construction of the Akosombo Dam and the Mactaquac Dam have been recognized to be associated with opportunity costs to the immediate locations in which they were built and the economy in general (Miescher, 2014 p.341-366; Bourgoin, 2013 p. 23). A total investment of USD 196 million in the construction of the Akosombo Dam in the early 1960s was a huge financial commitment that could have been invested in oil or gas for the production of power supply in the 1960s. A barrel of oil was USD 2.88 compared to the huge investment of \$196 million for the construction of the Akosombo Dam (U.S. Energy Information Administration, 2023; p.2). The case of the Mactaquac Dam construction which cost \$92.3 million could have also been

invested in Wind energy which is a renewable energy source with cleaner technology (Dehghani-Sanij et al, 2022; p. 10).

Another opportunity cost associated with the Akosombo Dam is the agricultural lands that were given up for the construction of the dam. Residents of 739 villages who were mostly subsistence farmers were relocated to a different area due to the construction of the Dam (Miescher & Tsikata, 2009; p. 15-53). A total land area of 5802 square kilometers hosts the Akosombo Dam and this is equivalent to 850200 hectares of agricultural land lost to the Dam's construction in Ghana. This is also equivalent to 3-6 tons of rice per hectare which could have generated \$100-\$1000 per hectare after the sale of these rice. This is a huge loss to the agriculture sector of Ghana. Meanwhile, the Akosombo dam rakes in a revenue of \$0.13 per kilowatt hour for electricity usage by Ghanaian households. This means that agricultural lands were sacrificed for the construction of the dam to achieve the big push industrialization agenda, which in the end fell below its expectations due to the fall in the price of aluminum on the world market (Miescher & Tsikata, 2009) p. 15-53. The opportunity cost associated with the Mactaquac Dam constituted the inundation of agricultural properties of some 338 families through the displacement of the farmers engaged in livestock and aquaculture (Wark, Steadman & Willet, 1969) p. 13.

Social costs can also be argued to be one of the opportunity costs associated with the dam construction project. The construction of the Akosombo was associated with the effort to resettle 80,000 residents from 739 villages with different customs (Miescher & Tsikata, 2009) p. 15-53. The big push for industrialization therefore ignores the complications for resettled people which arose mainly out of their cultural diversity, scarcity of land, and lack of government expediency in releasing compensation to the affected residents (Brown, 1987) p. 100. Likewise, the Mactaquac Dam construction also led to the relocation of some towns and the removal of cemeteries that hosted the memories of loved ones. This social cost associated

with the Dam construction also serves as an avenue for breaking social ties with loved ones (Reilly, Adamowski, & John, 2019) p. 13.

Another opportunity cost associated with the dam construction is the destruction of biodiversity. In the dam construction process, vast areas of land are cleared with deep trenches. This leads to the destruction of plant and animal species that are used for pollination and soil aeration (Wu et al., 2019: pp. 480-489). This tends to affect the biodiversity nature of the area in which these dams are constructed.

Another opportunity cost associated with the dam construction is the accumulation of soil sediments that can accumulate to cause the collapse of the dam. These sediments are usually collected downstream or within the dam areas and their accumulation could lead to the collapse of the dam (Wang et al., 2014: pp. 4275-4287). The recognition of soil sediments usually leads to additional cost of maintenance through dredging. This tends to divert funds from sustainable environmental practices such as tree planting exercises by the dam authorities to working on these existing projects.

### Summary of Chapter

The current chapter has discussed the influence of the Tennessee Valley Authority on the construction of the Mactaquac Dam which serves as a multipurpose dam for the New Brunswick Province. The Mactaquac Regional Development Project was unprecedented to the extent that it approached the development of the area thoroughly, by incorporating various sectors of the economy to achieve greater output from the physical and social changes caused by the dam's construction. The benefits of the Mactaquac Dam are enjoyed not by the residents of the Mactaquac area but by the New Brunswick province as a whole. The tourist centers associated with the project also provide revenue for the province all year round. One important lesson from the Mactaquac Dam construction that has assisted in detecting floods is the

development of effective early warning systems to prevent future occurrences. The next chapter examines the role of effective early warning systems and economic incentives for flood victims.

## **Chapter 5**

### **Early Warning Systems and Economic Mitigations for Disaster Victims**

This chapter outlines some of the major systems put in place by the Mactaquac Regional Development Project to provide signals for impending floods through communication compared to the Volta River Project. The chapter hopes to set the two projects studied in this thesis into context by concluding with economic mitigations adopted by the management of these two projects.

The construction of the Akosombo Dam and the Mactaquac Dam has been beneficial to the government of Ghana and the New Brunswick Province, respectively. Despite these benefits, there are challenges such as floods associated with such large-scale projects (Gyau-Boakye, 2001; pp. 17-29; Bourgoin, 2013; p 42). To prevent the devastation of these dam floods to lives and properties, the management of dams has developed early warning systems to make sure the downstream communities are usually prepared to move to safe grounds before the flooding actually occurs (Mioc et al., 2015; pp. 183-202). While the adoption of the Early Warning System in the Mactaquac Dam is recognized to be effective, the Volta River Project has weak early warning systems (Thiemig, De Roo & Gadain, 2011; pp. 63-78).

An effective early warning system worldwide requires local community participation by ensuring that the communities affected are fully aware of the impending disaster to prepare adequately for them through information dissemination (Collins & Kapucu, 2008; pp. 587-600). Early warning systems (EWS) highlight the potential risks associated with the disaster (e.g., the occurrence of flooding, or the approach of a storm). The level of exposure to the disaster and the level of vulnerability associated with the disaster are assessed under the early warning system framework (de León et al., 2006; pp.23-28). The adoption of early warning systems serves as a protection mechanism through the combination of scientific disaster

monitoring strategies and social design factors that include the people who are at potential risk (Grasso & Singh, 2011; pp. 1-7).

