

Ghana's Akosombo Dam, Volta Lake Fisheries & Climate Change

Stephan F. Miescher

In Ghana, the Pwalugu Dam in the Upper East is in the final planning stage. Whereas promoters of Ghana's first dams emphasized the need for generating electricity to modernize and industrialize the new nation, the planners of Pwalugu have focused on water issues. Due to climate change, droughts have had a devastating impact on local agriculture. The dam's primary purpose is an irrigation scheme and flood control. This essay historicizes these concerns by revisiting the Akosombo Dam, Ghana's largest hydroelectric dam, completed in 1965. The discussion juxtaposes personal recollections of dam-affected communities with reports by administrators, biologists, and social scientists. The essay draws on government records, scientific studies about Volta Lake, and oral histories. Ultimately, it argues, builders and administrators of the Akosombo Dam failed to address most water issues, despite ample knowledge about their existence. One hopes that these shortcomings will not be repeated in the Pwalugu project.

Over the last fifteen years, as several contributions to this issue of *Dædalus* note, Africa has experienced a resurgence of dam-building, with several major projects under construction or nearing completion.¹ In Ghana, the Bui Dam across the Black Volta was finished in 2013.² The Pwalugu Dam on the White Volta is in the final planning stage with construction by Sinohydro soon to begin. In the 1950s and 1960s, the promoters of Ghana's first dams emphasized the need for generating electricity to modernize and industrialize the new nation. The planners of the Pwalugu Dam have embraced a different rhetoric. Water issues have moved to the foreground. Due to climate change, the Northeast and Upper East Regions, where Pwalugu is located, have endured droughts with a devastating impact on local agriculture.³

At a stakeholder meeting in 2019, the Volta River Authority (VRA) promised that Pwalugu would address water security. Its primary purpose would be an irrigation scheme covering an area of 24,000 hectares that would produce rice and maize as well as provide a water supply during the dry season and flood control. Since Burkina Faso built the Bagre Dam upstream on the White Volta in 1992, spilling during the rainy season has caused devastation to riverine communities. Elec-

tricity generation at Pwalugu, through a hydroelectric plant with an installed capacity of 60 megawatts and a related 40-megawatt solar project, would be secondary. Pwalugu's reservoir, the stakeholders learned, would be small, only 135 square miles. Still, with a nod to a global discussion, VRA officers emphasized that Pwalugu would increase the generation of renewable energy capacity and thus enhance Ghana's commitment to the United Nations Convention on Climate Change.⁴ At the sod-cutting ceremony in November 2019, President Nana Akufo-Addo foregrounded water security. He stated that the dam would "avert the perennial flooding caused by the spillage of the Bagre Dam." The large irrigation project, which should benefit fifteen thousand farmers, would mean a change from the northern regions' current agricultural pattern, in which farm work comes to a halt during the dry season. "Irrigation," the president added, "remains a key strategy to achieve food security, the eradication of poverty and generation of rural employment." The president emphasized the potential for aquaculture (fish farming) in the Pwalugu reservoir. He reminded his audience that the older hydroelectric dams, Akosombo and Kpong, were planned with irrigation schemes that did not materialize. The story of Pwalugu "[would] be different."⁵ The president said nothing about displacement and other social impacts of the dam. According to recent media reports, 4,200 people would be displaced by the Pwalugu multipurpose dam.⁶

This essay historicizes concerns about water use and climate change in connection with the Pwalugu Dam by revisiting the Akosombo Dam, Ghana's first and largest hydroelectric scheme that was completed as part of the Volta River Project in 1965, with an installed capacity of (now) 1,000 megawatts. Akosombo created a vast reservoir, Volta Lake, which covers, when full, an area of 3,275 square miles and extends 250 miles to the north. The lake not only transformed the Volta Basin's ecology but displaced eighty thousand people and created new inland fisheries. What were the social and ecological impacts of this large dam project, both upstream and downstream? How did the communities impacted by the dam experience these changes? What have been the conceptions of water usage and climate change since the 1960s, and how have they impacted public discourse and policies?

The planners of the Volta River Project produced detailed studies about the dam's ecological and social impacts in the Volta Basin where the flooding would occur and in the Lower Volta, the downstream area that would be severely affected by the river's changed flow pattern. When the project was implemented in the early 1960s, these concerns were tossed aside. This discussion juxtaposes personal recollections of dam-impacted communities with reports by administrators, biologists, social scientists, and other experts. The essay draws on the VRA archive, scientific studies about Volta Lake, and oral histories. Ultimately, it argues, the builders and administrators of the Akosombo Dam failed to address most wa-

ter issues, despite ample knowledge about their existence. One hopes that these shortcomings will not be repeated in the Pwalugu project.

The Volta River Project, which straddles the colonial and postcolonial divide, was at the center of agendas concerning modernization, development, and nationhood in Ghana during the 1950s and 1960s. Conceived in the interwar period for the benefit of the metropole, the project was reshaped during the final years of British colonial rule. In 1915, Australian geologist Albert Kitson had the idea of harnessing the Volta River to process local bauxite into aluminum. In 1938, South African engineer Duncan Rose used Kitson's plan and formed a company to secure bauxite and dam concessions in the Gold Coast (colonial Ghana). During World War II, the rising demand for aluminum generated interest in the Gold Coast's bauxite. After the war, multinational companies and the British government became interested in creating an integrated aluminum industry in the Gold Coast, fitting with Britain's colonial development initiatives. When Kwame Nkrumah's government of the Convention People's Party came to power in 1951, it moved the Volta project to the center of its modernization agenda.⁷

The Preparatory Commission, formed under the auspices of the British and Gold Coast governments, endorsed the scheme that included a hydroelectric dam at Ajena, an alumina plant and smelter at Kpong, and miles of railway tracks.⁸ Initially, the advocates of the Volta project expressed little concern about its environmental and social impact. They considered the Volta Basin to be mostly uninhabited and grossly underestimated the number of people who would be affected. A confidential report in 1951 stated that "the reservoir would inundate very little of economic value" and that only 18,000 people would be displaced.⁹ The Preparatory Commission provided a correction. It suggested that 62,000 people living in the Volta Basin would have to be resettled. Whereas the commission recommended monetary compensation for the loss of buildings, land, and tree crops, people were "expected to resettle themselves" over a period of four years prior to the flooding.¹⁰

