

Original Research Article

Spillage of Akosombo and Kpong dams in Ghana: perspectives on socio-economic and public health impacts on affected populations and proposed mitigation strategies

ABSTRACT

Background: The negative impact of floods on humans and the environment cannot be overemphasized. Annually, different parts of Ghana get flooded resulting in the loss of lives and significant damage to property.

Objective: This study assessed the devastating consequences of the controlled spillage of the Akosombo and Kpong dams in Ghana, with resultant effect on an estimated 150,000 people living in downstream and upstream communities.

Methods: The was an observational study. Government reports, published media reports, NGO publications, and field visits were also used to assess the extent of damage, challenges faced by local communities, and mitigation measures initiated.

Results and Discussion: The spillage led to the loss of critical infrastructure, displacement of healthcare workers, and suspension of medical and surgical cases. To the best of our knowledge, the current study comprehensively captured the scale of devastation of the floods on people and their livelihoods in 7 out of the 16 regions within 21 administrative districts across Ghana, and proposed workable strategies to mitigate future happenings.

Conclusion: An immediate effective response and mitigation efforts must include clean water supply, emergency food relief, and mental health support. Long-term resilience strategies, early warning systems, and climate sensitive interventions are essential coupled with improved collaboration among key stakeholders and disaster preparedness at the local level. The study underscored the urgent need for comprehensive measures to mitigate the impacts of future disasters and enhance community resilience.

Keywords: Floods, Volta River Authority, Akosombo dam spillage, public health impacts, vector-borne diseases

1. INTRODUCTION

The research carried out by the International Flood Initiative in 2003 highlighted the significant impact of floods, which represent the predominant category of water-related natural disasters. These floods not only result in considerable harm to human lives and property but also have far-reaching consequences for cultural and ecological resources [1]. Causes of floods can be categorized into two main groups, as noted by Nott in 2006 [2] namely, natural factors, often driven by climate forces, and human-induced factors, which include urban development and vegetation clearance. While natural factors play a significant role in causing floods globally, changes in flood patterns are primarily attributed to human activities, such as deforestation [3].

Floods are not classified as natural disasters until they result in damage to human lives or property. However, their adverse effects can be mitigated through the implementation of advanced warning systems, as emphasized by Sinclair and Pegram in 2003 [4]. Additionally, many economically disadvantaged individuals live near riverbanks, often due to the lack of alternative housing options. Unfortunately, these residents not only face a higher risk of flooding due to their locations but also due to their limited financial resources [5].

The impact of floods on human beings is of utmost significance, as it extends its reach across various aspects of human existence. This encompasses the physical environment, human health, and agricultural produce [6]. Depending on its magnitude and speed, flooding has the potential to harm a wide range of structures, such as bridges, vehicles, buildings, sewerage systems, roads, and canals. Additionally, it can lead to water contamination [7].

In Ghana, the Akosombo and Kpong hydro-electric power plants located on the Volta River Basin are owned and operated by the Volta River Authority (VRA) [8]. The power generating capacity of the Akosombo and Kpong dams are 1,020MW and 160MW respectively [9]. One of the most notable outcomes of the Akosombo hydroelectric power plant is its capacity to supply electricity to neighboring countries, strengthening regional ties and fostering economic cooperation. Ghana extends its electrical generosity to nations such as Togo, Benin, and Cote d'Ivoire, offering a valuable resource for domestic and commercial purposes [10]. This interconnectedness through electricity exchange serves as a testament to the VRA's

pivotal role not only in Ghana but also in bolstering the energy security and economic growth of its neighboring countries.

This study assessed the negative impacts of the 2023 controlled spillage of the Akosombo and Kpong dams, resulting from increased water inflow, with severe impacts on downstream communities, and the urgent need for comprehensive measures to mitigate the impacts of future disasters and enhance community resilience. The Akosombo hydroelectric dam and the opening of the spillways are shown in Fig. 1.a and Fig. 1.b respectively.



Fig. 1.a Akosombo dam constructed in 1965



Fig. 1.b Akosombo dam opens spillways.