Components of Early Warning System

Werner (2011; p.4) and Carsell (2004; p.8) established an early warning chain that seeks to trace the flow of disaster from its detection stage until it occurs. It comprises six (6) main activities that follow the disaster occurrence beginning from when they start until they occur. Werner (2011; p.4) and Carsell (2004; p.8) argued that the early warning chain flow is based on an ‘end-to-end’ system of warning, which means that the failure of even an element can cause the failure of the whole system.

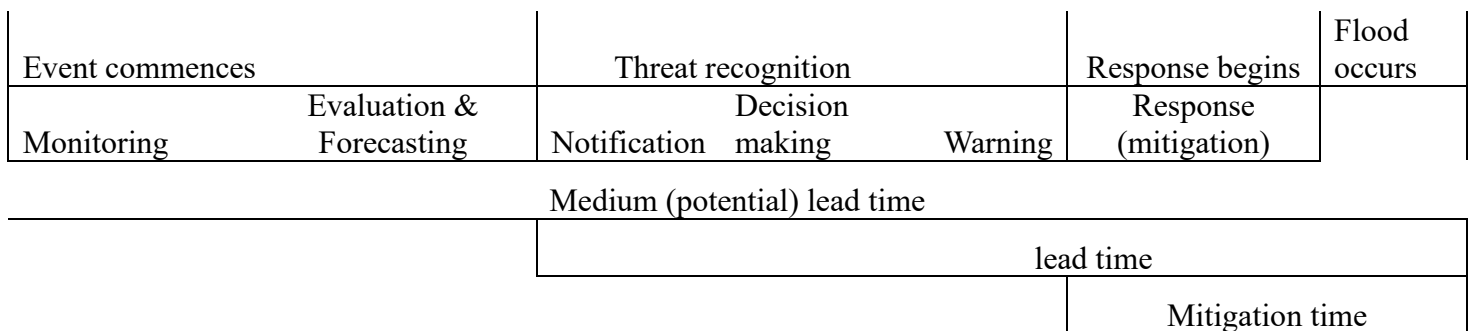


Figure 5.1: Elements of warning chain based on Werner (2011) and Carsell (2004)

Figure 5.1 presents the occurrence of an event such as a natural disaster that requires the gathering of information at the commencement of the event. Information can be gathered through the monitoring of systems before the occurrence of the disaster. The receipt of enough information on the occurrence of an event such as a natural disaster requires time to obtain the data to run either one or two hydrological models. Once threats become recognizable, information needs to be communicated to stakeholders. After making considerable decisions such as issuing warnings and alerts, users initiate important responses for the oncoming disaster such as moving to higher grounds or taking cover in buildings. It becomes important to say that any considerable action such as the evacuation of the identified areas should be completed



before the occurrence of flooding (disasters). This approach is useful for identifying accurate times and needs of various stakeholders within the disaster-prone zone.

### Insurance as an Economic Incentive for Disaster Victims

Floods like other natural disasters pose two main challenges to the victims. These include how to contain the cost of the damage they cause and how to provide a financial safety net or relief to victims to help them overcome the losses associated with the flood (Pasterick, 1998; p.125-154). The damages caused by floods are usually contained through the construction of dams or land use regulations. This tends to provide a source of security for people to move closer to the lands that usually flood without thinking about the future consequences (White, 1963: pp. 412-432).

The adoption of insurance packages has been recognized as one of the major economic incentives aimed at building resilience among risk-prone residents (Michel-Kerjan, 2010: pp.165-186). While floods are difficult to prevent in low-lying areas closer to major water bodies, the purchase of flood insurance packages serves as an avenue to have access to financial claims after the occurrence of a disaster (Gardiner, 2020; p. 1). The existence of the National Flood Insurance Program in the United States assists households by providing an environment favourable for their living after the occurrence of floods (Michel-Kerjan, 2010; pp.165-186). This relieves them off the burden of starting life from zero after the occurrence of floods.

The purchase of insurance serves as a financial safety net for the stakeholders such as private property owners and businesses. Insurance companies sometimes also provide expert advice by encouraging households to adopt certain risk-mitigation measures including the use of flood-resistant materials in the construction of their houses (Linnerooth-Bayer & Mechler, 2007; pp. 54-61).

## Lessons for Ghana on Early Warning System and Flood Insurance

While the early warning systems are not fully integrated into the Akosombo Dam's construction, the Mactaquac Dam has Early Warning Systems that provide timely information about the residents downstream (Mioc et al., 2015; pp. 183-202). The adoption of risk maps in Canada is becoming more and more important as a tool to highlight the areas that are likely to be affected by floods during heavy downpours. The Mactaquac Dam and the town of Fredericton have been added to the risk maps in Canada to provide important information on the likelihood of floods occurring. This cannot be said to be the case of the Akosombo Dam construction. The management of the Akosombo Dam has enough data to map the flood-prone areas but financial resources to have an interactive map do not exist on their website. This is an important lesson that can be drawn from the Mactaquac Regional Development Project.

Also, a National Flood Insurance Programme in Canada delivered through a partnership between the Federal Government and the Property and Casualty (P & C) insurance industry provides adequate funds for affected victims during the flood (Oulahen, 2015; pp. 603-615). This a useful lesson for the Ghana Insurance Industry to provide customized insurance services to communities downstream of the Akosombo Dam.

