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Environmental Consequences of Receded Iyi-Ocha Lake Surrounded by Federal Polytechnic Oko, Amaokpala and Nanka Communities

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ABSTRACT

A The purpose of this project is to share the finding of study and advocate the need for the administration of Federal Polytechnic Oko to undertake the issue of providing Water to the Polytechnic community as paramount and the solution to the receding Iyiocha lake which could useful in the provision of water. The poor state of water and sanitation facilities in the campus particularly the permanent site is a major factor for the declining health and the reduction in productivity among the students and staff. The major water and sanitation related ailments reported in the school apart from malaria are diarrhea and worm infestation, which indicates that water and sanitation facilities are inadequate in the campus and to ascertain the cause of solution to the receding lake. Therefore, there is a need for such facilities to be provided and upgraded in spite of the environmental consequences of the receding lake which is to be (-1.1) due to environmental impact, also in the rainy season to observe good contribution of water from the lake to the ground water ,as it ceases to discharge to the Lake during rainy season. The main objectives are to identify enough water to serve the population with adequate water supply and promoting better health practice focusing on the use of clean water, good hygienic and proper excretion disposal. Moreover rainfall data was collected from the department of Geography and Meteorology, Nnamdi Azikiwe University Awka, was used to determine the re

Keywords: environmental impact, recession, water supply, lake, and hygiene

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Introduction

Water is one of the fundamental elements of life and it is essentially for survival of mankind as defined precisely by Garg (2013) in his water supply engineering. Paju et al (2004) in their integrated water resources planning and management concluded that water is recognized as a basic and crucial natural resource for over all development of any nation. However, due to uneven distribution of water resources, increase in demand and unplanned use therefore, the planning and management of the scarce water resources became a key issue in the polytechnic.

The availability of water does not match with the demand in terms of quantity and quality in the campus.

WHO and WORLD BANK (2009) quantify the effect of water scarcity and it's significant, concluded that it must be appreciated that water resources are limited and that human activity has an impact on the environment. The research on Iyiocha Lake could bring solution to water scarcity in the institution. Iyiocha as a lake and body of water surrounded by land which has some minimum surface area free of rooted vegetation and with an average hydraulic retention time of more than twelve days. Iyiocha has a natural outflow that discharges to Odor River in Amaokpala. It loses water solely by evaporation, underground seepage and outflow. Iyiocha is an oligotrophic lake, which is fairly clear and clean, and deep free from weeds or large algae bloom at the centre. It has a low nutrient level and does not support the growth of large fish population. Obviously Iyiocha is an intermittent lake as it disappears in the dry season and reappears in the rainy season Orji and Ezenwaji (2017).

Eduputa et al (2015) as observed in their morphometric and regional planning aspects of Otalu River basin are of the view that Iyiocha is in the nature of low land lake and more placed and sedimentary, has less sloppy bottom and generally contains more plants life along the banks some years ago Iyiocha used to be the main source of water for polytechnic, Oko, and Amaokpala communities before the institution was totally fenced with block wall.

The lake disappeared and reappeared completely some years ago. It has weeds, at its banks and no weeds at the centre. There are some silt-materials deposited by the runoff and surprisingly the water is fairly clean. The lake has two channels that recharge it with water, from federal Polytechnic and Nanka buttaye, while a channel discharges the water to Odor River in Amaokpala. More so,the lake is recharge through the underground water in the dry season and runoff in the rainy season over a time land water use activities which are included by both natural and human activities have led to land degradation, blooming of toxic algae in the water ways eutrophication problem, rapid discharge the lake to ground water. Iyiocha is an immense lake that receives water from Federal Polytechnic at it discharge to Odor River and it gradually recedes or vanishes as the case may be, over the course of four months in the dry seasons some years ago, as stated by Orji and Ezenwaji (2007) in their seasonality and distribution of fecal indicator in Agulu Lake.

Gaston (2006) in his global pattern biodiversity is of the view that most of the receding stream such as iyiocha are affected due to global warming and the dramatically change of world's geography.

At the extremely adverse dry season the lake recedes to mere trickle and the flow dropping precipitously causing the search of water among the farmers who cultivate vegetables and small crops for sale.

The lake is slightly polluted in the rainy season as storm water carriers surface pollutants, as nitrate from farmland to deposit in the lake and in the dry season comes eutrophication as the lake recedes.