2. METHODS

2.1 Study design

This was an observational study conducted in the affected areas from September 15 to October 30, 2023. Government reports, published media reports, NGO publications, and field visits were also used to assess the extent of damage, challenges faced by local communities, and mitigation measures initiated.

2.2 Study area

Ghana, the study area, is a country in West Africa located between latitudes 4.5°N and 11.5 °N and longitude 3.5 °W and 1.5 °E (see Fig 2). Ghana is bordered to the east by the Republic of Togo, to the West by the Republic of Cote d'Ivoire, to the north by the Republic of Burkina Faso, and to the south by the Gulf of Guinea. Tropical monsoon typically defines the climatic condition of Ghana and about 65% of the land is under agricultural use [11, 12]. The West African Monsoon (WAM) controls the rainfall in Ghana, where the atmospheric pressure system influenced by the temperature gradient and energy between the Sahara and the Gulf of Guinea [13]. The Inter-Tropical Discontinuity (ITD) modulates this atmospheric pressure system and the oscillatory motion of the ITD between the south and the north of Ghana results in the bi-modal and uni-modal rainfall distribution across the country [14, 15]. Uni-modal rainfall is experienced in northern Ghana from April through to mid October and peaks in August or September. However, southern Ghana is characterized by bi-modal rainfall distribution. First rainfall occurs between March to July and peaks in June whereas the second occurs between September and mid-November and peaks in October. Several factors which influence rainfall pattern in the country include sea level temperature, local convective activity and atmospheric dynamic stability [16]. Ghana experiences the harmattan as a result of the north-east desert wind between December and February. The harmattan which results in low humidity, hotter days and cooler nights is prevalent in the northern part of Ghana compared to the southern part.