In its investigations, the Preparatory Commission focused on the fisheries of the future Volta Lake. It anticipated a catch "vastly in excess" of the current production on the Volta River and its tributaries. An ample fish supply would address the "protein deficiency" in the nation's diet. E. B. Worthington, a colonial fisheries expert, forecasted for the lake a yield of 18,000 tons of fish per year. He expected that it would take years for the lake to realize its potential.¹¹ Unresolved issues included the stocking of fish, attracting fishers willing to move to the lakeside, the provision of "stouter river craft," and organizing marketing efforts. The commission anticipated that trained personnel would be required for the lake's "effective development." Many of these issues would be resolved without government interference.¹²

In the mid-1950s, about one thousand Tongu fishers operated in the area from the dam site to the heads of the future lake. They were part of a migratory economy that connected the Lower Volta with the upper parts of the river and its tributaries. Upstream economic activities “were an integral part of livelihoods in the Lower Volta,” as social scientist Dzodzi Tsikata has argued.¹³ Tongu fishers, according to the Preparatory Commission, migrated north for the catching season in the first half of the year. The majority maintained connections with their hometowns and returned to the Lower Volta with the onset of the floods in June or July. The upstream fishing communities – the fishermen and their families – included about six thousand people during the dry season, and half that number during the annual flood. They lived in small, scattered villages, built with the “most rudimentary structures.” Their annual catch was 8,000 pounds of fish. The commission anticipated that these communities would relocate to their hometowns during the filling of the lake. Once the lake had formed, they would return and settle on its edges.¹⁴

The seasonal variations of water flow shaped the livelihoods of Lower Volta communities and their migrations. The Volta’s annual floods not only replenished about four hundred fishing channels and ponds but irrigated the farms along the river and creeks.¹⁵ While river and creek fishing was a male activity, clam fishing was exclusively conducted by women. The commission estimated the annual value of the clam catch at about £25,000. A later study increased the figure to £100,000.¹⁶ The commission assumed that the clam industry would not be much impacted by the dam. Economist Rowena Lawson later urged the government to transplant the clam beds to creeks since the loss of the clam industry would “seriously affect the livelihood” of 2,500 women.¹⁷

The commission recommended an allocation of £500,000 to cover the government’s commitment for the Lower Volta. This amount included funds for additional enquiries, for widening and restoring creeks, and for paying compensation of £350,000 for the lost fisheries in creeks and ponds. The commission argued that any decline in fishing channels “would be insignificant compared to the eventual increase [in fisheries] anticipated for the lake area.”¹⁸ This optimistic prediction did not materialize. Instead, as Tsikata’s study has documented, the Lower Volta experienced a dramatic decline in livelihood. Creek and clam fishing were among the “more spectacular casualties of the Volta River Project.” My research in Mepe, once a center of clam fishing, confirmed this assessment.¹⁹

The Preparatory Commission addressed the anticipated public health problems of the new lake. British medical experts identified four water-related diseases: malaria, *trypanosomiasis* (sleeping sickness), *onchocerciasis* (river blindness), and *schistosomiasis* (bilharzia). The commission expected a higher incidence of malaria, since two different *Anopheles* mosquitos would find breeding places at the lake margins. The commission was less certain whether trypanosomiasis would

increase, possibly through lake transport, since its carrier, the tsetse fly, was more common in the north. It suggested clearing vegetation at major landing sites and inoculating fishers and boatmen. Onchocerciasis, transmitted through the bite of the blackfly, was widespread above and below the dam site. Damming the Volta would flood the blackfly's breeding grounds in the inundated area. During construction, spraying with DDT was expected to protect workers from onchocerciasis. Urinary schistosomiasis, a chronic disease, was widespread in the Volta delta and upstream from the future dam, with a high infection rate among migrant fishermen. The commission anticipated that the lake would become infested with its vector snail and proposed a Lakeside Health Section within the VRA to study these diseases. While the Volta project would cover the cost of health and sanitation issues caused by the formation of the lake, it would not cover the health of migrants settling on the lakeside for economic reasons. Their needs remained the responsibility of the government; the VRA would merely provide technical information and act as paid agent for control measures.²⁰

The Preparatory Commission endorsed the Volta River Project. Following Ghana's independence in 1957, Aluminium Limited of Canada, the main corporate sponsor, withdrew. But the Cold War came to the project's rescue. The U.S. government saw in the Volta scheme an opportunity to assert its influence in Africa. In 1958, President Dwight Eisenhower and Prime Minister Nkrumah agreed to update the engineering reports and explore the potential of private U.S. funding. The following year, Kaiser Engineers proposed a more modest and cheaper version of the project. The Kaiser report suggested a larger dam at Akosombo, an aluminum smelter that merely refined imported alumina at Tema, and a five-hundred-mile transmission grid to connect cities and mines of southern Ghana with Akosombo. The report deferred the production of alumina from Ghana's bauxite, thus suspending the original plan for an integrated aluminum industry. Kaiser Engineers, eager to cut costs, ignored the dam-impacted communities. In late 1961, after prolonged negotiations with Kaiser Aluminum, which would operate the future smelter, the World Bank, the United States, and the United Kingdom, Nkrumah finally secured the funding for the Volta River Project.²¹

Dam construction began in 1961 before concrete steps toward resettlement were undertaken. The VRA, the state agency established to build the Akosombo Dam, became responsible for resettlement. The planners, abandoning the Preparatory Commission's call for self-help, developed strategies of how to "improve" the lifestyles of the dam-affected people. In 1963, Nkrumah assured the National Assembly that people's relocation would provide them "with new villages with better communal facilities and better farming methods."²² The *Seven-Year Development Plan*, the blueprint for the country's modernization, considered resettlement "an exercise in positive economic development" to trans-

form “the lives of the people involved.”²³ The government would introduce new forms of farming and fishing. Resettlement would contribute to Ghana’s anticipated transition from tradition toward modernity. By 1963, the VRA had launched the construction of fifty-two townships designed to propel the “backward” dwellers from 739 villages into modernity. The resettlement towns were seen as “bridge-heads of modernisation in a sea of rural backwardness and underdevelopment.”²⁴

Most experts considered the evacuation, as well as the planning and construction of the fifty-two resettlement towns in such a short period, a tremendous achievement.²⁵ Regardless of the size of their previous homes, each household received the one-room “core house” that was supposed to be the beginning of a larger compound house.²⁶ But many settlers were unable to complete their houses. Although the envisioned mechanization of resettlement agriculture contained “good ideas,” as former resettlement officer E. A. K. Kalitsi commented, such “grandiose planning” failed.²⁷ The desertion of resettlement towns could not be halted.

