International Journal of TROPICAL DISEASE & Health

Volume 45, Issue 7, Page 55-67, 2024; Article no.IJTDH.118108
ISSN: 2278–1005, NLM ID: 101632866

Spillage of Akosombo and Kpong Dams in Ghana: Perspectives on Public Health Impacts on Affected Populations and Proposed Mitigation Strategies

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Authors' contributions

This work was carried out in collaboration among all authors. Authors CYD and JPK conceived the study. Authors CYD, CMOA, BDA, JJA, EKV, JPK spearheaded the review including database searches, screening, updating and appraising articles. Authors CYD, CMOA, BDA, JJA, EKV drafted the manuscript which was critically reviewed by authors JPK, NTKDD and PFAK Mentorship during the development and writing of the review was provided by JPK, NTKDD and PFAK. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijtdh/2024/v45i71560

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/118108

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Cite as: *Dumevi, Christopher Yaw, Christopher Mfum Owusu-Asenso, Bright Darko Amoah, Joyce Junior Asiamah, Ezekiel Kofi Vicar, James-Paul Kretchy, Nicholas Tete Kwaku Dzifa Dayie, and Patrick Ferdinand Ayeh-Kumi. 2024. "Spillage of Akosombo and Kpong Dams in Ghana: Perspectives on Public Health Impacts on Affected Populations and Proposed Mitigation Strategies". International Journal of TROPICAL DISEASE & Health 45 (7):55-67. https://doi.org/10.9734/ijtdh/2024/v45i71560.*

Original Research Article

Received: 07/04/2024
Accepted: 10/06/2024
Published: 14/06/2024

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 public health impacts of the controlled spillage of the Akosombo and Kpong dams in Ghana on the people living in downstream and upstream communities.

Methods: Government reports, published media reports, NGO publications, and field visits were used to assess the extent of damage, challenges faced by local communities, and mitigation measures initiated. Personal observation by the researcher through transect walk of the affected communities between September 15 and October 30, 2023 was also conducted.

Results and Discussion: The spillage led to the loss of critical infrastructure such as schools, houses, toilet facilities, water supply systems and electricity. Overcrowding in temporary shelters provided for displaced persons served as a conduit for possible transmission of communicable diseases. The suspension of healthcare services in areas inundated by flood waters worsened the plight of residents including the vulnerable members of the society such as pregnant women, children, the aged, persons living with disability and the very poor. The submersion of farmlands, crops and drowning of livestock and poultry had serious implication for food security and the livelihoods of the affected individuals. 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: The public health impacts resulting from the controlled spillage of the Akosombo and Kpong Dams on affected individuals was enormous. Possible surge in vector-borne disease transmission such as malaria, dengue, zika, and a probable increase in communicable and non-communicable diseases. Although short term measures were adopted to mitigate the impact of the flood on affected individuals through the provision of clean water, beddings, emergency food relief, long-term resilience strategies including early warning systems, climate sensitive interventions, effective collaboration among key stakeholders and disaster preparedness at the local level will help avert or reduce the severity of future floods. 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

A 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 and upstream 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 the spillways are shown in Fig. 1.a and Fig. 1.b respectively.

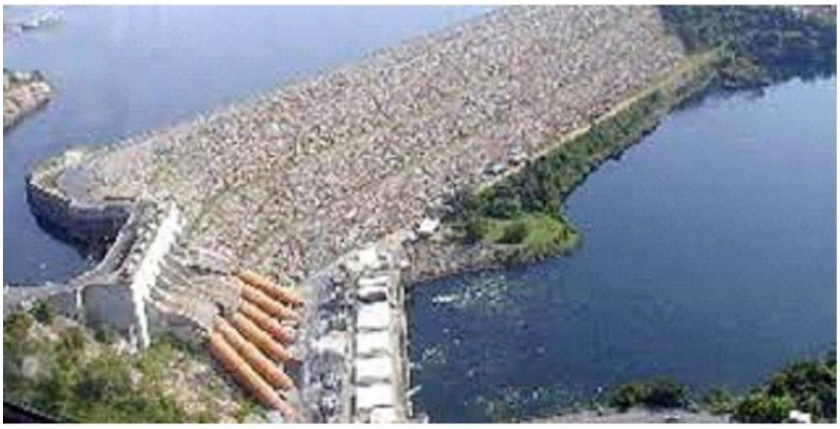

Fig. 1. a. Akosombo dam constructed in 1965

Fig. 1. b. Akosombo dam opens spillways

2. METHODS

2.1 Study Design

Government reports, published media reports, NGO publications, and field visits were used to assess the extent of damage, challenges faced by local communities, and mitigation measures initiated. Personal observation by the researcher through transect walk of the affected communities between September 15 and October 30, 2023 was also conducted..

2.2 Study Area

Ghana, the study area, is a country in West Africa located between latitudes 4.5ºN and 11.5 ºN and longitude 3.5 ºW and 1.5 ºE (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.