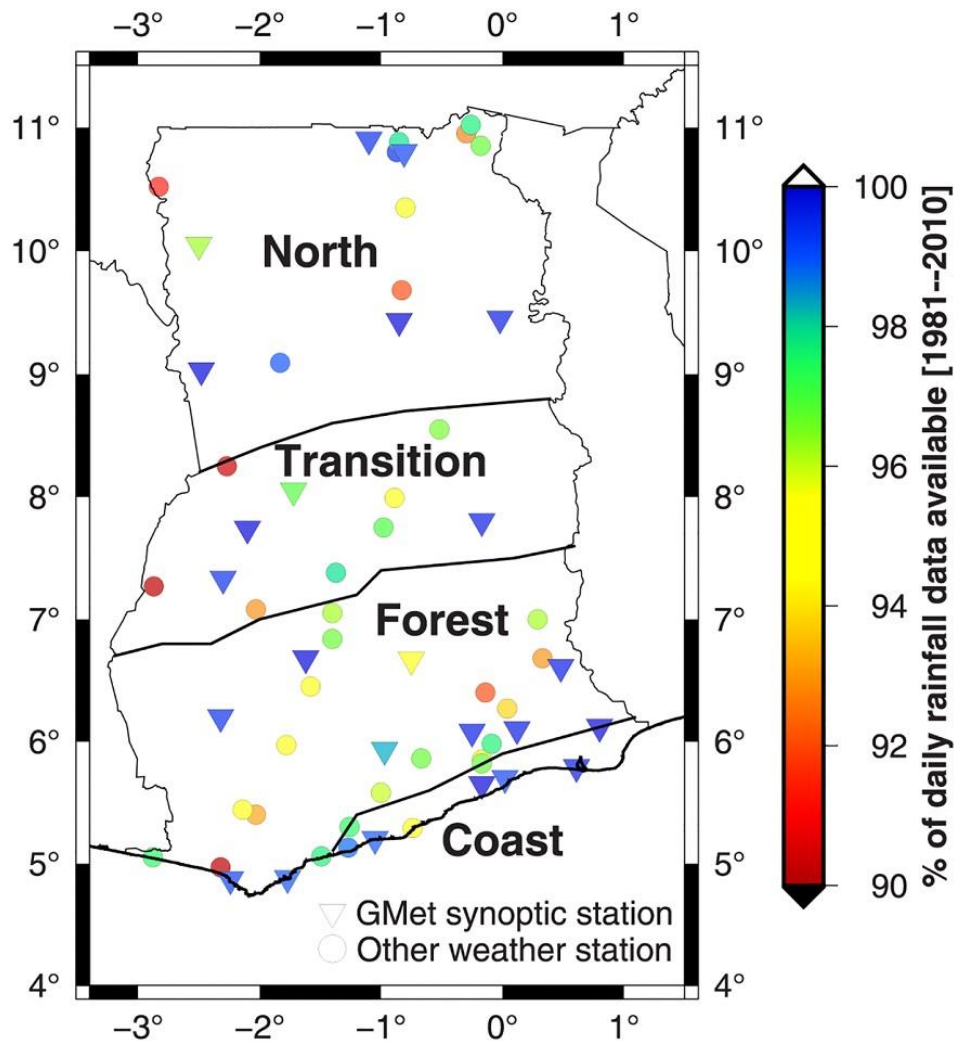


Fig 2: Geography of Ghana Credit: [13]

Ghana is categorized into five distinct climatic zones due to the significant changes in climatic variables such as rainfall and temperature over time. These distinct climatic zones include; the Sudan Savannah, Guinea Savannah, Transition, Forest and Coastal zones [17]. The new zonation is a result of the expansion in the size of Sudan and Guinea Savannah southwards, shrinking of the Transition zone as the Guinea Savannah took over a greater portion of it in the southeastern part of Ghana. Additionally, the shrinking of the Forest zone in size together with the shift in the northwest, while the coastal belt has expanded significantly in size to cover the entire coast of Ghana. These changes are strong indications of climate change and its possible impact on weather patterns.

2.3 Source of data

We conducted field visits and extensive review of existing literature, including academic papers, electronic media reports, government reports, and non governmental organization (NGO) publications. This provided a baseline understanding of the issue and the existing mitigation efforts. The field visits were conducted in areas directly impacted by the spillage of the dams to ascertain the conditions and challenges faced by local communities, assess the extent of damage, and identify ongoing mitigation measures.

The literature search strategy consisted of five key elements: Akosombo dam spillage, floods in Ghana, climate change, effects of climate change, and man-made disasters. Search terms for 1) Akosombo dam spillage was combined with search terms for 2) floods in Ghana (including regions and districts). Search terms for 3) climate change was combined with search terms for 4) man-made disasters and 5) effects of climate change. These combinations were necessary to compile a comprehensive search strategy to address the aim of the study. Academic literature databases (Pubmed, Web of Science, Google Scholar), Websites of Media outlets in Ghana (Myjoyonline.com, Citinewsroom.com, Ghana News Agency, Ghana Broadcasting Corporation); Websites of government agencies, online search engines such as Google for “grey” literature.

2.4 Data management

Finalized search strings and references were used to search electronic databases. The search results were imported into Mendeley Desktop (version 1.19.4, Mendeley Ltd., London, United Kingdom) for storage and the removal of duplicates (Christopher Yaw Dumevi, Christopher Mfum Owusu-Asenso, Bright Darko Amoah). The inclusion and exclusion criteria guided the search, selection and review of the relevant literature such as abstracts, commentaries, news reports and full articles. Three author-reviewers independently screened the literature (Christopher Yaw Dumevi, James-Paul Kretchy, Nicholas Tete Kwaku Dzifa Dayie) and a fourth independent reviewer (Patrick Ferdinand Ayeh-Kumi) resolved any conflicts. Irrelevant literature was excluded paving the way for the compilation of a final list of literature included in this study. There was no grading of included literature.

3. RESULTS

The Volta River Authority on September 15, 2023 began a controlled spillage of the Akosombo and Kpong dams as a result of a consistent inflow of water into the Akosombo dam. The water level prior to the spillage was 272.50 ft (83.058m) to protect the dam from imminent collapse. This necessitated the opening of the spillways of the Akosombo and Kpong dams between September 15 and October 30, 2023 which led to severe flooding in downstream communities along the Volta River Basin. Water and electricity supply to affected communities were cut, personal belongings, and domestic animals were washed away by the raging water levels leaving many affected individuals without food and potable water for days .

