



Sustainability and Resilience of Aiba Dam in Iwo, Nigeria

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ABSTRACT: Aiba dam was created to supply pipe-borne water to the Iwo community and environ. This paper highlighted challenges to the dam survival and recommended opportunities for improvement in the light of deterring sociological and cultural barriers to its sustainability. The challenges facing the dam include natural viz:- climate change, sedimentation, senescence (ageing trees) and anthropogenic challenges which include management-related problems, urban sprawl, farming practices in the dam area and refuse dump. The paper suggested that relevant government agencies needs to be proactive on ensuring the sustainability of the dam especially in the areas of public enlightenment, reforestation, dredging of the dam, institution and implementation of relevant legal instruments; also, putting in place appropriate measures towards mitigating climate change impact to ensure the survival of the dam and to ascertain that it performs the purpose for which it was created. Further investigation to determine the status of the dam through the use of satellite imageries and geographic information system are suggested.

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Aiba Dam, located in Iwo, Osun state (Figure 1) lies between longitude 004° 11' to 004° 13' and latitude 07° 38' to 07° 39' of the equator. It came into full operation officially on June 1, 1957 and can be classified as one of the oldest dams in the south-western part of Nigeria. The dam is approximately 1.91 billion cubic meters storage dam supplied freshwater from a catchment area of 54.39km² the dam is 11.58m high, 455.2m long and a mean depth of 0.75m. Aiba dam was purposely constructed to provide potable water for the inhabitants of Iwo and its immediate suburbs. Actually, the needs for spatial, adequate, reliable and sustainable supply of water have necessitated the construction of water reservoirs alternately referred to as dams. Imevbore *et al.* (1986) suggested that Impoundment of water is inevitable in the pursuit and provision of sufficient water for year-round irrigation needed to implement government policy on food production. According to Hanson and Nilsson (1984); Giers *et al.*, (1998); World Commission on Dams (2001) also Wijesundara and Dayawansa (2011), dams, worldwide, could have single- or multi-purpose functions. In Nigeria, many dams were constructed for multipurpose reasons to perform two or more of the following function: flood control, supply of water for domestic and industrial purposes, irrigation purposes, hydropower generation, fisheries etc. Adams (1975) added energy generation, recreation as well as pollution control as other functional benefits derivable from dam construction.

For these benefits, notable dams in Nigeria include Bakolori in Zamfara State, Ikere Gorge Dam in Oyo State, Jibiya and Kainji Dams in Niger State, Tipa Dam in Kano State, Oyan Dam in Ogun State and Aiba Dam in Iwo among others. The Aiba water reservoir (Figure 2) constructed over seven decades ago is the only dam in the city of Iwo, Osun State, and had been used for providing water and supplementary fish farm. Dam management is bedeviled with various challenges in different parts of the world. In Nigeria, some of these challenges could be found in literatures such as Baba (1993), Yaya *et al.* (2015), Ologunorisa (2009) and Abdulahi *et al.* (2013). Impact assessment of dams covering technical, financial, social, environmental and economic performances define their degree of sustainability. Diverse challenges face different dams depending on location. Kimmage (1999) stated that change in the hydrology of the dam location, changes in the design criteria and natural disasters are factors that could pose threat to the sustainability of dams. Olawepo (2008) also argued that the legacies of dam project construction influence peoples' culture and social stability. Igweonu and Joshua (2012) further submitted that water dams are profitable in developing small hydropower resources even though small variability or change in the environmental conditions could negatively affect such dams. By 2018, Adelodun and Choi (2018) listed impediments like funding constraints and famers' attitudes and awareness towards irrigation systems as

