Surface Water Sources for an Earth Dam in Mbabuande River Catchment Area, Gwer West LGA, Benue State, Nigeria

Malum, Japhet. Flayin.[1] *, Ayogbo, Gideon Teryila. [2]Dzapine, Stephen Tersur.[3]
[1, 2,] Department of Agricultural and Environmental Engineering, Joseph Sarwuan Tarka University, Makurdi, Benue State. NIGERIA
[3,] Department of Geography, University of Nigeria, Nsukka, Enugu State, Nigeria.
*Correspondence author: jmflayin@gmail.com

D.O.I: 10.56201/ijgem.v9.no6.2023.pg34.49

ABSTRACT

A dam is a structure placed across a flowing body of water to stop the flow. It is the barrier that stops or restricts and divert the flow of water into a reservoir/ water course. In Mbabuande village in Gwer-west local government area of Benue state, Nigeria; river Kpukuru, a seasonal river is located at the southern part of Tse-Ilyu village, (Mbabuande) and flows towards the northern side at a very high velocity during rainy season due to high slope. This makes the river to dry quickly, leading to water scarcity among the inhabitants throughout the dry season. Wells dug to augment surface water availability in the dry seasons dry up quickly due to the rapid growing human population. The community has resorted to constructing small earth dams using hand tools, but such earth dams easily dry up. The need for alternative solution to the water supply problem in Mbabuande calls for this research; to investigate and provide baseline information on the surface water potentials from the catchment area. The dam location and the catchment boundaries are marked on 1:50,000 map, and being a small earth dam, the area topographical map and river tributaries were used to measure the catchment area for the surface water. The catchment tributaries were taken from Areas marked as D, E, F, G, A and back to area D. The amount of water the catchment produce was determined from design peak runoff rate formula. Annual rainfall, runoff and evaporation losses were equally determined. Water requirement of the 3 communities in Mbabuande was determined using water demand for domestic purposes, livestock and building structures. Domestic water demand/consumption was calculated from water demand for drinking, food processing/ cooking, bathing, clothe washing and utensils washing, using standard estimate for a single person /capita/day. Census data for the communities was obtained. The data was used to forecast the population for the period of 20 years. The population forecast for the three communities was estimated using indices of Arithmetic equations. Total water requirement in a year was found to be, 547,352, 52.2 m^3/year. Total dam reservoir storage water requirement for a year in addition to evaporation losses and wasted water, was found to be, 957, 866,91.35 m^3. Storage capacity of dams above 350,000 m^3 should have a standard depth (D) of 5.4 m within an area of 20 ha, at Full Supply Level (FSL) of 181m and throwback (TB) of 1,383m. Therefore, the storage capacity potential for the earth dam in the study area was calculated to be, 356,861 m^3.

***Keywords**: Surface water, Catchment area, Design criteria, Earth dam, Storage capacity*

1.0 INTRODUCTION

Surface water supply is becoming progressively more difficult in the dry season. Surface geophysical methods provide information on the straight graph and structure of the geological environment as well as aquifer properties, the type and extent of superficial material and their nature of extent and underlying bedrock (Albritton, *et al*, 2014). Most methods of assessing surface water supply are through the construction of dams.

A dam is a structure placed across a flowing body of water to stop the flow. It is the barrier that stops or restricts the flow of water or underground stream (Jansen, 2008).

Reservoirs created by dams not only suppress flood but also provide water for activities such as irrigation, human consumption, industrial use and aquaculture and navigability. Hydro power is often used in conjunction with dams to generate electricity. Dams generally serve the primary purpose of retaining water, while other factors such as flood gates are used to manage or prevent water flow into specific land regions. In times of floods, uses of dams can serve as protections for the towns and cities downstream of the river (WCD, 2000; Rankine, 2007; Peck, 2008; Tahmiscioğlu *et al.*, 2016).

Dams are classified by the material used to construct them. Dams built of concrete, stone, or masonry is called gravity dams, arch dams or buttress dams. Dams built of earth or rocks are called embankment dams. Dams can be formed by human agency, natural causes. Man-made dams are typically classified according to their size (height), intended purpose or structure,(ICOLD, 2017).

Embankment dams are any dam constructed of excavated natural materials, as either earth fill or a combination of earth and rock fill. Embankment dams are generally built in areas where large amounts of earth or rocks are available. Embankment dams represent about 75% of all of the dams in the world and are classified as either, earth fill dams, rock fill dams or earth and rock fill dams, (IADC, 2012,),(ICOLD, 2017).

Some dams combine two or more of the uses stated above, but a majority of large dams, as registered by ICOLD, are single purpose. Multi-purpose dams are complex and tend not to perform as well as single-function dams. Also, for certain combination of functions, a delicate balance has to be maintained. For example, irrigation, hydroelectric and water supply dams require the reservoir to be at full capacity for efficient functioning while flood control requires water levels to be lower than maximum to hold the extra surging waters (Lindstrom and Granit, 2012).

In many rural populations in developing countries, particularly with regard to agricultural water, the prominent driving forces for increasing pressures are the availability of the water. Like in most of the Western African Sahel, multipurpose dams are usually preferred that will provide typical users of dams for livestock, irrigation and fish production. Surface water for domestic use may be added but because of the generally low quality of the water, water treatment is more easily done and managed at the household level (home water-filtering devices), (Jean *et al.*, 2012).

This research work is a conceptual design of an earth dam across river Kpukuru, Mbabuande in Gwer-West Local Government Area (LGA) of Benue state , Nigeria. River Kpukuru which is located at the southern part of Tse-Ilyu village, (Mbabuande) flows towards the northern part at a very high velocity during rainy season because it is situated at a higher elevation. This makes the river to dry quickly in the dry season and it leads to water scarcity in the area throughout the dry season(SDBSG, 2009).