The shutting down of the Ghana Grid Company (GRIDCo) sub-station (electricity power distributor) at Fievie near Sogakope in the South Tongu district of the Volta region severely hampered healthcare delivery in Sogakope and Adidome hospitals. Some districts severely impacted by the floods include, North Tongu, Central Tongu, South Tongu, Anlo, and Keta all in the Volta Region; Asuogyaman and Ada districts in the Eastern and Greater Accra Regions respectively. Some communities in the Keta and Anloga were also flooded due to the overflow of lagoons in the Keta basin as a result of the Akosombo dam spillage. Although VRA has spilled water from the Akosombo dam in the past, the current spillage is most devastating compared to the impact of previous spillages in 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1974, 1991, and 2010 [18].

An estimated 150,000 people have been affected by the flooding directly or indirectly with many homes, personal belongings and livelihoods lost due to the floods [19]. Latest records reveal flooding in 21 administrative districts within seven (7) regions which lie along the upper and lower Volta basin due to increasing flow of water from the Bagre Dam in Burkina Faso into the Akosombo and Kpong dams resulting in spillage of excess water [19]. The widespread devastation is shown in Fig. 3. Although the impact of the spillage was felt largely along the lower volta basin, other areas upstream were severely impacted (**Table 1**).

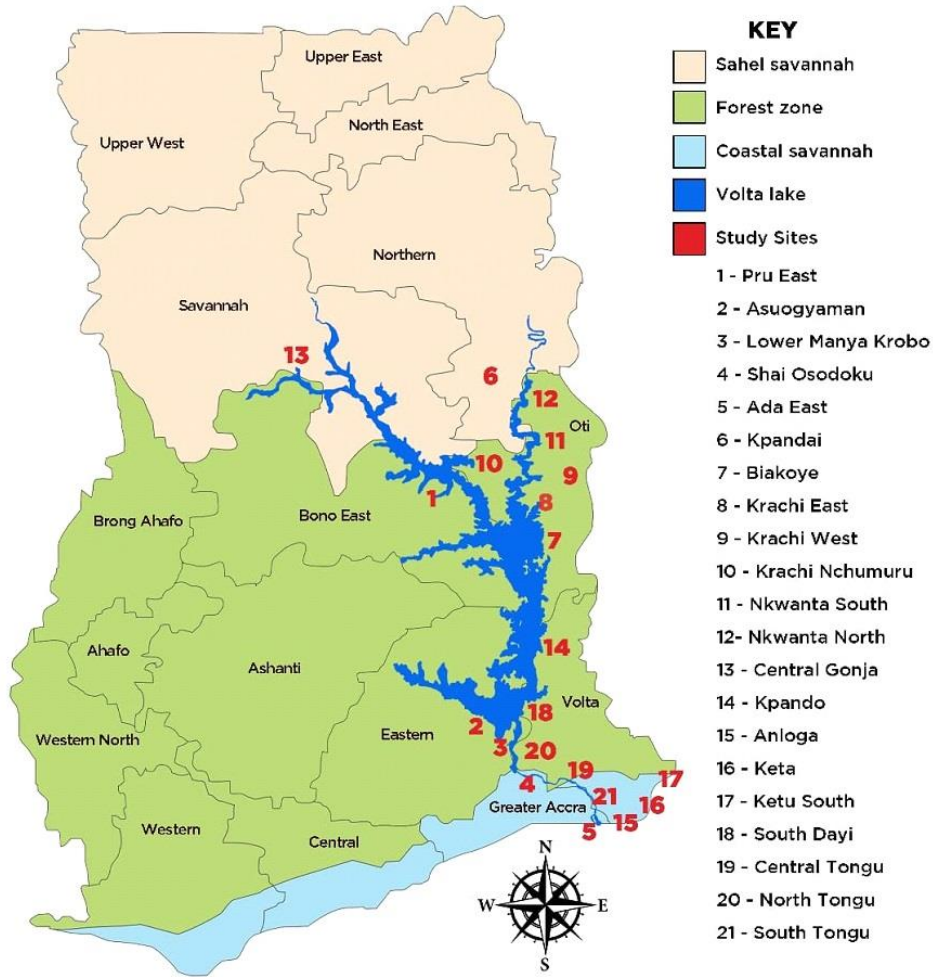


Fig. 3. Areas affected by the Akosombo and Kpong dam spillage.