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.

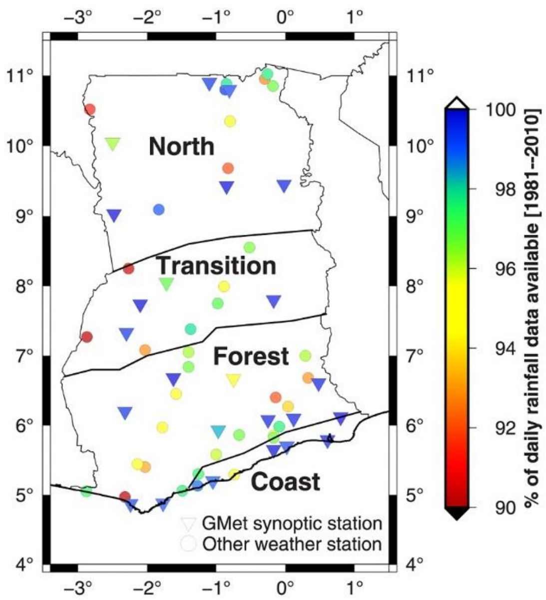

Fig. 2. Geography of Ghana
Credit: [13]

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 govenmental 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, assessed the extent of damage, and identified 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/news, citinewsroom.com/news, 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. 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.

Participant involvement: No human subject participation directly or indirectly.

Data analysis: Due to the heterogeneity in the study design, study settings, and impact of the flood on affected individuals, a thorough narrative synthesis was done to address the objective of the study. The findings of the study were graphically presented and tabulated highlighting the region, district and communities that were negatively impacted.

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 from the Bagre Dam located in Burkina Faso. The maximum and minimum levels of the Volta Lake are 278.0 ft (84.73 m) and 240.0 ft (73.15 m) respectively. The water level prior to the controlled spillage was 272.50 ft (83.058m). The opening of the spillways of the Akosombo and Kpong dams between September 15 and October 30, 2023 was to prevent the imminent collapse of the dams which resulted in severe flooding in downstream communities along the Volta River Basin.

Water and electricity supply to affected communitiues 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. Although VRA has spilled water from the Akosombo dam in the past, the current spillage was most devastating compared to the impact of previous spillages in 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1974, 1991, and 2010 [18].

Table 1. Devastating effect of the spillage of the Bagre Dam (in Burkina Faso), and Akosombo and Kpong Dams (in Ghana) on Ghanaian communities

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	Kete-Krachi, and environs
	Krachi Nchumuru	Bagamsi, Buafori, 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 and lorry park, Atsito, and environs
	Keta	Adzido, Keta central, Galosota, Fiaxor, 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

An estimated 150,000 people have been affected by the flooding directly or indirectly with many homes, personal belongings and livelihoods lost [19]. Latest records revealed 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 the spillage of excess water [19]. The widespread devastation is shown in Fig. 3. Although the impact of the spillage was felt largley along the lower volta basin, other areas upstream were severely impacted (Table 1).