Press reports and VRA publicity material claimed that there was an orderly and well-organized move into the resettlement towns.²⁸ Interviews that I conducted in Amate revealed a different experience. Resettlement, especially the evacuation, was traumatic and often chaotic. In October 1964, 2,063 inhabitants of the cocoa town of Worobong in the Afram Plains were relocated to Amate, with over 1,800 settlers from thirty-eight other villages. The new town with 621 houses was located in a forest whose canopy had once provided shade for cocoa farms.²⁹ Adwoa Fosuaa, then a thirty-year-old mother, recalled the evacuation day. Lorries arrived and took the people from Worobong to Amate, where the houses were unfinished with wet cement.³⁰ The houses did not include kitchen and bathing facilities. Some settlers completed their houses right away; most did not have the means to do so.³¹

People shared haunting images about the displacement. Resident Janet Obenwaa recalled joining a canoe after the flooding. When paddling to the site of Worobong, they could only recognize the tips of coconut palms rising from the town. Everything else had been submerged. Yet surveying the water, to their horror, they noticed floating caskets washed out from their graves, as well as ante-lopes, grasscutters, and snakes desperately trying to reach the shore.³² Since the settlers had lost their crops, the World Food Program agreed to feed them with food that was strange to them, like yellow corn, corned beef, and luncheon meat. “It was a sad story,” Fosuaa recalled. “Some people cried until their eyes turned red.” Men drowned their sorrows in alcohol.³³

The VRA devolved its responsibilities to other government units in December 1965. Local councils would now provide services to the resettlement towns. They faced an enormous task that included water supply, sanitary facilities, food inspection, cemeteries, recording of births and deaths, market stalls, lockup shops, schools, streets, and feeder roads. Although the towns’ markets, as the VRA exec-

utive secretary opined, could become a revenue source “with little bit of investment,” it was far from clear how local authorities would have the means to pay for these new responsibilities.³⁴

The local councils were unable to deliver. Access to clean drinking water and sufficient farmland remained perennial issues. In Amate, a fallen tree damaged the pump house. Seventeen months later, still no water flowed from the standpipes.³⁵ Visiting VRA officers recorded evidence of failing water pumps, tensions among settlers, and insufficient acreage of farmland in the years after the flooding. Yet the bureaucratic language does not capture the sense of loss and agony the settlers experienced. There was a large exodus from the resettlement towns. Sociologists E. K. Afriyie and David Butcher estimated that by 1968, only 38.7 percent of the original settlers remained. People left because of shortage of farmland, insufficient housing space, and other livelihood challenges. The promised scheme of mechanized agriculture had failed.³⁶

A changing climate meant less rainfall and more hardship for the settlers. A pioneering study conducted during lake formation found no conclusive evidence about significant changes in monthly rains but noted a “tendency towards decreasing rainfall amounts” near the resettlement town of Kete-Krachi.³⁷ Yet residents in Amate observed transforming weather conditions long before climate change became a global issue. They noted fewer rains, stronger winds, and growing difficulties to plant crops like plantains and cocoa. In the 1970s, the military regime of Ignatius K. Acheampong, as part of its Operation Feed Yourself, launched an irrigation project that allowed Amate settlers to grow large fields of tomatoes, onions, and peppers. For a while, farmers did well, and some people returned. Kwaku Atuobi Yiadom recalled how his mother harvested eighty-six boxes of tomatoes in one year.³⁸ The irrigation system lasted for about eight years. Two decades later, the government continued to post an irrigation manager in Amate, drawing a salary while watching over the defunct project, much to the chief's dismay. The manager of the broken irrigation scheme blamed the “illiterate villagers” for its failure.³⁹

These days, Amate, with its large number of abandoned houses and poverty, resembles a ghost town. Many core houses remain unfinished. These abandoned and incomplete houses, according to anthropologist Thomas Yarrow, are a reminder of the “unrealized possibilities and promises” of modernization in resettlement towns. They provide vivid evidence of a future that might have been.⁴⁰ In Amate, the situation is more complicated. According to several elders, the flooded cocoa town of Worobong was more “modern” than what they had in Amate. In resettlement, they experienced a reverse modernization.

The scientific study of Volta Lake, and its ecologies and fisheries, is intimately linked with the career of Letitia Obeng, the country's first woman scientist. In a 2014 interview, she recalled how she became a “water per-

son.” After receiving her bachelor’s degree in zoology from the University of Birmingham in 1952, Obeng taught at the University College of Science and Technology in Kumasi. She obtained a master’s degree from Birmingham in 1961 and then a Ph.D. from the University of Liverpool in 1964. For her dissertation, she studied the blackflies that transmit the parasitic worm that causes onchocerciasis. She returned to Ghana just as Volta Lake was forming and looked for opportunities to study the new lake. Aquatic research was then a marginal scientific endeavor. Receiving support from Nkrumah, who was always curious about the latest trends in science, Obeng founded the Institute of Aquatic Biology in 1965.⁴¹

The Institute of Aquatic Biology was built on the findings of the Preparatory Commission. The fast pace of dam construction had made it difficult to pursue most of the enquiries the commission had suggested.⁴² Obeng’s scientific agenda received a big boost in 1968, when the VRA launched the Volta Lake Research Project (VLRP) with support from the United Nations Development Programme. Obeng became VLRP’s Ghanaian comanager.⁴³ The initiative enabled foundational research on Volta Lake, such as its biological changes, impact on public health, and the emergence of fisheries. Volta Lake became a well-known case study for new scholarship on man-made lakes. Funding for lake research dried up in Ghana in the late 1970s and little was published for two decades.⁴⁴ What were some of the findings of these early attempts to study the waters of this vast lake?

With the closure of the Akosombo Dam in May 1964, the riverine condition of the Volta River gradually transformed into a lacustrine one. The rotting of submerged vegetation caused an oxygen deficiency that killed fish. Fisheries officer John Adjetey had recommended in vain that at least the main areas of resettlement along the lakeshore should be cleared of trees and other vegetation in order to improve the conditions for fish to live and spawn.⁴⁵ Fortunately, the oxygen deficiency did not last long. An initial survey recorded that herbivorous *Tilapia* species, particularly *T. galilaea*, *T. nilotica*, and *T. zillii*, had increased in abundance in areas with plenty of plankton. *Chrysichthys* (catfish), a bottom feeder, was caught in small quantities around Akosombo in 1964, becoming the dominant species by 1966. The carnivorous *Lates niloticus* (Nile perch), a high-priced fish, showed “marked increase in population” around Kpando and Kete-Krachi.⁴⁶ Unlike the Preparatory Commission’s forecast, fish-stocking was not necessary. Rather, there was a “boom in the fish population after the initial adverse ecological changes that affected some fish,” as Obeng noted.⁴⁷ *Tilapia* species were prolific and multiplied rapidly due to ample food.

