ISSN:
Print - 2277 - 0755
Online - 2315 - 7453

Journal of Agricultural Science and Environment

EFFECTS OF HUMAN ACTIVITIES ON THE UTILIZATION OF SOME DAMS IN KANO STATE

***[1]S.A. MUHAMMAD, [2]A. ADNAN, [3]A. AMIR, [4]I.A. ALI, [5]D.T. SALISU**

[1]Department of Science, School Continuing Education, Bayero University, Kano
[2,4,5]Department of Geography, Faculty of Earth and Environmental Sciences, Bayero University Kano. Nigeria.
[3]Department of Geography and Regional Planning, Faculty of Social Science, Federal University, Dutsen Ma.
***Corresponding Author**:msahmad.sce@buk.edu.ng

ABSTRACT

Rapid population growth coupled with climate variability especially inconsistent rainfall necessitates the construction of dams/reservoirs to augment the inadequacy of rainfall for food production, water supply and sustainable development. This study identified and assessed the effects of human activities on the function and utilization of some dams in Kano State, through field observations, interview and analysis of relevant data. The results indicated that various human activities such sand excavation along the spillway, clearing of vegetation for irrigation and farming within the perimeters of the dams have led to serious gulley erosion and consequently large quantities of sediment transported and deposited (siltation) in the bed of the dams, while the use of agrochemical for irrigation led to rapid emergence and growth of aquatic grasses due to eutrophication, thus leading to increase in turbidity and channel blockage which impedes smooth water supply in the downstream areas. The result also shows that the reservoirs installation capacities are declining with age at different alarming rates due to sedimentation. Marashi dam remarkably declined by 18%, Pada and Magaga dams each reduced by 15.5% and Guzu-Guzu dam suffered 15.4% reduction. Watari dam is reduced by 14% while Gari, Tomas, Karaye and Challawa-Gorge dams declined by 6.4%, 7.5%, 8.5% and 9.08% respectively. This rate of capacity reduction of the reservoirs due to sedimentation spanned within 45years of existence (1971-2016) which makes *the state losing a whopping 5.75M^3 Mil of water annually. The study thus; proffer some precautionary measures on the optimal functioning and utilization of the dams.*

Keywords: Dam, Irrigation, Sand excavation, Siltation, Gulley erosion, Eutrophication

INTRODUCTION

The quest for survival coupled with human ingenuity necessitate the needs for mankind to harness nature for his benefits. The availability of fresh and sustainable surface water often obtained from man-made conserved sources like dams and reservoirs is of immense significance to the people of the Kano State.

However, man depends mainly on the available fresh water impounded in reservoirs, lakes and rivers, which constitute less than 50% of the total amount of the water in the biosphere (Umma et al., 2014). Water storage in reservoirs is one of the primary mechanism for coping with the variability of water supply and demand (Wisser et al., 2013). Globally, water from reservoirs supplies an estimated 30-40% of irrigated areas (World Commission on Dams, 2000), contributes 20% of global electricity generation in the form of hydropower and a number of other beneficial purposes such as flood control, recreation, navigation and many other purposes (Wisser et al., 2013).

The Sudano-Sahelian nature and persistence drought in some parts of Northern Nigeria including Kano State especially in the late 1960s and early 1970s has necessitated the creation of dams and impoundment of water in the reservoir for domestic water supply, irrigation, livestock farming and fisheries production (Umma et al., 2014; KMWR, 2015).

Apparently, there are approximately 60,000 constructed dams and reservoirs worldwide (Masaki et al., 2017). Kano state has the largest concentration of man-made lakes in Nigeria with about 26 reservoirs in the state (KSMWR, 2015). Over the past three decades, climatic variability and increased human activities such as farming activities, both rain fed and irrigation, within the catchments basin of the reservoirs have resulted in the degradation of the dams such as gradual silting up, eutrophication (nutrient building), escalated gulley erosion and invasion of exotic aquatic weeds such as typha grass, used of agrochemicals such as fertilizers(Umma et al., 2014), flood plain encroachment, sand excavation and deforestation.