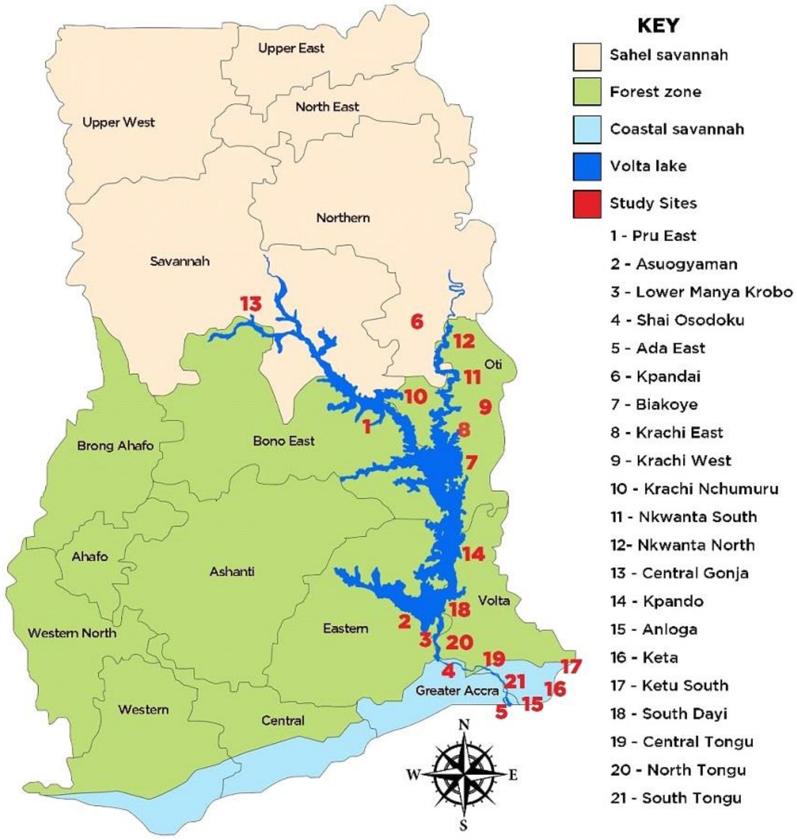

Fig. 3. Areas affected by the Akosombo and Kpong dam spillage

4. DISCUSSION

The Akosombo Dam, historically stood as a linchpin of Ghana's electricity generation infrastructure. The current study explored the devastation caused by the controlled spillage of the Akosombo and Kpong dams in Ghana that led to the displacement of about 150,000 people. 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. Critical social infrastructure such as schools, hospitals, water treatment facilities, electricity sub-stations, roads, bridges among others were severely affected by the floods. Taylor and Davies [21] reported similar 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 by flood leaving commuters either stranded or risk being swept away by the torrential current of the flood waters. Okuyama et al., [23] opined that, the 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.

In the South Tongu district of the Volta Region of Ghana, 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 water sources for domestic use. The negative environmental impact and loss of economic activities in downstream communities calls for a rethink in 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: Jery Clinton Donkor

The spread of 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 created overcrowding conditions in temporary shelters, raising concerns about the potential spread of communicable diseases. Cholera and typhoid fever, which are transmitted through contaminated water as a result of insanitary and compromised environmental sanitation [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, typhoid, cholera, dysentery, and epidemics are commonly associated with flooding in Bangladesh and Nepal with overwhelming impact on 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 in affected communities across Ghana. 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 and staples such as cassava, maize, banana, plantains, and groundnut were especially vulnerable. In the Anloga, Keta, and Ketu South districts of the Volta region, large tracts of vegetable farms; carrot, cabbage, sweet pepper, and onions have all been submerged when the langoon overflowed its banks as a result of increased volume of water in River Volta and its tributries. With local food production severely hampered, affected populations are at risk of facing acute food shortages. Many individuals and families struggled to secure adequate and nutritious diet. The destruction of crops, farmlands, and livestock due to flooding in Nepal has negative impact on the food security situation of the country. Also, starvation due to lack of food resulted in the death of day laborers in Bangladesh [30]. Malnutrition, therefore, can have long-lasting consequences on the physical and cognitive development, immune function, and overall well-being of children, pregnant women and the aged [20].

Vector-borne diseases (VBDs) such as malaria, dengue, Zika, and Lyme disease pose significant public health threats, particularly in resource-limited regions [32]. The surge in VBDs, exacerbated by flooding, is a pressing concern in areas like South Asia, where vulnerable populations are mostly affected [29]. Flooding, intensified by climate change, urbanization, and anthropogenic factors such as hydroelectric dam spillage, profoundly impacts the dynamics and epidemiology of VBDs [33,34]. The formation of stagnant water bodies resulting from dam spillage provides ideal breeding habitats for vectors, particularly mosquitoes. These conditions can lead to a surge in mosquito vector populations, heightening the risk of diseases like malaria and dengue as the floodwaters recede [35,36]. Additionally, the expansion of floodplains can facilitate the geographic spread of vector species, introducing VBDs to new areas [37]. The recent dam spillage in Ghana, affecting diverse ecological zones, highlights the potential for serious public health implications through the introduction of novel vector species in previously uncolonized areas.

Flooding not only boosts vector abundance but also increases vector-human contact [38]. Higher humidity levels and numerous water bodies enhance mosquito and tick activity, leading to more frequent disease transmission. This is particularly concerning for malaria and arboviral disease transmission, as communities remain at greater risk during the post-flood period [39]. Moreover, the displacement and crowding in emergency shelters during floods create conditions favorable for vector-human interactions, thus enhancing disease transmission [40,41]. Damaged sanitation infrastructure and contaminated water sources further exacerbate the risk of waterborne diseases, which may co-occur with VBDs during floods. The potential for outbreaks increases, necessitating stringent vector control measures and health education programs [42]. These findings emphasize the critical need for integrated vector management and proactive public health strategies to mitigate the impact of flooding on VBD transmission [43-45].

4.1 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 some 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 exposed the vulnerability of many affected persons. Many island communities were completely cut off from the inland for weeks without any essential supplies.

c. Ineffective collaboration among state institutions. That was necessary to broaden consultation and sensitization of communities along the Volta Basins on the impeding spillage of the Akosombo and Kpong dams. These key stakeholders include, the Volta River Authority, Ghana Meteorological Agency, National Commission on Civic Education, local adminstrative councils and other relevant stakeholders

d. Lack of disaster preparedness by local government authorities.

4.2 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.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENTS

We acknowledge Jerry Amenyo-Quarm and Jerry Clinton Donkor for the photos used in this write-up. We thank the leaders of the affected communities for granting access to members of the team for the purpose of this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
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