Sustainability Science (2019) 14:487–499
https://doi.org/10.1007/s11625-018-0588-8

ORIGINAL ARTICLE

Impacts of Ghana's Bui dam hydroelectricity project on the livelihood of downstream non-resettled communities

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Received: 12 January 2018 / Accepted: 30 May 2018 / Published online: 5 June 2018

Abstract

Ghana's socio-economic development, since independence, has been driven by the Akosombo and Kpong dams that provide water (for domestic, agriculture and industrial use) and hydroelectricity. It was hoped that with these past experiences, the Ghana government would be in a better position to manage the livelihood issues of the newly built Bui hydroelectricity dam better. Using a modified political ecology framework, this study examined the implications of the Bui dam project on the livelihoods of the downstream communities, which have received limited scholarly attention. Results from 158 household questionnaire interviews, corroborated by in-depth interviews with relevant stakeholders and focus group discussions indicate a complete lack of compensation package of any form for affected downstream communities. Fishing and farming, the dominant livelihood strategies of the households interviewed, have become unproductive and unsustainable leading to reduced incomes. Additionally, the unregulated activities of small-scale gold miners (galamsey) in the river bed which were made possible after the Bui dam's construction were cited by most interviewees and focus group discussants for its negative impacts on human and ecological health. In a nutshell, existing livelihoods systems of downstream non-resettled communities post the Bui dam construction have been severely disrupted. Addressing the present challenges facing downstream communities in an integrative and participatory manner should be the top priority of the dam planners and implementers especially the Bui Power Authority and the District Assemblies.

Keywords Hydroelectricity · Bui Dam · Black Volta · Political ecology · Downstream communities

Introduction

The importance of dams in socio-economic development all over the world cannot be overemphasized. Many countries would look different today without hydroelectricity, irrigation, water supplies, flood control, and recreational activities around reservoirs. Dams are built to irrigate crops, generate energy from hydropower, improve navigation, control floods, and supply water. Currently, large dams are estimated to contribute directly to 12–16% of global food production (WCD 2000). In Ghana, the Akosombo and Kpong dams have contributed immensely to socio-economic development (Gyau-Boakye 2001) through the provision of drinking water, irrigation and hydroelectricity. The energy mix of Ghana, for instance, is highly tilted in favor of hydroelectricity with the Akosombo and Kpong dams, both on the Volta River, supplying close to 70% of electricity consumed. While dams can contribute to economic growth, the services they provide may come at a cost (Tchotsoua et al. 2008; Dandekar and Mehta 2010). Over the last century, the construction of big dams to generate power, supply water and control floods has unleashed a damaging cascade of social and environmental consequences—including the destruction of fisheries, subsistence farmlands, homes and communities (Rosenberg et al. 2000; Scudder 2005; Richter et al. 2010).

Handled by Siddharth Sareen, University of Bergen, Norway.

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s11625-018-0588-8) contains supplementary material, which is available to authorized users.

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Beyond their overwhelming importance, large dams can also have devastating effects on rivers, freshwater ecosystems (Stave et al. 2005), and the people who depend on them with or without compensation and livelihood assistance. The devastation of freshwater ecosystems directly affects the livelihoods of millions of people who live upstream and downstream of dams, especially in developing countries. Displacement of people is usually the most vivid and direct impact of construction of dams. For example, the World Commission on Dams in its report in 2000 estimated that 40–80 million people have been displaced worldwide by the construction of dams (WCD 2000; Krueger 2009). Richter et al. (2010) further underline that, beyond direct displacement, an estimated 472 million river-dependent people have been impacted by large-scale dam construction across the world. These are mostly upstream inhabitants whose livelihoods are directly threatened by the filling of the lake. Many of the people upstream get compensation and most times resettled and given livelihood assistance for some determined period. Whereas the benefits of large dams have generally been delivered to urban centres or industrial-scale agricultural developments, river-dependent populations located downstream of dams have commonly experienced a difficult upheaval of their livelihoods, loss of food security, and other impacts to their physical, cultural and spiritual well-being (Goldsmith and Hildyard 1986; Scudder 2005; Fujikura and Nakayama 2013). A consensus is emerging amongst researchers on an often unspoken of but a major challenge on the erosion of livelihood activities in the downstream communities that are often ignored in terms of resettlement and compensation (Bosshard 2010; Kirchherr et al. 2016a, b).

While downstream river-dependent communities may benefit from some degree of flood protection and enhanced irrigation opportunities provided by dams, adverse impacts are far more common and usually outweigh the benefits to downstream people, resulting in a reduction of their incomes and livelihoods (Cernea 2004; Richter et al. 2010; Sivongxay et al. 2017). In the development of the Bui dam in Ghana, which aimed at producing 400 MW of power on the Black Volta River, the upstream communities were planned for and resettled to make way for the filling of the lake. The resettlement by the Bui Power Authority (BPA) has not raised too many challenges for the authority and the resettled communities. This is because the dam had been in the works for over 50 years and that a national park had been created around the section of the Black Volta River where the dam was constructed. Against this background, the total number of people resettled were only 1200 (Obour et al. 2016). However, there was no provision made for the downstream communities even though there is ample evidence that downstream communities in Ghana suffered livelihood challenges following the construction of the Akosombo and Kpong dams (Gyau-Boakye 2001; Tsikata 2006).