The study area, Tse-Ilyu village is transversed by river Kpukuru with river Nyume as a main tributary and confluenced at a point called Ayogbo's farm area. Water is stored and occupies a wider area at the Ayogbo's farm but fluctuate during the rainy season (May to October). In the dry season (November to April) water is obtain by abstraction for domestic use, bricks making, and livestock consumption. Wells dug to augment surface water availability in the dry seasons are used up quickly in the middle of the dry season due to the rapid growing human population to the extent that water supply is now one of the most serious predicaments of the people at Tse-Lyu village in Mbabuande.

The members of the community have resorted to constructing small earth dams using hand tools. But such earth dams easily dry up hence the people remain with no sources of water supply throughout the dry season. This research is to investigate and provide baseline information on the surface water potential at Mbabuande catchment area as might be provided by the two seasonal rivers, and to critically assess the design criteria of an earth dam that will store water throughout the dry season.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study area is located at Tse-Ilyu village, Mbabuade, in Gwer-West Local Government Area, Benue state (Figure 1). Benue state is located at 7°19'60.00" N 8°44'59.99". The geographical coordinate of Gwer West LGA is $7^0$37'55.60'' N $8^0$12'59.62'' East of Naka town (Figure 2). The average elevation above sea level of Naka town is 112m (Mille, 2012). The occupation of the people is majorly agriculture and marketing of agricultural products.

The hydrogeology of the area showed 90% shale and is likely to yield very low water. There is a little indication of dolerite in the area, although aromagnetic maps have not been studied. The alluvium by the river contains groundwater (Donald *et al*, 1999; SDBSG, 2009).

2.1.1 Site selection

The project site falls within the Eastern savannah zone of the Gwer-West LGA. The mean annual rainfall of the area ranges from 500mm to over 1200mm. The rainy season begins in April and ends in October. With heaviest rainfall is between August and September (Mille, 2012). The area is drained by tributary rivers from sources points such as Nyume, Hyula-igbo, Anjande, Ande. There are hand dug shallow wells without standard information as to the depth of the potential yield of groundwater in the area (SDBSG, 2009). The research applied geophysical survey to explore the surface water potential of the study area in order to delineate possible sites for an earth dam.

The study area Tse-Ilyu, Mbabuande comprised of three settlements are close to each other, as the beneficiaries of the earth dam. The three areas are: Tse-Lyu, Tse-Ngyer and Tse-Akyegh and represented for the purpose of the study as Area A, B and C respectively as shown in aerial view(Plate 1) and sketch features (Figure 3).

2.2 Dam Catchment Area

The dam location and the catchment boundaries are marked on 1:50,000 maps(in the absence of standard equipment)(Sahu, 2009), and being a small earth dam, area topographical map and river tributaries were used to measure the catchment area for the surface water. The catchment

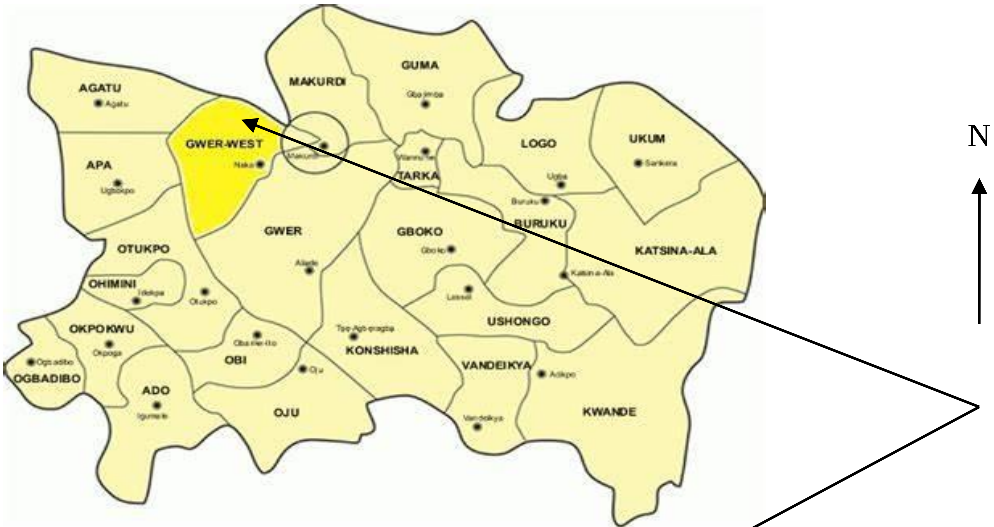
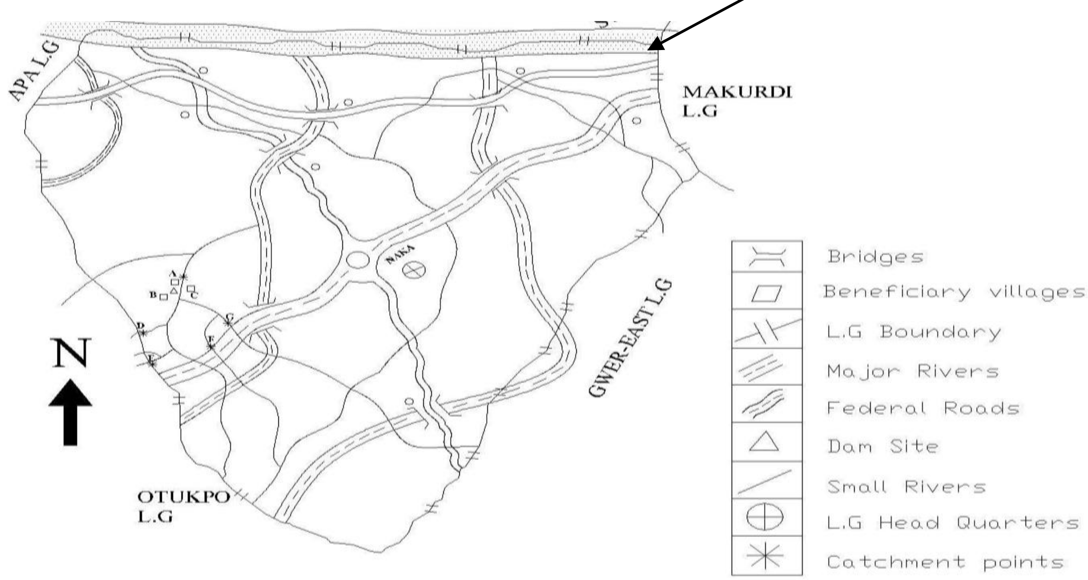