The impact of recession interferes with breeding success massive elimination of wild

life, such as fishes, birds and other animals. This lake requires sufficient rainfalls which can recharge it and ensures adequate habitats for Lake Biota and to keep the lake temperature very ambient.

Statement of Problem

The water supply in the polytechnic is epileptic as a result of some non functional boreholes and mostly the receding Iyiocha Lake which occurs mostly in the dry season, approaches the month November and recharges the ground aquifers. The increase in global temperature causes the changes in the seasons which lead to decreases in rainfall.

In adequate of water supply in the campus leads to students tracking long distance to fetch water before attending lecture and some resort to defecating in the rear bushes.

The potential associated with water scarcity is becoming an emerging risk of strategic important for businesses to thrive and the absenteeism of students to lecture. All these are as the result of environmental consequences of Iyiocha recession.

Significant of the Study

Iyi-ocha plays a vital role in supporting Polytechnic community in developing the economy of the institution, examples are Department of hospitality and food technology even the admission rate of the new-intakes. It could be use to create a better future and to address issues of maintaining and enhancing environmental health and sanitation, limiting inaccessibility for-water, lack of flexibility use and improving water use efficiency and improving community involvement.

It will serve as a means of transportation from one community to another, example from Nanka to Amaokpala verse versa. Moreover, it will improve socioeconomic of the communities around, domestic and industrial water supply and employment opportunities.

Aim and Objective

The aim of this research work is based on restoration of receding Iyiocha Lake which purpose is to identify and test constraints, opportunities and strategy for enabling the polytechnic to deliver an acceptable water service to the campus by finding lasting solution to water scarcity in the school. It provides some background and brief information on the potable water supply and outlines typical constraint facing by the students and staff of the polytechnic.

Moreso, objectives are to develop viable mechanism through which the provision of water utility could be achieved in alleviating sanitation problem of both students and staff through.

- Identifying enough water to serve the population with adequate water supply.
- Providing reasonable access to safe water to the polytechnic community.
- Improving the quality of life of the polytechnic community through promotion of better health practices, focusing on the use of clean water, good hygiene and proper excretion disposal.
- Increasing capacity of the polytechnic community in supporting administration’s activities, planning and maintenance of water supply and sanitation.
- Finding reason of Iyiocha occasional disappearance and reappearance.
- Finding a lasting solution to the lake recession.

Review of the problem

Some hundred billion gallons of water just missing over the years in Africa because of change in climate, lack of integrated water resources, development and environmental impact assessment (Ezenwaji, 2007) water is the hub of life and indispensible part of all terrestrial ecosystem and it is the greatest resources of humanity and the basic need and human right of every citizen that helps human beings survival in every aspect of life such as

drinking, food production, daily necessities, comfort and luxury as stated by Gupta (2013) in his water resource engineering.

Water is essential for all socio-economic development and for maintaining healthy ecosystem (environment), WHO (1997) in global school physical environmental and health initiative.

Access to clean and safe water is fundamental for socio-economic modernization and the provision of safe water reduces private and public health expenditure as well as saving the economy value of the days of sickness. More so, plays a vital role in supporting community and it developing economy(Ezenwaji and Okoye 2011)

Population increase and development call for increase in allocation of ground and surface water for domestic agriculture and industrial revolution (Mass, et al, 2015). Moreover, human development is inextricable linking with issues relating to proximity quantity and quality of water, (Monroe, 2006). Water has an economic value in all its competing uses and shall be recognized as economic goods, (Modi, 2008) in his irrigation water resource and water power engineering.

Walther et al (2002) in their ecological responses to recent climate change nature gave the importance of growing demand for water, is one of the major factors threatening the sustainability human health and ecological integrity in the coming years. Also the scarcity of water associated with rapid urbanization posing striking challenges in the management practice of water resources in the school and environs.

Ezenwaji and Okoye (2011) are of the opinion that most stream and lakes in Africa are disappearing today faster than ever at an unprecedented rate. They further stated that, Agulu Lake in Anambra receded dramatically in 2003 and reappeared in 2004 with in a short period causing and adverse health effects and caused the death of fishes and reptiles. Likewise, Therivel (2004) in strategic environmental assessment in Action noted that the existence of an Oasis in Niger Republic decreasing the point of becoming a desert due to diversion of water from Lake Chad basin for crops irrigation.