Current scholarly works examining local scale socio-economic and livelihood impacts of the Bui dam from our review have mostly concentrated on upstream and resettled communities (Yankson et al. 2017; Obour et al. 2016; Arthur 2016; Atindana et al. 2015; Mettle 2011). Others have focused on actors, stakeholder roles and sustainability of a project (Kirchherr et al. 2016a, b; Hensengerth 2013). Consistent with other parts of the world, studies on the Bui dam's impact on downstream communities' livelihood conditions have received limited attention. This study, therefore, examines the livelihood challenges experienced by the downstream communities from the Bui dam hydroelectricity project. The main goal is to highlight the developmental challenges that downstream communities are facing, because they were not planned for in the resettlement package leading to the construction of the Bui dam. It is expected that the results of the study will generate academic discourse and inform policy to address any challenges emanating from the Bui project and inform future dam planning and development.

Conceptual framework

This study adopts a modified political ecology framework to examine the potential livelihood outcomes of the Bui dam project on downstream communities (Fig. 1). Fundamentally, the political ecology framework focuses on nature–society relations (Perreault et al. 2015). It identifies and analyses power relations between different actors, institutions and stakeholders (Tan-Mullins 2007). As Yankson et al. (2017) clarify, the framework can be critical for assessing unequal power relations between actors, thus enabling one to properly explain the uneven distribution of access and control of environmental resources. In applying this modified framework, we acknowledge Harvey's (1993) argument that "all ecological projects are simultaneously political-economic projects and vice versa". Thus, governance decisions have a major influence on the rate and magnitude of positive and/or negative impacts on affected (downstream) communities. Exploring governance actions and processes in large-scale dam construction helps promote understanding and appreciation of how diverse institutions, actors and stakeholders roles, needs and perspectives are recognized and incorporated in the planning, construction, management and monitoring phases of large-scale dam construction.

The political ecology framework has been used by Tan-Mullins et al. (2017) and Yankson et al. (2017) to analyze the impacts of dams by highlighting the governance issues

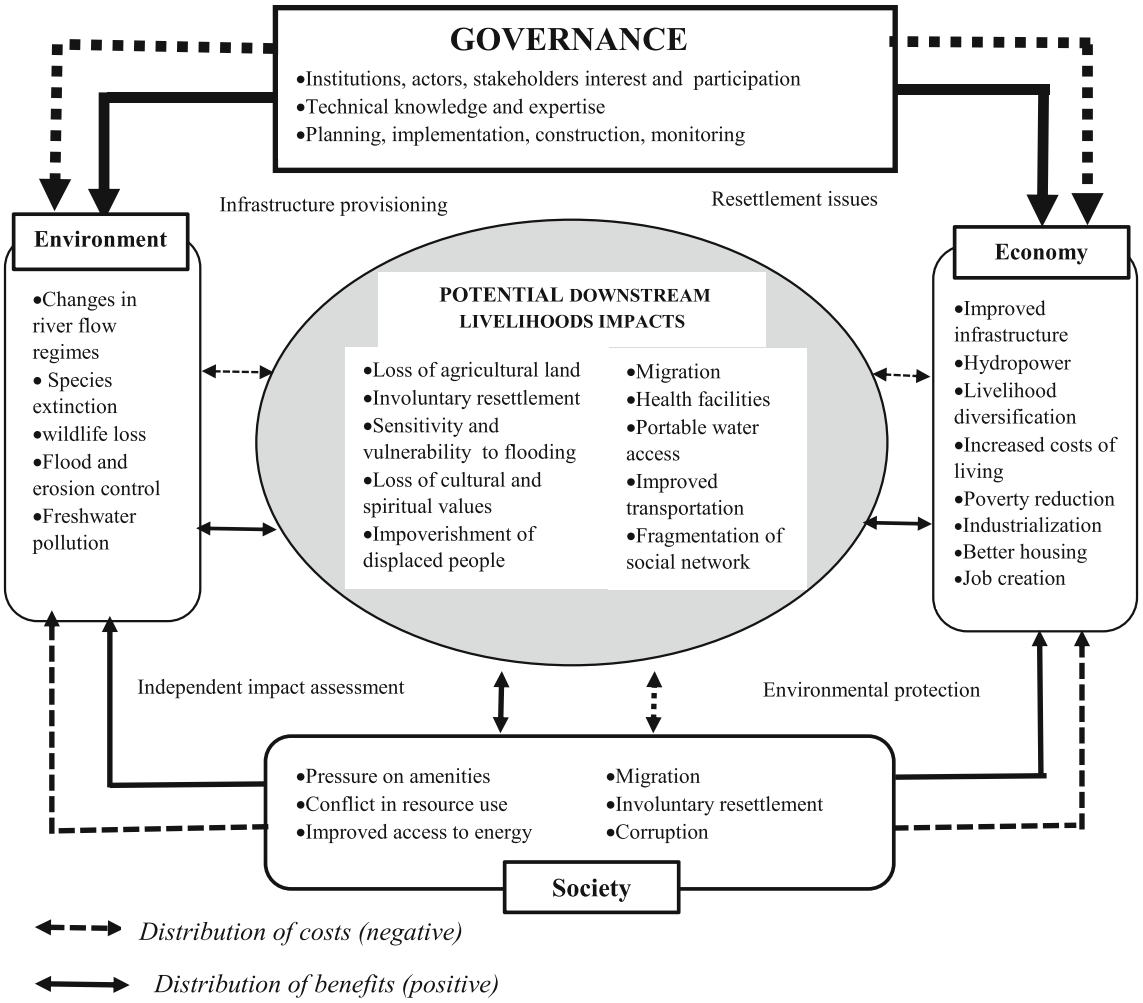

Fig. 1 Conceptualization of the study derived from the political ecology framework

