Research Article

EVALUATION OF WATER SHED SUSTAINABILITY AT OJI RIVER UNDER STOCHASTIC PARAMETER

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Abstract

Water is absolutely essential not only for survival of human, but also for animals, plants and all other living things. In many developing countries lack of potable water have been a great problem, one of the most affected regions in West Africa in Nigeria, though it has quite large resources of freshwater and reliable rainfall it is one of the countries that is most encountered by drinking water problems. Many communities depend on few wealthy men for their daily water demand, many other villages around river line areas depends on surface water. This work aim at Evaluating the sustainability of Oji river Enugu State Nigeria and providing potable and wholesome water to the area under most beneficial and economical means.

Keywords**:** Evaluation, Water Shed, Stochastic, Parameter.

Introduction

Water is a chemical compound which may occur in a liquid or solid form or also in gaseous form. Water is absolutely essential not only for survival of human beings, but also for animals, plants and all other living beings. Furthermore, it is necessary that the water required for their needs must be good and it should not contain unwanted impurities or harmful chemical compounds or bacteria in it (Rim-Rukeh, 2018; Joseph, Umoren and Offiong, 2016). Therefore in order to ensure the availability of sufficient quantity of good quality water, it becomes almost imperative in a modern society to plan and build suitable water supply schemes which may provide portable water to the various sections of community in accordance with their demand and requirements.

Background

Clean water is essential for humans and has a profound effect on health. It is a medium that disease causing – agents may be transported into humans. Water impacts on human health through consumption of water consisting of pathogenic organisms or toxic chemicals. Water also impacts negatively on health if not consumed in a required amount, leading to dehydration or personal health issues.

The usage of water does not only stretch to drinking but also other activities such as cooking, hygiene practices etc. Access to clean water varies today with several areas that are vulnerable of water deficiency or suffer from scarcity. Clean water deficiency is both a projected and also an increasing ongoing problem in Nigeria water security in areas with low societal security and less developed infrastructures are often more vulnerable to natural effects such as earthquakes, storms, flooding etc. The effects of such events are also even more devastating to low developed countries that may lack social and economic ability to handle casualties and destruction due to these events. Scientists claim that the access to clean water due to increase in population.

To provide drinking water with sufficient quality has shown to be one of the most important roles of a water resources engineer. The aim of the study is to evaluate the amount of water available in Oji River and to provide a portable and whole some water for Oji Local Government using Oji River as the source.

Area of Study

Oji River is a local government Area in Enugu State Nigeria. It has border with Anambra State and about State, the towns within Oji River Local Government Area include Inyi, Achi, Awlaw, Akpugoeze and Ugwuoba.

Oji Local Government have a land mass of about 403km2 and a population of 126,587 as at 2006 census and an estimated population of about 173,800 people in 2016.

Problem Statement

i. The problem starts from inability of many people in Oji local government to access portable water for use
ii. Inability of maintenance and water resources agencies to provide wholesome and sufficient water for Oji people of Enugu State.
iii. High rate of water borne diseases in Oji local government area.
iv. High dependent of individuals on few wealthy people for provision of water supply
v. High demand rate of water during dry season
vi. Inability of water resources agencies to evaluate and plan the best and most economic way of providing portable water for the people.

The Scope of Study

The overall scope of this thesis is to access, evaluate and choose the best and most economical water supply project for water resources agency in Enugu State.

Rivers

Rivers are the most important sources of water for public water supply schemes. It is a well known fact that most of the cities are settled near the rivers and it is generally easy to find a river for supplying water to the city. Rivers may be perennial or non-perennial. Perennial rivers are those in which the water is available throughout the year. Such rivers are generally fed by rains during rainy season and by snow during summer season.

Limitations of the study

i. Inability of water resources agencies to provide hydrological data of Oji river
ii. Lack of up to date on birth and death rate by National population commission
iii. Lack of fund

Literature Review

According to Amehmid *et al* (2002), water stabilization ponds have the capacity to remove parasites associated with fecal waste mixed with waste water effluents.

According to UNICEF and World Health Organization, Urban Sanitation Coverage is estimated to be 32% higher than rural coverage in developing nations.

WHO (2006) States that intestinal bacterium are a primary concern in lower income countries, where drinking water contaminated by excreta may lead to instances of typhoid fever.