Figure 1: Map of Benue state



Scale: 1:2500

M 5 10 15 20 25 30 35

10000

Figure 2: Topographical Map of Gwer West LGA

Source: GWLGA, (2010)

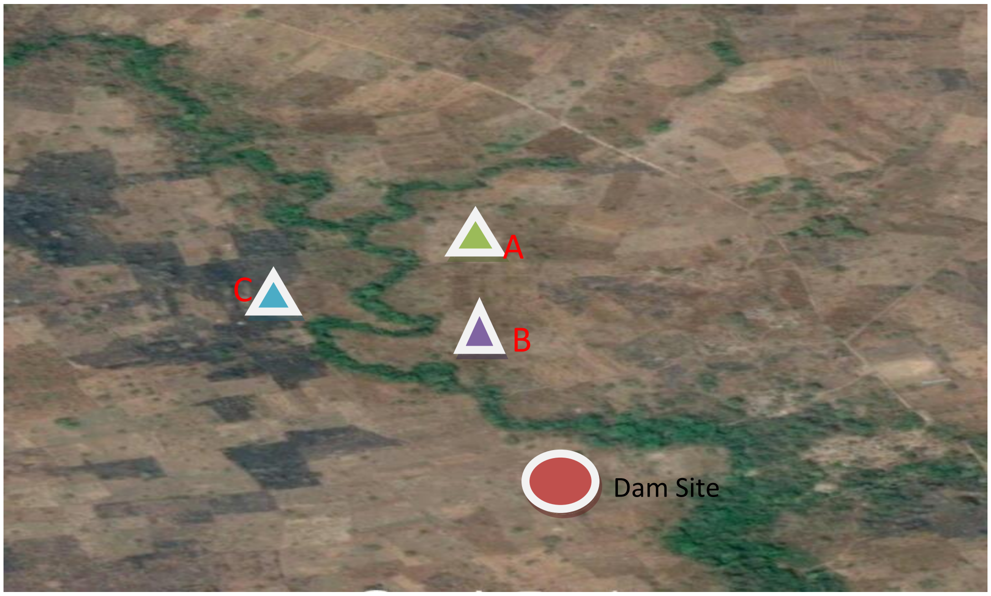
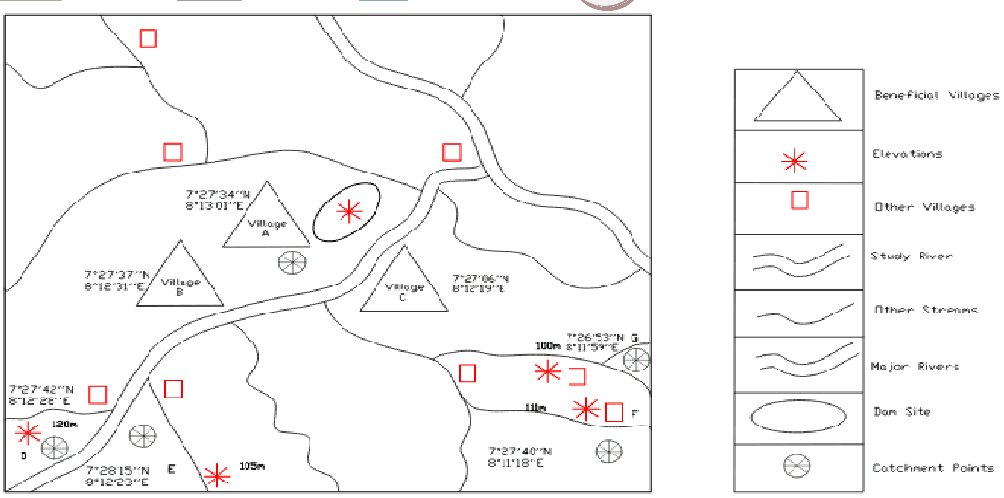


Plate 1: Earthed Map showing the Tributaries
Source: http://www.google.com/search?=earth&stick, 2022.

KEY

Area A Area B Area C Dam Site



Scale: 1:45 000

M 10 20 30 40

10000

Figure 3: Sketch of the Study Area

tributaries was taken from Areas: D, E, F, G, A and back to Area D (Figure 4). The amount of water a catchment produce can be determined from the formula, (Nelson, 2015).

$$Q_{des} = 2.8 \times C \times I \times A \quad (1)$$

Where:

Q_{des} = The design peak runoff rate, (l/s).

C = Runoff coefficient

I = the rainfall intensity at the time of concentration read from the chosen IDF curve; if no IDF are available, a value of 100mm/hr can be taken (in mm/hr).