and the unequal distribution of costs and benefits associated with dam projects in Africa and Asia. Within the framework, power according to many authors is conceptualized as relating to the differential ability to control access to valuable environmental resources, aimed at control and/or access to the economic benefits emanating from resource exploitation (see for example Peluso 1992; Dauvergne 1994; MacAndrews 1994; Bryant 1996, 1997; Tan-Mullins 2007). In developing environmental resources, the state becomes the principal actor and is expected to satisfy competing needs. The need for the development of hydroelectricity to facilitate economic development in most developing countries has ignited heated debate about where to strike the balance between development and other important national interests (Yankson et al. 2017). According to Tan-Mullins (2007), the state in developing hydropower dams is expected to balance the need for energy for development and the protection of the environment due to its unique remit to act in the "national interest" (Bryant and Bailey 1997: p.48). Besides their economic importance, the development of large dams has been opposed as a result of their severe environmental impacts and socio-economic challenges of dam-affected people (Nüsser 2003) including the often neglected downstream communities.

The Bui dam was constructed at a time when Ghana was undergoing a prolonged period of power shortage and energy rationing. This created a goodwill among the populace for the construction of the estimated 400 MW power plant at the Bui gorge to help curtail the frequent power outages the nation was facing (Yankson et al. 2017). The proposal for the construction of the Bui dam had always been opposed by many stakeholders citing environmental concerns and Ghana's poor record in dealing with dam-related socio-economic problems based on the experiences of the Akosombo and Kpong dams that have been built earlier. According to Gyau-Boakye (2001), the huge environmental and social costs of the two earlier dams included an estimated 88,000 people who were displaced and had to be resettled amidst many irregularities

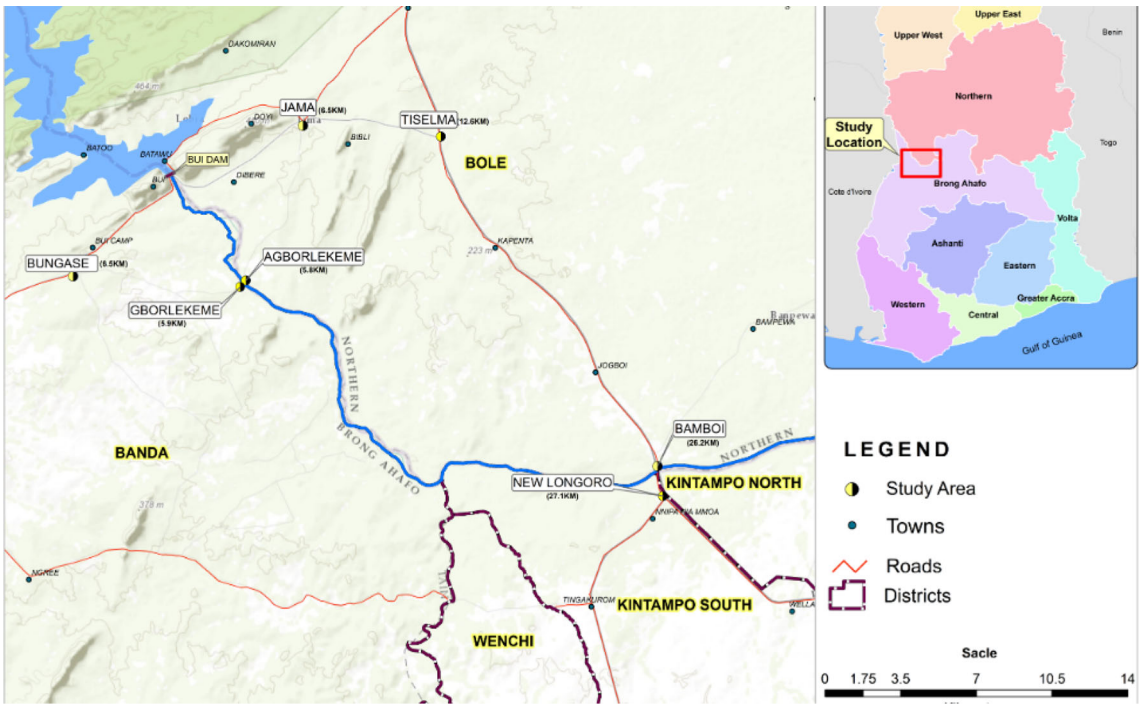

Fig. 2 Map of the study area showing downstream communities of the Bui Dam. *Source:* Produced by the authors

associated with the compensation schemes. Tsikata (2006) and International Water Management Institute (IWMI) (2009) have also elaborated on the untold socio-economic hardships faced by downstream communities such as the collapse of the (clam) fishing industry, lack of property rights, health and loss of artifacts with cultural and religious significance following the construction of the Kpong dam (Owusu et al. 2017).