Nelson and Murray (2008) consider stabilization pond to be favorable for developing countries since they require less energy, and maintenance compared to conventional mechanical system.

Cosmas *et al* (2015) conducted research on comparative assessment of the physico-chemical and microbial trends in Njaba River Niger Delta Basin, Southeastern Nigeria and reported that industrial activity and its effluent have contaminated surface water with large amount of heavy metals.

Vander Hoek *et al* (2003) reported that ground water beneath wastewater irrigated agricultural fields in Pakistan had higher concentration of Contaminants.

According to Murray and Ray (2010), treated wastewater that is reused for irrigation has the potential to improve crop yields, conserve water and offset the demand for chemical fertilizer.

Oyeylola (2012) carried out field analysis on microbial assessments of soil sediments of Foma River, Ha–Nmo Ilorin, Nigeria and reported that turbidity and BOD of surface water were as a result of mining of dolomite and soil wearing away.

Ajibade (2004) observed that the Asa River in Ilorin, North Central Nigeria was polluted while Jaji *et al* (2007) in their study of Ogun River in the South West of the country came up with similar conclusions.

Emmanuel *et al* (2010) has observed negative impacts of discharged effluent from a waste water treatment plant on a receiving watershed in South Africa.

The United State Environmental protection Agency (USEPA 2004) estimates that one out of every three kilometers of the streams in most developing countries is contaminated to some extent. Each day 25,000 people are said to die from their everyday use of contaminated water and many millions more suffer from frequent and devastating water borne illnesses (WHO, 2004).

According to Murray and Ray (2010), treated wastewater that is reused for irrigation has the potential to improve crop yields, conserve water and offset the demand for chemical fertilizer.

Cofie *et al* (2006) believe that at a minimum, high performing waste treatment system are characterized by consistent operational care and maintenance.

Vander Hoek *et al* (2003) report that groundwater beneath wastewater irrigated agricultural field in Pakistan had higher concentration of contaminants.

Summary of Literature Review

From the review of different journals relating to evaluation and supply of portable water using river as a source, it shows that;

i. It is almost impossible to get a portable water free from chemical and biological impurities from rivers
ii. Rivers are good source of water supply if treated
iii. Due to high rate of flow in rivers, it is important to design a screen to remove suspended solids
iv. Treatment of portable water should be carried out using the latest (WHO) standards
v. Many populations lack access to portable and wholesome water.

Data Collection Methodology

1. Data were collected from National population commission Enugu State (No 72 Gariki Enugu State), the other population where gotten by estimation from the commission.
2. The total area of the river was gotten from Anambra Imo river basin authority.

Collection of Water for Analysis

River data collection sample where collected at two different locations. The places were;

- At the swimming platform
- At the fetching point

Precaution taken in collection of water samples

Before collecting samples, the bottles were first rinsed with the sample to be collected, submerged below the water level and allowed to fill completely. The bottles were then screwed on tightly to prevent leakage. Samples were sent to Laboratory for analysis within 30 hours upon collection.

Precaution taken in collection of borehole samples

Ten different bottles where used (white and yellow), the yellow bottles were sterilized, these sterilized bottles were used to collect sample for bacteria sample while the yellow bottles were used to collect samples for chemical analysis. The samples were then sent to the Laboratory within 30 hours.

Method of Evaluation of some sources of water supply in Oji Local Government Area

Two methods which can be used to supply water to Oji Local Government Area were evaluated to know the most economical among them, the two methods were;

- From Oji river
- Borehole

The two methods were evaluated in terms of cost and maintenance and a decision was made on which method was most economical.

Analysis of Results

Evaluation and decision of the most economical means of water supply in Oji LGA

Before any water resource project is embarked on, an economic analysis should first be carried out to know the most economical alternative to be used. The data in Table 1 shows the estimated cost, management and useful life of the projects.

