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Investment Appraisal and Financial Evaluation of Hydropower Projects

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Abstract: *This study evaluates the hydropower potential of the Otamiri River by conducting a hydrological assessment of climatic factors influencing its catchment, specifically the reach flowing through the Federal University of Technology, Owerri. The work focuses on estimating peak design floods for the watershed using the Gumbel probability distribution technique across different return periods. Unit hydrographs, storm hydrographs, runoff hydrographs, and a flood duration curve were developed to characterize the hydrologic response of the basin. Key watershed characteristics—including peak discharge, lag time, time of concentration, and rainfall intensity—were computed using the Soil Conservation Service approach alongside relevant empirical equations. To assess the flow available for energy generation, river stage and head data obtained from the River Basin Development Authority were analyzed, and flow duration curves were generated. Results from the analysis indicate that dependable flows at 50%, 75%, and 100% exceedance probabilities correspond to estimated power outputs of 34.5 MW, 11.3 MW, and 1.5 MW, respectively.*

Keywords: *Hydropower, hydropower potential, river Otamiri*

I. INTRODUCTION

Hydropower, also known as hydraulic or water power, is the energy obtained from water that is in motion. This energy originates from the continuous natural process known as the water cycle or hydrologic cycle, in which gravity causes water to move from higher elevations to lower areas. As water flows downhill, it gains significant force, which can be harnessed to produce electricity in hydroelectric systems. Essentially, hydropower represents the usable mechanical energy stored in moving water that can be transformed into electrical energy through hydropower plants.

Hydropower is widely recognized as a clean, renewable, and dependable source of energy that supports national goals related to environmental protection and sustainable energy development. It plays a crucial role in electricity generation among renewable energy sources for several key reasons. Unlike fossil fuels, it is naturally replenished, and compared to other renewable sources such as wind, its power supply is more stable over short periods. Additionally, hydropower produces very low greenhouse gas emissions, making it environmentally favorable.

This form of energy is derived from water descending through rivers and streams under the influence of gravity. The moving water possesses kinetic energy, which results from its flow over riverbeds and interaction with rocks and sediments. By capturing this kinetic energy and directing it through turbines, hydropower plants are able to generate electricity. The amount of electricity produced depends mainly on two factors: the volume of water flowing through the system and the vertical distance, or head, between the water source and the turbine. Greater water flow and higher head result in increased power generation.

Hydropower generation is therefore closely linked to both the water level and discharge rate of a river. Increasing environmental concerns associated with fossil fuel–based energy systems, resistance to large hydropower projects due to land acquisition and population displacement, challenges related to nuclear energy, and the growing demand for electricity have all emphasized the need to explore alternative and sustainable energy sources.

Hydropower stands out as a well-established, reliable, and economically competitive technology. It is known for having one of the highest energy conversion efficiencies among all energy sources, with approximately 90% efficiency from water flow to electricity output. Although hydropower projects require significant initial capital investment, they typically offer long operational lifespans along with minimal operation and maintenance costs.

The primary aim of this study is to assess the hydropower potential of the Otamiri River by analyzing key parameters such as river discharge, rainfall patterns, and cross-sectional depth characteristics.

II. HYDROPOWER POTENTIAL

The World Energy Council (2004) describes the hydropower potential of a river as its inherent capacity to produce energy, representing the theoretical possibility of electricity generation when suitable conditions are present. This potential reflects the natural ability of a river to generate power, assuming all necessary physical and hydrological factors are favorable. It is important to recognize that this theoretical estimate is derived from assessments of terrain characteristics and the volume of runoff that can be utilized by allowing water to fall from its elevation to sea level**.**

Eurelectric (1997) defines gross hydropower potential as the total amount of energy that could be produced annually if all naturally occurring runoff were fully captured and used for power generation at every possible location, down to sea level or national boundaries, assuming no energy losses. This gross potential is primarily influenced by the river basin's topography and the level of precipitation it receives.