Even though an environmental and social impact assessment (ESIA) was conducted prior to the construction of the Bui dam, to satisfy both local and international requirements (Table S1), the downstream communities were not included in the compensation package for livelihood support. In this sense, the governance process may have failed to adequately recognize and incorporate the needs of relevant actors and stakeholders. Some writers cite critics as saying that the ESIA embellished the overriding benefit of the project and its potential to enhance economic development at both the local and country levels (Bui Power Authority (BPA) 2011; Obour et al. 2016). With the experiences of the Akosombo and Kpong dams, one would have expected that the downstream communities would have been planned for and assisted with livelihood challenges resulting from the Bui dam's construction. However, the resettlements failed to cover the downstream communities creating an emerging livelihood challenge.

Data and methods

Study area

The study was carried out among the non-resettled communities below the Bui dam impoundment on the Black Volta River in Ghana (Fig. 2). In all, seven communities were selected for the study based on their proximity (below 30 km) to the dam. The communities fall under three local government district assemblies (DAs) in the Northern and Brong-Ahafo regions of Ghana. They included Bamboi, Jama, Tiselma and Agborlekeme in the Bole district of the Northern Region; Bungase and Gborlekeme in the Banda district and New Longolo in the Kintampo North district all in the Brong-Ahafo Region. The main livelihood activities of the studied communities are fishing, farming and petty trading. DAs, in terms of administrative and political governance in Ghana, are the second-level administrative sub-division below the level of the region. The primary mandate of DAs in Ghana includes planning, initiating, coordinating, managing and executing policies and developmental projects in respect of all matters affecting the people within their areas of jurisdiction (Institute of Local Government Studies 2010). Thus, the DAs in the study area were expected to collaborate with the BPA, the state agency in charge of the execution and management of the Bui project.

Historically, the Bui dam's development is traced to the discovery and identification of the Bui gorge as a

suitable site for hydroelectric power in 1925 by Albert Kitson, a British-Australian geologist and naturalist. However, several planning, technical and implementation challenges and constraints including persistent coup d'états (political instability) in Ghana inhibited the implementation of the project (Fink 2005). In July 2007, a 622 million financing package ($560 million was extended by the Chinese government through China Exim Bank and US$60 million by Government of Ghana) for the Bui dam development was approved by Ghana's Parliament (Hensengerth 2011). The Bui Power Authority (BPA) was established by Act 740 of 2007 and became the main state institution in charge of the project (Hensengerth 2018). The construction of the main dam as a turn-key project by Sino Hydro, a Chinese construction company, started in December 2009 and was officially inaugurated in December 2013 (see also Table S1 in Supplementary Electronic Material for a detailed timeline of events).

Overview of Bui dam governance structure

Multiple stakeholder representations and the enactment of appropriate legal and policy instruments are imperative to ensure good governance of large-scale dam projects. In the case of the Bui dam hydroelectricity project, multiple stakeholders contributed to the planning, implementation and management at the national and regional levels. The BPA has had the overall responsibility for planning, executing and managing the Bui dam project. In addition, other state institutions, departments and agencies played and continue to play significant roles as far as the governance of the Bui dam hydroelectricity project is concerned. These included but are not limited to Ministries of Finance and Economic Planning, Energy, Foreign Affairs, Environment, Science, Technology and Innovation. Other state representatives include Water Resources Commission, Forestry Commission and Ghana Immigration Service (see Yankson et al. 2018). Local and community scale involvement and representation in the governance process of the Dam from our survey are indeterminate, at best. The only stage where local scale representation is clear was at the early stages of the project's development. This occurred when community leaders including chiefs, assemblymen and opinion leaders served as community contacts in discussions and sensitization of resettlement programs (Yankson et al. 2018). This early consultation was mostly limited to the upstream communities who were resettled to make way for the initial filling of the Bui dam. Post construction, the management is in the hands of the BPA with the District Assemblies (DAs) playing no active role.

Data collection and analysis

The survey design for this study was purely descriptive. A three-stage approach was adopted to collect field data. First, a reconnaissance survey was undertaken in the third week of July 2014 to afford the research team the opportunity of interacting with the planning officers of the three DAs in the study area (Table 1). The reconnaissance survey also provided the opportunity to test and refine our survey instruments. In-depth interviews were granted by the planning officers and information on who to contact in the dam-affected communities were also provided.

The second phase of data collection involved a questionnaire survey of which the target population was the farmers and fishers in the seven non-resettled communities. The respondents were purposively selected based on their location, availability and distance from the dam, gender, age and occupation. The number of interviews carried out in each community reflects the relative population size of the community. In all the communities, the research team made a conscious effort based on snowball sampling to identify and interview women farmers and fishers (Tongco 2007), as the impacts of the dam were perceived to have gender dimensions because of the different occupational roles. In all 158 questionnaires (approximately 10% of the total households in each community) were administered as shown in Table 1. Open-ended questionnaires were used

Table 1 Bui downstream non-resettled communities and number of interviewees by gender

Community	District assembly	Region	Males interviewed	Females interviewed	Total
Bamboi	Bole	Northern	27	11	38
Jama	Bole	Northern	18	6	24
Tiselemi	Bole	Northern	11	6	17
Agborlekeme	Bole	Northern	13	4	17
Bungase	Banda	Brong-Ahafo	14	11	25
Gborlekeme	Banda	Brong-Ahafo	8	4	12
New Longolo	Kintampo North	Brong-Ahafo	19	6	25
Total			110	48	158

and grouped under thematic headings like the socio-demographic background, the impacts of Bui dam impoundment on livelihoods and adaptation strategies to address the impacts. The interviews with households were done in the Twi or Brong language, which are the most widely used language and then translated to the English language by research assistants. Similar to the work of Okuku et al. (2016), direct observation such as a visit to the river bank was also used as a supplementary method to collect data to validate the information obtained through the semi-structured interviews.