Table 1: Estimation for Borehole

Project Name	Capital Cost (N)
Test on geological formation and aquifer storage	**4,000,000**
Suction pipe	**3,000,000**
Cost of drilling	**3,000,000**
Construction of sand filters	**3,500,000**
Aeration Tank	**20,000,000**
Pump	**5,000,000**
Distribution	**400,000,000**
Disinfection	**2,160,000**
TOTAL	**440,669,000**

The useful life of the borehole is 25 years Annual interest is 8%
Cost of maintenance = N12,000,000

Table 2: Evaluation of Supply through Oji River

Project Name	Capital Cost (N)
Construction of Screen	**2,000,000**
Sedimentation tank	**5,000,000**
Coagulation	**1,000,000**
Intake pipe	**5,000,000**
Distribution	**330,000,000**
Disinfection	**2,000,000**
Pump	**4,000,000**
Areation tank	**20,000,000**
Rapid sand filters	**3,500,000**
TOTAL	**372,500,000**

Useful Life = 30 years
Cost of Maintenance = 14,000,000
Annual interest of 8%
Beneficial cost for borehole

$$CRF = \frac{C(1+c)^N}{[(1+c)^N - 1]}$$

Where C = annual interest rate
N = Useful life
beneficial cost for borehole

$$= \frac{0.08\,(1+0.08)^{25}}{[(1+0.08)^{25} - 1]} = \frac{0.54}{5.84} = 0.092$$

Equivalent annual recovery cost for borehole = 4.40.66 x 106 x 0.092 = 40, 540,728

Annual maintenance = N12,000,000

Total annual cost = N40,540,728 + 12,000,000 = N52,540,728

Beneficial cost from Oji River from table 2

Annual Beneficial cost

$$= \frac{0.08\,(1+0.08)^{30}}{CRF} = \frac{C(1+c)^N}{[(1+c)^N - 1][(1+0.08)^{30} - 1]} =$$

$$= \frac{0.8}{9.06} = 0.088$$

Equivalent annual recovery cost for borehole = 371.5 x 10^6 x 0.088 = N32,780,000
Total annual cost = 32,780,000 + 14,000,000 = N46,780,000

As the total annual cost of river source is less than borehole. River source is more economical.

Population forecast of Oji LGA

Before embarking on any engineering project, it is very necessary to forecast the population of the area to know if the project will serve for the designated period of time.

From the data got from National population commission, the population of Oji local government area was 128,741 as at 2006 census and an estimated population of 173,000 at 2016.

Table 3: population of Oji LGA (2006 Census)

YEAR	POPULATION	INCREASE IN POPULATION
1996	99,350	**29,391**
2016	173,800	**45,059**
TOTAL		**74,450**
Average increase per decade (x)		**X = 74,4502 = 37,225**

The future population for 3 decades Pn = Po + n. X
Population after 1 decade beyond 2016
= P_{2026} = P1 = P_{2016} + 1 x X
= 173,800 + 1 x 37,225 = 211,025

Population for 2046
$P_{2046} = P_3 = P_{2016}$ + 3 x X
= 173,800 + 3 x 37,225 = 285,475

Estimation of volume of water in Oji River

Before embarking on a water resource project, the volume of water should first be estimated to know if it can serve the required purposes.

The data for the depth, length and width of the river was given by the Anambra Imo River basin and was converted to metres for easier calculation.

Given the length = 4950 (feet)
Width of river = 2500 feet
Average Depth = 1,387 feet
Area in Square feet 12375000
Surface Acres = 284.09
River volume in (gallons) = 128,395,991,688 gallons

Conversion of gallons of water to litres:
It is known that 3.785 litres make one gallon
Quantity of water in Oji River = 3.785 x 128,395,991,688 = 4.8 x 1011 litres

Oji River dimensions in meters
For Conversion 3.37 feet = 1 meter
Length $\frac{4950}{3.37}$ = 1,468.8m
Width = $\frac{2500}{3.37}$ = 741.83m

Depth of River = 1387 = 411.5m

Estimation of water demand for Oji Local Government Area.
Taking the average population for 2016 and 2046 = $\frac{173,800 + 285,475}{2}$ = 229,638 people
We design a water supply to serve 229,638 people

Average water demand for Oji local government 250 x 229,638 = 57.5 x 10^6 mld

Maximum daily demand = 1.8 x 57.5 mld = 103.5 mld
Maximum hourly demand = $\frac{270}{100}$ x (57.5) = 155.25 mld

Fire demand
Q = 4637 √p (1-0.01 √p)
= 4637 √229,638 (1-0.01 √229,638)
= 2.22 x 10^6 (1- 0.048)
= 2.22 x 10^6 x (3.79)
= 8.4 x 10^6 million litres 1 day

Coincident demand
The distribution system should be designed for 111.9 mld
Annual demand of Oji local government area = 155.25 x 10^6 x 365 = 5.66 x 10^{10}

The volume of water from the river was found to be 4.8 x 10^{11} while the annual demand for Oji people was 5.66 x 10^{10}, The volume of water available is greater that the volume of water required therefore the river is sufficient for supply of water to Oji local government area.