The portion of this theoretical potential that can be developed using existing technologies—without considering economic, environmental, or social constraints—is referred to as the technical hydropower potential (Bernhard et al., 2010). A further subset, known as the economic hydropower potential, includes only those projects that can be implemented at costs comparable to alternative energy sources. Beyond this, the exploitable hydropower potential accounts for additional limitations, such as environmental protection measures and other regulatory or site-specific restrictions.

III. MATERIALS AND METHODS

Climate and vegetation of study area: The Otamiri River is a prominent river system in Imo State, Nigeria. It originates from Egbu and flows southward through several communities, including Owerri, Nekede, Ihiagwa, Eziobodo, Olokwu Umuisi, Mgirichi, and Umuagwo, before extending to Ozuzu in Etche Local Government Area of Rivers State, where it ultimately drains into the Atlantic Ocean. The river spans approximately 30 km from its source to its confluence with the Oramiriukwa River at Emeabiam.

The Otamiri River basin occupies an estimated area of about 10,000 km² and receives an annual rainfall ranging between 2,250 mm and 2,750 mm. Vegetation within the watershed is predominantly characterized by degraded tropical rainforest, marked by dense undergrowth, climbing plants, and luxuriant green foliage. This rich vegetation cover is largely sustained by continuous decomposition of plant litter and organic matter.

Organic nature and type of soil: The Otamiri watershed is predominantly composed of sandy soils, with only minor proportions of clay, loam, and silt. The soils exhibit acidic conditions, with pH values ranging from 4.67 to 5.6 in both the upper and lower horizons. At the crest and valley bottom, pH values fall between 5.0 and 5.6, while comparatively lower acidity is observed at the midslope (Njoku et al., 2011).
In addition, the watershed is characterized by low organic carbon content, varying from 0.676 to 3.764 meq/100 g in the topsoil and from 4.27 to 5.34 meq/100 g in the subsoil, with reduced levels at the midslope. Nitrogen availability is also limited, with concentrations ranging between 0.008–0.068% in the upper soil layer and 0.018–0.048% in the lower layer (Njoku et al., 2011).

Geology and position: The study area lies within the sedimentary basin of southeastern Nigeria and encompasses Owerri metropolis and its surrounding communities. Geographically, it extends between latitudes 5°15′ and 5°35′ N and longitudes 6°55′ and 7°15′ E. Climatically, the area falls within the sub-equatorial zone, which experiences two distinct seasons: a wet season and a dry season, typical of southern Nigeria.

Geologically, the area is underlain by sedimentary deposits belonging predominantly to the Benin Formation of Miocene to Recent age, which overlies the Ogwashi–Asaba Formation of Oligocene age. The Benin Formation is largely composed of poorly consolidated sands, with occasional clay interbeds. These sands are generally coarse-grained and increase in thickness from north to south, beginning as a relatively thin unit at the boundary with the Ogwashi–Asaba Formation in the northern part of the area and becoming progressively thicker toward the coast. Within the study area, the formation attains an average thickness of approximately 800 m. The landscape is characterized by two major geomorphic features: strongly undulating hills and ridges, as well as extensive low-lying, nearly level surfaces. Several sedimentary structures such as channel fills, point bars, natural levees, backswamp deposits, and oxbow infills are present, reflecting variations in shallow fluvial depositional environments. The southern portion of the area is predominantly underlain by thick, unconsolidated sand deposits with minor clay lenses.

Hydrogeology:

The study area is hydrologically influenced by two major river systems: the Otamiri and the Nworie rivers. Seasonal variations strongly affect the discharge of the Otamiri River, with peak mean flows of approximately 10.7 m^3/s occurring during the rainy months of September to October, while lower mean flows of about 3.4 m^3/s are recorded in the dry season, typically from November to February. The estimated total annual volume of water discharged by the Otamiri River is approximately 1.7×10^8 m^3. Of this volume, about 22% (equivalent to 3.74×10^7 m^3) is derived from direct rainfall runoff and represents the sustainable yield of the river system (Egboka and Uma, 1985). Groundwater levels within parts of the Owerri urban area occur at depths ranging between 15 m and 35 m. The aquifer units in the area are laterally extensive and possess adequate thickness, making them capable of supporting groundwater abstraction (Ibe and Uzoukwu, 2001).