In addition to the household questionnaire interviews, focus group discussions (FGDs) were organized in four of the seven communities namely Bungase (2), Jama (2), Bamboi (2) and New Longolo (2). In each community, two FGDs were organized separately for male and female groups. Each group comprised eight to twelve participants and their ages ranged from the early twenties to late fifties. The other three communities (Tiselma, Agborlekeme and Gborlekeme) were left out of the FGD because of their small sizes and the fact that many of the elderly population had been captured during the questionnaire survey.

The computer-based program, IBM SPSS Statistics version 23 and Microsoft Excel 2013 were used to clean and code the quantitative data obtained from the surveys for analyses. The qualitative data, on the other hand, were organized into themes using content analysis (Mayring 2000): the views expressed by each participant were summarized and themes and patterns were established for the different views presented by the participants.

To conduct the research among the local people in the downstream areas of the Bui dam, the research team sought and obtained an ethical clearance from the Ethics Committee for the Humanities at the University of Ghana. The Ethical Clearance with the number ECH 078/13-14 was granted on May 25, 2014.

Results and discussion

Overview of socio-economic livelihood systems

Overall, the majority of the downstream population affected by the construction of the Bui dam are farmers and fishers. Based on the household survey, the majority of respondents interviewed identified themselves as farmers (45%), followed by fishers (30%). Traders and public sector workers represented 12 and 6%, respectively. All other categories of occupation constituted 7% of the livelihood of respondents. The results of the questionnaire survey indicated that the major impacts of Bui dam construction were felt by the fishers and the farmers more than the other livelihood activity participants.

Impacts of Bui dam construction on livelihood systems

Fisheries livelihoods

Several empirical studies have found that the construction of large dams alters the flow of rivers and affects populations that continue to be closely dependent on river ecosystems (WCD 2000; McKenny 2001; Stave et al. 2005; Krueger 2009; Strobl and Strobl 2011). Disruptions in the flow of a river due to the construction of a dam can mean a disruption in the freshwater goods and services that sustain river-dependent communities—especially fish (Richter et al. 2010). Most of the fishers interviewed in Agborlekeme, Gborlekeme and Bamboi indicated that the construction of the Bui dam has had a negative effect on the fishing industry and has actually ruined their main source of livelihood. The problems with fishing post-Bui dam construction were enumerated by interviewees to be mainly the reduction of fish stocks and the unregulated release of water from the reservoir during power generation. About 98% of the fishers reported that there has been a significant reduction in the quantity and diversity of fish that they catch after the construction of the Bui dam. The reported reduction in fish catch is consistent with findings in downstream communities elsewhere in Ghana as reported by Tsikata (2006) and in other parts of the world. For instance, the Pak Mum dam-affected communities in Thailand, it was observed that, post-dam construction, there was as high as 80% reduction in the amount of fish caught (Amornsakchai et al. 2000). At the women FGDs in Bungase and Jama communities, participants mentioned that fish species such as *Ctenopoma petherici, Hemichromis fasciatus, Citharinus citharus* and *Odaxothrissa mento* are no more caught by fishers since impoundments of the river for the Bui dam. Alhassan's (2013) study of the hydro-biology and fish production in the study area supports this assertion.

Interviewees (mainly fishers) in the studied area reported the unregulated release of water from the reservoir by BPA as the major challenge to their fishing activities besides the low catch. The unregulated release of water according to the respondents interferes with the post-dam construction flow regime and has consequences for fishing in terms of the frequent washing away of fishing nets, traps and canoes and reported accidental drowning of a fisher. At Agborlekeme village, several fishers the research team interacted with during the reconnaissance survey recounted the loss of life of a fisher during the early stages of power generation even though there was no documentary evidence. According to the interviewees from this village, this was ongoing because the BPA officials responsible for

regulating the flow of the river have direct communication medium with the downstream communities to alert them of impending release of water, periodically from the reservoir during power generation. Fishing was reported to have become both dangerous and unprofitable such that some fishers have migrated upstream to continue their activity, while others (28%) have shifted to alternative livelihood activities such as farming. About 47% of those who have changed occupations said that the new activity has become their main source of income and livelihood. Again, the majority of respondents (68%) who have changed livelihood activities since the Bui dam's construction cited low fish catch and unregulated spillage from the dam as the main challenges pushing them away from fishing. This result clearly indicates that the livelihood activity most affected b y post-Bui dam construction is fishing, which concurs with the findings from Tsikata (2006) study in the lower Volta Basin after the construction of the Kpong dam in the 1980s. There were also complaints by both farmers and fishers that the price of fish for household consumption has increased due to a reduction in fish catch which is affecting nutritional needs.