In recent time Dead Sea start receding slowly, wasting always and evaporating on hot summer has dramatic decreased the lake size as observed by Hampel et al (2010) in response of faults to climate driven changes in ice and water volumes on Earth’s surface They, also suggested to stem the disappearance of the Dead Sea, that Israel, Jordan and Palestine to agree to a plan, to pump some quantity of water per year from Red Sea.

In the same vein Lake Faguibine in Mali was one of the largest lakes in West Africa fed by the Niger River, the ecosystem supported a healthy economy of fishing, agriculture and livestock herding. In recent time, unfortunately droughts completely derived the lake, forcing residents to seek subsistence from other sources, Bindoff(2007). Therefore, the return of rains in the recent years added about six percent (6%) of former surface area to Faguibine but long term restoration appears impossible.

The Lake Chad basin in central Africa is one of the most dusting places on earth and an ecological catastrophe according to WHO and World Bank (2009). The lake shrank by ninety five percent (95%) and with the lack of water and marshes; dust chokes the area, beginning to process of dune formation and the desertification of a once lush habitat. In most cases the attendance of global warming is a potential change in precipitation and increase in average temperature cause great consequence in environment thereby loosing ecological values.

In the case of Iyi-ocha Lake the changing course is so drastically that the drainage basin no longer reaches its original out let and these changes may eventually impact human and

biological communities that have grown around the lake outlet.

Masamitsi (2012) provided an overview of the temperature reaching a scorching 52^{o} degree centigrade during the summer, the evaporation of Lake Assal in Djibouti is an unavoidable reality house in a volcanic crater the body of water which is likely separated from Guff of Aden, and the greater India Ocean by lava flows. He also maintaining that in such harsh condition Asaal Lake sees little rainfall runoff to feed the lake. Instead its volume is replenished through subsurface water flow from nearby gulf one.

One of just a few lakes that has not shrunk due to water diversion, Assal is still an important natural resources for the local economies. The lake is ten times more saline than seawater and its salt is harvested for distribution across Africa and Europe.

Lake Chad own by the following countries Chad, Niger, Nigeria and Cameroon is another lake affected by the effect of recession of the water. The Lake Chad basin in central Africa is one of the most dusting places on earth and an ecological catastrophe to the United Nation (2011). Like the Aral Sea, the Lake's main feeder, the Chari River has diverted to provide irrigation for farmer in different regions. Observation shows between 1963 and 2001 the lake shrank by ninety five percent to just 580 square mile. However, it was previously measure more than 10,000 square miles and with the lack of water and marshes, dust chokes the area, beginning the process dune formation and the desertification of a once lush habitat.

The nations of Chad, Nigeria, Cameroon Niger and Central African Republic, which are home to Chari River tributaries they hope to pump water from the Congo River North towards the Chari. Although the Congo dumps water in the Atlantic Ocean, the effect of diversion towards Chad remains unclear.

Moreover, Nzoiwu and Ezenwaji (2017) in contribution to Anthropogenic factor observation showed few years ago the Iyiocha Lake disappeared and reappears due to climate change. The lake, reappear in 2013 when the entire Nation witness heavy down pour and flooding that displaced most people from the river line area.

Causes of Iyiocha Recession

(i) Silt-deposit

Iyiocha is built up of silt deposits as has not been maintained or not dredged for many years. The rolling debris from the vegetation, such as overhanging trees or over grown banks is significant contribution to the problem of its recession.

More so, over wearing away on the banks caused by outflow of the water level of the lake increase.

As this process continues, there will be continuous wearing away of the bank of the lake, which will finally end up in total wearing away of the bank. Eventually, could cause a total recession of the whole water in the lake.

(ii) Outflow

An outflow of this lake towards Amaokpala, could be in the form of over flooding, evaporation, earth or concrete drainage system. Precisely excessive evaporation can cause the enormous loss of water in the lake.

(iii) Over-Dredging

At the downstream, poor dredging and sale of sharp sand for commercial purposes contributes tremendously to the recession of Iyiocha Lake.

(iv) Erosion

Erosion contributes a lot to receding of Iyiocha Lake due to negligence of the communities surrounding the lake. The communities channel the storm water coming from their bonuses towards the lake and even dump their refuges on the natural drains and water ways indiscriminately.

The water that flows out the lake through a sloppy ground and causes the wearing away of the banks leading to continuous outflow of water from the lake and if not controlled can cause the water in the lake to dry up. Erosion brings about silting which also causes the disappearance of Iyiocha in the past.