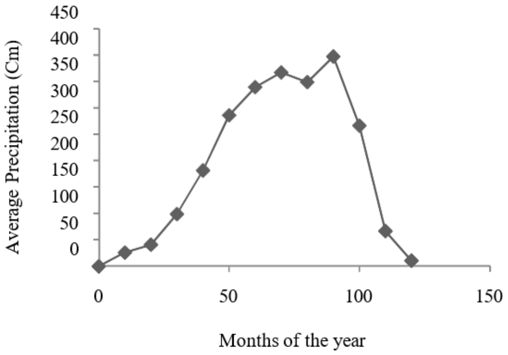

Fig. 1: Rainfall hydrograph of the catchment area

Fig 1 illustrates the hydrograph representing the relationship between average precipitation and the months of the year. The figure highlights the seasonal variation in precipitation, showing a progressive increase and subsequent decrease in rainfall across different months as influenced by the alternating rainy and dry seasons.

IV. METHODOLOGY

Data collection and literature: To assess the hydropower potential of the study area (Otamiri River), long-term climatic and hydrological records of the river must be gathered and systematically analyzed. These data are essential for evaluating water availability and understanding its temporal variability on both seasonal and annual scales (Lindsley et al., 1992). Estimating the hydropower potential further requires an analysis of the river's flow regime, including its magnitude and variation patterns. Such flow information can be derived either through direct hydrological computations or obtained from published hydrological yearbooks of River Basin Development Authorities and Meteorological Service Centers that operate monitoring stations within or near the study area (Arora, 2004).

V. RESULTS AND DISCUSSION

Results of Table 1 shows:
Column (2) Total Precipitation (T.P)
T.P = summation of rainfall values in each month from 1995-2010
Column (3) Average Precipitation (A.P)
A.P = total precipitation of each month/number of years
A.P = TP/n; Where n = number of years Column (4) Total Rainfall days (T.R.D)
T.R.D = summation of rainfall days in each month Column (5) Average Rainfall Days (A.R.D)
A.R.D = total rainfall days in each month between 1995-2010
Number of that month with the period Column (6) Rainfall Intensity (R.I)
R.I = TR/ARD
But critical Rainfall Intensity (I_c) $I_c = P/T_r\ (T_r + 1/T_c)$
where, T_r = Storm Period/Rainfall Days (ARD) T_c = Time of Concentration of the storm.
But $T_c = 0.0195\ [L^{0.77}/S^{0.385}] = 0.0195\ [30\times\ 1000^{0.77}/0.016^{0.385}]$
$= 0.0195\times13765.66 = 268.43$ min = 4.47 h.

Determination of watershed parameters:

- Lag time $T_l = 0.6\ T_c$

But T_c from 4.1 above = 4.47 h, substituting in the above relationship we have;

$T_l = 0.6 \times 4.47 = 2.68$ h.
-T_r is the same as the average rainfall days for each of the months.
-Area of the catchment in consideration is 100 km^2
-Slope, S = 0.016
Results of Table 2 shows:
Column 2, T_r = duration of rainfall (average rainfall days) converted to hours
Column 3, Peak Time, $T_p = T_r /2+T_l$ Where T_l = lag time = 2.68 h Column 4, Discharge, Q (m^3/s)
$Q = 2.78\ C\ I_c\ A$
where, C = characteristic discharge coefficient of watershed, 0.50
I_c = critical rainfall intensity for each month. A = Area of Watershed, 100 km^2

- The highest discharge value = 10112.25 m^3/s
- The lowest discharge value = 284.95 m^3/s
- The average discharge value = 5166.94 m^3/s

The Fig. 2, hydrograph represents the relationship of discharge with time, the graph portrays the trend of discharge (m^3/s) its rise, decline and fall with respect to the periods in the year.