### Summary of section

Comparatively, the Mactaquac multipurpose dam has a robust early warning system as well as a Flood Insurance Package with support from the Federal Government of Canada. The early warning system provides important opportunities for households to move to safer places before the occurrence of disaster and this is important in reducing the casualties associated with floods. Aside from the use of Early Warning Systems, an understanding of the capacities and vulnerabilities of the flood victims plays a crucial role in designing policies that will shape future construction projects such as dams and road infrastructure. The next section discusses

the capacities and vulnerabilities of disaster victims that be leveraged to build resilience for the affected victims or future occurrences.

## Section II: Capacities and Vulnerabilities Analysis of Disaster Victims

The Capacities and Vulnerability Analysis (CVA) focuses on the existing strengths (capacities) and weaknesses (vulnerabilities) of people that determine the impact of the crises (dam-induced flooding) on their well-being as well as the way they respond to these crises or natural disasters.

Capacities during flooding refer to the existing strengths that individuals or social groups possess to assist them in surmounting the negative impact of flooding. They usually relate to people's material and physical resources, their social resources, and their beliefs and attitudes. Capacities are built over time to enable people to easily overcome natural disasters that easily befall them (Davis et al., 2004; p.3). A community's ability to recover from negative shocks such as flooding also constitutes capacity building during flooding. On the other hand, vulnerabilities refer to the long-term factors or conditions that weaken people's ability to cope with crises such as natural or man-made disasters in an environment. Vulnerabilities also make people more susceptible to disaster. Vulnerabilities usually exist before disaster, contribute to their severity, and make recovery from disaster more difficult to achieve.

In the context of Capacities and Vulnerabilities Analysis (CVA), more attention is paid to the provision of short-term and immediate requests of the affected such as the provision of food and relief items to flood-affected communities. Addressing vulnerabilities, however, requires long-term solutions that tend to reduce any future occurrence of natural disasters.

## Categories of Capacities and Vulnerabilities

There exists physical or material, social or organizational capacities as well as motivational and attitudinal capacities and vulnerabilities that can be used in the management of disasters such as disasters.

### Physical or Material Capacities and Vulnerabilities

These include geographical or environmental features that individuals or societies possess such as land, farms, buildings, and other physical assets. In the case of the Akosombo Dam and the Mactaquac Dam construction, the physical or material capacities of the residents including their ownership of agricultural land, buildings, and other cottage industries served as a source of income for their living. Thus, the housing, technologies, water, and food supply, their access to capital and other amenities all form part of the physical or material capacities and vulnerabilities (Gyau-Boakye, 2001; p.13). The case of the Mactaquac Dam includes access to land for aquaculture farming, livestock, and wood logging from the forest reserves. These served as the material or physical capacities of the residents in Fredericton (Bourgoin, 2013; p.42). Access to physical and material capacities also differ in terms of victims of the Akosombo Dam floods and that of the Mactaquac Dam floods.

### Social or Organizational Capacities and Vulnerabilities

Social or Organizational capacities and vulnerabilities refer to the social fabric of a community, and they include the formal political structures and the informal institutions through which people make decisions. The existence of strong cultural practices among the residents closer to the Akosombo Dam served as a social capacity that united the residents under traditional leaders with common customs (Brown, 1987; p. 34). Social systems include family and community systems, and decision-making patterns within the family and the

communities (Miescher & Tsikata, 2009; pp. 15-53). Strong social or organizational capacities help build resilience in times of disaster while weak social or organizational capacities lead to vulnerabilities. Decision-making in social groups may differ based on men or women and their social roles. In the case of Ghana, men make most of the decisions at the family level while women's roles are limited to just household activities such as cooking, washing, and management of house activities.

In the case of Fredericton residents affected by the construction of the Mactaquac dam, the establishment of human resource mobility and training centers, research facilities, and town site development centers tend to hold the social capacities of the residents in good shape (Acres and Company Limited report, 1964; pp.6.10-6.12).

#### Motivational and attitudinal capacities and vulnerabilities

Motivational and attitudinal capacities and vulnerabilities refer to the cultural and psychological factors that may be based on religion, the community's history of natural disasters, and their expectation of emergency relief. The occurrence of natural disasters can be a source of catalyst for extraordinary efforts for communities, but when people feel victimized, and dependent, they may also become fatalistic and passive. This may end up affecting their capacities and increase their vulnerabilities in the occurrence of disaster. Vulnerabilities of the flood victims can increase because of inappropriate disaster relief aids.

Table 5.1: Capacities and Vulnerabilities Matrix

Categories	Capacities	Ghana	Canada	Vulnerabilities	Ghana	Canada
<b>Physical/ Material</b>	Access to boats for evacuation	✗	✓	Low-lying areas prone to flood	✓	✓
	Adequate food storage	✗	✓	Poor transport system	✓	✗
	Elevated homes	✗	✓	Inadequate drainage system	✓	✗
<b>Social/Organizational</b>	Vibrant local disaster committee	✗	✓	Inadequate government support	✓	✗
	Presence of Early warning system	✗	✓	Poor agencies coordination	✓	✗
	Community based organizations	✓	✓	Lack of emergency shelters	✓	✗
<b>Motivational/Attitudinal</b>	Awareness campaigns of flood risks	✓	✓	✓ Apathy towards government policies		✗
	Local leaders' trusteeship	✓	✓	Fear of resettlement	✓	✓
	Cultural practices that promote aid	✓	✓	Floods fatalism	✓	✓

Source: Adopted from Davis, Haghebaert and Peppiatt (2004).

Table 5.1 above shows the CVA matrix disaggregated by country (Ghana) and (Canada) in periods of disaster such as flooding.