Human activities in the form of engineering works, such as channelization, dam construction as well as other human interventions and activities posed serious effects on the balance of our fragile environment (Mertzanis et al., 2011). Key anthropogenic activities that greatly influenced and continue to threatened the functionality and utilization of dams as the reservoir ages includes; unceasing accumulation of sediments, eutrophication, phytoplanktons abundance in water and the spread of more invasive and non-native (exotic) species such as typha grass (Ramsar, 2000 in Umma et al., 2014) thus, alters both the biotic and abiotic conditions of the dams.

Evidently, the rate of sand excavation and clearing of vegetation for various human activities around dams and upstream leaves the soil bare and vulnerable to gully erosion which can be accelerated by especially high rainfall intensity.

Sediment influx and their deposit are the key factor that accelerates the impairment of a reservoir's useful life (Ran et al., 2012). Accumulation of sediments in reservoirs changes its morphological formation overtime (Hwang et al., 2007). Dam's sedimentation if not properly monitored and appraised could result in reduction of reservoir capacity, bed incision and ultimately result in collapsed of a downstream bank (Mahadi et al., 2015). Sediment deposit can be accelerated or decelerated based on the rainfall intensity, nature of soil, vegetation cover and topography of the catchment area (Palmieri et al., 2001).

Two of the most important factors that have direct bearing on the sediment influx rate are land-use changes in the upstream due to anthropogenic activities and the reduced trap efficiency of the reservoir (Rossi et al., 2009). The presence of sediments in a reservoir also deteriorates water quality and increases the risk of eutrophication thereby threatened the aquatic life (Mahadi et al., 2015).

This study is therefore, aimed at identifying and assessing the effects of human activities on the existence, utilization and sustainability of some selected dams in Kano State.

MATERIALS AND METHODS

Study Area

Kano State is located between Latitudes 10° 3'N and 12° 4'N of Equator and Longitude 7° 4'E and 9° 3'E of the Prime meridian occupying a total area of 20131Km^2, approximately 4.7% of the total land area of Nigeria. The mean annual Rainfall is about 884mm. The wettest month is August has the highest number of rainstorms and sediment generation while the mean annual temperature in area ranges from 26°C to 32°C (Murtala et al., 2015).

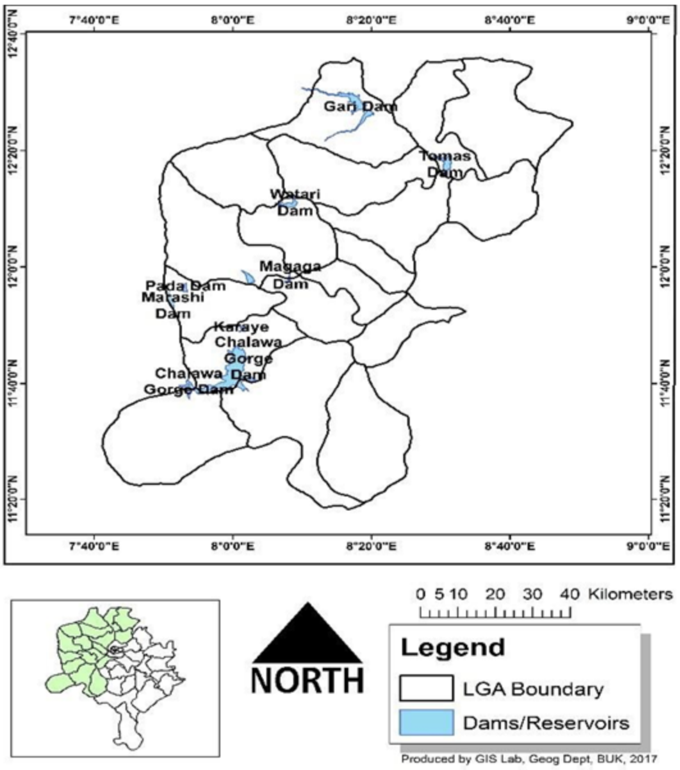

Fig: 2 Map of the Study Area

The elevation of Kano is generally above 650m and reaches well over 1000m around the Rishi Hills. Most of the rocky outcrops in the zone are of younger granites. The plains are developed on the rocks of the Basement. (Olofin, 2013). Kano State is drained by Kano and Challawa Rivers system with over 100 tributaries and 26 major rivers. Due to the topography of Kano State, all streams and rivers finally contribute their flows into the Challawa/ Wudil river system which eventually discharges into River Hadejia on their journey to Lake Chad. This is with the exception of Gari, Marke, Tomas and Dudduru rivers that discharge directly into the Hadejia river system, while Iggi discharges into Katagum River (KMWR, 2015).