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other factors militating against sustainability of dams. The submission agrees with Babayemi *et al.* (2015) who categorized challenges facing dam sustainability in Nigeria to include social, economic and ecological. Some of the ecological threats, in particular, include sedimentation causing weed growth and also causing poor water quality while, economic threats involve those related to destruction of economic trees and farmlands (Ogheibu, 2002; Saleh *et al.*, 2009). Makinwa (2016) noted that dams could be vandalized as a result of poor maintenance, broken down turbines; illegal fishing etc. and thus agreed with Ismail (2014) who posited that sustainable dam management could help minimize and reverse the alluded negative impacts on ecological and socio-economic fronts. Jullien and Shah (2005), also Amulachew *et al.*, (2008) strongly implicated deforestation and land degradation as leading causes of erosion and sedimentation that affect dams in Africa. Randle *et al.*, (2007) reported that many dams, on natural rivers, suffer degrees of sedimentation, continuously amplified by rainfall, runoffs and river channels erosion. Incidentally, accumulation of sediments and industrial effluents in the reservoir reduces its effectiveness, efficiency and sustainability. Williams and Wolman (1984), Richter *et al.* (2010), Sivongxay *et al.* (2017) and Hogeboom *et al.* (2018) examined the impacts of dam construction and degradation on the local community and conjectured that the environmental changes and social disruption resulting from dams and associated infrastructure manifest adverse effects on human health of the local population and downstream communities. Graf (1999) reported that rivers are capable of depositing considerable debris in dams. Thus, dam construction could be accompanied with erosion and sedimentation, changes in chemistry and temperature, also changes in fauna and flora composition. The Federal Environmental Management Agency (FEMA, 2005) and Sinokort *et al.* (1995) wrote considerable memoirs on the impact of climate change on water temperatures. The identified anthropogenic challenges include urban sprawl, illegal buildings, stalls, farming and fishing; human interference on dam water catchment area in form of open campsites, land clearings and garbage disposal challenges and dam susceptibility to pollutants. In the light of the challenges to dams so highlighted, pertinent it becomes to evolve sustainable management and resilience models for dams. Also bearing in mind that the United nation Conference on Environment and Development (UNCED, year?) promotes global partnership for economically viable, socially equitable and ecologically sound development, this work examined the sustainability of Aiba water reservoir in

Iwo township for fulfilling its primary purpose of supplying domestic water needs.

MATERIALS AND METHODS

Study Area: This research was carried out in Iwo Township (Figure 2) located on the coordinate axis of 7°38'N and 4°11'E Iwo has an area of 245km² and it is the headquarters of Iwo Local Government area (LGA) in Osun State, Southwestern Nigeria. Despite the recent notable increase in the population of the town, Aiba reservoir has been struggling to fulfill its mandate. It was revealed that the population of the town has been on the increase since inception of the dam. The report of the National Population Commission (NPC) showed that the population of Iwo was 191,348 as at 2006 and the annual growth rate of 2.6%. Thus the population of the town ten years after, 2012, was 223,206 and as at 2018, the population rose to 262, 817. Apart from the natural growth, the population of Iwo has witnessed significant increase as a result of the establishment of Bowen University in 2002 and the popular and periodic Odo-Ori Market which continues to be patronized by people from nearby cities and the rural suburbs apart from encouraging new settlers in the town. The increase has implications on the urbanization process as the former periphery of the town has been cleared for development purposes especially for building houses and other similar structures, thus the pipe-borne network of the dam has become inadequate and far from reaching the new areas. In view of these scenarios, many of Iwo inhabitants have resorted to ground water resource for their home use. This is obtained from dug-out wells, deep boreholes and motorized boreholes which are either provided by each household, religious bodies, philanthropists and even, government, especially, at State and Local levels. This is in addition to the prevailing tropical climatic condition which is characterized with about eight months of rainfall (March to October).