Catches showed a steady increase from 3,000 metric tons of fish in 1964 to a peak of 62,000 tons in 1969, and then a decline and stabilization around 40,000 metric tons.⁴⁸ VLRP scientists argued that the explosion of the fish population was typical for new reservoirs. After the initial peak, a decline followed and then the population would stabilize. They found “no indication of overfishing.” The scien-

tists admitted that precise knowledge of fish stock in such a large lake remained “unattainable.” What they offered were mere estimates and guidelines for management decisions.⁴⁹ Their estimates were based on statistical extrapolation from landed catches at major marketing centers.

When the water began to rise in 1964, Tongu communities did not return to the Lower Volta as the Preparatory Commission had anticipated but stayed on the lake. The VRA had provided limited housing in resettlement towns for about 1,200 fishers and their families. Most fishers were not interested. In Amate, Tongu fishers never took possession of their allocated “core houses.” Instead, they moved to the lakeside and established the village of Nketepa, which quickly became a market center.⁵⁰ Without state guidance, many Tongu fishermen migrated from the Lower Volta to the lakeshore. What for some had been an annual migration took an increasingly permanent form. One study, carried out in 1969–1970, located 950 fishing villages and estimated that about 20,000 fishers with 12,500 canoes were operating on the lake. Around 60,000 people were living in these fishing communities. Most of these villages were only accessible by water and had no government services such as schools, post offices, or clinics. The male population exceeded the female population, and few people were above fifty years old.⁵¹

By 1970, Tongus still dominated the fishing communities, although some fishers were Anlo Ewes and Dangmes from Ada and Ningo. A typical fishing unit consisted of a master fisher (*adela*) who owned his flat-bottomed canoe of about six to nine meters in length. Half of the fishers had a junior assistant (*adegbovi*) to bail water. Most fishers possessed over a dozen multifilament nylon gill nets. To set these nets, they tied the head rope between the branches of two submerged trees. The lack of tree clearing on the lake prohibited fishing with moving gear. During the main season, when the rains brought turbid water, an *adela* left with his *adegbovi* at dawn to visit his nets. Following a gendered division of labor, Tongu men fished while women did the processing—smoking and salt-drying—and selling of fish. While a married fisherman assigned these roles to his wife, a single *adela* depended on his mother, sister, or female friend. Profits were shared annually between the *adela* (57.2 percent), his wife (28.6 percent), and the *adegbovi* (14.3 percent). After the lake had filled, fishers could earn high incomes, about 700 cedis (US\$686) per canoe in 1970. The initial boom allowed some *adegbovis* to purchase their own gear. Tongus who used to work on cocoa farms or in construction, or had become teachers and clerks, returned to fishing and migrated to the lakeside. Fishers invested profits into their hometowns, building houses and opening shops, as well as into their children's education, before purchasing commodities like radios and sewing machines.⁵²

Eager to increase productivity, the VLRP carried out experimental field trials that showed how monofilament nets caught twice the amount than multifilament nets. Introducing such improved nets had other benefits. More *adelas* would em-

ploy *adegbovis* year-round and apprentice them in the art of fishing. Since the latter's profit share would increase, he could acquire his own gear sooner. Higher catches would make the use of larger boats and outboard motors more economic. In the mid-1970s, the Volta Lake Research and Development Project launched a program introducing monofilament nets.⁵³ Fishing communities, however, did not evolve in such linear fashion as anticipated. Rather, the changing lake conditions demanded a complicated adjustment of livelihood strategies with profound gendered implications.

Tsikata conducted extensive research in three fishing communities across the southern part of Volta Lake. Initially, the first wave of Tongu migrants focused on fishing, fish processing, and trading. They exchanged fish for foodstuff with their hosts. After a few years, when they experienced food shortages, they adopted drawdown agriculture on the banks of the lake. Once this area was no longer sufficient, they expanded their farms on higher ground with rain-fed agriculture. This changed the relationships with their host communities, as Tsikata has noted, "transforming many migrants from independent fishermen into tenant farmers." With the decline of fish stock in the 1980s, the original Tongu migrants and their children turned to farming and rearing of cattle, goat, and sheep. Women shifted to farming and trading for their livelihood. Men who mainly fished moved to the lake's more remote parts with larger stock.⁵⁴

The second wave of migrants from coastal areas had the technology and experience to operate more successfully on the open lake. The Dangme fishing company proved to be a suitable work unit. Each company consisted of a male head who owned fishing equipment and a boat, adult male fishing assistants hired on contract, children doing related work like net fixing, and women responsible for fish processing. Such companies could purchase outboard motors that increased their reach, allowing them to fish all year. Fishing assistants rarely earned enough money to buy their own boats and gear. By the 1980s, the Dangme and the Fanti had become the main fishers on Volta Lake. Some Tongu who had done well branched out into other activities like operating transport boats, among them Louis Acorlatse, a leader of fishers at Kpando Torkor.⁵⁵

Male-centered migration from the Lower Volta to the lakeside created gender inequality. While in the Lower Volta women had generated their own income through clam fishing and trading, in lakeside fishing villages, they remained dependent on men for whom they worked processing fish. In the long run, women had little to show for their efforts and few investments to support themselves in old age. Only in marketing centers like Kpando Torkor did some women have more success in making livelihoods as fishmongers. But success in trading was frequently not sustainable, particularly if women made investments in male businesses like transport, as was the case for Damali, an elderly woman interviewed by Tsikata. Damali moved to Kpando Torkor with her husband in the mid-1960s and

bought with her considerable profits from trading two transports boats operated by relatives, a car for her grandson, and cows looked after by a cousin. By 2000, Damali had lost these investments.⁵⁶

Migrating Tongus, and later Dangmes and Fantes, established the lake's fishing industry without state intervention, which resulted in poor infrastructure, no pipe-borne water, and a lack of government services in lakeside settlements. Migrants stayed connected with their hometowns, where their children were schooled, and participated in family affairs. Those who could afford it put up houses, looked after kin, and contributed to development associations. With the lake's economic decline, migrants' ability to support relatives and children in the Lower Volta decreased. Still "hometowns retained their value," as Tsikata noted. They served "as places of ritual importance, a source of cheap labor, a refuge in times of crisis and a place to retire to or be buried at."⁵⁷ Migrants' eagerness to maintain hometown connections countered the sense of remaining strangers in relation to host communities on the lakeside.