Capacities of various components for the design
The screen is designed for maximum daily demand of 103.5 mld

The pipe mains carrying the water from the intake to the treatment plant and then to services = 155.25mld.

The filters and other unit at the treatment plant may be designed for maximum daily demand
Required capacity = 2 x 57.5 mld
= 115 mld

The pumps are not operated for all the 24 hours, assuming the pump operate for 12 hours per day = $\frac{24 \times 115}{12}$ mld = 230 mld

Design of Screens

Screens are generally provided in front of the pumps or the intake works, so as to exclude large sized particles, such as debris, animals, trees, branches, bushes ice etc. Coarse screens are called trash tracks are placed in front of the fine screens. Coarse screens consist of parallel iron rods placed vertically or at a slight slope at about 2.5 to 5cm apart.

While designing the screens, clear openings should have sufficient total area, so that the velocity through them is not more than 0.8 to l m/sec.

Average water demand to be pumped = 103.5 mld

Assuming the pumping takes place for 12 hours a day.

The discharge to be pumped = $\frac{103.5 \times 10^6}{103 \times 12 \times 60 \times 60}$ = m^3/s = 2.3 m^3/m

Assume 20 mm diameter steel bars with 150 mm opening. We assume the velocity through the bar screen as 0.9 m/s

The area of openings required at each level =

$\frac{Q}{V} = \frac{2.3}{0.9} = 2.55m^2$

Assuming a height of 1m height of screen Openings of the required opening = 2.55m

No of opening required = $\frac{2.55}{0.15}$ = 17

No of bars = 17

Length occupied by 20 mm & bars = 17 x 0.02 = 0.34

Total length of screen = 2.55 + 0.34 = 2.89 m say 2.9 m

Hence provide length of 2.9 length of coarse screen of height 1.0 m

Design of bell mouth entry

Area of bell mouth entry = Discharge /Velocity through the bell mouth

= Velocity of the bell = $\frac{103.5}{10}$ ml/hr

= $\frac{10.35 \times 10^6}{10^3}$ m^3/hr

= $\frac{10.35 \times 103}{60 \times 60}$ = 2.87m^3/s

$\frac{\text{discharge}}{\text{velocity}} = \frac{2.3}{2.8}$ = 0.82m

If d is diameter of the bell mouth entry. Then

II. d^2 = 0.82 x 4

d = $\sqrt{\frac{0.82x4}{314}} = \sqrt{1.04}$

= 1.01 m

Hence, use 1.1 m mouth provided with perforation for fine screen

Design of intake conduit

Assuming the flow conduct velocity as 2.0 the area of conduit required

= $\frac{\text{Discharge}}{\text{Velocity}} = \frac{2.3}{2.0} = 1.15m^2$

Diameter of pipe (D) is given by

II D^2 = 1.15 x 4

D = $\frac{\sqrt{1.15 \times 4}}{II}$ = 1.46

= 1.2 m

Flow velocity through 1.2m dia. Conduit will be =

$\frac{2.3}{II/4 \times (1.2)2}$ = 0.5 m/sec

Loss of head:

The loss of head through conduit up to treatment works

V = 0.85CH . $R^{0.63}$ $S^{0.54}$

CH = Coefficient of the pipe material

Table 4: Table of values of C_H for Hazen William's Formula

Pipe Material	**Value of CH (in mks units) Depending upon smoothness of the pipe materials**
Concrete (regardless of age)	**130**
Cast iron	
New	**130**
5 years	**120**
20 years old	**100**
Welded steel (New)	**120**
Pivoted Steel (New)	**110**
Vitrified day	**110**
Brick sewers	**100**
Asbestos cement	**140**

CH = Coefficient of the pipe material = 140 for Asbestos – cement pipe from (from table 6.2