#### Physical/ Material Capacities and Vulnerability

Table 5.1. shows the material or physical capacities and vulnerabilities between Ghana and Canada in times of disaster such as flooding. Under capacity considerations, Ghana lacks access to boats during flooding leading to the use of traditional crafts such as hand-make canoes which can be risky to use during floods while Canada has access to speed boats that are easily deployed to flooded areas to save numerous lives (Owusu & Obour, 2021: pp.2387-2403; Vasseur et al, 2007; pp. 119-170). Also, capacities such as adequate food storage occur in the case of Canada due to large-scale commercial farming activities compared to Ghana where agricultural production is done on a subsistence basis (Darfour & Rosentrater, 2016; p.12). This reduces the capacities of Ghanaians during flooding periods but increases the capacities of developed countries such as Canada in periods of disaster such as flooding. While the construction of buildings is usually done on elevated grounds, developing countries such as Ghana tend to build on non-elevated grounds due to the high cost of construction thereby resorting to the use of mud and bricks. This increases the vulnerability of residents closer to flood-prone areas during flooding compared to Canada where construction of buildings is done on elevated grounds (Dodoo-Arhin et al., 2013; pp. 110-119).

#### Social/Organizational Capacities and Vulnerabilities

In terms of the social or organizational capacities and vulnerabilities, it can be observed from Table 5.1 that while Ghana has zero to weak local disaster committees, Canada has adequately resourced local disaster committees that work with government agencies to ensure quick response to flood-prone residents (Mensah-Bonsu, 2022: pp. 88-110; Buckland & Rahman, 1999 pp.174-191). The presence of early warning systems also serves as a capacity for

developed country residents such as Canada compared to developing countries such as Ghana that have weak early warning systems. This tends to reduce the huge negative impact of disaster during its occurrence compared to developing countries such as Ghana which have zero to non-existent early warning systems (Perera et al., 2019: p.14). In Canada, there are early warning and emergency management officials at provincial levels with adequate Federal government support (Perera et al., 2019: p.14) unlike Ghana where government support for these National Disaster Management Offices is under-resourced (Kwadwo & Morkla, 2024; pp. 19-23).

### Motivational/Attitudinal Capacities and Vulnerabilities

The last section of the Capacities and Vulnerabilities Analysis focused on attitudinal and motivational capacities and vulnerabilities. While the residents of Ghana and of Canada have relevant knowledge on awareness of flood risks in both countries, apathy towards government policies is recognized as a main risk in the vulnerability analysis in disaster communities in Ghana (Bawole, 2017; pp.122-139). Cultural practices that promote aid are recognized as capacities in both Ghana and Canada through voluntary donations in aid of affected communities during floods. For example, Faith Based Organizations such as Salvation Army work both in Canada and in Ghana to support vulnerable people during disasters (Okyere et al., 2024) p.1-24.

### Section III: Discussion and Insights and Lessons

Efforts to close the regional disparities and the developing countries' under-development have existed since time immemorial. The influence of the Tennessee Valley Authority (TVA) project on the Akosombo Dam and the Mactaquac Dam shows the tight decisions that planners, government, and investors have to make to large-scale projects such as the construction of dams. The TVA management's tight decision-making structure to thwart public participation led to excess power-generating capability. Notwithstanding the low rates



associated with the TVA power supply to consumers, no evidence has been found to support the argument that the TVA rates caused an increase in the number of industries.

The TVA has maintained a reputation for creating benefits for the area it serves leading it to become a model for similar developments around the world such as the Akosombo Dam in Ghana and the Mactaquac Dam in New Brunswick Province. However, the role and influence of the TVA on the construction of the Akosombo Dam and the Mactaquac Dam have been questioned since other TVA coverage areas also experienced income growth, manufacturing employment, and electrification of the rural areas around the same time. Replicating such a project should therefore be critically examined.

The replication of the TVA project in Ghana using the Volta River Project was faced with complications. It was found that the aspects of multi-purpose river development that provide the most social benefits feasible to developing countries were not considered. The resettlement of about 80,000 people during the dam construction was not considered at the initial stages. The Volta River Project contributed to the diversification of the Ghanaian economy but did not meet the potential benefits that initial planners had expected. From the lessons learned, resettlement schemes were not adequate compared to the Mactaquac Dam Project which carefully planned for mobility grants to enable households to resettle easily. This forms part of the unique nature of the Mactaquac Dam that can be learned by the Volta River Authorities.

The Mactaquac Dam Project which followed the TVA project was found to be successful in increasing the province's ability to generate power with renewable energy. The new town of Nackawic centralized those displayed by the various Mactaquac-related projects, unlike the Akosombo Dam project which scattered 739 communities. The Nackawic town offered new employment opportunities at the new pulp mill.

Unlike the Akosombo Dam, which is now beginning to develop its recreational facilities, the largest benefit associated with the Mactaquac Dam is the development of its recreational facilities and the sense of pride and belonging instilled in the people from the region. Comparable services are also offered to the people living in the Tennessee Valley area.

It is useful to note that the Mactaquac Dam has experienced just one flood since its construction while the Akosombo Dam has experienced more than ten floods. This means that an assessment of the capacities and vulnerabilities is useful among these victims as they device annual community groups to educate community members. The Mactaquac Dam is however being used as a model for the development of early warning systems for the residents downstream of the Akosombo Dam. The people in the Mactaquac area were greater benefactors of the multipurpose river development project compared to the residents of the Akosombo Dam area.

#### Useful Lessons for Future Projects based on the Akosombo and the Mactaquac Dam construction

The Akosombo Dam and the Mactaquac Dam construction which were both influenced by the Tennessee Valley Authority provide useful lessons due to the flood challenges associated with these projects for the development of future projects.