Fishers' outmigration from the Lower Volta also had public health implications. The migrating Tongu fishers carried schistosomiasis that became a serious health hazard for the new lakeside communities. The Preparatory Commission had noted that urinary schistosomiasis was prevalent among "migrant fisher folk" who moved along the Volta River. The commission recommended building resettlement towns at least one mile back from the lake's 280-foot contour and equip them with clean pipe-borne water and latrines to minimize any needs for accessing the lake and thus the risk of contamination.⁵⁸ The proposed survey about the health of the population in the lake area was not executed, which limited knowledge about the changing health conditions in the lakeside communities and resettlement towns.

Migrating fishers infected with schistosomiasis extended the boundaries of the disease. The formation of the lake with its slow-moving water created a perfect environment for the vector snail *Bulinus*. The spread of aquatic plants, not foreseen by the planners, provided the snail with an ideal habitat. Weeds like water lettuce and bull rush quickly covered the flooded woodlands in the Afram arm, while hippo grass spread around Yeji forming "sudd islands" in association with other plants.⁵⁹ Initially, researchers focused their investigations on the vector snail's distribution and association with aquatic plants. When the VRA established the VLRP, the lake's health hazards became one of its primary concerns. One study showed that on the lake's western shores, the incidence of schistosomiasis among children under the age of ten had risen to 90 percent. On the eastern shore, infection rates were lower. Obeng suggested that the steep lakeshore prevented the growth of weeds. Snail hosts were also found in the mud and browsing on rocks.⁶⁰ Infection rates rose rapidly along the Afram, reaching nearly 100 per-

cent by 1968 for children aged four to sixteen in Asuboni and in the resettlement towns of Amate and Mpam.⁶¹ A VLRP survey of 140 villages mapped the prevalence of urinary schistosomiasis, with infection rates between 75 and 100 percent in the Pampram, Afram, and Sene arms and around Yeji. This study remained unpublished; the VRA was reluctant to make the problem known.⁶²

The other major health concern was onchocerciasis, or river blindness. As anticipated by the Preparatory Commission, the lake's flooding eliminated the breeding sites of its vector *Simulium damnosum*. Yet on the Asukawkaw River, one of the lake's eastern tributaries, the prevalence was high, reaching 90 percent among people over fifteen years old. Downstream from Akosombo, the Senchi and Kpong rapids formed another *Simulium* breeding ground until the Kpong Dam was built in the late 1970s. The VRA sought to control onchocerciasis through the spraying of DDT and spilling at Akosombo, which was only an option prior to the 1970s drought. The lake flooded the riverine forests that had been the breeding ground of the tsetse fly. The feared transmission of trypanosomiasis, or sleeping sickness, from the north through lake transport did not happen. Malaria and schistosomiasis, however, remained endemic. By the 1970s, there had been some improvements in resettlement towns, with the establishment of health posts and easier access to outside facilities. But the sixty thousand fishers living in isolated villages remained exposed to riverine disease; their situation had "worsened."⁶³ The health hazards of Volta Lake drew international publicity. When a 1972 BBC documentary reported on "the other side" of man-made lakes in Africa, the segment on Volta Lake addressed waterborne diseases. The Ghana High Commission in London objected to this reporting and urged the VRA to contain such negative publicity.⁶⁴ By the 1990s, Ghanaian officials acknowledged the lake's unresolved health challenges. L. K. A. Derban, former director of VRA Health Services, painted a bleak picture about the prevalence of urinary schistosomiasis. Effective measures to control its vector snail by eliminating aquatic weeds had not been introduced. Rather, the migration of fishers to the lake's remote corners had led to an increase in areas where infection rates had been low. A long-term campaign would require surveillance and treatment of patients, combined with "effective sanitary measures" that included an efficient disposal system for human excrements, a safe water supply, "adequate bathing and washing facilities," and a program to control snails and aquatic weeds at landing stations. Since boat-landing sites had become useless due to the ongoing drought, fishers and their children had "frequent water contact to fish and swim." Intestinal schistosomiasis, previously unknown, appeared in the Lower Volta, which Derban interpreted as an indicator of poverty and poor living conditions.⁶⁵

Since the late 1980s, the VRA has strengthened its efforts in aquatic weed control, particularly in the Kpong head-pond, where the weeds threatened the intake of the generating station. During such exercises, people were screened and treat-

ed for schistosomiasis.⁶⁶ The VRA commissioned the boat *Onipa Nua* in 1990 to deliver free medical service and public health education to fishing communities and other lakeshore dwellers. Every year, the *Onipa Nua* visited between seventeen and eighty-six lakeside villages.⁶⁷ Yet these efforts remained merely palliative, since the disease cycle of schistosomiasis had not been broken. That would require not only treating human carriers, controlling weed and vector snails, and limiting people's contact with lake water but changing people's sanitary habits by providing them with urinals, latrines, and clean water.⁶⁸ It is a high bar but one that could be achieved. Education outreach and proper sanitary facilities could stop the disease. Although snails will always live in the water and people will continue having contact with the lake, radically reducing the numbers of parasites would bring real change.⁶⁹

The damming of the Volta River at Akosombo had a fundamental impact on Ghana. Downstream, with the end of the annual floods, water disappeared from the Lower Volta. The drying up of small streams and ponds resulted in migration and transformed livelihoods. Upstream, the formation of a massive lake displaced eighty thousand people in the Volta Basin. The VRA launched a resettlement program that sought to provide housing in fifty-two townships with modern amenities for the displaced people. The outcome was different from what the planners had promised. Water pumps broke down, land clearing for settler agriculture remained insufficient, and irrigation projects like the one at Amate were short lived. Unable to make a living, many residents abandoned the resettlement towns. The anticipated modernization did not happen.

This essay has tracked Volta Lake's ecologies and fisheries since the closing of the Akosombo Dam in 1964. Although the Preparatory Commission had extensively studied the project's impact on the flood basin and the Lower Volta, the commission failed to anticipate many consequences. The swift migration of Tongu fishers to the lakeside, followed by Fantes, Anlos, and Dangmes, unfolded without state guidance. Fish-stocking was unnecessary. Instead, fishers adapted to the lake's changing ecology and adjusted their livelihoods. They established their own settlements with no or limited state services. Lakeside communities had to live with waterborne diseases.