R = Hydraulic mean depth

R = $\frac{d}{4}$ (for pipes running full

$\frac{1.2}{4} = 0.55$

V = flow velocity through the pipe = 0.5m/s

S = Slope of the energy line

0.5 = 0.85 x 140 x (0.55) 0.63 S0.54

$= S^{0.54} = \frac{0.5}{0.85 \times 140 \times (0.55)^{0.63}} = S^{0.54}$

$= \frac{0.5}{81.65}$

$S^{0.54} = (0.0061)$

$S = 0.0061^{0.54} = 0.063$

$S = (0.063)^{0.54}$

$= 0.063\ 054 = 6 \times 10^{-3}$

$S = \frac{HL}{L} = \frac{\text{Head loss}}{\text{Length of pipe}}$

$L = \frac{1}{8} \times 1000$ m

$HL = \frac{1}{8} \times 1000$ m x (6 x 10-3)

Conduit for supply of water to Oji LGA

Maximum daily demand = $\frac{103.5 \times 10^6}{10^3 \times 24 \times 60 \times 60}$

= 1.19 cumecs

Flow velocity = A.V

Velocity = 0.5

$A = \frac{1.19}{2.8} = 0.425m^2$

Diameter of pipe = $\frac{0.425}{2} = 0.22m$

= 22 cm diameter pipe

Design of Sedimentation Tanks

The clarification of water by the process of "Sedimentation" can be effected by providing conditions under which the suspended material present in water settle out. Storage reservoirs may also serve as sedimentation basins, but they cannot affect proper sedimentation, because of factors such as, the density currents, the turbulences caused by wind etc. Sedimentation tanks are either horizontal inflow tanks or vertical up flow tanks.

Design

Given the maximum daily demand of 115 mld

Taking detentation period as 4 hours

Quantity of water to be treated

$\frac{115 \times 10^6}{24} \times 4 = 19.16 \times 10^6$

= 19160 cu.m

The capacity of the tank required = 19160cu.m

Assume velocity of flow to be 0.4m

The length of the tank required

= velocity of flow x Dentention period 0.4 x (4 x 60) = 96 m

Cross sectional area of the tank required

$= \frac{\text{capacity of the tank}}{199.5} = \frac{19160}{96} =$

Length of the tank = Approximately $200m^2$

Assume water depth of 4 m, the width of the tan = $\frac{200}{4} = 50$

Using a free board of 0.5m, the overall depth = 0.5 + 4 m = 4.5

Provided a rectangular sedimentation tank with overall size of 96m x 50m x 4.5m

Determination of pump horse power

Average demand of Oji local government area = 115 mld = 115000 cum

$$\text{Quantity } Q = \frac{115,000}{24 \times 60 \times 60} = 1.33\text{cumec}$$

Since the pump is to work for 12 hours per day.

$$\text{For average work / Per day} = 1.33 \times \frac{24}{12} = 2.66\text{cumec}$$

Taking height to be lifted as 12 m

$$\text{Water horse power required} = \frac{rwQH}{0.735}$$

$$= \frac{9.81 \times 2.66 \times 12}{0.735} = 426\text{H.P}$$

Provide pump of 426 H.P

Coagulation

From the laboratory experiment of the water, it was observed that the water was turbid and needs to be coagulated in. The coagulation should be carried out at the sedimentation tank. The calculation for quantity of alum (line) required should be examined at the laboratory.

Design of filtration tank

Assume 4% of water required for back washing 4% x 115 MLD = 5.75 MLD

Daily water demand of the filtered water = 115 +5.75 = 120.75 MLD

Assume 1 hour is lost daily in backwashing filters effective time = 24-1 = 23

$$\text{Filtered water required per hour} = \frac{120.75}{23} = 5.25\text{ML/h}$$

Taken rate of filtration as 4500 (litres) hr/sqm

$$\text{Area of filter} = \frac{5.25 \times 10^6}{4500}$$

= 1164.6 squm approximately 1165 squm

Size of filter = 20 m x 15 m

Area of filter = 300 m^2

$$\text{No of units required} = \frac{1165}{300} = 3.88$$

That is 4 approximately

Using filter as a standby unit = 4+1 = 5

Provide 5 rapid stand filters of size 20m x 15m

Disinfection

Disinfection not only removes the existing bacteria from water, but also ensure their immediate killing even afterwards. The chemical which is used to disinfect must be able to give residual sterilizing effect for long period.