#### Comprehensive Evaluation of Projects before implementation

The Akosombo Dam and the Mactaquac Dam provide useful information for future projects to engage in a comprehensive evaluation of projects before they are implemented. This is important in listening to the concerns to those who may be directly affected by the projects before their implementation. While such projects may be beneficial to the industrialization drive of their respective countries, it would also be important to factor into the construction the needs of the communities closer to such projects before they are finally implemented.

### Adequate financial Resources before commencement

Future projects of such nature such as the construction of dams should make sure adequate resources are available before they commence. This will make the managers of the project stick to the original intention and plans involved in the project before they are completed. One major challenge associated with the Akosombo Dam was the sourcing of financial resources for the commencement of the project. Though the project was touted to be a miracle project for Ghana at that time, the original plans were not adhered to due to financial constraints at the start of the construction. This made a lot of associated projects such as tourist sites abandoned during the construction period. Future projects should make sure there are enough resources before they start.

### Comprehensive Evaluation of Projects

Future projects such which includes infrastructure construction should be properly evaluated before they are implemented. The social costs, economic costs, and environmental costs should all be properly evaluated before such projects are started. For example, the construction of the Akosombo dam which led to the displacement of 80,000 residents from 739 communities could have been installed using oil and gas plants. The opportunity cost and the possibility of floods associated with such projects should all be considered before they are constructed. The installation of early warning systems and economic incentives should all be included in assessing future comprehensive projects since these were lacking in the earlier industrialization projects such as the Akosombo Dam construction project.

### Renewable Energy for Future Projects

As part of the effort to fight climate change, future projects should be based on renewable energy sources such as wind energy or solar energy which are less harmful to use

and do not require a lot of space for construction. This will reduce the possibility of using large areas of land and displacing a lot of people. Renewable energy sources also do not have the associated risk of flooding affecting nearby communities and residents. This is also cheaper to use than the construction of dams which affects the environment negatively.

## **Chapter 6**

### **Summary, Conclusions, and Policy Recommendations**

This thesis has explored two main multipurpose river development projects implemented in Ghana (Akosombo Dam) and Canada (Mactaquac Dam) with the major goal of improving the living standards of people in their respective regions through the provision of power supply for industrialization in these two countries. Each of the projects was based on the influence of the Tennessee Valley Project as well as the Big Push model. The complexities associated with each project of each project are assessed to reflect their economic contribution as well as their failure to consider the social dimension of multipurpose development.

Chapter Two focused on assessing the Big Push theory of Industrialization of development in the 20<sup>th</sup> century leading to the establishment of multipurpose development goals such as dam construction and industries with a specific focus on the Akosombo Dam and the Mactaquac Dam. It also places the two main projects into perspective and analyses the influence of the Tennessee Valley Authority (TVA) on these two major projects in Ghana and Canada.

The influence of the Tennessee Valley Authority on the construction of the Akosombo Dam and the Mactaquac Dams was also assessed in Chapter 3. Despite the differences between the Volta River Project and the Mactaquac Dam construction which were both influenced by the Tennessee Valley project, all these three projects have similar outcomes of providing cheaper power supply for the industrialization drive of their respective regions. The study focuses on the Akosombo Dam and the Mactaquac Dam primarily due to the similarity in following the Tennessee Valley Project and with the specific focus of both being constructed around the same period. These two spaces have regions with different environmental and geographical characteristics that shape dam's construction and its ability to hold more water at

its surface area for multipurpose development. Therefore, the selection of the TVA model should be more critically evaluated before continuing to replace this model across countries as the TVA model ignores the social dimension of infrastructure development.

Chapter 4 described the existence of Early Warning Systems and economic incentives such as the use of insurance packages as a safety net for affected residents during flood. The use of an effective early warning system (EWS) in every part of the world requires local community participation by ensuring that the community affected is fully aware of the natural or man-made disaster to prepare adequately for them through information dissemination.

Chapter 5 paid attention to the Dam-Induced Flooding, Capacities, and Vulnerability Analysis of Ghana and Canada. The Akosombo Dam is the largest hydroelectric Dam in Ghana with the economic benefit of providing lower electricity supply to the Ghanaian populace. The most recent flooding resulting from the Akosombo Dam spillage occurred in October 2023 leading to the displacement of 30,000 people who live close to the dam. The impact of Floods includes economic, social, health, and psychological effects. The Mactaquac Dam, which has also experienced flooding, has had a devastating impact on the livelihoods and infrastructure in New Brunswick Province. Section 2 of Chapter 5 focused on an analysis of the Capacities and Vulnerabilities framework by identifying the capacities of flooded residents and the vulnerabilities associated with flooding in these communities. The ability of the residents within a flood-prone area to make use of capacities and assess their vulnerabilities is also important in understanding how people affected by natural or man-made disasters can recover from the shocks of disasters such as flooding through the resources at their disposal. The opportunity cost of constructing such dams, which includes the loss of agricultural lands and social costs associated with resettlements was also assessed in the study.

The largest benefit associated with the Akosombo Dam is the provision of electricity at a lower cost for the Ghanaian populace while the Mactaquac Dam has been recognized as a major tourist attraction site for many visitors in the New Brunswick Province. Higher gains from fishing hatcheries have been identified as some of the benefits associated with the Mactaquac Dam while the construction of the Akosombo Dam has been heralded as one of the largest projects in Tropical Africa. Despite the national pride associated with these projects, the residents close to these Dams are the most affected people in times of flood. The case of the Akosombo Dam is worse due to the high prevalence of poverty among the residents closer to the Dam whose lands were taken away from them for the construction of the Dam with little or no compensation payment at all. The displacement of their tribes and loss of ancestral touch has affected them to date. The people in the Mactaquac Dam areas were greater beneficiaries of multipurpose river development projects compared to the Akosombo Dam neighbours.