The reduction in fish stocks (Alhassan 2013) and migration of fishers are consistent with the construction of other dams elsewhere. For instance, the construction of the Tucurui dam in Brazil resulted in a significant decline in fish catch (Richter et al. 2010). The number of people engaged in fishing also reduced greatly with the affected population totaling over 100,000 (WCD 2000). Similarly, Pearse-Smith (2012), reported that there has been a reduction in the supply of fish stocks in the Mekong Basin due to environmental changes created by the hydropower development. The general cause of the reduction in fish stock is ascribed to increased turbidity and sediment loads (from increased riverbank erosion). This condition consequently reduces the light available for algal growth or smothered bottom-growing algae which are an important food source for some fish species (Hirsch and Wyatt 2004).

The fishers also reported numerous challenges regarding access to the river post-dam construction with 33% indicating that accessing the river had become difficult and dangerous. Reasons cited for limited access to the river included flooding of paths to the fishing sites, prevention by the authorities from fishing on the lake, and the fear of uncontrolled release of water from Bui dam. Overall, a majority of the respondents (72%) identified polluted water and reduction in fish catch as the main challenges facing the downstream communities post-Bui dam construction. A fisher from Agborlekeme summed up his frustration with the statement below:

> Although there is no restriction there is no motivation to go to the river because of low fish catch since the Bui dam was constructed.

The pollution results from reported discharges of effluents (which was more of a problem during the initial stages of dam construction) and the current takeover of the downstream territory by illegal small-scale gold miners (locally termed 'galamsey' operators) in the river bed (Fig. 3). This operation has only been possible to post-Bui dam construction as the impoundment upstream has led to a reduction in river flow downstream and pollution of the water. From our interviews, locals from all downstream communities indicated that chemicals (including mercury) used by illegal miners to amalgamate gold is altering fish population in addition to the risk it poses to humans health. With the downstream communities not being factored into the official resettlement and compensation package, coupled with the limited financial, technical and human resource capacity of the newly created Banda district where these downstream communities are located, basic amenities like water, pliable roads and electricity remain a challenge.

Farming livelihoods

Most of the farmers interviewed indicated that the construction of the Bui dam has had little direct impact on farming activities at the downstream. However, 39% of the respondents indicated that the loss of arable lands to periodic flooding has resulted in more competition for farmland. Qualitative data from focus group participants revealed that reduction in available farmland is a major concern for communities and households. The reduction in farmlands was attributed to the movement of people from the upstream communities to the resettlements in the downstream area, which has increased the demand for farmlands. All the 1200 people resettled were moved by the BPA to land downstream (Raschid-Sally et al. 2008). The reduction in households' farm sizes was commented on by a farmer from Bungase as follows:

> Farm sizes are gradually declining due to increasing population density. This is because we have to share our farmlands with households who relocated to this community as they lost their farmlands and other livelihood systems to the Bui Dam hydroelectric project.

Interestingly, farmland access and size were the predominant issues of discussion during the 3rd Ghana Dam Forum (27th, 28th and 30th October, 2009) whose aim was to discuss and explore practical solutions to the livelihood and institutional challenges from the Bui Dam resettlement project (ModernGhana 2009).

Fig. 3 Small-scale illegal gold mining (galamsey) operation downstream of the Bui dam. *Source:* Fieldwork (June 2016)

The reduction in the size of farmland for use by downstream communities as a consequence of the construction of the Bui dam is consistent with the experiences of dam construction in other parts of the world (Bui Power Authority (BPA) 2011; Strobl and Strobl 2011; Tilt et al. 2009; Duflo and Pande 2007). Tilt et al. (2009) reported that the Manwan Dam project in China severely impacted the agricultural sector of the affected countries including Laos, Cambodia,. For instance, in 1991, the per capita farmland ranged from 1.02 to 1.96 mu (0.067–0.129 ha) with an average holding of 1.79 mu (0.118 ha) per capita. Following the completion of the Manwan Dam in 1996, Tilt et al. (2009) reported that this figure decreased to 1.21 mu (0.08 ha) per household. The same study further reported the quality of available agricultural lands to have changed significantly. The increase in population has therefore resulted in the demand for farmlands. Indirectly, farming practices as the main livelihood activity have been affected after the construction of the Bui dam. Approximately, 16% of farmers interviewed changes in the types of crops grown in the area. They reported an increase in the cultivation of cashew which takes up land that could have been used for food crops. Strobl and Strobl's (2011) analyses of dam impacts on agriculture within river basins in Africa also highlights loss in cropland productivity. Duflo and Pande's (2007) investigation in India, however, indicates improved agricultural productivity at the upstream of dams. Our study found that a proposed irrigation project which was attached to the construction of the dam has been abandoned by the government, which, according to the farmers, has affected agricultural activities/production in the community. The failure to implement the irrigation scheme and other agricultural-related research and education component of the dam project supports the framework of this study that the state as the principal stakeholder was from the beginning only interested in harnessing the electricity potential of the dam project and probably nothing else. The goodwill offered by the populace as a result of the power shortage and the demand for electricity in the country has perhaps also restrained the people from demanding of the state to deliver the other components of the project. Change in government during the construction phase and cost overrun of the Bui dam hydroelectric project may also be plausible reasons for the non-implementation of the irrigation project, although our study could not validate these assumptions.