Fig 1: Location of Iwo town in Osun state, Nigeria

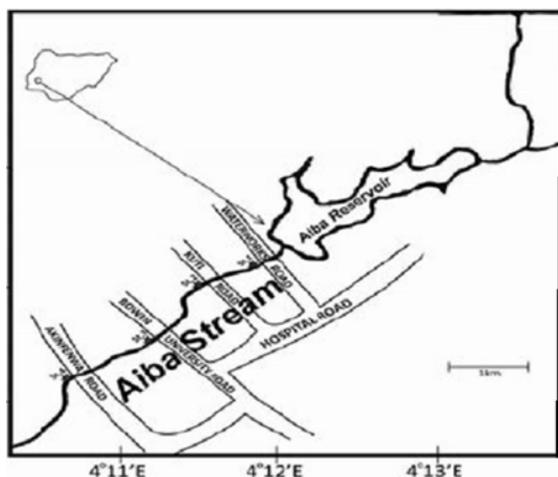


Fig. 2: Sketch of Aiba watershed and reservoir After Akindele and Liadi (2014)

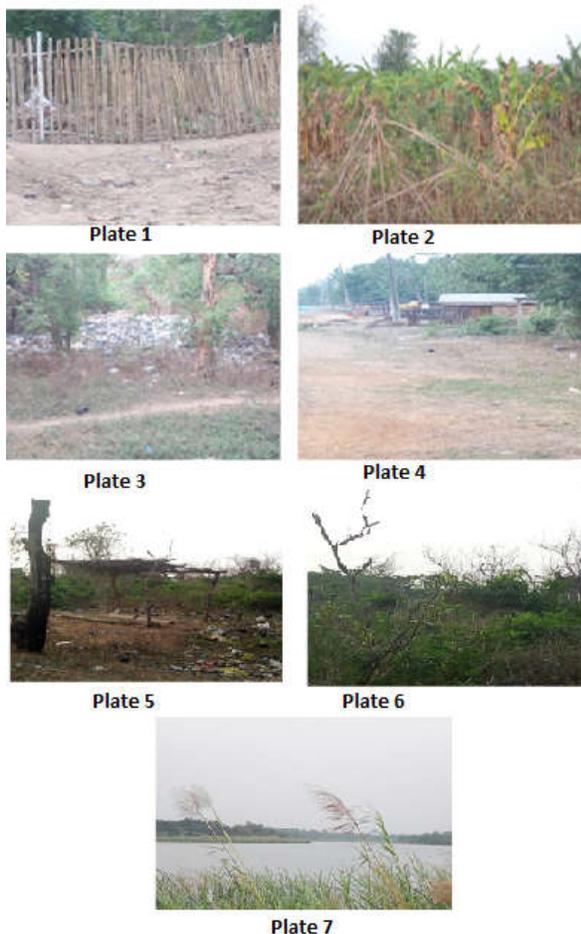


Plate 1: A section of forest near Aiba dam cleared and fenced for cropping. **Plate 2:** A mix-crop farm adjacent (<50m) to the dam. **Plate 3:** A refuse dump site near the dam less than 50m away. **Plate 4:** Section of the forest cleared to build furniture workshop and cafeteria with the dam just few meters away. **Plate 5:** Burnt site near the dam portend greater exposure to soil erosion. **Plate 6:** Macroplankton vegetation on protruded isle in the dam. **Plate 7:** Ageing trees and vegetation changes the microclimate of the dam site.

Data Collection and Analysis: Direct visitation to Aiba dam, desk studies and oral surveys were employed on community stakeholders. Fifty (50) members of the community were randomly selected within the political wards at an average of five (5) per ward purposely for in-depth interview on their perception on the reservoir. The selected respondents: indigenes and non-indigenes, male and females, who have lived in the town for not less than two decades were interviewed. A stakeholder workshop was also conducted at Bowen University to present our findings and get feedbacks needed to ascertain credibility of data obtained. The outcomes of the research effort are thus presented.