#### Policy Recommendations

Based on the conclusions of the study, the following suggestions are made for policy decisions.

Though future projects of such nature can draw ideas from existing models such as the TVA, the development of multipurpose projects should be context-specific and not be based on a one-size-fits-all approach. This can help to reduce some of the externalities associated with the construction of such projects shortly. The use of adequate feasibility studies based on the sentiments of the beneficiaries and nearby communities can be well analyzed before final decisions are taken.

The adoption of renewable energy sources can be recognized to be another avenue to be used in the provision of electricity without deep excavation of the earth to conserve water that has the potential to result in flooding. Electricity of solar and wind panels for electricity

generation is important to achieve the needed energy for usage by households and the industrial sector.

Leveraging on the capacities and minimizing the vulnerability in dam construction zones can be another way to have the best outcomes from electricity production. The ability of the government to provide adequate education for the residents in flood-prone areas can help minimize the impact of flooding in these areas. In addition, resources such as financial and physical resources should be adequately provided for the residents to depend on and not only on agricultural activities.

Resourcing of Disaster Management Organizations should be one of the topmost priorities of the government. While most Emergency Management Organizations in developing countries do not have enough equipment for managing disasters, most of their governments are focused on short-term measures and approaches to assisting victims instead of providing enough resources for them. Resources in the form of vehicles, life jackets during flooding, and speed boats should be well financed for the EMOs in flood-prone areas.



## REFERENCES

- Acheampong, T., & Mensah, K. A. (2018). Towards an Integrated Bauxite and Aluminium Industry in Ghana. *Natural Resource Governance Institute, Accra, 10*.
- Arnell, N. W., & Hulme, M. (2000). Implications of climate changes for large dams and their management. *Thematic review II, 2*.
- Asumadu-Sarkodie, S., & Owusu, P. A. (2016). The potential and economic viability of solar photovoltaic power in Ghana. *Energy sources, Part A: Recovery, utilization, and environmental effects, 38(5)*, 709-716.
- Bourgoin, S. (2013). Disregarded sentiments: discovering the voices of opposition to the Mactaquac Dam.
- Bourgoin, S. (2013). Disregarded sentiments: discovering the voices of opposition to the Mactaquac Dam.
- Bourgoin, S. (2013). Disregarded sentiments: discovering the voices of opposition to the Mactaquac Dam.
- Bradshaw, M. J. (1988). *Regions and regionalism in the United States*. Macmillan education.
- Brown, P. H., Tullos, D., Tilt, B., Magee, D., & Wolf, A. T. (2009). Modeling the costs and benefits of dam construction from a multidisciplinary perspective. *Journal of environmental management, 90*, S303-S311.
- Buckley, H., & Tihanyi, E. (1967). Canadian policies for rural adjustment: a study of the economic impact of ARDA, PFRA, and MMRA.

- Collins, M. L., & Kapucu, N. (2008). Early warning systems and disaster preparedness and response in local government. *Disaster Prevention and Management: An International Journal*, 17(5), 587-600.
- Darko, D., Kpessa-Whyte, M., Obuobie, E., Siakwah, P., Torto, O., & Tsikata, D. (2019). The context and politics of decision making on large dams in Ghana: an overview.
- Davis, I., Haghebeart, B., & Peppiatt, D. (2004). Social vulnerability and capacity analysis. *Geneva: Provention Consortium*.
- de León, J. C. V., Bogardi, J., Dannenmann, S., & Basher, R. (2006). Early warning systems in the context of disaster risk management. *Entwicklung and Ländlicher Raum*, 2(1), 23-28.
- Dehghani-Sanij, A. R., Al-Haq, A., Bastian, J., Luehr, G., Nathwani, J., Dusseault, M. B., & Leonenko, Y. (2022). Assessment of current developments and future prospects of wind energy in Canada. *Sustainable Energy Technologies and Assessments*, 50, 101819.
- Dickison, J. J. (2006). *Resource Development in Mactaquac Regional Development* (Doctoral dissertation, UNIVERSITY (OF NEW BRUNSWICK)).
- Dickison, J. J. (2006). *Resource Development in Mactaquac Regional Development* (Doctoral dissertation, UNIVERSITY (OF NEW BRUNSWICK)).
- Easterly, W. (2006). Planners versus searchers in foreign aid. *Asian Development Review*, 23(02), 1-35.
- Gans, J. (1998). Industrialization Policy and the 'Big Push'. In *Increasing returns and economic analysis* (pp. 280-304). London: Palgrave Macmillan UK.

- Gardiner, G. (2020). Flood Victims Are at the Mercy of the Elements and of Their Insurers: The Case for an Improved National Flood Insurance Program. *Loy. J. Pub. Int. L.*, 22, 1.
- Gereffi, G. (1990). Paths of industrialization: An overview. *Manufacturing Miracles: Paths of Industrialization in Latin America and East Asia*, 3(31).
- Gertler, L. O. (1969). Observations on the Mactaquac Regional Development Plan. *Regional Planning in Canada: A Planner's Testament*.
- Grasso, V. F., & Singh, A. (2011). Early warning systems: State-of-art analysis and future directions. *Draft report, UNEP*, 1, 7.
- Gyau-Boakye, P. (2001). Environmental impacts of the Akosombo dam and effects of climate change on the lake levels. *Environment, Development and Sustainability*, 3, 17-29.
- Hance, W. A. (1956). Economic development in tropical Africa. *The American Economic Review*, 46(2), 441-451.
- Kanter, A. (1972). Congress and the defense budget: 1960–1970. *American Political Science Review*, 66(1), 129-143.
- Kanyagui, K. (2008). Impact of mega projects on developing economies (Case study: Akosombo Hydro Electric Dam, Ghana). *Unpublished Master of Project Management thesis, University of Greenwich, London*.
- Keilty, K., Beckley, T. M., & Sherren, K. (2016). Baselines of acceptability and generational change on the Mactaquac hydroelectric dam headpond (New Brunswick, Canada). *Geoforum*, 75, 234-248.