(v) Over Pumping

Over pumping of water from Iyiocha for commercial purpose by the water tanker vendors also contribute to the receding effect of the lake. As the extraction of water continues due to increase in demand of water the quantity of water being extracted becomes more than the quantity of water recharging the lake and this leads to the reduction in water table or level. When the extraction is a continuous process the whole water in the lake drains up.

(VI) Increase in Temperature

The scourge imposed by temperature increase affects Iyiocha as Nigeria a West African country is situated close to equator in tropical zone. The release of carbon and other green house gases is leading to depletion of ozone layer, which exposes the earth to direct sun rays, also increases the temperature of the earth above normal, in the tropical region.

(vii) Low Annual Rainfall

The low annual rainfall caused the receding effect on the lake, as there is always high demand of water from the communities surrounding the lake. The demand out runs the supply or recharge from both surface and groundwater.

(viii) Deposit of Sediments

When some sediment carried from run offs are deposited with lake and the continuous increase in the deposit raises the water in the lake beyond the free board allowance and thereby exceeding the lakes free board allowance which in turn cause outflow. This outflow which is a trickle form causes the lake bank to break and when this action break bank is not controlled, water will drastically escape the lake.

Methodology

Study Area

Iyi-ocha Lake is surrounded by Federal Polytechnic Oko, Amaokpala and Nanka Communities all in Orumba Local Government Area in Anambra State. The Lake is geographically coordinated at 63.000” N-6^{o}230” and 7^{o}6’00”E – 7^{o}5’25”E see fig:

Federal Polytechnic is an academic environment predominantly students, Nanka and Amaokpala Communities are mostly formers and business people, especially commercial sand dredgers select.

The area is found in Ameki formation of unconsolidated and friable soil. The climate is hot equatorial with average maximum at 33^{o}C and 21^{o}C minimum.

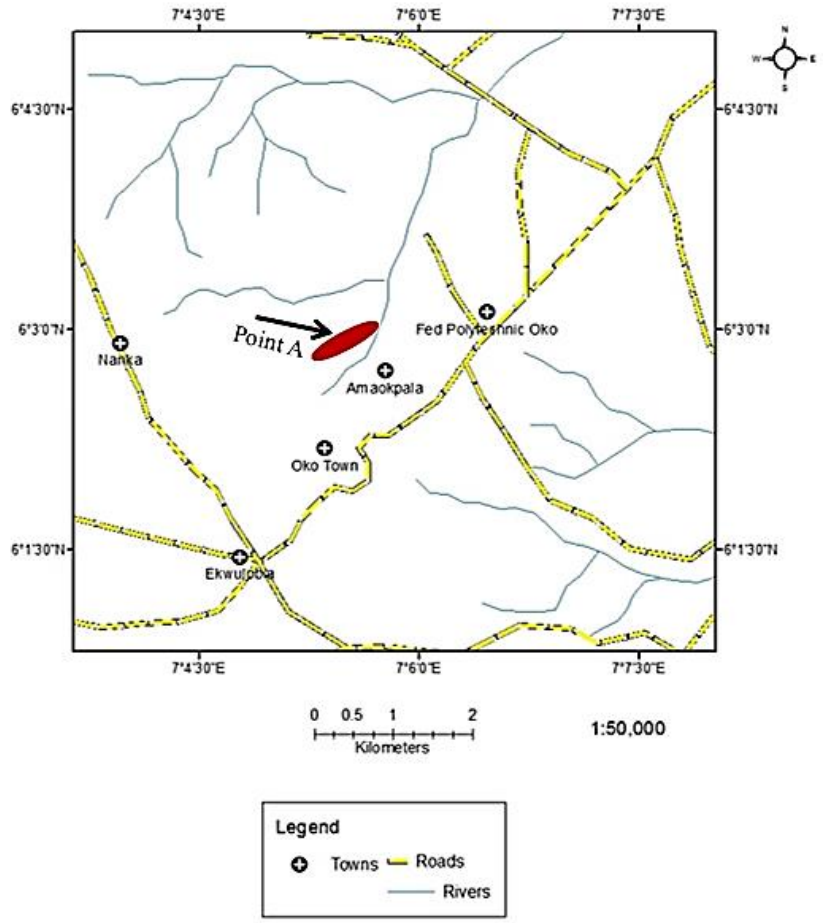
The rainfall, temperature, relative humidity wind and wind speed was collected from Nnamdi Azikiwe University, Geography and Meteorological Department.