METHODS

Data used in this study were derived from field observation, interview and secondary sources. At the field, only the physical characteristics and conditions of the Dams/reservoirs were observed with the view to assessing the level of the impacts of human activities within and around the Dams. The manifestation of these conditions have direct or indirect link with human activities; these are, sand excavation and clay block making along spill way, farming within the perimeters (embankment) of the dams, aquatic weed infestation, siltation and gulley erosion.

However, semi structured interview was conducted with an official of the custodian of the dams (Kano State Ministry of Water Resources), this was done with the view to elicit more information about the dams. It was learnt during the interview that informal irrigation by farmers and construction of small dams by the LGAs Councils in the upstream of the reservoir have been identified. Furthermore, secondary data about the physical characteristics of the dams were also sourced during the interview session.

The secondary data were obtained from Kano State Ministry of Water Resources (KSMWR). The data contained records on the total storage capacity, active storage capacity, dead capacity, average annual rainfall and year of commission of the studied dams. The data were used to estimate the reservoirs reduction capacities as well as their rate of depletion with time due to sediment influx using equations 1, 2 and 3 as developed by (Abdurrahman, 2011). The choice is guided by the simplicity and efficiency of the formula.

Volume of Sediment = (*TC-AC*) ……………….. (1)
Percentage of Sediment = (*VS/AC* x 100) ……... (2)
Rate of Deposition/Year = (*VS/AR*) …………… (3)

Where; *TC* is the Total Storage Capacity, *AC* is the Active Capacity, *VS* is the Volume of Sediment, *AR* is the Age of Reservoir and *MCM* is M^3 Mil.

RESULTS AND DISCUSSIONS

Observed Human Activities on the Reservoirs

Human activities within and around the dams have been identified. These includes; sand excavation and clay block making along spill way, clearing of vegetation and tillage for irrigation purpose, excessive informal irrigation upstream and farming within the perimeters (embankment) of the dams as they recedes during the dry season. These were the various human activities identified, thus threatening the existence, function and optimum utilization of the dams. However, their consequential implications include aggravated soil erosion, sedimentation and aided proliferation of aquatic weeds such as is ***M^3 Mil***.

typha grass infestation as well as degrading both the physical and biochemical quality of the water.

Table 1. Characteristics of studied Dams from commissioned year to 2016

Dam	Total Storage Capacity (MCM)	Active Capacity (MCM)	Dead Capacity (MCM)	Av. Annual Rainfall (mm)	Year Commissioned
Tomas	60.3	56.6	4.5	838	1976
Gari	214	203	13.7	813	1980
Watari	104.55	92.74	14.6	813	1980
Pada	12	10.5	1.86	813	1980
Marashi	6.77	5.79	1.21	813	1980
Karaye	17.22	15.99	1.46	940	1971
Challawa-Gorge	969	904	87.9	841	1992
Magaga	19.68	17.22	3.05	813	1980
Guzu-Guzu	24.6	21.53	3.79	813	1979

Source: Adopted from Kano State Ministry of Water Resources (2017); Modified by Abdulhamid et al., 2017

Observed Reservoir Sedimentation Rate

The different dams studied varies considerably from one another in size, storage capacity, average annual rainfall received, number of contributing rivers/ streams as well as the rate of sediment inflow as presented in Table 1 and 2.

The active reservoir capacities of each of the dams were compared with the total storage capacities and the difference between the two capacities gave the dead capacities which is loss due to sedimentation. The computed results were presented in Table 2. The rate of depletion indicates the volume of sediment in reservoir. It was estimated, that over the life time of each of the dams, there has been inflow of sediments into the reservoirs, thus resulting in the reduction from the initial storage capacity (Table 2).