Other livelihood systems

Our results showed that the construction of the Bui dam has impacted the downstream communities' livelihood systems, beyond fishing and farming. According to officials from the district assemblies, whereas larger towns like Bamboi, New Longoro and Bungase have benefited from electricity supply, the smaller villages like Agborlekeme and Gborlekeme have not seen any improvement in the provision of social amenities (at the time of fieldwork). The inequity in basic amenities provisioning has negatively impacted on the sustainability alternative and essential livelihood systems and jobs of the downstream area post-Bui dam construction. For instance, the water supply situation has equally been improved in the larger communities with the provision of boreholes, whereas the smaller communities close to the river have not been provided with any such boreholes. The smaller communities continue to rely on the river water for consumption and other domestic uses.

The majority of the focus group discussants in both women and men groups indicated that poor water quality and lack of basic amenities since the construction of the Bui dam have made the smaller communities vulnerable through out-migration. Anecdotal evidence showed that it is usually the civil servants like teachers posted to these study villages who out-migrate, leading to the closure of basic schools in the studied area. In the village of Gborlekeme, for instance, lack of amenities and out-migration of teachers was reported by community leaders to have put in the only primary school built with bamboo in the community on the verge of collapse (Fig. 4). The reduction of the water quality as indicated earlier has come about as a result of the reported dumping of industrial waste by the dam construction company and the operation of galamsey operators who dig and wash gold ore in the river bed. Our interviews with relevant stakeholders revealed that pollution of water bodies has been compounded largely because of the lack of integrated effort by officials from BPA, DAs and EPA in the monitoring of activities of galamsey operators. A number of the leaders in all the seven studied communities interviewed were of the assertion that, the state as the principal actor appears to be solely interested in the hydroelectric power generation and the activities that affect the power generation and nothing else. This, according to the respondents is evidenced by the fact that the state had in the past used the military to drive out illegal miners and fishers upstream but never done anything of the sort in the downstream area. During the focus group meeting at New Longolo, the community leader intimated:

> Those of us in the downstream have completely been ignored by the management of the BPA in the resettlement and compensation package as well as efforts at addressing the unintended impacts. The authorities have failed to provide us with basic social amenities and infrastructures like potable water, irrigation and fishing tools even though we have been affected like the upstream communities. Now, our main source of water is polluted with poisonous chemicals due to galamsey. It seems that we are being neglected because we are a small community. Please use your work to inform the government of our plight.

Results from our interactions with officials from the DAs confirmed that the downstream communities were not included in the resettlement and compensation package. Not much has been provided for the downstream communities in terms of infrastructure or services. With the opportunities of fishing especially upstream and gold mining, population increase has ensued post-dam construction and is putting pressure on the limited social amenities. For example, the people of Bungase who participated in both men and women FGDs lamented the pressure on the small health center and lack of resources due to newly resettled people. Findings from an earlier investigation by Yankson et al. (2017) indicated that the pressure on the health facility at Bungase has been made worse by the absence of a functional health facility at the Bui resettled community, which is very close to Bungase village. A dissatisfied FGD participant from Bungase village lamented the pressure on health facilities as follows:

> The hospital is not in the best of conditions and the number of people accessing it has increased since the Bui dam was built and new people moved here. We have to spend more time at the hospital and the quality of the service we get has also gone down.

Rise in rental costs, according to household survey interviewees and FGDs participants is a direct outcome of the Bui dam construction. This condition for most locals can be attributed to the sudden in-migration of people

Fig. 4 Primary school at the village of Gborlekeme—a depiction of the general lack of amenities in the downstream area. *Source:* Fieldwork (June 2016)

Table 2 Summary of impacts of Bui dam on downstream communities' livelihood systems

Livelihood systems category	Impacts mentioned by interviewees
Farming livelihoods	Reduction in farmland size
	Unhealthy competition for farmlands
	Movement of people to upstream communities
	Low yield from cultivated crops
	Lack of irrigation schemes
Fisheries livelihoods	Reduction in fish catch (species loss)
	Loss of fishers' lives
	Unprofitability of fishing
	Exit from fishing activities
	Increased in the price of fish for household consumption
	Difficulty in accessing the river
	Pollution of river
	Uncontrolled release of water causing flooding
Other livelihoods	No access to water in small communities
	Improvement in quality of water in big communities
	Close down of primary school
	Increased illegal mining (galamsey)
	Pressure on limited social amenities
	Increase in the costs of rent

prospecting and mining gold in the river bed. Table 2 provides a summary of the impacts discussed above.

Adaptation strategies of the affected communities

An analysis of the survey findings generally revealed that livelihood activities disruption and resources access constraints of downstream communities due to the construction of the Bui dam has led locals to reorganize their socio-economic activities. Overall, the majority of household survey participants (74%) reported that there has been a reduction in their incomes from their present livelihood activities. Locals have in response adopted a mix of closely related coping and adaptive strategies centred around farming, petty trading and migration.

The main occupation that most respondents have changed from is fishing to farming. About 67% of the people stated that they have changed their main occupation from fishing into farming, whiles the remaining 33% have taken up petty trading (e.g., selling of water, used clothes). The two most important in situ adaptation measures employed in the downstream communities are farming and petty trading. It was also found out that there was a strong spatial and gender differentiation in the choice of farming or petty trading as an adaptation measure. Whiles people in the smaller communities like Agborlekeme and Gborlekeme have taken to farming, most respondents who moved to petty trading were in bigger communities like Bamboi, Bungase and Jama. Our survey also found out that female respondents (68%) were mainly involved in petty trading of merchandise in the bigger communities. The high number of women in petty trading is not surprising as in rural communities in Ghana, trading especially in agricultural produce, is seen as the domain of women due to cultural norms (Opare and Wrigley-Asante 2008).