In rainy season the flood carries silt through runoff and deposits them in the lake. The process of siltation continues over long period of time resulting in the formation of alluvial soil (Ezenwaji, 2009). Iyiocha Lake is semi-perennial and very important to Federal Polytechnic and the neighboring town like Amaokpala, and Oko Communities, see fig. 1.

The survey was done in the rainy season using local canoes to measure across the breadth at five intervals to determine the average depth(2.03m) and intervals 25m chainage to determine the length of 953m.

Also,the rainfall data was collected from Nnamdi Azikiwe University,department Geography and Meteorology at an average 70m radius.

MAP OF FEDERAL POLYTECHNIC OKO AND ENVIRONS



GOOGLE IMAGE OF FEDERAL POLYTECHNIC OKO AND ENVIRONS

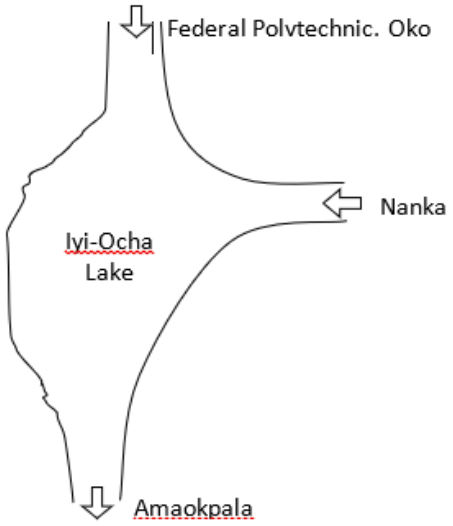


Fig.1: Plan View of Iyiocha Lake

After precipitation over the surface area, the surface runoff resulting from this precipitation loses some quality of water through evaporation, filtration, surface storage and transpiration.

The surface runoff travels from the up hills surroundings the Lake to contribute to the Lake recharge after rainfall. The interflow or subsurface flow percolates the surface but remains entrapped in a layer just below the surface. The water flows with the prevailing slop of the earth's surface and is influenced by the geology of the area that is hilly. The interflow joins the lake and contributes to total Lake Water Ezenwaji et al (2015), in the area of Ameki formation with unconsolidated and friable soil the soil condition is favorable in the area and therefore infiltration goes deeper into the soil to join the ground water table.

In the dry season when the water level falls below water tables, the discharge takes place from groundwater to the lake. The contribution of groundwater to the lake discharge is at smaller rate as it is restricted to permeability of the soil but it continues over a long time and this causes Lake Recession. Moreover during dry season the direct runoff to the Lake ceases as the ground water tend to recharge the Lake. In the season of no rainfall, the ground water reservoir is slowly exhausted and the Lake gradually recedes and runs dry stated by Garg (2013) in Irrigation engineering and hydraulic structure reference to fig. 2:

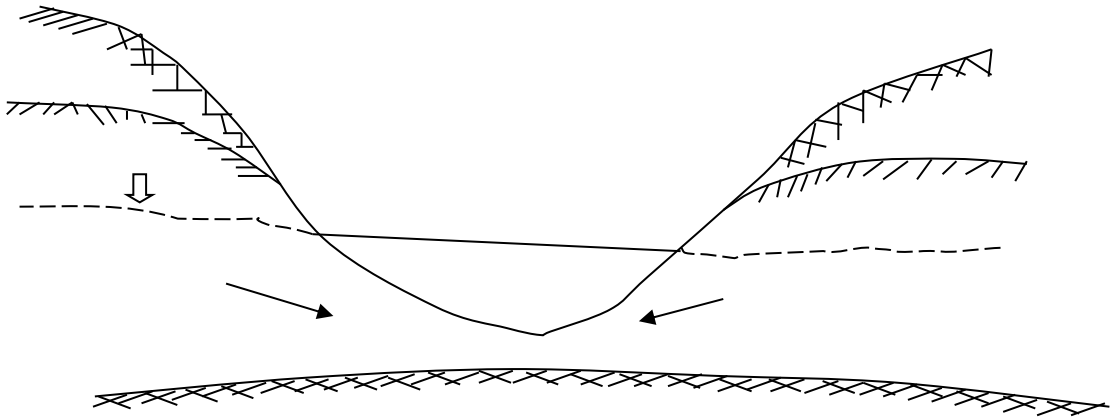


Fig 2: Ground water flow to Lake

Contrary, in the rainy season the Lake receives enough water (precipitation) and there is good contribution of water from the Lake to the groundwater, as it ceases to discharge to the stream by Gard (2010) in his elementary irrigation and engineering. In this period it rises enormously fast to higher level and aquifer being saturated with water from the Lake, sees Fig.3 below:

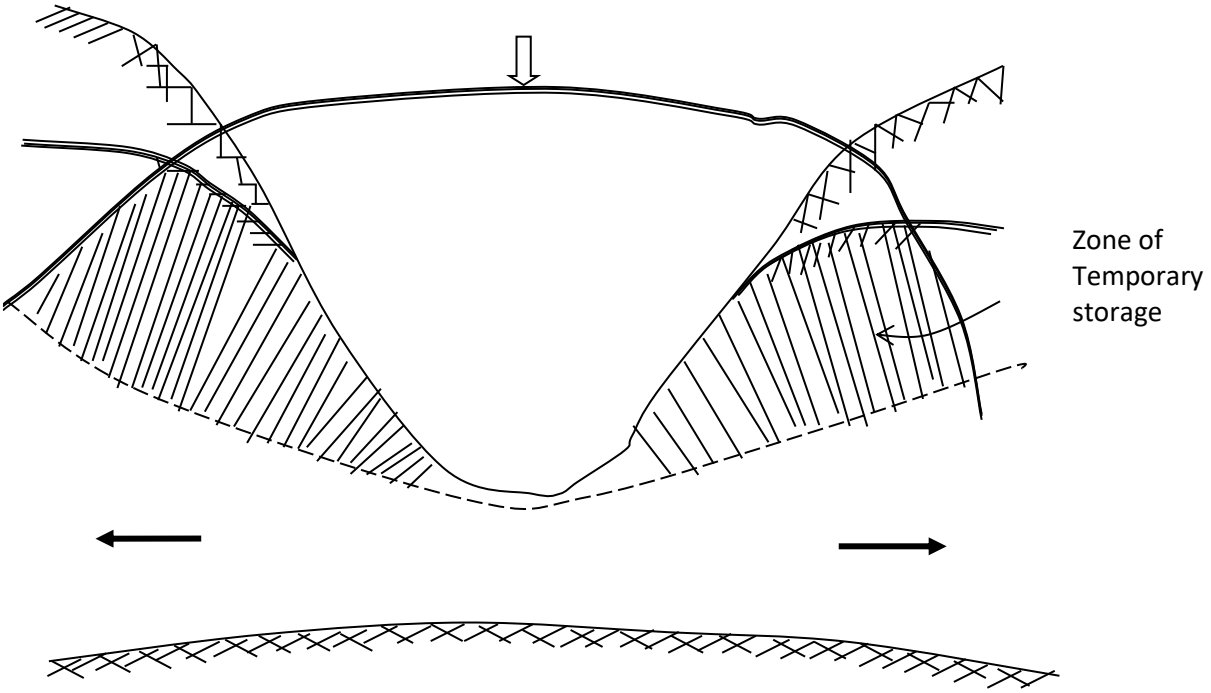


Fig. 3: Recharge from Lake to ground water

Table 1: Moving, rain fall, temperature, Relative humidity wind and wind speed (2017)

Month	Wind	Wind speed	Rain	Temperature	Relating humidity
Jan.	131.83	0.49	0.00	26.98	49.9
Fed.	160.57	0.48	17.53	29.76	54.5
Mar.	175.30	0.50	94.74	29.28	73.3
Apr.	168.57	0.49	156.97	28.92	75.0
May	162.12	0.44	179.83	28.11	77.5
June	171.81	0.48	333.76	28.77	80.7
July	171. 43	0.45	458.21	25.91	83.7
Aug.	183.93	0.49	312.16	25.90	83.1
Sept.	171.08	0.48	157.99	26.09	83.0
Oct.	163.78	0.45	161.80	27.03	80.2
Nov.	161. 50	0.36	22.10	28.55	74.5
Dec.	149.15	0.33	0.00	27.62	66.4

Table 2: Monthly rainfall, coefficient of infiltration and infiltration (2016)

	Rain	Coef. Infiltration	Infiltration
1.	0.00	0.90	0.00
2.	17.53	0.90	15.78
3.	94.74	0.79	74.85
4.	156.97	0.77	120.87
5.	179.83	0.58	104.30
6.	333.76	0.37	123.49
7.	458.21	0.37	169.55
8.	312.16	0.37	115.50
9.	157.99	0.37	58.46
10.	161.80	0.37	59.84
11.	22.10	0.37	8.18
12.	0.00	0.37	0.00
	Σ1895		**Σ850.82**

Water Budget/Balance Equation

The method balances all the incoming out going and stored water in the Lake over one year in the lake over one year 2016 processing by following the equation with reference to table (1) and (2).