Table 2: The Present Dams/Reservoirs Capacity (from commissioned year to 2016)

Dam/Reservoir	Total Storage Capacity (MCM)	Active Capacity (MCM)	Dead Capacity (MCM)	Reduction Capacity (%)	Depletion/year (MCM)	Reduction Rate/year (%)
Tomas	60.3	56.6	4.5	**7.5**	**0.11**	**0.12**
Gari	214	203	13.7	**6.4**	**0.38**	**0.18**
Watari	104.55	92.74	14.6	**14**	**0.4**	**0.39**
Pada	12	10.5	1.86	**15.5**	**0.5**	**0.43**
Marashi	6.77	5.79	1.21	**18**	**0.03**	**0.5**
Karaye	17.22	15.99	1.46	**8.5**	**0.03**	**0.19**
Challawa-Gorge	969	904	87.9	**9.08**	**3.82**	**0.38**
Magaga	19.68	17.22	3.05	**15.5**	**0.08**	**0.44**
Guzu-Guzu	24.6	21.53	3.79	**15.4**	**0.1**	**0.42**

Source: Data Analysis (2017)

The results from Table 2 also revealed that Marashi Dam with least storage capacity has shown a remarkable reduction of 18% due to sediment deposition, thus, threatening and compromising the adequate function and utilization of the reservoir. However, Pada, Magaga and Guzu-Guzu dams shows an unprecedented level of 15.5%, 15.5%, and 15.4% reduction respectively. Besides Watari Dam shows 14% reduction while Gari, Tomas, Karaye and Challawa-Gorge Dams presented the least rate of reduction of 6.4%, 7.5%, 8.5% and 9.08% respectively. This rate of capacity reduction of the reservoirs due to sedimentation spanned within 45years of existence of the dams (1971-2016).

The results from Table 2 further revealed that Gari Dam is depleting annually at the rate of 0.18% (0.38 M^3Mil), Watari Dam is depleting at 0.39% (0.40 M^3Mil) per year. Pada Dam is depleting at 0.43% (0.50 M^3Mil) annually while Marashiri Dam is the worst hit, depleting at the rate of 0.5% (0.033 M^3Mil) per year. Karaye Dam is depleting at 0.19% (0.32 M^3Mil) annually. Challawa-Gorge Dam is depleting at an annual rate of 0.38% (3.82 M^3Mil). However, GuzuGuzu Dam is depleting at 0.42% (0.10 M^3Mil) per annum while Magaga Dam is being depleted at the rate 0.44% (0.08 M^3Mil) per year. All the studied dams except for Tomas, Gari and Karaye with annual reduction capacities of 0.12%, 0.18% and 0.19% respectively, presented an annual loss rate relative to installed capacity higher than estimated median value of 0.36% by Wisser et al., (2013). This loss rate is for reservoir with storage capacity higher than 1 M^3 Mil (Wisser et al., 2013).

However, Kano State is losing approximately 5.75 M^3Mil annually of water storage for drinking, irrigation and other purposes from only nine of its numerous dams, this is just 0.04 M^3Mil below the active storage capacity of Marashi Dam. The loss of reservoir capacity of these dams presents grievous consequences to Kano State both socially and economically considering its current large population size, which is growing at the rate of 3.5%

annually (NPC, 2006).

With an exploded population alongside climate variability especially rainfall, the reduction in dams' capacity poses a great threat to the utilization and sustainability of available water for domestic, agricultural and other purposes. Thus, fresh water availability should grow concurrently with the increasing demand for various purposes of the ever growing population.

CONCLUSION AND RECOMMENDATIONS

The study shows that dams/reservoirs in Kano state are seriously losing their productive capacities with age due to various degrees of human activities. All dams except Tomas, Gari and Karaye are declining in storage capacity due to sedimentation at annual rate above the 0.36% median value for large dams. The state is losing approximately **575*M³Mil*** of water storage that could be utilized for various purposes ranging from irrigation, water supply, Hydro Electric Power (HEP) generation, etc. The study, thus, recommended for proper policy that will govern the dams' utilization, creation of buffer zone around the dams to guard against any human activity that may endanger the dams and proper awareness on the use of agrochemicals for irrigation farming.