Development of parameters for flow duration curve: For the determination of the flow duration curve the Table 3 shows the various values used to obtain the graphical relationship.

Table 1: Values for total precipitation, average precipitation, rainfall days and rainfall intensity

Month	Total precipitation (cm)	Average precipitation (cm)	Rainfall days	Rainfall days (average)	Rainfall intensity (cm/hr)
January	418.30	26.14	22	1	4.97
February	657.00	41.06	38	2	7.66
March	1583.10	98.94	97	6	18.21
April	2902.00	181.38	195	12	33.33
May	4573.70	285.86	237	15	52.40
June	5422.80	338.93	251	16	62.15
July	5869.30	366.83	333	21	67.21
August	5576.14	348.51	340	21	63.88
September	6352.50	397.03	341	21	72.75
October	4258.50	266.14	288	18	48.76
November	1068.40	66.78	75	5	12.32
December	172.20	10.76	15	1	2.05

Table 2: Values for storm hydrograph

Month	T_r (hrs)	T_p (hrs)	Discharge (m^3/s)
January	24	14.68	690.83
February	48	26.68	1064.74
March	144	74.68	2531.19
April	288	146.68	4632.87
May	360	182.68	7336.00
June	384	194.68	8638.85
July	504	254.68	9342.19
August	504	254.68	8879.32
September	504	254.68	10112.25
October	432	218.68	6777.64
November	120	62.68	1712.48
December	24	14.68	284.95

Table 3: Values for percentage time of flow

Month	Discharge (m^3/s)	Number of days of rainfall (m)	% of time
September	10112.25	21	8.3
July	9342.19	21	16.7
August	8879.32	21	25.0
June	8638.55	16	33.3
May	7336.00	15	41.7
October	6777.64	18	50.0
April	4632.87	12	58.3
March	2531.19	6	66.7
November	1712.48	5	75.0
February	1064.74	2	83.3
January	690.83	1	91.7

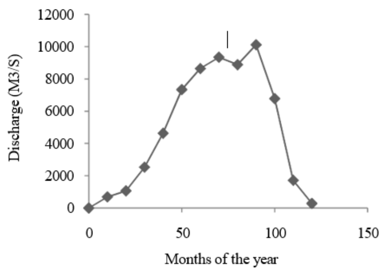

Fig. 2: Discharge hydrograph of the catchment area

Column 2, discharge
Column 3, number of rainfall days, m
Percentage (%) time

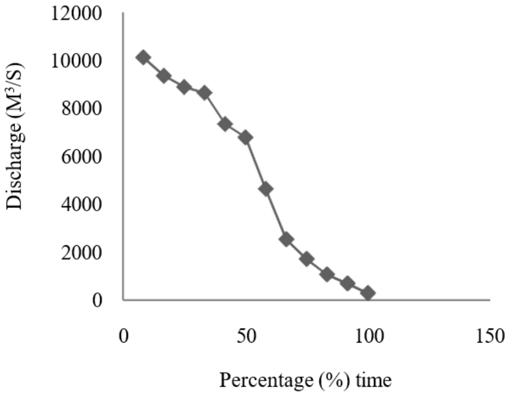

Fig. 3: Flow duration curve of Otamiri River

Column 4, % time of rainfall, P = m/n×100 where,
m = Number of times a particular event has been equaled or exceeded
N = Number of days of event/total number of events

The flow duration curve presented in Fig. 3 exhibits a downward trend, indicating a reduction in discharge as the percentage of time increases. This behavior reflects the strong seasonal influence on river flow throughout the year, characterized by distinct wet and dry periods. Consequently, streamflow availability varies over time and is directly governed by seasonal water availability across different proportions of the year.