Σ Inflow - Σ outflow - Δs change in storage

Σ Inflow

- Surface water inflow = Isf
- Ground water inflow = Igf
- Precipitation =R

Σ Outflow

- Surface water outflow
- Ground water outflow
- Evaporation E

$\Sigma I - \Sigma O \pm \Delta s$

Iyi-Ocha Lake

Observation for a period of 305 days Average surface of Iyiocha Lake

Actual Depth :2.03m

Length:1.15lcm

Width :107m

Rainfall:1895mm

Infiltration:850.82mm

Mean surface inflow rate 205m^3/n

Mean surface outflow rate 225m^3/n

Coefficient of Evaporation = 0.47

Surface Inflow

205 x 24 x 260 = 1,279, 200 m^3

Rainfall

1895/1000 x 107 x 953 = 193,235m^3

Total Inflow = 1,472,435m^3

Surface Outflow

225 x 24 x 260=1404,000m^3

Infiltration

(850.82/1000) x 107 x 953 = 86,759m^3

Evaporation

(1895/1000) x 107 x 953 x 047= 90,821m^3

Total Outflow= 1,581,580m3

Total Inflow – Total Outflow= (109,145)m^3

1733780 – 1,861289 = -109,145m^3

Receding Level-$\frac{109{,}145m^3}{107\ x\ 953m2} = -1.1m$

Analysis and Discussion

Observation, shows that the area is in Ameki formation of unconsolidated and friable soil condition, favorable to rapid infiltration that goes deep into the soil to meet the ground water table .In the dry season the direct runoff to the lake ceases and the ground water tend to recharge the lake. Moreover in the season of low rainfall the ground water reservoir is slowly receded and runs dry as observed from the calculation (receding level 1.1m). It is also shows how incremental temperature increases can produce sudden and dramatic environmental impact. Even the relative humidity, with wind velocity contributed much in the recession of the lake.

Consequently, the recession is being caused by two factors, which are natural and non natural. In the institution only the two functional boreholes in the medical and the main administration building cannot meet up the demand for portable water, both in the permanent and extension sites.

The three climate elements are used as independent variable and are correlated on the receding Lake. However, the natural trend of low rainfall, the less likely is relative humidity, as climate affects all the parameters, temperature, rain fall and relative humidity which adversely affect the Lake in receding.

Conclusion

In availability of sufficient portable water supply to the institution, especially in the dry season has caused restiveness among the students in the campus. The students depend on water vendor and occasionally trekking to nearby communities in search of precious gold called water.

The provision of portable drinking water is minimal in the up campus but none in the extension site, therefore, the polytechnic administrative should deem it fit to ameliorate the problem by harnessing Iyi-ocha Lake.

Moreover, the provision of potable water to the Polytechnic Community should not be over emphasized as there is no atom of water at the extension site, the only water borehole is not functional, which caused emotional effects on the students who defecate around. A solution to the development of Iyiocha Lake will not only bring succor to the entire Polytechnic also to the nearby communities who are totally depend on the Lake Resource and commercial activities in the campus

Although the previous administrative made some effort to harness the lake to the benefits of both staff and students, inability and questionable indicative of incompetence on the part of executing contractors, or the desire to make profits at the expense of well-being of the Polytechnic community, being provided with the facility.

Recommendations

- The identification and conformation of key constraints facing the receding Iyiocha Lake must be tackled with immediate attention in order to provide the entire polytechnic community with acceptable water service.
- The solution to receding Iyiocha Lake should be jointly implemented through the high participatory approach of both the Allumina Association of the institution and the Polytechnic Authority to facilitate quick completion.
- Moreso, the responsibility of operation and maintenance should be delegated to the staff of works department who have enough experience in strategic management concept and can derive a solution oriented planning framework for its operation.