Table 1. some regions and districts affected by the spillage of the Akosombo and Kpong dams

Region	District /Municipal	Some affected Communities
Bono East	Pru East	Yeji, Futudeke, and environs

Eastern	Asuogyaman	Abume, Kudikope, Kokonte Kpedzi, Ahenbrom, Dzidzokope, Mama Kope and environs
	Lower Manya Krobo	Akuse and environs
Greater Accra	Shai Osodoku	Asutsuare, Blonya, Ashimi, Fawkpi, Avakpo, Volivo Landor, Alabonu, Kewum Atrobinya, Kesegakope, Torgome, and environs
	Ada East	Ada, Agavedo, Tuanikope Island, Anazome, parts of Ada Foah, Big Ada and communities at the estuary
Northern	Kpandai	Lonto, Sika Kura, no 1&2, Kpadjai, Gyeakope, Tetekura, Vuvukope, and environs
Oti	Biakoye	Tapa-Abotoase, Kwamekrom, Obosumanu, Fahiakoho, Bumbula, and environs
	Krachi East	Dambai, Kove Kope, Cannab, Mepe Kope, Teflekordzi, Kudorkope, Kekpodzi, Wulubu, Adakponu, Korvekope, Asikanfo-Ambatem, Wulubu,
	Krachi West	Kekte-Krachi, and environs
	Krachi Nchumuru	Bagamsi, Buaforti, D/A Primary and Junior High School at Papatia Grubi, Anyinamae and environs
	Nkwanta South	Kabiti, Odumasi and environs ,
	Nkwanta North	Kabonwule, Damanko
Savannah	Central Gonja	Buipe and environs
Volta	Kpando	Kpando Tokor and environs

Anloga	Parts of Anloga township, Anloga market& lorry park, Atsito, and environs
Keta	Adzido, Keta central, Galosota, Fiakor, Kedzi, Azizadzi, Keta Business College (Ketabusco), Anyako, and environs
Ketu South	Havedzi, Blekusu, Adina, Horvi, Amutinu
South Dayi	Tongor-Dzemeni and environs
Central Tongu	Adidome, Afetorgborkope, Mafi Dugame, Kebedogo, Akpokofe, Devime, Bekpo Avadimewoe-kope, Akpokope, Kebegodo, Siamekope, Atsemkope, Dokpoe and environs
North Tongu	About 90% of Mepe township flooded, Battor Aveyime,
South Tongu	Fievie, Sogakope, St. Comboni Catholic Hospital, Tefle, Vume, Sokpoe, Alikekope, Agorme, Agbave, Villa Cisneros, Sogakope Beach Resort and Spa, Holy Trinity Spa and Health Farm, Ahiatrogakope, Havorkope, Adadzikope, Agbokope, Sukladzi, Ashiagborkope, Tsinuto, and environs

4. Discussion

The current study explored the devastation caused by the controlled spillage of the Akosombo and Kpong dams in Ghana. This is in line with the report by Adegoke et al., [20] which stated that, more than 9,500 people in Sikasso, Kolikoro, Segou, Mopti, Timbuktu, Gao, Kidal and Menaka in Mali were affected by flooding. The Akosombo Dam, which historically stood as a linchpin of Ghana's electricity generation infrastructure, due to the controlled spillage of excess water has become a focal point of despair and devastation. Critical social infrastructure such as schools, hospitals, water treatment facilities, electricity

sub-stations, roads, bridges among others were severely affected by the floods. Agrees with Taylor and Davies [21] who reported the negative impacts of frequent flooding on roads, railway lines, electricity supply, and communication infrastructure in Cape Town, South Africa. In Vietnam, Duy et al., [22] [reported that](#), transport systems are frequently inundated with flood waters leaving commuters either stranded or risk being swept away by the torrential current of the flood waters. According to Okuyama et al., [23], such destruction of social and physical infrastructure such as transport networks is the “direct damages” of flooding. The resultant effect is reduction in economic activities, leading to change production and or consumption behaviour as well as investment decisions.