A = the surface area of the catchment area (m^2),

From figure (4) measurement was taken from the first order tributaries at Area D through Area E to Area F to G to A and back to Area E forming a particular shape.

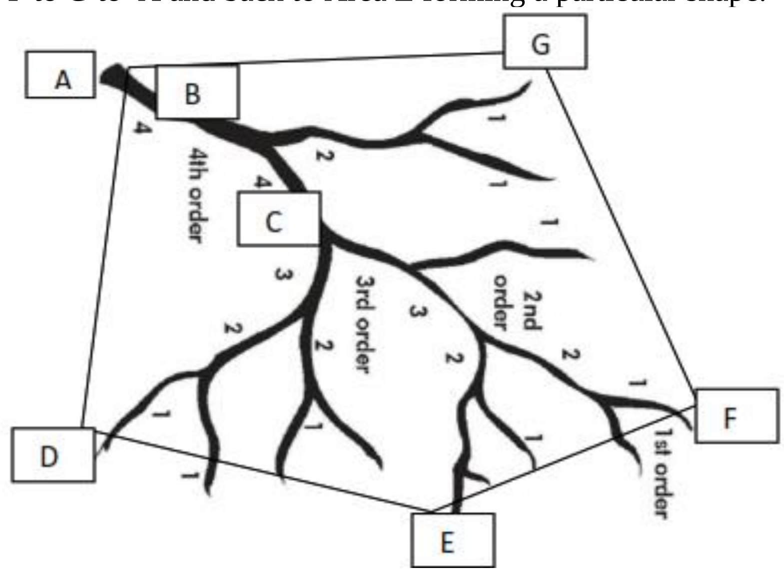


Figure 4: Points of catchments on the tributaries

Source: Field survey sketch

2.2.1 Determination of Annual rainfall, runoff and evaporation

Mean annual runoff: Mean annual runoff (MAR) from a dam catchment is conventionally expressed as an equivalent runoff depth, in (mm) (Sahu, 2009). The simplest means of expressing the mean annual runoff is to apply the runoff coefficient to the mean annual rainfall (Sahu, 2009).

$$MAR = ROC \times MAP \quad (2)$$

Where MAR = Mean Annual Runoff

ROC = Runoff Coefficient

MAP = Mean Annual Precipitation

$$\text{So, } ROC = \frac{MAR}{MAP} \quad (3)$$

Runoff coefficient (C): Is a dimensionless coefficient relating the amount of runoff to the amount of precipitation received. It is a larger value for areas with low infiltration and high runoff and lower for permeable, well vegetated areas forest, flat land (Smout and Shaw, 2013) and calculated as:

$$C = \frac{\text{Total runoff}}{\text{Total rainfall}} \quad (4)$$

Where: C = runoff coefficient.

Mean annual rainfall: By arithmetic method (Dawei, 2010),

$$P_{av} = \frac{\sum p_i}{n} \quad (5)$$

Where,

P_{av} = precipitation average

Pi = precipitation amount

n = no. of readings

Evaporative loss: Evaporation rates from a dam can be estimated using pan data from the meteorological station located in the same region and climatic zone of the dam. It is known that pan data over estimate evaporation rates from larger bodies of open water such as small dams, and following (Shaw, 2017), using a pan factor of 0.7 is recommended to convert monthly pan evaporation rates to small dams' evaporation rates. In the database, data from the nearest station with similar characteristics to the dam location could be used if local evaporation data is unavailable.

2.3 Domestic Water Demand.

The quantity of water required in the houses for drinking, bathing, cooking, washing etc, is called domestic water demand and mainly depends upon the habits of the people (Puli, 2005). The estimation of water consumption per person is obtained as shown in Table (1).

Table 1: Domestic Water Consumption for a Single Person

Consumption/capita	Water/capita/day (liters)
Drinking	8
Food processing/ cooking	20
Bathing	10
Cloth washing	20
Utensils washing	10

2.3.1 Water requirement of the communities

To determine the water requirement for any community, information on the number of people and livestock has to be known. The water demand for domestic purposes, livestock and building is estimated. Thus, the three beneficiary communities represent village A, B and C respectively. Table 2 below shows the total number of people in the three villages (NPC,2006).

Designing and constructing a dam is done to last for certain period of years. The capacity of the dam is calculated to supply sufficient water to meet the future demand of the communities as the population increases with years. The population forecast for the communities is calculated using the formula, (NBTE, 2008).

Table 2: Total Number of People in the Villages

Name of village	No of households	Average No of people /house	Total no. of people in a village
A	7	4	28
B	5	2	10
C	11	7	77
Total			**115**

$$\frac{dp}{dt} = ka \qquad (6)$$

Where: dp/dt represents the changes in population P in unit time and Ka is arithmetic constant.

$$\Rightarrow \quad dp = K_a dt$$

$$\Rightarrow \quad P_f - P_i = K_a (t_f - t_i) \qquad (7)$$

Where: P_f = future population, P_i = Initial population

2.3.2 Water for building of structures.

The amount of water required for building of structures as well as for bricks molding will vary greatly depending on the number of houses and season. The number of structures to build is expressed in percentage of the number of households of a particular village. Also, the water consumption per structure is expressed in percentage of the total water required for a particular village. Therefore the number of houses to build is given as,

No. of houses to build = 20% x no. of households per village (8)

⇨ No. of houses to build = 20% x No. of households in village (A- C)

Analyses also show that, 5% of the total water required for each village is consumed per structure, that is;

Water required for building = 5% x total water required per village (9)

2.3.3 Water for livestock.

The amount of water required by livestock will vary greatly depending on the number of houses, season, temperature, moisture content of animal forage and type of animals. According to Marcel, (2003), Rod and Peter,(2016) and Miranda *et al.*, (2021), an average chicken and duck consume about 0.77 and 1.5 L/day of water, goats 6 L/day, pig or swine 12 L/day per day since it is also use for swimming, sheep 5 L/day. Therefore:

Total water requirement by animals in litres = No. of households x Average no. of animals/house x average water consumption/day (10)

2.3.4 Total water requirement

A reasonable estimate of water demand from the earth dam was worked out by adding together the total water requirements for domestics, building of structures and livestock. The total water requirement in litres can be converted into cubic meters (m^3) by dividing it by 1000. Therefore; the total water requirement = total water required for domestic + total water requirement for livestock.