Since the early 1960s, Ghanaian scientists have explored the ecology of Volta Lake. With funding and support from intergovernmental agencies, they turned Volta Lake into one of the best-studied man-made lakes in the Global South. By the late 1970s, this knowledge production slowed to a trickle. Two decades later, when funding resumed, the scholarly and political context had changed. While experts had earlier suggested policies to expand the lakes' fisheries, the focus had shifted to stock management. Concerns about overfishing and sustainability moved to the foreground.⁷⁰

Drought has become a recurrent issue for Volta Lake. Ghana experienced the first of several energy crises in 1983. They were the result of climate change that brought declining rainfall in the Volta Basin, the catchment areas of Volta Lake, which drains the Black and White Volta and Oti Rivers systems in northern Ghana, Burkina Faso, Togo, and Benin. Rising temperatures produced higher evaporation. Poor rainfall and increased evaporation resulted in lower water levels and a reduction of power generation at Akosombo.⁷¹ Electricity shortages challenged the notion of Akosombo as a secure power supply. The planners had not foreseen such a situation. They were more concerned with future floods as they had experienced them during the dam's construction. Kaiser Engineers designed the Akosombo Dam with twelve floodgates.⁷² What are the future projections? A recent study analyzing global climate models predicts that the Volta Basin will become warmer and slightly wetter during 2011 to 2040 compared to 1981 to 2010. Some areas, however, will become warmer and dryer during the same period, and warmer temperatures will mean more evaporation.⁷³

Over the last decade, Ghanaian scientists, government officials, and local stakeholders have addressed some of the adverse issues of hydroelectric dams. They conducted a study to re-optimize the operations of Akosombo and Kpong for the Lower Volta. The proposal sought to re-create seasonal floods by operating the dams in a way that mimics natural flow regimes. During the rainy season's peak inflows, dam operators would significantly increase hydropower generation. Higher outflow from Volta Lake would replenish streams and ponds in the Lower Volta and wash out aquatic weeds. Yet re-operation would require expensive investments in alternative power supplies and transmission capacity. Moreover, downstream communities have adjusted to the postdam regime over the last fifty years. Since they experienced the negative impacts of the VRA spilling large quantities of water at Akosombo in 2011, they are now "reluctant to accept and adapt to the restoration flows." Instead, the study recommended alternative forms of weed control and increased irrigation that would enable lucrative dry-season vegetable farming to improve livelihoods.⁷⁴

It is encouraging that these discussions about mitigating dams' water challenges are taking place in Ghana. One hopes that such insights with attention to impacted communities will be considered during the building of the Pwalugu project, and that the shortcomings of Akosombo will not be repeated.

ABOUT THE AUTHOR

Stephan F. Miescher is Professor of History at the University of California, Santa Barbara. He is the author of *A Dam for Africa: Akosombo Stories from Ghana* (2022), *Making Men in Ghana* (2005), and the documentary film *Ghana's Electric Dreams* (with R. Lane Clark). He is working on a book, tentatively entitled *Ghana's Inland Ocean: Ecologies and Infrastructures of the Volta Lake*.

ENDNOTES

- ¹ Jyhjong Hwang, "An Offer You Can Refuse: A Host Country's Strategic Allocation of Development Financing," *Dædalus* 150 (4) (Fall 2021); and Allen Isaacman, "Cahora Bassa Dam & the Delusion of Development," *Dædalus* 150 (4) (Fall 2021).
- ² For Ghana's Bui Dam, see Isaac Odom, "Dam In, Cocoa Out; Pipes In, Oil Out: China's Engagement in Ghana's Energy Sector," *Journal of Asian and African Studies* 52 (5) (2017): 598–620; and Stephan F. Miescher and Dzodzi Tsikata, "Hydro-Power and the Promise of Modernity and Development in Ghana: Comparing the Akosombo and the Bui Dam Projects," *Ghana Studies* 12/13 (2009/2010): 15–53.
- ³ Michael Kpessa-Whyte, Emmanuel Obuobie, Pius Sakwah, et al., "The Context and Politics of Decision Making on Large Dams in Ghana: An Overview," FutureDAMS Working Paper 002, University of Manchester, 2019.
- ⁴ Video recording of VRA Stakeholder Consultative Meeting, Nalerigu, Northeast Region, Ghana, August 14, 2019, <https://www.youtube.com/watch?v=DABfv7s8aI4> (accessed February 27, 2020).
- ⁵ "Akufo-Addo Cuts Sod for \$993m Pwalugu Dam and Irrigation Project," Myjoyonline.com, November 29, 2019, <https://www.myjoyonline.com/news/2019/November-29th/akufo-addo-cuts-sod-for-993m-pwalugu-dam-and-irrigation-project.php> (accessed February 27, 2020).
- ⁶ "Pwalugu Dam Construction: Over 4,200 Persons in 20 Communities to Be Displaced," Myjoyonline.com, April 30, 2021, <https://www.youtube.com/watch?v=aRGettwJlk> (accessed July 29, 2021). For earlier reporting, see "Pwalugu Multipurpose Dam Project to Affect 400 Households," Myjoyonline.com, October 24, 2019, <https://www.myjoyonline.com/news/2019/October-24th/pwalugu-multipurpose-dam-project-to-affect-400-households.php> (accessed February 27, 2020).
- ⁷ James Moxon, *Volta, Man's Greatest Lake: The Story of Ghana's Akosombo Dam*, rev. ed. (London: Deutsch, 1984), 49–58; and John Olav Hove, "The Volta River Project and Decolonization, 1945–1957: The Rise and Fall of an Integrated Aluminum Project," in *Aluminum Ore*, ed. Robin S. Gendron, Mats Ingulstad, and Espen Storli (Vancouver: University of British Columbia Press, 2013), 187–192. For Nkrumah's broader vision, see Stephan F. Miescher, *A Dam for Africa: Akosombo Stories from Ghana* (Bloomington: Indiana University Press, 2022).
- ⁸ Preparatory Commission, *The Volta River Project*, vol. 1–3 (London: HMSO, 1956).
- ⁹ Public Records and Archives Administration Department, Koforidua ADM/KD 29/6/624, *Volta River Circular*, January 25, 1951, "strictly confidential."