Determination of maximum annual observed flood for recurrent intervals: The determination of the maximum annual flood in the study area was done to predict the flood pattern and the increase observed as regards the discharge (Q). Within the return periods (Tr). The Table 4 shows the various values used in the estimation of the flood:
$\sum Q = 62000.26$
N = 16 years, $x = \sum Q/12 = 0.52 \times 10^4$, $\delta = (\sum(X - x)^2/n - {}_{1)}1/2$
where, n = 16; substituting values we have the following;
$= (15.45/16 - 1)^{0.5} = 0.321 \times 10^4$

Table 4: Values for estimation of design flood for return periods, using gumbels distribution method (Arora, 2004)

Month	Q (m^3/s)	Rank (m)	$T_r = n+1/m$	(X -x)	$(X - x)^2$
September	10112.25	1	17.00	0.49×10^4	2.40×10^7
July	9342.99	2	8.50	0.41	1.70
August	8879.32	3	5.67	0.37	1.37
June	8638.00	4	4.25	0.34	1.16
May	7336.00	5	3.40	0.21	0.44
October	6777.64	6	2.83	0.16	0.26
April	4632.87	7	2.43	-0.06	0.03
March	2531.19	8	2.13	-0.27	0.73
November	1712.48	9	1.89	-0.35	1.23
February	1064.74	10	1.70	-0.41	1.70
January	690.83	11	1.55	-0.45	2.03
December	284.95	12	1.42	-0.49	2.40

Table 5: Values of stage of Otamiri River from 1978-1987 and 1997

Month	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1999
January	0.27	0.34	0.46	0.65	0.67	0.91	0.91	0.93	1.00	0.96	0.53
February	0.26	0.40	0.40	0.63	0.61	0.86	0.91	0.90	0.98	0.94	0.51
March	0.36	0.35	0.42	0.60	0.63	0.78	0.94	0.91	1.12	0.97	-
April	-	0.43	0.11	0.36	0.59	0.63	0.77	0.89	0.92	0.98	0.39
May	-	0.44	0.13	0.36	0.72	0.74	0.79	0.86	0.99	1.00	0.39
June	0.18	0.47	0.21	0.43	0.62	0.83	0.82	0.90	0.98	1.00	0.40
July	0.23	0.44	0.34	0.45	0.66	0.83	0.90	0.93	0.95	0.99	0.43
August	0.24	0.52	0.36	0.58	0.63	0.80	0.94	0.98	0.94	1.04	0.45
September	0.47	0.65	0.50	0.72	0.63	0.91	0.88	1.05	1.02	1.15	0.71
October	0.60	0.83	0.54	0.74	0.72	1.00	0.96	1.02	1.03	1.01	0.88
November	0.63	0.63	0.56	0.65	0.72	0.90	0.96	0.94	1.01	1.02	0.63
December	0.53	0.59	0.49	0.62	0.74	0.91	0.85	0.93	1.01	0.99	0.53
Average	0.31	0.52	0.38	0.57	0.66	0.84	0.81	0.94	1.00	1.00	0.53

Since n = 16, from appendix we interpolate between values of 15 and 20 to obtain Y_n and δ_n; for Y_n; 20 = 0.5236; 16 = Y_n; 15 = 0.5128

$(20-16)/16-15 = (0.5236-0.5128)/Y_n-0.5128$ 4 = $0.0108/Y_n-0.5128$

$Y_n = 2.062/4 = 0.5155$

For the value of δ_n; 20 = 1.0628 16 = δ_n; 15 = 1.0206

$(20-16)/ 16-15 = (1.0628-1.0206)/\delta_n - 1.0206$

$4\delta_n = 0.0422+4.0824$ $\delta_n = 4.1246/4 = 1.0312$

Therefore the values $Y_n = 0.5155$ and $\delta_n = 1.0312$, for n = 16 years

Determination of a and Q_f; $a = \delta_n/\delta = 1.0312/0.321 = 3.212$

$Q_f = Q - (Y_n/\delta_n)\ \delta = 0.52 - (0.5155/1.0312)0.321 =$
$0.52 - 0.16 = 0.36$