Migration is reported as the third most important adaptation measure. However, it is rather the youth that looked mostly at migration as a favorable response to the post-dam construction challenges. A return migrant in Agborlekeme stated his disappointment with the impacts of Bui dam construction on livelihoods;

> When they were planning to construct the Bui dam, government authorities said that the youth will have more jobs and money, improved potable water and irrigable farmlands, but it was all a lie. Life became more difficult for my family, so I moved to Kumasi for a while.

The above quote indicates how households and communities' expectations of benefits in the form of improved livelihood systems and better access to resources have been dashed after the construction of the Bui dam. Unfortunately, the construction of the Bui dam appears to have further threatened and devastated existing livelihood activities. Interestingly, interviewees who have taken up new livelihood activities in response to the challenges posed by the construction of the Bui dam elaborated on further challenges with their new livelihood system. Locals who have moved into farming reported poor soils (45%),

lack of financial resources and inputs (54%) in addition to limited land availability (69%) as the main challenges confronting their new activities.

About 42% of the farmers reported that due to the Bui dam filling up, land for farming is often submerged and this adds to the existing pressure on lands for farming downstream. Again, 22% of farmers reported that the emerging tree crop industry (mainly cashew) is taking up farmlands and creating pressure on land for cultivating food crops. During the focus group discussions, participants across all the studied communities intimated that they would have loved to invest in cashew farming as well but the lack of capital is a major challenge. Participants reported that no financial institution was ready to offer them loans, since they did not have any valuable property to use as collateral. This point was reemphasized by most petty traders interviewed who indicated that the lack of capital to set up or expand their small businesses is the primary challenge.

Conclusions and recommendations

The contribution of large-scale hydropower dams in the socio-economic development of both developed and developing economies has been well-established. In the same vein, empirical studies continue to discuss the severe and often negative social and environmental impacts from their construction and implementation. Our study findings revealed that even though the government of Ghana, in pursuing the development of Bui dam hydropower project on the Black Volta River at the Bui gorge was principally responsible for safeguarding the interests and needs of all the stakeholders, the after effects indicate otherwise for downstream non-resettled communities.

We found out from our field surveys that the social and livelihood systems of downstream communities have been greatly disrupted as they were not accounted for in the design and implementation of the resettlement and compensation package by the BPA.

The logical inference from the present case is that the government of Ghana and other key players failed to take valuable lessons from past experiences of communities who were affected during the construction and implementation of the Akosombo and Kpong dams.

The key challenges faced by the downstream communities include loss and disruption of their main livelihood activities mainly fishing, farming and pollution of drinking water. The main issue with fishing has to do with changes in river regime that have affected fish catch and unregulated water releases during power generation. Our findings showed that there is no communication between the downstream fishing communities and the BPA such that periodic water release from the Bui dam leads to loss of fishing gears like nets, traps and canoes and pose a danger to the lives of the fishers. Farming was also found to be equally challenged, since the planned irrigation component of the dam project has not been implemented by the relevant stakeholders led by the government of Ghana through the BPA. Thus, there is a suspicion among local people and some researchers speculate that the state was more interested in the power generation component of the project than addressing all the competing needs. The goodwill of the people who are confronted with power outages as a result of low electricity generation in Ghana at the moment is also restraining them from demanding the state to have a holistic and participatory approach to the development of the Bui project. Additionally, many of the downstream communities including those studied have also been redemarcated into the newly created Banda district which lacks the human capital and financial resources to address some of the livelihood challenges emanating from the construction of the Bui dam.

On the basis of the findings, we recommend that the state through BPA and the District Assemblies should take immediate steps to address the challenges in the downstream communities starting from the opening of lines of communication with the communities. This channel, once established, will help to address problems of the release of water that takes the communities by surprise and put lives and property in danger. There is also the need to reactivate the proposed irrigation component of the dam project to support all year round agriculture production to address the reported increased unemployment situation in the communities. The provision of social amenities by the BPA, the District Assemblies and the Central government and the strict monitoring of activities especially mining in the riverbed is urgently needed to help stem the out-migration and also prevent a possible future health emergency. Finally, we recommend that the BPA offers the urgently needed job training and business management skills to especially those people who are self-employed and engaged in petty trading. We are of the view that offering the training will give the needed skills and help improve the incomes and livelihood of communities to forestall the growing out-migration resulting from the dam's construction.

Considering the complexities of social, economic and ecological impacts associated with dam construction with regards to space and time, an integrated analysis of the impacts of the Bui dam construction on downstream communities is needed. Based on the findings of our study, we recommend future studies to focus on (i) a longitudinal survey of the impacts of illegal small-scale mining (galamsey) activities on the health of locals (ii) Bui dam construction impact on communities' traditional culture, norms and practices and (ii) impacts of Bui dam on diverse

social and vulnerable groups including women, children and migrants in both downstream and upstream communities.

Acknowledgements The authors would like to thank the Office of Research, Innovation and Development (ORID), University of Ghana (UG) for offering support [Grant Number URF/7/ILG-040/2013-2014] through the 7th UG Research call to support the field work that resulted in the production of this paper.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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