2.3.5 Total water storage

To determine the total water storage in (m^3), evaporation and seepage causing natural losses from any open reservoir is also taken into account. Evaporation loss can remove up to 2.5 meters depth of water per year from an open dam reservoir. In a hot climate evaporation takes about 50% of the total water from a reservoir in a year. Seepage may account for about half of that evaporation (ie 25% of the water in the reservoir) (Thornton, 2000).

=> Estimated evaporation loss (50%) = reservoir water x 50%
=> And Estimated seepage loss (25%) = reservoir water x 25%
Domestics and livestock water usage (25%) = reservoir water + water loss

2.4 Dam Capacity

Dam capacity can be estimated using the proposed dam depth, dam width and the throwback at the full supply level (FSL). Throwback is the distance between the dam axis and the upstream limit of the reservoir pool, at the spillway crest elevation(SOT, 2008; US ACE, 2004). Equation by Wallingford, (2004); AAF, (2016) was used to calculate dam capacity:

$$\text{Capacity (C)} = 0.264 \times D \times W \times TB \qquad (11)$$

Where:
C = Dam capacity (m^3)
D = maximum water depth i.e. difference in elevation between lowest point in the reservoir bed at the dam and the spillway crest level (m).
W = the width of the water surface of the dam at the spillway crest level (m)
TB = the “throwback” at the spillway crest level.

2.4.1 Dam height, crest width and throwback.

According to Watermeyer, (2009); Burhan *et al.,* (2015), the height of small earth dam is between 4 to 6 meters.

$$\text{Generally, dam height } H = D + 1 \text{ m} \qquad (12)$$

Where, D = dam depth in meters

The throwback of an earth dam depends on the dam capacity.

2.4.2 Volume of earth works

According to Weich *et al*; (2001), Thomas *et al,* (2008), estimate of the volume of earth works at the feasibility or site selection stage of small projects can give accurate results using the equation:

$$V = 0.216 \times H \times L \times (2 \times C_w + H \times S) \qquad (13)$$

Where:
V = volume of the earth works (m^3)
H = the dam crest height i.e. the full supply depth plus the freeboard (m)
C_w = the crest width in (m)
S = the combined upstream and downstream embankment slopes

The Crest width of small earth dams according to Suresh, (2002), has a minimum of 3 m wide. The top width is the function of the dam height,(John, 2010; Ian and Rod,2012; Narasimha, 2021). For dams of height less than 30 m.

$$C_w = 0.4H + 1 \qquad (14)$$

Where : H = Height of the dam
W = crest width

3.0 RESULTS AND DISCUSSION

3.1 Dam Catchment Area

Catchments areas were measured after taking the coordinates and elevations of the study area from village A, D, E, F, G and back to village A (plate2 , figure 5), giving an area of a pentagon which can be divided as shown in figure 6 and 7. From figure 6,

Area of section A = length x breath	=	1.61 x 1.78	=	2.87km^2
Area of section B = ½ x b x h	=	½ x 1.78 x 0.29=		0.26km^2
Longest length of fig 15,	=	$\frac{\text{opposite}}{\text{Adjacent}}$	=	$\frac{1.78}{0.29}$ = 6.14 km
Also from figure 16, the height	=	$\frac{\text{adjacent}}{\text{Hypotenuse}}$	=	$\frac{3.07}{2.7}$ = 1.13 km
Area of section C = 1/2 x b x h	=	½ x 3.07 x 1.12 =		1.72 km^2
Area of section D = 1/2 x b x h	=	½ x 3.07 x 1.12 =		1.72 km^2
Therefore, total area, A_T	=	$A_a + A_b + A_c + A_d$		
	=	2.87 + 0.26 +1.72 + 1.72= 6.57 km^2		
	=	6570 m		

Therefore the design peak runoff flood (Q_{des}) from the tributaries was calculated using equation (1).

$$Q_{des} = 2.8 \times C \times I \times A$$

$$\text{But, } C = \frac{\text{Total Runoff}}{\text{Total Rainfall}} \qquad (15)$$

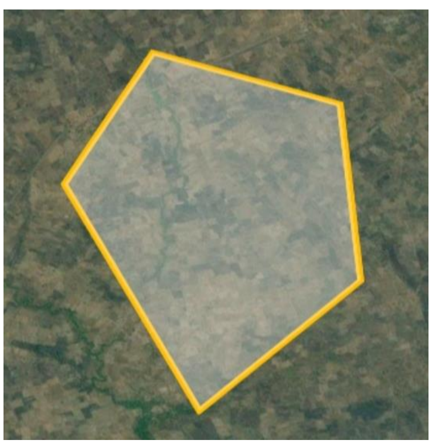


Plate 2: Measured catchment Area in the study Site.

Source: Site Survey, (2022).