- A concrete weir should be constructed at outflow end to improved and retain some quantity of water in the rainy season which, could sustain the dry season period.

REFERENCES

1. Ashish Kumar & Siddhearth Jain (2013). *Water Resources Engineering*. ARDENT Publication New Delhi 1st Edition.
2. Bindoff, N.L. (2007). *Observation: Oceanic Climate Change and Sea Level, Implication for Earth's Heat Balance.*
3. Bond David, P.G. Wignall, Paul, B. (2008). *The role of sea level change and marine anoxia*.
4. D. Masse, J.L. Chatte, Escopel (2015). *Ecological engineering for sustainable agriculture in arid and semi –arid West Africa.*
5. Darko Mensah E, Salifu, L.Y. (2006). *SEA of water and Environmental Sanitation: A Practical Guide Environmental Protection Agency (EPA).*
6. Eduputa, B.M., Ezenwaji, E.E. and Onwuka, S.U. (2015). Morphometric and regional Planning Aspects of Otalu River Basin. *Nigeria Geographical Journal. New Series 14*; pp. 83-96.
7. Ezenwaji, E.E. (2009). *Climate and Change Household Water Supply Strategies in Aguata and Orumba Area Climate Change and the Nigeria environment*. pp. 613-624 Jamoe Publisher, Enuge Niger.
8. Ezenwaji, E.E. and Okoye, A.C (2011). *A multivariable Assessment of the Quality of Water from Mamu River and Potential for the Supply of Water to Awka Capital of Anambra State Nigeria: Ecological problems*. Related Disasters and Sustainable Development; German Press; Germany.
9. Gaston, Kelvin, J. (2000). *Global Pattern in Biodiversity*.
10. Hampel, A., Hetzel, R. & Maniatis, G. (2010). *Response of faults to Climate-driven, Challenges in ice and water volumes on Earth's Surface*.
11. Margaret Munroe (2006). *Climate Change Causing Corrosive Water to Affect Arctic Marine Life Study.*
12. Modi, P.N. (2008). *Irrigation Water Resources and Water Power Engineering*. Standard Book House, New Delhi.
13. Nzoiwu, C.P. and Ezenwaji, E.E. (2017). Contribution of Anthropogenic Factor to the Observed Surface Area Variation of Agulu Lake, Anambra State. *Journal of Geography Meteorology and Environment 2*(1), 41-49.
14. Orji, M.U. and Ezenwaji, E.E. (2007). Seasonality and Distribution of Faecal Indicators in Agulu Lake Anambra State Nigeria. *Journal of Science Engineering and Technology Vol.14* No.1 pp.1227 – 2287.
15. Phil-Eze, P.O. and Ezenwaji, E.E (2009). Rural water-supply Development Strategy for Environment Sustainability in Old Aguata Local Government Area of Anambra State. *International Journal of Architecture and Built Environment Vol.1* No.1 pp.77-83.
16. Raju KS Sarkar AK Darsh, M.L. (2004). *Integrated Water resource Planning and Management.* Jain Brothers – New Delhi.
17. Sanjay Gupta (2013). *Water Resources Engineering*. 1st Edition VAYU Education of INDIA New Delhi.
18. Santosh KUMAR GARG (2010). *Elementary Irrigation Engineering*. KHANNA Publishers, New Delhi.
19. Santosh-Kamer Harg (2013). *Water Supply Engineering.* Khanna Publications, New Delhi 23rd Edition.
20. Santosh-Kumar Garg (2013). *Irrigation Engineering and Hydraulic Structures*.
21. Subramanya, K. (2013). *Engineering Hydrology 4th Edition*. McGraw Hill Education.
22. Therivelt (2004). *Strategic Environment Assessment in Action, Earths can*.
23. UNICEF and IRC (2007). *A manual of School sanitation and Hygiene*.
24. Walther, G.R., Post E. & Convey, P. (2007). *Ecological Responses to Recent Climate Change Nature 416* (6879) 389-395.
25. WHO & World Bank (2009). *Climate Change and Biological Diversity: Convention on Biological Diversity.*
26. WHO (1997). *Global school physical environmental and health initiative*.
27. World Health Organization and UNICEF (2006). *Meeting the MDG drinking water and sanitation target. The urban and rural challenges of the decade.*
28. Wurbs, R.A and Wessley, P.J. (2007). *Water Resources Engineering*. Prentice-Hall of INDIA, New Delhi