Determination of the reduced variate Y_T for the desired return period

$Y_T = -\text{loge} [+\text{loge} [T_r/T_r - 1]]$

For a return period of 20 years. i.e., T_r = 20 years, we have;

$Y_T = -\text{loge} [+\text{loge} [20/20-1]] = 2.98$ For T_r = 25 years

$Y_T = -\text{loge} [+\text{loge} [25/25 -1] = 3.19$ For T_r = 30 years

$Y_T = -\text{log} [+\text{loge} [30/30 -1]] = 3.38$

Estimation of the magnitude of the maximum annual flood:

$Q = Q_f + Y_T/a$

For the various return periods of 20, 25 and 30 years, respectively we have;

$Q_{20} = 0.36+2.98/3.212 = 1.288$
$= 1.288 \times 10^{4} m^3/s$
$Q_{25} = 0.36+3.19/3.212 = 1.353$
$= 1.353 \times 10^4 m^3/s$
$Q_{30} = 0.36+3.38/3.212 = 1.412$
$= 1.412 \times 10^4 m^3/s$

The maximum annual flood for the return periods are as follows:

T_r 0f 20 years, $Q_{20} = 1.288 \times 10^4\ m^3/s$ T_r of 25 years, $Q_{25} = 1.353 \times 10^4\ m^3/s$ T_r of 30 years, $Q_{30} = 1.412 \times 10^4 m^3/s$

Determination of the stage of Otamiri: The maximum annual flood for the study area was evaluated in order to analyze flood behavior and assess variations in discharge (Q) across different return periods (Tr). This analysis provides insight into the frequency and magnitude of flood events. Table 4 presents the relevant parameters and values employed in estimating the flood characteristics.

$\sum Q = 62000.26$
N = 16 years, $x = \sum Q/12 = 0.52 \times 10^4$, $\delta = (\sum(X - x)^2/n - 1)^{1/2}$
where, n = 16; substituting values we have the following;
$= (15.45/16 - 1)^{0.5} = 0.321\times10^4$

N/B expunged table is found in the appendix
From the above table the average stage during the above period is given by:

$A = \sum AV/n = 7.56/11 = 0.69$ m

Table 6: Hydropower potential of river at various flows

Time of flow (%)	Available flow (m^3/s)	Net head (m)	Turbine efficiency (%)	Generator efficiency (%)	Power (KW)
50	6700.00	0.69	80	95	3.45×10^4
75	2200.00	0.69	80	95	1.13×10^4
100	284.95	0.69	80	95	0.15×10^4

The Otamiri River stage values presented above were computed using the hydrological data obtained from the Anambra–Imo River Basin Development Authority for the specified study period, as shown in Table 5.

Assessment of hydropower potential (H.P):
Average monthly discharge:
= 1/12(cumulative of all discharge)
= (690.83+1064.74+2531.19+4632.87+7336+8638.55
+9342.19+8879.32+10112.25+6777.64+1712.48+ 284.95)×1/12
= 4447.04 m^3/s

According to Sule *et al.* (2011), the hydropower potential, H.P of the river is given by:

$P = g\,Q\,H\,E_t\,E_g$
where,
g = Acceleration due to gravity (9.81 m^2/s)
Q = Available flow
E_t = Efficiency of the turbine
E_g = Efficiency of the generator
H = Head or stage of the river

But on converting the power from KW to MW we have the following (Table 6):

Power, P at 50% time of flow = 34.5 MW
Power, P at 75% time of flow = 11.3 MW
Power, P at 100% time of flow = 1.5 MW

VI. CONCLUSION

Based on the statistical evaluation of hydrological data collected for the Otamiri River and its associated catchment, the estimated **available hydropower potential (AHP)** varies with flow reliability. At a 50% flow exceedance level, the AHP is approximately **35.4 MW**, while at 75% flow reliability it decreases to **11.3 MW**. Under conditions of continuous (100%) flow availability, the estimated hydropower potential is about **1.5 MW**. Given the relatively low elevation difference (hydraulic head) within the catchment, a **run-of-river hydropower scheme** is considered the most suitable option for the study area. In such systems, energy generation relies primarily on the kinetic energy of the flowing river water acting directly on the turbine blades rather than on water storage or significant head

Furthermore, the level of economic development and self-sufficiency of a nation is strongly influenced by its capacity to generate adequate and reliable electrical power, which is essential for supporting industrial activities, production processes, distribution networks, and the overall energy demands of the population..