REFERENCES

Abdurrahman U. T. 2011. Assessment of Dam Storage Capacities (A Case Study of Thomas, Kafiin-Chiri and Magaga Dams), An unpublished undergraduate project submitted to the Department of Civil Engineering Kano University of Science and Technology, Wudil, Kano State.

Hwang, S.J., et al. 2007. *Moderating effects of the geometry of reservoirs on the relation between urban land use and water quality.* Landscape and Urban Planning, **82**(4): p. 175-183.

Kano State Ministry of Water Resource (KSMWR) (2015), Committee on Development of Master Plan for Rivers and Streams in Kano State, Kano State Ministry of Water Resources.

Mahadi L.Y., Usman T.A., Muhammad T.A. Amina S.A., Muttaqa U.Z., Ali S.M. 2015. The Progressive response of Sahelian Dams to Sediment Intrusion: Case of Kano State Between 1976 and 2009. *Applied Mechanics and Materials, 301-1306, Trans Tech Publications, Switzerland.*

Masaki, Y., Hanasaki, N., Biemans, H., Hannes Müller Schmied H.M., Tang Q, Wada Y., Gosling S. N., Takahashi K., Hijioka, Y. 2017. Intercomparison of global river discharge simulations focusing on dam operation—multiple models analysis in two case-study river basins, Missouri–Mississippi and Green–Colorado, Environ. Res. Lett. 12 (2017) 055002.

Mertzanis, A., Papadopoulos, A., Goudelis G., Pantera, A., Efthimiou, G. 2011. Human - induced impact to the environment and changes in the geomorphology: Some examples of inland and coastal environments in Greece, Journal of Ecology and the Natural Environment 3 (8), 273-297, August 2011.Accessed online at http://www.academicjournals.org/jene ISSN 2006-9847©2011 Academic Journals.

Murtala, U. M., Abdulhamid, A., Badamasi, Ahmed. M., 2015. Rainfall Dynamics and Climate Change in Kano, Nigeria. Journal of Scientific Research &

Reports 7(5): 386-395.

NPC 2006. *The Population and Housing Census of the Federal Republic of Nigeria: Priority Tables*, The National Population Commission.

Olofin E.A. Location, relief., landforms. In Tanko AI, Mumale SB. (Eds.) 2013. Kano Environment, Society and Development. London and Abuja, Adonis and Abbey Publishers.

Palmieri, A., Shah, F., Dinar A. 2001, *Economics of reservoir sedimentation and sustainable management of dams.* Journal of Environmental Management, **61**(2): 149-163.

Ramsar Convention Bureau 2002. Background papers on wetland values and function. Gland, Switzerland: Ramsar Convention Bureau.

Ran, L., et al. 2012. *Cumulative sediment trapping by reservoirs in large river basins: A case study of the Yellow River basin.* Global and Planetary Change.

Rossi, A., et al. 2009. *The response of the Mississippi River to climate fluctuations and reservoir construction as indicated by wavelet analysis of stream flow and suspended-sediment load (1950–1975).* Journal of Hydrology, **377**(3–4): 237-244.

Umma, M, Ibrahim, M, Tasi'u, Y.R., Binta, S.B., Jamila, M.H., Hassan KY 2014. Effects of anthropogenic factors on the phytoplanktons distribution of Watari Dam, Kano State. Standard Research Journal of Agricultural Sciences Vol 2(8): 136-141, December Special Issue 2014 (ISSN: 2311-2751) http://www.standresjournals.org/journals/SRJAS

Wisser, D., S. Frolking, Hagen S., Bierkens, M. F. P. 2013, Beyond peak reservoir storage? A global estimate of declining water storage capacity in large reservoirs, Water Resour. Res., 49, 5732–5739, doi:10.1002/wrcr.20452.

World Commission on Dams 2000. Dams and development. A framework for decision making, Report, Earthscan Publication., London.

(Manuscript received: 31st October, 2018; accepted: 3rd September, 2019).