- Kingsford, R. T. (2000). Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia. *Austral Ecology*, 25(2), 109-127.
- Kumi, E. N. (2017). The electricity situation in Ghana: Challenges and opportunities.
- Ligon, F. K., Dietrich, W. E., & Trush, W. J. (1995). Downstream ecological effects of dams. *BioScience*, 45(3), 183-192.
- Linnerooth-Bayer, J., & Mechler, R. (2007). Disaster safety nets for developing countries: Extending public—Private partnerships. *Environmental Hazards*, 7(1), 54-61.
- McCartney, M. P., Sullivan, C., Acreman, M. C., & McAllister, D. E. (2001). Ecosystem impacts of large dams. *Background paper*, 2.
- Mei, X., Van Gelder, P. H. A. J. M., Dai, Z., & Tang, Z. (2017). Impact of dams on flood occurrence of selected rivers in the United States. *Frontiers of Earth Science*, 11, 268-282.
- Michel-Kerjan, E. O. (2010). Catastrophe economics: the national flood insurance program. *Journal of economic perspectives*, 24(4), 165-186.
- Miescher, S. F. (2014). “Nkrumah’s Baby”: The Akosombo Dam and the dream of development in Ghana, 1952–1966. *Water History*, 6, 341-366.
- Miescher, S. F. (2014). “Nkrumah’s Baby”: The Akosombo Dam and the dream of development in Ghana, 1952–1966. *Water History*, 6, 341-366.
- Miescher, S. F. (2014). “Nkrumah’s Baby”: The Akosombo Dam and the dream of development in Ghana, 1952–1966. *Water History*, 6, 341-366.

- Miescher, S. F. (2014). “Nkrumah’s Baby”: The Akosombo Dam and the dream of development in Ghana, 1952–1966. *Water History*, 6, 341-366.
- Miescher, S. F. (2021). Ghana's Akosombo Dam, Volta Lake Fisheries & Climate Change. *Daedalus*, 150(4), 124-142.
- Miescher, S. F. (2022). *A dam for Africa: Akosombo stories from Ghana*. Indiana University Press.
- Miescher, S. F., & Tsikata, D. (2009). Hydropower and the promise of modernity and development in Ghana: Comparing the Akosombo and Bui dam projects. *Ghana Studies*, 12(1), 15-53.
- Miescher, S. F., & Tsikata, D. (2009). Hydropower and the promise of modernity and development in Ghana: Comparing the Akosombo and Bui dam projects. *Ghana Studies*, 12(1), 15-53.
- Murphy, K. M., Shleifer, A., & Vishny, R. W. (1989). Industrialization and the big push. *Journal of political economy*, 97(5), 1003-1026.
- Nadarajah, S., & Kwofie, C. (2024). An extreme value analysis of water levels at the Akosombo dam, Ghana. *Heliyon*, 10(14).
- Pasterick, E. T. (1998). The national flood insurance program. *Paying the price: The status and role of insurance against natural disasters in the United States*, 125-154.
- Perera, D., Smakhtin, V., Williams, S., North, T., & Curry, A. (2021). Ageing water storage infrastructure: An emerging global risk. *UNU-INWEH Report Series*, 11, 25.

- Reilly, K. H., & Adamowski, J. F. (2017). Spatial and temporal scale framing of a decision on the future of the Mactaquac Dam in New Brunswick, Canada. *Ecology and Society*, 22(3).
- Reilly, K. H., Adamowski, J. F., & John, K. (2019). The role of place meanings in opposition to water-related infrastructure projects: the case of the Mactaquac Dam, New Brunswick, Canada. *Ecology & Society*, 24(4).
- Reilly, K. H., Adamowski, J. F., & John, K. (2019). The role of place meanings in opposition to water-related infrastructure projects: the case of the Mactaquac Dam, New Brunswick, Canada. *Ecology & Society*, 24(4).
- Ro, Y. J., & Jung, K. Y. (2010). Impact of the dam water discharge on the circulation system in the Kangjin Bay, South Sea, Korea. *Ocean Science Journal*, 45, 7-25.
- Sherren, K., Greenland-Smith, S., Chen, Y., Comeau, L., Beckley, T., & Parkins, J. (2016). Mactaquac and beyond: Citizen perspectives on energy issues in New Brunswick.
- Siakwah, P., & Torto, O. (2022). Analysis of the complexities in the water-energy-food nexus: Ghana's bui dam experience. *Frontiers in Sustainable Food Systems*, 6, 734675.
- Smiley, D. V. (1963). Conditional grants and Canadian federalism: a study in constitutional adaptation. (*No Title*).
- Springate, David J. V.(1972). "Regional Development Incentive Grants and Private Investment in Canada: A Case Study of the Effect of Regional Development Incentives on the Investment Decisions of Manufacturing Firms." Ph.D. thesis, Harvard University, 1972
- Stanke, C., Murray, V., Amlôt, R., Nurse, J., & Williams, R. (2012). The effects of flooding on mental health: Outcomes and recommendations from a review of the literature. *PLoS currents*, 4.