REFERENCES

[1]. Arora, K. R. (2004). *Irrigation, water power and water resources engineering* (4th ed.). Standard Publishers/Distributors.
[2]. Bernhard, L., Czisch, G., & Vassels, S. (2010). Europe's hydropower potential today and in the future. *European Journal*, *8*, 1–22.
[3]. Bhattacharya, P. K. (1988). *Water power engineering* (3rd ed.). Khanna Publishers.
[4]. Deschande, M. V. (1986). *Elements of electrical power station design* (3rd ed.). Wheeler Publishers.
[5]. Egboka, B. C. E., & Uma, K. O. (1985). Water resources of Owerri and its environment, Imo State, Nigeria. *Journal of the Ministry of Geology*, *22*, 57–64.
[6]. Eickemeser, P., Hansen, G., Edenhofer, O., Riahi-Madnya, R., Sokona, Y., Seyboth, K., Matschess, P., Schlömer, S., & von Stechow, C. (2001). *Special report on renewable energy sources and climate change mitigation*. Cambridge University Press.
[7]. Eurelectric. (2000). *Statistical yearbook* (Vol. II). Union for the Coordination of Transmission of Electricity (UCTE).
[8]. Ibe, K. M., & Uzoukwu, S. C. (2001). An appraisal of subsurface geology and groundwater resources of Owerri and environs based on electrical resistivity survey and borehole data evaluation. *Environmental Monitoring and Assessment*, *70*(3), 303–321.
[9]. Iloeje, N. P. (1972). *A new geography of West Africa*. Longman Group Ltd.
[10]. Inamdar, S. S., Sinha, A. K., & Dudhari, S. (2006). Assessment of small hydropower potential using remote sensing data for sustainable development in India. *Energy Policy*, *34*, 3195–3205.
[11]. Khang, M. (2006). Development of hydropower in Myanmar. In *Small hydropower development and programmes worldwide* (pp. 21–24). http://www.hrscp.org
[12]. Kucuker, B. C., Baruah, D. C., Bordoloi, P. K., & Patra, S. C. (2011). Assessment of hydropower potential using geographical information system and hydrologic modeling techniques in the Kopili River Basin, Assam, India. *Applied Energy*, *88*(1), 298–309.
[13]. Lindsley, R. K., Franzini, J. B., Freyberg, D. L., & Tchobanoglous, G. (1992). *Water resources engineering* (4th ed.). McGraw-Hill.
[14]. Njoku, J. D., Nnaji, A. O., & Iwuji, M. C. (2011). Spatial analysis of soil fertility using geographical information system (GIS) technology. *African Research Review*, 511–524.
[15]. Sharma, R. K., & Sharma, T. K. (2003). *Water power engineering* (1st ed.). S. Chand and Company Limited.
[16]. Simmers, I. (1988). *Estimation of natural groundwater recharge*. North Atlantic Treaty Organization, Scientific Affairs Division.
[17]. Sule, B. F., Salami, A. W., Bilewu, S. O., Adeleke, O. O., & Ajimotokan, H. A. (2011). Hydrology of River Oyun and the hydropower potential of Unilorin Dam, Ilorin, Kwara State, Nigeria. *New York Science Journal*, *4*(1), 69–78.
[18]. Uma, K. O. (1984). *Water resources of Owerri and environs* (Unpublished master's thesis). University of Nigeria, Nsukka.
[19]. World Energy Council. (2004). *Survey of energy resources*. World Energy Council.