RESULTS AND DISCUSSION

Impact Assessment of the Aiba Dam: Indicative survey revealed that the main challenges facing Aiba dam could be grouped as anthropogenic or natural. The anthropogenic factors include (1). Management-related challenges (2). Farming activities in the vicinity of the dam (3). Dumping of refuse in the dam area (4). Urban sprawl and encroachment into the forested area housing the dam with illegal structures and (5). Bush burning which often expose soil surface to runoff. The natural factors, on the other hand include (1). Climate change (2). Increased sediment deposits into the dam (3). Growth of planktons and (4). Ageing trees. The anthropogenic, human-induced factors are hereby subdivided into management-related issues and illegal agricultural practices

Management-related issues: The management-related problems include governments' attitude and policies and their effects on management of the dam. Despite the fact that the dam was purposely constructed to provide water for Iwo inhabitants and its suburbs, the policies of government at times works against the effectiveness of the dam. For instance, government's emphasis on the provision of potable water by providing boreholes and motorized dug-out wells is an attempt to downplay adequate funding of the dam. Apart from this, budgetary allocation for water resources development and for dam management and maintenance are so small and may not be released on time. Even, when funds are released for the purchase of necessary water-treatment chemicals and other facilities, such funds are either misappropriated and/or embezzled. Lohdip and Gongden (2013) corroborated this view when it was lamented that despite quantum of funds often released for water projects development in Nigeria yet the sector is still in jeopardy due to what Kankara and Farouk (2018) attributed to misappropriation of funds.

Farming activities and practices: The sustainability of Aiba Dam could be jeopardized if all acts of illegal agricultural practices, including crop production and fishing activities are not curbed. Several farm plots within the forest site of the dam which probably could be with the knowledge of the Management or not pose danger to the survival of the reservoir. Plates 1 & 2 are farm plots of varying sizes consisting of crops such as cassava, cocoyam, banana and plantain along the circumference of the dam. Not only this, it was discovered that the growers of such crops apply chemical fertilizers which when washed into the dam could affect the quality of the water and also the aquatic life. Youdeowel, *et al.*, (2019) already reported that farming activities close to the dam site could encourage internal erosion/seepage, fauna degradation and the quality status of the dam water. In addition, land clearing for the purpose of farming, especially, exposes the dam water to accelerated evaporation from its bank.

Dumping of refuse in the vicinity of the dam: Plate 3 shows a refuse dump brought by human activities which have encroached into the area of Aiba water reservoir. The activities of various technicians such as motor mechanics, vulcanizers, wood workers, iron benders and blacksmith workers and others eventually generate wastes which are dumped within the slope areas of the dam. These wastes could eventually find their ways into the water, which could alter the quality and the status of aquatic life if not halted. Olutona *et al.* (2016) also noted the challenge of refuse dump within the coverage of this dam and its effect on the chlorinated organic compounds in the stream.

Urban sprawl around the dam perimeter: In the course of this study, it was discovered that the life of the dam is in jeopardy in view of various buildings, illegal stalls found around the dam. The current scenario of encroachment into the forest within which the dam is located, even, by the government, needs to be halted. Plate 4 shows part of the dam area encroached with illegal structures by government or individuals. The dam is already endangered with the incursion of various human structures and continuous interference on the courses of the tributaries that supply water into the dam. Ismail (2014) already reported similar observation that urban development were found to cause disruptions in the flow of rivers and urban drainage system.

Bush burning: The forest harboring Aiba Dam has been subjected to annual bush burning evidence of which is shown in plate 5. This act, if not checkmated has the tendency to expose the soil in the forest to direct surface runoff (Kebede, 2012) which invariably

could lead to increased sediment deposits into the dam. Such deposits encourage the growth of plants and also reducing the depth of the dam. In addition to the above, other natural factors were identified to have profound effects on the health and sustainability of Aiba Dam. These include climate change, eutrophication regime of macroplanktons, sedimentation and degraded and dead vegetation in the dam vicinity.

Climate change: Extreme weather conditions such as heavy rainfall will influence the ability of the dams to accommodate the increased water level (Ismail, 2014). Apart from this, Ismail further reiterated that during dry season when the weather is hot, dams shrink thereby causing reduction in the level of the dam. Thus, drastic measure is required to determine the status of Aiba water reservoir, especially in relation to its ability to retain water or otherwise in view of the reported trend in the rainfall pattern in the area as observed by Ogunbode and Ifabiyi (2019). Investigation into anthropogenic activities which could aggravate the impacts of natural factors needs to be embarked on if the life span of the dam will not be threatened. Presently, the downstream bed has become almost waterless due to low discharge from the reservoir.