- ¹⁰ Preparatory Commission, *The Volta River Project*, vol. 2, 123–128, para. 352–371, quoted para. 359.
- ¹¹ *Ibid.*, 224, para. 81–83, 227–228, para. 102–104.
- ¹² *Ibid.*, 224, para. 82–83; and Dzodzi Tsikata, *Living in the Shadow of the Large Dams: Long Term Responses to Downstream and Lakeside Communities of Ghana's Volta River Project* (Leiden, The Netherlands: Brill, 2006), 71–83.
- ¹³ Tsikata, *Living in the Shadow of the Large Dams*, 101–103, quoted on 102.
- ¹⁴ Preparatory Commission, *Volta River Project*, vol. 2, 216, para. 22–25.
- ¹⁵ *Ibid.*, 143–144, para. 38, Annex B, 182–184.
- ¹⁶ *Ibid.*, 156–157, para. 98–101; Rowena M. Lawson, “The Economic Organization of the Egeria Fishing Industry on the River Volta,” *Proceedings of the Malacological Society of London* 35 (6) (1963): 274, 278–279, 284; and Tsikata, *Living in the Shadow of the Large Dams*, 103–111.
- ¹⁷ Preparatory Commission, *The Volta River Project*, vol. 2, 164, para. 141, 175, para. 212; and Rowena M. Lawson, “The Development of the Lower Volta,” *Economic Bulletin of Ghana* 7 (4) (1963): 88.
- ¹⁸ Preparatory Commission, *The Volta River Project*, vol. 2, 176, para. 213, 181, para. 239.
- ¹⁹ Tsikata, *Living in the Shadow of the Large Dams*, 121; and interview with Agnes Fornyikpor and others, Mepe, Ghana, December 19, 2016, with the assistance of Ishmael Nuworkpor.
- ²⁰ Preparatory Commission, *The Volta River Project*, vol. 1, 60–64, para. 385, 390–405, 411–412, 415; vol. 2, 194–195, para. 8–17, 202–207, para. 61–67, 69–87; and Tsikata, *Living in the Shadow of the Large Dams*, 79–81.
- ²¹ Kaiser Engineers, *Reassessment Report on the Volta River Project for the Government of Ghana* (Oakland, Calif.: Kaiser Engineers, 1959). For the prolonged negotiations, see Miescher, *A Dam for Africa*, chap. 2.
- ²² Kwame Nkrumah, “Volta River Project to the National Assembly, 25 March 1963,” in *Selected Speeches: Kwame Nkrumah*, vol. 5, comp. Samuel Obeng (Accra: Afram Publications, 1997), 23.
- ²³ Office of the Planning Commission, Ghana, *Seven-Year Development Plan, 1963/64 to 1969/70* (Accra: Office of the Planning Commission, 1964), 210.
- ²⁴ Kofi Diaw and Einhard Schmidt-Kallert, *Effects of Volta Lake Resettlement in Ghana: A Reappraisal after 25 Years* (Hamburg: Institut für Afrika-Kunde, 1990), 12; and Laszlo Huszar, “Resettlement Planning,” in *The Volta Resettlement Experience*, ed. Robert Chambers (New York: Praeger, 1970), 155.
- ²⁵ Chambers, ed., *The Volta Resettlement Experience*, 267–268. For a more critical assessment, see Diaw and Schmidt-Kallert, *Effects of Volta Lake Resettlement in Ghana*, 129.
- ²⁶ A “core house” is a house with a concrete foundation and aluminum roofing for three rooms, a stoep (veranda), and a kitchen porch, yet with the walls of only one room completed.
- ²⁷ Interview with E. A. K. Kalitsi and Louis Casely-Hayford, Accra, Ghana, July 8, 2008.
- ²⁸ P. H. Johnson, “Volta–Bright Life for Displaced Villagers,” *Ghanaian Times*, April 20, 1963, 5. For VRA publicity, see Keith Jopp, *Volta: The Story of Ghana's Volta River Project*

- (Accra: Volta River Authority, 1965), 43; and E. A. K. Kalitsi, "The Organization of Resettlement," in *The Volta Resettlement Experience*, ed. Chambers, 54–55.
- ²⁹ Interview with Nana Atuobi Yiadom, Amate, Ghana, September 4, 2005. Interviews in Amate were conducted in Twi; Joseph Kwakye assisted with translations. I am deeply grateful to him. See VRA Archives RMT/140, "Resettlement Area Group No.1," n.d. (1963); and VRA Archives RMT/140, "List of Resettlement Sites Area 1 (Kwahu)," June 14, 1963.
- ³⁰ Interview with Adwoa Fosuaa, Amate, Ghana, September 3, 2005.
- ³¹ Interviews with Kwabena Oboye, Abetifi, Ghana, March 19, 2008; and interview with Thomas Brako, Abetifi, Ghana, March 20, 2008. See Diaw and Schmidt-Kallert, *Effects of Volta Lake Resettlement in Ghana*, 51.
- ³² Interview with Janet Obenewaa, Abetifi, Ghana, March 17, 2008.
- ³³ Interview with Fosuaa.
- ³⁴ VRA to Minister of Local Government, December 11, 1965, in VRA Archives RMT/123, "VRA Resettlement Memorandum," 1970, appendix 1a.
- ³⁵ VRA Archives RMT/33, Trekking Notes (May 1966); and VRA Archives RMT/33, Trekking Notes (October 1967).
- ³⁶ E. K. Afriyie and David A. P. Butcher, *Socio-Economic Survey of the Volta Resettlement: Four Years after Evacuation* (Accra: Volta Lake Research Project, 1971), 81; and Diaw and Schmidt-Kallert, *Effects of Volta Lake Resettlement in Ghana*, 99–102. For accounts of out-migration, see Miescher, *A Dam for Africa*, chap. 5.
- ³⁷ A. N. De-Herr Amissah, "Some Possible Climatic Changes that May Be Caused by Volta Lake," in *Man-Made Lakes: The Accra Symposium*, ed. Letitia E. Obeng (Accra: Ghana University Press, 1969), 81.
- ³⁸ Interview with Kwaku Atuobi Yiadom, Amate, Ghana, March 14, 2008; and interview with Oboye.
- ³⁹ Interviews with Samuel Sidney Vigbedor and Nana Birifa Dankwa II, Amate, Ghana, July 27, 2006.
- ⁴⁰ Thomas Yarrow, "Remains of the Future: Rethinking the Space and Time of Ruination through the Volta Resettlement Project," *Cultural Anthropology* 32 (4) (2017): 576.
- ⁴¹ Interview with Letitia E. Obeng, Accra, Ghana, April 1, 2014. See also Letitia E. Obeng, *A Silent Heritage: An Autobiography* (Kew, Surrey: Goldsear, 2008), 243–252.
- ⁴² Tsikata, *Living in the Shadow of the Large Dams*, 72.
- ⁴³ Letitia E. Obeng, "Volta Lake: Physical and Biological Aspects," in *Man-Made Lakes: Their Problems and Environmental Effects*, ed. William C. Ackermann, Gilbert F. White, E. B. Worthington, and J. Loreena Ivens (Washington, D.C.: American Geophysical Union, 1973), 87, 89. For efforts at the University of Ghana to study Volta Lake, see G. W. Lawson, "Volta Basin Research Project," *Nature* 99 (1963): 858–859.
- ⁴⁴ For early research output, see Obeng, *Man-Made Lakes*. For a later account, see Chris Gordon, "An Overview of the Fish and Fisheries in the Volta Basin," in *The Sustainable Integrated Development of the Volta Basin in Ghana*, ed. Chris Gordon and Julius K. Amatekpor (Accra: Volta Basin Research Project, 1999), 82–83. For more recent research, see P. A. M. van Zwieten, C. Béné, J. Kolding, et al., eds., *Review of Tropical Reservoirs and Their Fish-*