The Agordomi water treatment and distribution plant was shutdown leaving the inhabitants of Sogakope without potable water for weeks. Similar study conducted by Augusto & Santos, [24] on the operation of the Weija Dam in Accra reported the challenges of managing excess water during periods of heavy rainfall, leading to spillage and downstream flooding leading to contamination of sources for domestic use. The negative environmental impact and loss of economic activities in downstream communities calls for a rethink of managing excess water solely by spillage according to Owusu-Ansah et al., [25]. The devastation caused by the flood waters in some affected areas are shown in **Fig. 4**



Fig. 4. devastation caused by the flood waters in some affected areas

Key

A. Flooded homes. **Photo credit:** myjoyonline.com

B. Flooded Dambai market, Oti Region. **Photo credit:** myjoyonline.com

C. St. Comboni Secondary Technical School Teachers' bungalow, South Tongu district
26/10/2023 at 14:12 GMT **Photo credit:** Jerry Clinton Donkor.

D. Flooded homes. **Photo credit:** myjoyonline.com

E. Flooded toilet facility at Mepe, North Tongu District, Volta Region. **Photo credit:** Jerry
Amenyo-Quarm 25/10/2023 at 8:07GMT

F. St. Comboni Secondary Technical School, Girls' lavatory, South Tongu district 26/10/2023 at
14:09 GMT. **Photo credit:** Jerry Clinton Donkor.

Waterborne diseases through flooding is a serious public health threat [26, 27]. The floodwaters, often a turbulent mixture of rainwater, sewage, and pollutants, serves as a breeding ground for a host of waterborne pathogens [25]. Moreover, the displacement of thousands of people from their homes has created overcrowded conditions in temporary shelters, raising concerns about the potential spread of communicable diseases. Cholera and typhoid fever, two notorious and waterborne diseases, have a distressing tendency to flourish amidst such unsanitary and compromised environments in stagnant water [28]. This finding agrees with Mirza, [29] and Dewan [30] who opined that, the pollution of water for domestic use, risk of the spread of water-borne diseases such as diarrhoea, gastroenteritis, typhoid, cholera, dysentery, and epidemics are common phenomena associated with flooding in Bangladesh and Nepal affecting the most vulnerable people in society such as the poor, women, children, and the elderly

The forced displacement of individuals from their homes and communities, has profound psychological burden on many. The loss of homes had a deep emotional and psychological rift that could manifest as anxiety, depression, post-traumatic stress, and a pervasive sense of grief. The survivors grapple with a sense of emptiness, a feeling of being adrift, as they come to terms with the altered landscape of their lives. A study conducted by Fitzgerald et al., [31] revealed that, comparatively, resource limited-countries experience severe impacts of floods such physical trauma, anxiety, panic attacks than developed countries and that one-third of deaths associated with flooding in developing countries are linked to traumatic experience and heart attack.

These mental health challenges, often underestimated in the immediate aftermath of a disaster, persisted long after the floodwaters receded, requiring sustained attention and support to help individuals and communities rebuild not only their physical homes but also the sanctuary of their mental and emotional well-being.

The floodwaters submerged fields and pastures, destroying crops and livestock. The loss of these vital resources meant not only economic hardship but also a severe reduction in the availability of locally produced foods. Communities that relied heavily on subsistence farming were especially vulnerable especially staples such as cassava, maize, including banana, plantains, and groundnut. In the Anloga, Keta, and Ketu South districts, large tracts of vegetable farms; carrot, cabbage, sweet pepper, and onions

have all been submerged. With local food production severely hampered, the affected population faced acute food shortages. Many individuals and families struggled to secure an adequate and nutritious diet, which can potentially lead to malnutrition and heightened destruction of crops, farmlands, and livestock due to flooding in Nepal has negative impact on the food security situation of the country. Additionally, starvation due to lack of food resulted in the death of day laborers in Bangladesh [30]. Malnutrition can have long-lasting health consequences, affecting physical and cognitive development, immune function, and overall well-being of children, pregnant women and the aged [20].

Vector-borne diseases (VBDs), including those transmitted by mosquitoes, ticks, and other vectors, pose significant threats to public health and safety. These diseases, such as malaria, dengue, Zika, and Lyme disease, are responsible for high morbidity and mortality and especially in resource-limited areas of the world [33]. According to Mirza [29], the surge in vector-borne diseases such as malaria and dengue are direct after effects of flooding affecting the most vulnerable in the society in South Asia.