Eutrophication: The growth of planktons and other smaller plants on the water without check has the potential to undermine the sustenance of the dam. The stability of some macrophytes on the water surface or sides could increase the eutrophication process. Continuous spread of these macrophytes without any directed ameliorative measure could endanger the lifespan of the dam. Plate 6 shows a protruding isle with macrophytic plants in the midst of the dam. This suggests availability of soil bed in the water body, which if allowed, could reduce the dam size, its capacity and eventual sustenance.

Sediment deposit: Anthropogenic activities within the coverage of the dam environment could aggravate surface runoff which could lead to increase in the sediment deposits of the dam. Continuous clearing of the land for farming, annual bush burning, refuse dumps, including plant ageing are avenues to open up land surface for direct runoff. Sedimentation reduces the depth of dam and also encourages flora growth which if not checked may have negative impact on the capacity of the dam. This observation was corroborated by Kebede (2012) when it was revealed that accelerated soil erosion is a major watershed problem in many developing countries including

Ethiopia. It was further argued that soil erosion in various forms such as sheet, rill, gully bank and bed, river bed and bank and landslides provide sediments to critical water bodies. This, according to the author was attributed to climate change, which apparently causes major climatic events such as flooding or drought, also accelerates soil erosion.

Degraded vegetation in the dam vicinity: Plate 7 shows some trees and shrubs within the dam vicinity that are ageing and are gradually dying off. The dead roots of these trees adjacent to the dam gives room for internal erosion and seepage which may have negative consequences by reducing the level of water. Apart from this, some farm plots have been observed within the forest as a result of the removal of part of the vegetation. Continual practice of this nature may gradually lead to total removal of the vegetation thereby exposing the dam to ordinary fish pond in the nearest future. Similar observation on the consequence of forestless environment on the sustainability of dam was made by Richter *et al.* (2010).

Implications of the Study: Sustainability of dams is predicated on credible and sound management practices. The Aiba dam in Iwo is currently threatened by natural and human factors. The negative impacts were highlighted in this work and steps towards their amelioration proffered. Remedial actions were recommended to ensure that the life span of the dam is prolonged. Measures need to be put in place to ameliorate the negative consequences of the naturally induced problems while human associated challenges are minimized through positive attitudes of all stakeholders. Undue stresses on the dam from illegal farming, fishing and encroachments that result in erection of illegal structures, buildings and stalls should be curbed by appropriate agencies of the government. Proper education and enlightenment should also be extended to the community touching on implications of their actions which could jeopardize the life span of the dam. It is also desirable that the adverse impacts of climate change be mitigated right away as a predictive response towards the dam sustainability. Government should consider dredging the dam to boost its capacity and give it a new life. It would be cheaper to dredge a pre-existing dam than to embark on the construction of a new one for its cost implications. The dam surroundings would benefit from tree planting schemes to protect its surroundings from further degrade. There is need for continuous replanting of trees in this area to replace the aged ones. Skilled staff should be employed to manage the dam while other challenges related to management should be checked and appropriate legislation put in place to protect the dam. Occasional checks on the

embankments of the dam by appropriate engineers should be employed to ensure the dam's ability to hold water back in the reservoir. The sustainability of Aiba dam is paramount in view of the enormous roles it plays and still has to play in the community, particularly for water supply.

Conclusion: An investigation of the present situation of Aiba Dam was conducted through direct visitation, desk studies, oral survey, interview and stakeholders' workshop. The investigation revealed that the dam is seriously under threat through both anthropogenic activities and natural events such climate change. It thus implies that relevant agencies of the government should arise towards subduing these challenges in other to ensure the survival of Aiba dam and also, to ensure that it continues to serve the purpose for which it was created. Further investigation into the status of the dam through modern technologies such as remote sensing and geographic information system is highly recommended.

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