- Steel, R. W. (2014). The Volta Dam: its prospects and problems. *Dams in Africa Cb*, 63-75.
- Tennessee Valley Authority. Information Office. (1983). *A history of the Tennessee Valley Authority*. Tennessee Valley Authority, Information Office.
- Treadwell, B. W. (1967). *THE VOLTA RIVER PROJECT: A CASE STUDY OF UNITED STATES FOREIGN POLICY*. American University.
- Velazquez, O., Pescaroli, G., Cremen, G., & Galasso, C. (2020). A review of the technical and socio-organizational components of earthquake early warning systems. *Frontiers in Earth Science*, 8, 533498.
- Verkade, J. S., & Werner, M. G. F. (2011). Estimating the benefits of single value and probability forecasting for flood warning. *Hydrology and Earth System Sciences*, 15(12), 3751-3765.
- White, G. F. (1963). Contributions of geographical analysis to river basin development. *The geographical journal*, 129(4), 412-432.
- Yazdi, J., Sabbaghian Moghaddam, M., & Saghafian, B. (2018). Optimal design of check dams in mountainous watersheds for flood mitigation. *Water resources management*, 32, 4793-4811.
- Young, C. (2012). *The postcolonial state in Africa: Fifty years of independence, 1960–2010*. University of Wisconsin Pres.
- Zhong, Y., & Power, G. (1996). Some environmental impacts of hydroelectric projects on fish in Canada. *Impact assessment*, 14(3), 285-308.
- Bourgoin, S. (2013). Disregarded sentiments: discovering the voices of opposition to the Mactaquac Dam.
- Costa, J. E. (1985). *Floods from dam failures* (Vol. 85, No. 560). US Geological Survey.

- Desjardins, P. M. (2011). Regional disparities in Canada: Interprovincial or urban/rural. *Région et développement*, 33(33), 59-80.
- Dumevi, C. Y., Owusu-Asenso, C. M., Amoah, B. D., Asiamah, J. J., Vicar, E. K., Kretchy, J. P., ... & Ayeh-Kumi, P. F. (2024). Spillage of Akosombo and Kpong Dams in Ghana: Perspectives on Public Health Impacts on Affected Populations and Proposed Mitigation Strategies. *International Journal of TROPICAL DISEASE & Health*, 45(7), 55-67.
- Gans, J. (1998). Industrialization Policy and the 'Big Push'. In *Increasing returns and economic analysis* (pp. 280-304). London: Palgrave Macmillan UK.
- Gyau-Boakye, P. (2001). Environmental impacts of the Akosombo dam and effects of climate change on the lake levels. *Environment, Development and Sustainability*, 3, 17-29.
- Hansen, N., Higgins, B., & Savoie, D. J. (1990). *Regional policy in a changing world*. Springer Science & Business Media.
- Ho, M., Lall, U., Allaire, M., Devineni, N., Kwon, H. H., Pal, I., ... & Wegner, D. (2017). The future role of dams in the United States of America. *Water Resources Research*, 53(2), 982-998.
- Liel, A. B. (2011). The influence of engineering organization on design and construction processes at Tennessee Valley Authority dams of the 1930s. In *Structures Congress 2011* (pp. 2320-2331).
- Maizels, A., & Nissanke, M. K. (1984). Motivations for aid to developing countries. *World development*, 12(9), 879-900.
- Mason, J. W., & Bossie, A. (2020). Public spending as an engine of growth and equality: lessons from World War II. *Roosevelt Institute*.



- McAllister, I. (1982). *Regional development and the European Community: a Canadian perspective*. IRPP.
- McCraw, T. K. (1985). *TVA: Fifty Years of Grass-Roots Bureaucracy*.
- Michel-Kerjan, E., & Kunreuther, H. (2011). Redesigning flood insurance. *Science*, 333(6041), 408-409.
- Mioc, D., Nkhwanana, J. N., Moreiri, K. K., Nickerson, B., Santos, M., McGillivray, E., ... & Tang, P. (2015). Natural and man-made flood risk mapping and warning for socially vulnerable populations. *International Journal of Safety and Security Engineering*, 5(3), 183-202.
- Murphy, K. M., Shleifer, A., & Vishny, R. W. (2000). Industrialization and the big push. *Readings in Development Microeconomics*, 1, 171-196.
- Oulahen, G. (2015). Flood insurance in Canada: Implications for flood management and residential vulnerability to flood hazards. *Environmental Management*, 55, 603-615.
- Perera, D., Smakhtin, V., Williams, S., North, T., & Curry, A. (2021). Ageing water storage infrastructure: An emerging global risk. *UNU-INWEH Report Series*, 11, 25.
- Reilly, K. H., & Adamowski, J. F. (2017). Spatial and temporal scale framing of a decision on the future of the Mactaquac Dam in New Brunswick, Canada. *Ecology and Society*, 22(3).
- Schaffer, D. (1990). Managing the Tennessee River: Principles, practice, and change. *The Public Historian*, 12(2), 7-29.
- Selznick, P. (1953). *TVA and the grass roots: A study in the sociology of formal organization* (Vol. 3). Univ of California Press.

- Selznick, P. (2011). *TVA and the grass roots: A study of politics and organization*. Quid Pro Books.
- Thiemig, V., De Roo, A., & Gadain, H. (2011). Current status on flood forecasting and early warning in Africa. *Intl. J. River Basin Management*, 9(1), 63-78.
- Tilt, B., Braun, Y., & He, D. (2009). Social impacts of large dam projects: A comparison of international case studies and implications for best practice. *Journal of environmental management*, 90, S249-S257.
- Turner, J. R., & Xue, Y. (2018). On the success of megaprojects. *International Journal of Managing Projects in Business*, 11(3), 783-805.
- Yazdi, J., Torshizi, A. D., & Zahraie, B. (2016). *Stochastic Environmental Research and Risk Assessment*, 30, 1457-1471.