Flooding, exacerbated by climate change, urbanization, and extreme events such as hydro-electric dam spillage (anthropogenic causes) is a natural disaster that has profound implications for the dynamics and epidemiology of vector-borne diseases [32, 34]. The interaction between flooding and vector-borne diseases necessitates a comprehensive understanding of the issue to effectively mitigate its public health impacts.

The spillage of the dam led to the creation of stagnant water bodies, such as puddles, swamps, and temporary pools, which served as breeding habitats for varied vector species. Mosquitoes, in particular, are well adapted to exploit these conditions, laying their eggs in water collections, thus initiating the development of new generations. As floodwaters recede, leaving behind a myriad of breeding sites, mosquito populations can surge [35]. This proliferation is of particular concern, as it may lead to a surge in diseases such as malaria and dengue [36]. Furthermore, the expansion of floodplains due to prolonged inundation can result in vector species extending their geographic range, introducing VBDs to new areas [37]. The current dam spillage in Ghana affected communities situated within different ecological zones, this may have serious public health implications through the introduction of novel vector species in areas that were not previously colonized.

Flooding can stimulate increased vector activity, resulting in a higher incidence of vector-human contact [38]. Elevated humidity levels and the presence of numerous water bodies may lead to an upsurge in mosquito and tick activity. This can amplify the transmission of diseases, as the vectors become more active in their search for blood meals. In the context of malaria transmission, this increased activity can put communities at greater risk, particularly during the post-flood period when populations are still displaced [39]. Flooding not only influences vector abundance but also alters the transmission dynamics of VBDs. The disruption of human populations, forced displacement, and crowding in emergency shelters during floods create favorable conditions for vector-human contact, enhancing disease transmission [40, 41], resulting in the introduction of novel pathogens and foster the emergence of new disease foci. Also, damaged sanitation infrastructure and contaminated water sources further exacerbate the risk of waterborne diseases, which may co-occur with VBDs during flood events. The potential for disease outbreaks increases, as exemplified by the surge of vector-borne infections following flooding in endemic regions. Such scenarios necessitate stringent vector control measures and health education programs to mitigate disease outbreaks [42]. This corroborated the findings of Akanda et al., (2020) who conducted a study in Oaxaca, Mexico and emphasized the need to prioritize water security in the management of vector-borne diseases.

Lapses identified

- a.** Ineffective community engagement and sensitization by Volta River Authority. Most affected communities were not aware of the spillage and had short time to evacuate or move to higher grounds. This led to the loss of valuable personal belongings and properties.
- b.** Late response by the National Disaster Management Organization (NADMO) to affected communities. Although the Ghana Navy helped to evacuate about 8,000 people in the parts of the Volta Region, there was no such response in other affected regions. The late arrival of NADMO officials with some relief items days after victims were displaced leaves much to be desired. Many island communities were completely cut off from the inland communities for days and weeks and

the inhabitant were left without any support or relief. Affected persons without families or friends had to sleep in the open or uncompleted structures without food or water.

- c. Ineffective collaboration among state institutions. The Volta River Authority, Ghana Meteorological Service, National Commission on Civic Education, local administrative councils and other relevant stakeholders. This was to broaden consultation and sensitization of communities along the Volta Basin on the impending spillage of the Akosombo and Kpong dams.
- d. Lack of disaster preparedness by local government authorities. Commuting by road from one community to another is greatly hampered by the rising water levels with people using, boats and canoes without life jackets.

Limitations of the study

The results of the study was based on available data as described in the methods and not from the affected individuals.

5. CONCLUSION

The devastating flood and the controlled spillage of the Akosombo and Kpong dams in September 2023 had profound and far-reaching impacts on the affected populations and regions. The floods affected critical infrastructure, with overarching effect on education, food security, healthcare, energy, business among others. This study recommends the strengthening of existing collaboration between VRA and key stakeholders to avert the negative impact of any future controlled spillage. We advocate a comprehensive mental health assessment and immediate psychological intervention for all survivors in the affected communities. This would be one giant step to getting the lives of affected individuals back to normalcy.

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