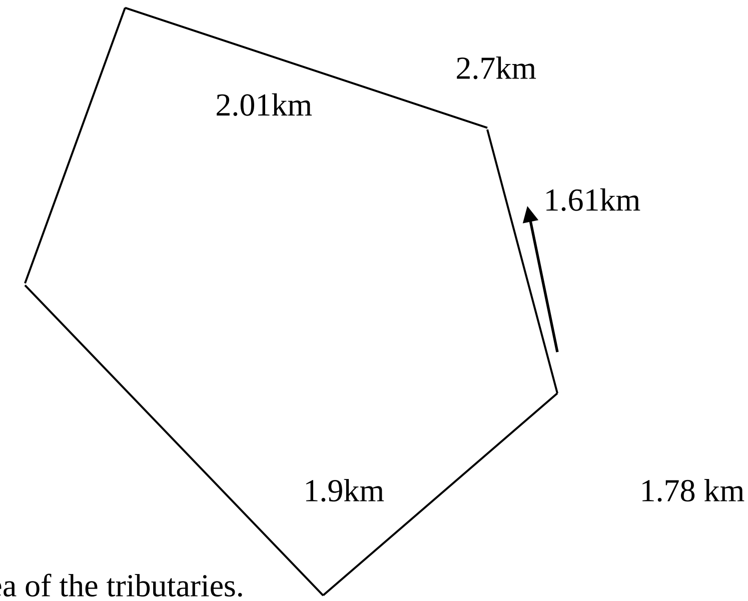
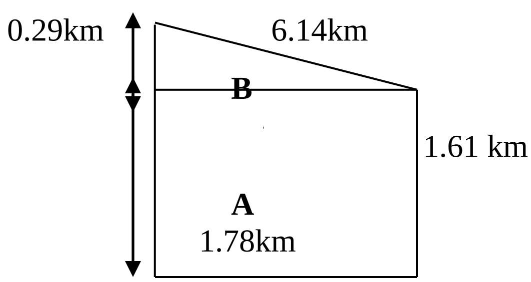


Fig 5: The catchment area of the tributaries.



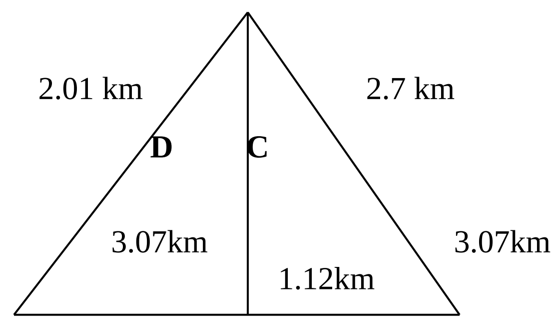


Fig 6: First section of the catchments **Fig 7:** Second section of the catchments

The values of Mean annual rainfall (precipitation)(MAP) (NiMet,2019) and Mean annual runoff (MAR) (MWREM, 2019) for Benue State were found from equation to be:

MAP = 98.8 mm

MAR = 39.55 mm

Therefore, $C = \frac{39.55}{98.8} = 0.40$

The rainfall intensity of the study region (Benue state) for 14 years (MWREM, 2019) was 316.2 m/hr = 0.088mm/s

Therefore, $Q_{des} = 2.8 \times 0.40 \times 0.088 \times 6570 = 647.54$ mm/s

3.2 Total Water Requirement for the Communities

Total water requirement for a village = Total no. of people in a village x daily consumption /capita/day.

Total water requirement for village A = total number of people in village A = 588 people.

Daily consumption/capita/day = 68 litres (L)

Total water requirement (TWR) = 588 x 68 = 39 984 L

TWR for village B was found to be = 28 560 L

TWR for village C = 54 060 L

The total water required by the three communities are presented in Table (3). The population forecast for the three communities in twenty years can be estimated using equation (7).

Table 3: Domestic Water Needed for Households in the Villages (A, B and C)

Name of village	No of households	Average No of people /house	Total no. of people in a village	Daily consumption /capital/day	Total water required (litres)/day
A	49	12	588	68	39 984
B	42	10	420	68	28 560
C	53	15	795	68	54 060
Total			**1803**		**122 604**

$$\frac{dp}{dt} = ka$$

$$dp = K_a dt$$

$$\Rightarrow P_f - P_i = K_a (t_f - t_i)$$

$$P_f = P_i + ka(t_f - t_i)$$

For this research, the arithmetic constant (K_a) using average population of the 3 villages(A,B,C) (Table 3), is 1803. Therefore:

$$K_a = \frac{1803}{3} = 601$$

Assuming the dam's life span is for the next two decades (20 years). The population forecast for the period of 20 years (from 2023- 2043) is calculated using equation (7).

$$P_f = P_i + ka(t_f - t_i)$$

$$P_{2033} = 1803 + 601(2033 - 2023)$$

$$= 1803 + 601(10) = 7813 \text{ people}$$

$$P_{2043} = 7813 + 601(2043\text{-}2033)$$

$$= 7813 + 601(10) = 13823 \text{ people}$$

Therefore, future population in two decades time (2043) will be 13, 823 people.

The total water required = total number of people x water consumption/capita/day

=> 13823 x 68 = **939,964 L/day**

3.3 Water for Building of Structures.

a. Number of houses to build in a year

Equation (10) is used to calculate the number of houses to build;

No. of houses to build = 20% x no. of households per village

⇨ No. of houses to build in village A = 20% x 49 = 9.8 = 10 houses

For village B, = 20% x 42 = 8 houses

And village C, = 20% x 53 = 11 houses.

b. Water required for building structures in a year

Water required for building structures for the three villages were obtain using equation (9):

Water required for building = 5% x total water required per village

For village A, = 5% x 39 984 = 1, 999.2 L, village B require 1, 428L and village C, 2 703 L

Total water required for building = 1, 999.2 + 1, 428 + 2, 703 = **6,130.2 L (**Table 4).