- eries: *The Case of Lake Nasser, Lake Volta, and Indo-Gangetic Basin Reservoir* (Rome: Food and Agriculture Organization of the United Nations, 2011), 85–126.
- ⁴⁵ VRA Archives SD-R/440, J. N. N. Adjete to Principal Secretary, Ministry of Agriculture, September 6, 1963.
- ⁴⁶ Frank M. K. Denyoh, “Changes in Fish Population and Gear Selectivity in the Volta Lake,” in *Man-Made Lakes*, ed. Obeng, 206, 208.
- ⁴⁷ Obeng, “Volta Lake,” 93.
- ⁴⁸ Lawrence I. Braimah, “Management of Fisheries Resources of Volta Lake,” in *The Sustainable Integrated Development of the Volta Basin in Ghana*, ed. Gordon and Amatekpor, 64.
- ⁴⁹ Willis A. Evans and John Vanderpuye, “Early Development of the Fish Populations and Fisheries of Volta Lake,” in *Man-Made Lakes*, ed. Ackermann et al., 118, 120.
- ⁵⁰ E. A. K. Kalitsi, “Volta Lake in Relation to the Human Population and Some Issues in Economics and Management,” in *Man-Made Lakes*, ed. Ackermann et al., 77; and interview with Oboye.
- ⁵¹ W. Taylor, “People in a Rapidly Changing Environment: The First Six Years of Volta Lake,” in *Man-Made Lakes*, ed. Ackermann et al., 103, 105; and Kalitsi, “Volta Lake,” 82.
- ⁵² D. A. P. Butcher, “Sociological Aspects of Fishery Development on Volta Lake,” in *Man-Made Lakes*, ed. Ackermann et al., 108–110.
- ⁵³ *Ibid.*, 112–113. For the introduction of Japanese monofilament nets, see Volta River Authority, *Annual Report* 13 (1974): 19.
- ⁵⁴ Tsikata, *Living in the Shadow of the Large Dams*, 330–331, 337–338, 308.
- ⁵⁵ *Ibid.*, 331–332, 357–358; and interview with Louis Acorlatse, Kpando Torkor, Ghana, April 12, 2014.
- ⁵⁶ Tsikata, *Living in the Shadow of the Large Dams*, 375–379, 381.
- ⁵⁷ *Ibid.*, 327, 396–397.
- ⁵⁸ Preparatory Commission, *Volta River Project*, vol. 2, 202, para. 61, 195–196, para. 18, 20.
- ⁵⁹ J. B. Hall, E. Laing, M. Hossain, and G. W. Lawson, “Observations on Aquatic Weeds in the Volta Basin,” in *Man-Made Lakes*, ed. Obeng, 334.
- ⁶⁰ Obeng, “Volta Lake,” 94–95.
- ⁶¹ I. Paperna, “Study of an Outbreak of Schistosomiasis in the Newly Formed Volta Lake in Ghana,” *Zeitschrift für Tropenmedizin* 21 (4) (1970): 411–425.
- ⁶² David Hart, *The Volta River Project: A Case Study in Politics and Technology* (Edinburgh: Edinburgh University Press, 1980), 91–92.
- ⁶³ Kalitsi, “Volta Lake,” 83–84; Hart, *Volta River Project*, 94–95; and B. B. Waddy, “Prospects for the Control of Onchocerciasis in Africa with Special Reference to the Volta River Basin,” *Bulletin of the World Health Organization* 40 (1969): 843–858.
- ⁶⁴ VRA Archives SD-R/63, J. Amartey, Ghana High Commissioner, London to Public Relations Department, Accra, Ghana, March 3, 1972; VRA Archives SD-R/63, Public Relations Department to E. L. Quartey, VRA, March 24, 1972; and VRA Archives SD-R/63, Quartey’s minute, September 13, 1973. BBC 2 aired the documentary film *Man-Made Lakes of Africa* (dir. John Mansfield) on March 26, 1972.

- ⁶⁵ L. K. A. Derban, "Public Health Aspects of the Volta Lake," in *Sustainable Integrated Development*, ed. Gordon and Amatekpor, 29–31.
- ⁶⁶ Volta River Authority, *Annual Report* 25 (1987): 25.
- ⁶⁷ Volta River Authority, *Annual Report* 29 (1990): 9, 32; and Volta River Authority, *Annual Report* 36 (1997): 34.
- ⁶⁸ F. K. Yeboah, "Mitigating Actions Taken by the VRA on Dam Affected Communities," in *Sustainable Integrated Development*, ed. Gordon and Amatekpor, 129.
- ⁶⁹ Interview with Chris Gordon, University of Ghana, Legon, April 21, 2014.
- ⁷⁰ Van Zwieten et al., *Review of Tropical Reservoirs and Their Fisheries*.
- ⁷¹ Phillip Gyau-Boakye, "Environmental Impacts of the Akosombo Dam and Effects of Climate Change on the Lake Levels," *Environment, Development and Sustainability* 3 (1) (2001): 17–29, esp. 26–29.
- ⁷² Moxon, *Volta, Man's Greatest Lake*, 137–138.
- ⁷³ Emmanuel Obuobi, Barnabas Amisigo, Federick Logah, and Kweban Kankam-Yeboah, "Analyses of Changes in Downscaled Rainfall and Temperatures Projections in the Volta Basin," in *Dams, Development and Downstream Communities*, ed. Y. Ntiamoa-Baidu, B. Y. Ampomah, and E. Antwi-Ofosu (Tema, Ghana: Digibooks, 2017), 179.
- ⁷⁴ Eric Antwi Ofosu, Marloes Mul, Maxwell Boateng-Gyimah, et al., "Overview of the Re-Operation and Re-Optimisation of the Akosombo and Kpong Project," in *Dams, Development and Downstream Communities*, ed. Ntiamoa-Baidu et al., 25.