Table 4: Water for Building structures in the Villages (A, B and C)

Name of village	No. of households (NHH)	No of houses to build (20% of NHH)	Total water requirement (TWR) (liters)	water consumption/structures (5% of TWR) (liters)
A	49	10	39 984	1 999.2
B	42	8	28 560	1 428
C	53	11	54 060	2 703
Total				**6 130.2**

3.4 Water Requirement for Livestock

Total water requirement by animals in villages (A, B,C) was estimated using equation (10):
No. of households x Average no. of animals/house x average water consumption/day.
In village (A), average number of goats/house was 12, sheep 5, pigs 5, chickens 13 and ducks 3. Total water required for goats = 49 x 12 x 6 = 3,528L. For sheep 1,225L, pigs, 2,940L,chickens , 490.49, ducks, 220.5L. Total water required for livestock in village A = 3,528 + 1,225 + 2 940 + 490.49 + 220.5 = 8 404L (Table 5). Total in village (B) 6 740 L, village (C), 12 194.77 L. Total water required for livestock = total water requirement by animals in village A + B + C = 8 404 + 6 740 + 12 194.77 = 27 338.8L.

Table 5: Water Requirements for Livestock in Village A

Type of livestock	No. of households	Average no. of animals per house	Average water consumption per (L)	Total water requirement in (L)
Goats	49	12	6	3528
Sheep	49	5	5	1225
Pigs	49	5	12	2940
Chickens	49	13	0.77	490.49
Ducks	49	3	1.5	220.5
Total				**8404**

3.4.1 Total water requirement in a year.

The total water requirement = total water required for domestic + water required for livestock = 122,604 + 27 338.8 + = 149,942.8 L/day Therefore the total water requirement for a year = 149,942.8 x 365 days = 547,291, 22 L/year. Water required for building structures was then added, that is; 54,729,122 + 6,130.2 = 54,735,252.2 L/year, (in cubic meters), = 547,352,52.2 m^3.

3.4.2 Total dam reservoir storage

This is the total water requirement for a year in addition to evaporation losses and wasted water:

a) Estimated evaporation loss (50%) of total water required, i.e total water required x 50% = 547,352,52.2 x 50% = 273,676,26.1 m^3
b) Estimated waste water (25%) of total water required, i.e total water required x 25% = 547,352,52.2 x 25% = 13683813.05 m^3.

Total water loss = 273,676,26.1 + 13683813.05 = 410,514,39.15 m^3

Total estimated water storage requirement in the reservoir = total water required + total water loss = 54,735,252.2 + 410,514, 39.15 = 957,866,91.35 m^3 (Table 6).

Table 6: Total Estimated Water Storage Requirement for the Reservoir

Water consumption	Amount (m^3)
Total water required (TWR)	547,352,52.2
Estimated evaporation loss	273,676,26.1
Estimated waste water	136,838,13.05
Required storage capacity of water reservoir (100%)	**957, 866,91.35**

3.4.3 Storage capacity

According to Mitchell, (2007), dams with total storage above 350,000 m^3 should have a standard depth (D) of 5.4 m within an area of 20 ha, with width (W) of the water surface at Full Supply Level (FSL) of 181m and a corresponding throwback (TB) of 1,383m.Therefore, the storage capacity was calculated using equation (11).

$$\text{Capacity (C)} = 0.264 \times D \times W \times TB$$
$$= 0.264 \times 5.4 \times 181 \times 1383 = 356{,}861 \text{ m}^3$$

4. CONCLUSION

Conceptual design of an earth dam in Mbabuande Gwer west LGA of Benue state was done.The amount of water the catchment could produce was determined from design peak runoff rate formula. Annual rainfall, runoff and evaporation losses.Water require ment of the 3 communities in Mbabuande was determined using water demand for domestic purposes, livestock and building structures.Domestic water demand/consum- ption was calculated from water demand for drinking, food processing/ cooking, bathing, clothe washing and utensils washing, using standard estimate for a single person /capita/day. Census data for the communities was used to forecast the population‘s water requirement for the period of 20 years. Total water requirement in a year was found to be,547,352,52.2m^3/year.Total dam reservoir storage water requirement for a year in addition to evaporation losses and wasted water, was found to be, 957, 866,91.35 m^3. Storage capacity of dams (above 350,000 m^3) with standard depth (D) of 5.4 m within an area of 20 ha, at Full Supply Level (FSL) of 181m and throwback (TB) of 1,383m, was calculated to be, 356,861 m^3.

REFERENCES

AAF (Albert Agriculture and Forestry)(2016).Small Earth Fill Dams. http://www. Alberta.ca> Agriculture and Forestry.

Albritton, J. Jackson, L, and Bangert, R. (2014). Foundations Grouting Practices at Corps of Engineers Dams”. Technical reports GL-84-13. U.S Army Engineers Waterways Experiment Stations.

Burhan,S.M.,Abdulmajeed,M.R.Shvan,F.A.and Kakaham, M.H(2015).Designed of Proposed Earth Dam. *https://www.academia.edu/29133915/Design_of proposed earth dam.*

Dawei, H.(2010). Conscise Hydrology. 1st edition. ISBN 978-87-7681-536-3. Pp 122. Dawei Han and bookboon.com.

GWLGA, (Gwer West Local Government Area), (2010). Surveying Department, Division of Gwer West LGA into Raav and Mbakpa as Separate Local Governments in Benue state, Nigeria.

IADC(InternationalAssociation of Dredging Companies)(2012). Initiating Hydraulic Fill Projects. No 4. *Retrieved from* http://www.iadc-dredging.com.

Ian S., and Rod S.(2012).Small Earth Dams. WEDC Loughborough University Leicester shire LE11 3TU UK.

ICOLD (International Commission onLarge Dams)(2017).Role of Dams. http//:www.icold cigb.org/ Dams/dams.asp.

Jean, P.,Jean,M.F.,and Domitille,V.,(2012).Small reservoirs and water storage for Small holder farming. The case for a new approach. AGwaters.http://www.Awm-Solutions. iwmi.org.

John,P.F,(2010). The Design and Construction of Small Earth Dams. Appropriate-Technology-Vol.3-No.4-P.4-7-Design.

Lindström, A. and Granit, J.(2012).Large-Scale Water Storage in the Water, Energy and Food nexus Perspectives on benefits, risks and best Practices. *Retrieved from.http://www .siwi.org/documents/Resources/Papers/Water_Storage_Paper*.

Marcel,D.(2003).Water Consumption for Livestock and Poultry Production.https://www. research gate .net/publication/269393738.

Miranda,A.M.,Gerald,S.andMichelle,M.(2021).LivestockWater Requirements. NDSU Extention AS1763. https://www.ag.ndsu.edu/publications/.

Mitchell, R. J. (2013). Earth Structure Engineering, Allen and Unwind, inc, Boston.USA.

MWREM, (Ministry of Water Resources and Environment, Makurdi), (2019). Assessment of Mean Annual Runoff, Evaporation, and Rainfall Intensities in Benue State.

Mille,T.G,(2012).GST113,Nigerian Peoples Culture Lecture Note,in the Departmentof Managementt Science, and Education, Federal University of Agriculture Makurdi.

Mitchell,T.B.(2007).TheYield from Irrigation Dams of Low Storage Ratio.*Journal and proceeddings, Zimbabwe Institution of Engineers*. Pp 627-630.

Narasimha,R.K.V.(2021).Design Principles of Earth Dams.https://www.academia.edu/2913 3915/.

NBTE(National Board for Technical Education)(2008). Water Supply and Sanitary Engineering. UNESCO-Nigeria Technical and Vocational Education Revitalisation Project-Phase II.

Nelson,K.D.(2015). Mgt. of Watershed and Silt Load.Kenya-Belgium Water Development Programme.

NiMet.(Nigerian Meteorological Agency, (2019).Headquarters,Tactical Air Command, Makurdi, Nigeria.

Peck, R.B,(2010).Where has all the Judgement Gone? The Fifth Laurits Bjerrun Memorial Lecture, Presented on May, 5th, 2010, the Norwegian GeotechnicalInstitute Oslo.

Puli,V. R.,(2005).Water Supply and Sanitary Engineering. First Edn. State Institute of Vocational Education Andhra Pradesh. Hyderabad.

NPC, (Nigerian Population Census) (2006).Nigerian Popn. Commission, Benue State, Nigeria.

Rankine, W. (2017). On the Stability of Loose Earth, *Philosophical Transactions of the Royal Society of London*, Vol. 147.

Rod,D andPeter,W.(2016).4.WaterRequirements.Feedlot Design and Construction. https://www.mla.com.aumla.com.au/globalassets/mla-corporate/research-and-development/program-areas/.

Sahu,R.K,(2009).Technical Bulletin:Small Farm Reservoirs.India Council Agricultural Research, New Delhi, India.

Shaw, D.N. (2017). A Guide to Design and Construction of Medium Sized Earth Dam, Ministry of Water Development Zimbabwe.

Smout, I, and Shaw R. (2016). Technical Brief 48: Small Earth Dams, Waterlines, Volume 14, No.4, P15-19, Intermediate Technology Publications London.

SOT(State of Tasmania) (2008).Guidelines for the Construction of Earth-Fill Dams.https://dpipwe.tas. gov.au/Documents/.

Wallingford, H.R (2003). Sedimentation in Small Dams – Impacts on the Income of Poor Rural Communities. OD TN 118.

SDBSG(Surveying Department Benue State Government),(2009).Identification of Local Government Areas and their Head Quarters in Benue state, Nigeria.

Tahmiscioğlu, M.S., Anul,N. Ekmekçi,F.,and Durmuş, N., (2016).Positive and Negative Impacts of Dams on the Environment International Congress on River Basin Management, Yücetepe/Ankara.

Thornton,J.(2000). Source Book of Alternative Technologies for Freshwater Argumentation in Africa,cap.1.1.13. United Nation Environment Programs.

Tomas,J.,Kristin,M.H.,Carl,B.H.and Ulrik,D.(2008).Background for the Determination of Dam Height in the SATSIE Dam Design Guidelines. Report 08003.

US.ACE(2004).Design and Construction Consideration for Earth and Rock- Fill Dams. https://www.publications.usace.army.mil/portals/76/engineermanuals/em1110-2-2300.

Wallingford,H.R,(2003).Sedimentation in Small Dams-Development of Catchment Characterization and Sediment Yield Prediction OD TN 120.

Wallingford, H.R, (2004). Guidelines for Predicting and Minimising Sedimentation in Small Dams.Report OD 152, DFID. Zimbabwe.

Watermeyer, J.M, (2009). Small Earth Dams and Weirs – Implementation Manual. Agricultural and Rural Development Authority, Zimbabwe, and GTZ.

WCD(World Commissionon Dams) (2000).Dams and Development:Anew Frame work for Decision-Making.EarthscanPubl.Ltd,London and Sterling,VA.*http://www.WCDDAMS report*.

Weich,S.,Burton,E.,Blanchard,M.,Prince,M.,Sproston,KandErens,B.(2001).*Measuring the Built Environment:Validity of a Site Survey Instrument for Use in Urban Settings*. Health & Place.**7**(4):283-292.*doi*:*10.1016/S1353-8292(01)00019-3.*