THE LEVEL OF CONTAMINATION OF OJI RIVER

The results of the laboratory analysis carried out at Oji River at four sampling points are presented in table 5.

The laboratory test result of physico-chemical properties for the four sampled points, the Average of the four samples is calculated.

Table 5: Physio-chemcial properties of the water Samples

Parameters	A	B	C	D	Average
pH	5.80	6.0	5.90	6.20	5.98
Temperature(%)	27.50	30.00	28.45	29.80	28.93
Colour	Objectionable	Objectionable	Objectionable	Objectionable	Objectionable
Odour	Objectionable	Objectionable	Objectionable	Objectionable	Objectionable
Conductivity at 29^{o}cms/cm	290	200	189.40	245.35	231.18
Total dissolved solid; mg/L	380.00	269.45	345.60	350.00	336.26
Calcium, ca mg/L	150.00	200.10	178.45	211.00	184.86
Chloride, cl mg/L	750.00	1100.00	800.00	945.00	918.75
Sulphate $S0_4$ mg/L	100.00	130.00	115.00	125.00	117.5
Phosphate $P04^3$mg/L	1.50	1.20	0.99	1.0	1.172
Sodium Na (PPm)	54.15	60.00	57.40	50.30	55.46
Potassium K (PPm)	<0.0001	0.0001	0.0001	0.0015	0.00045
Turibidity NTU	15.60	10.45	18.45	12.30	14.2

Table 6: Laboratory result analysis of heavy metal for the collected samples

Heavy metal	**A**	**B**	**C**	**D**	**Average**
Mercury Hg	0.001	0.001	<0.0001	0.0001	0.0001
Lead (Pb)	0.21	0.25	0.40	0.35	0.302
Zinc (Zn)	0.30	0.26	0.45	0.28	0.322
Manganese (mn)	0.03	0.08	0.06	0.03	0.05
Copper (Cu)	0.25	0.98	0.36	0.40	0.49
Iron (fe)	1.50	1.00	0.90	1.25	1.16
Cadium (cd)	0.034	0.018	0.025	0.020	0.024
Chromium	0.15	0.23	0.26	0.30	0.235

Table 7: Laboratory Result of Microbiological Analysis of Collected Sample from Oji River

	Sample A		Sample B		Sample C		Sample D	
Microbial Group	Plate Reading	Unit Cfu/ml	Plate Reading	Unit Cfu/ml	Plate Reading	Unit Cfu/ml	Plate Reading	Unit Cfu/ml
Colifor	0.01	0.01	0.01	0.01	0.001	0.001	0.002	0.002
Ecoli	0.03	0.03	0.03	0.03	0.1	0.1	0.1	0.1
Streptococci	0.15	0.015	0.19	0.19	1.0	1.0	1.05	1.05
Salmon ell asp	0.004	0.004	0.10	0.10	0.03	0.03	0.14	0.14
Shigella sp.	1.00	1.00	1.01	1.01	1.09	1.09	098	0.98
Clostri di asp	0.10	0.10	0.12	0.12	0.11	0.11	0.8	0.8
Yeast mold	0.001	0.001	0.13	0.13	0.01	0.01	0.01	0.01

Table 8: Treated water sample from Oji River correlated against WHO Standard for physio-chemical parameters.

X	Y	Xy	X^2	Y^2
8.2	8.25	67.65	67.24	68.06
30	30.01	900.30	900	900.60
250	250.0	62.500	62,500	62,500
250	250.50	62625	62,500	62750.25
75	74.85	5613.73	5625	5602.52
200	200.25	40,050	40,000	40,100.06
200	200.02	40.004	40,000	40,008.0
0.01	0.01	0.0001	0.0001	0.0001
200	200.03	40,006	40,000	40012
0.00001	0.00001	0.0000000001	0.0000000001	0.0000000001
2	1.5	3	4	2.25
∑x=1215.2	∑y=1215.42	∑xy=251769.6	X^2=261596.2	Y^2=251943.74

$$\frac{11(251769.6-(1215.2)(1215.42))}{\sqrt{11\,(251596.2)^2-\,(1215.2)^2\;11\,(251943.74-\;1215.42)^2}})$$

$$\frac{1292487.22}{1287474.12}=1.00$$

$$r=1.00$$

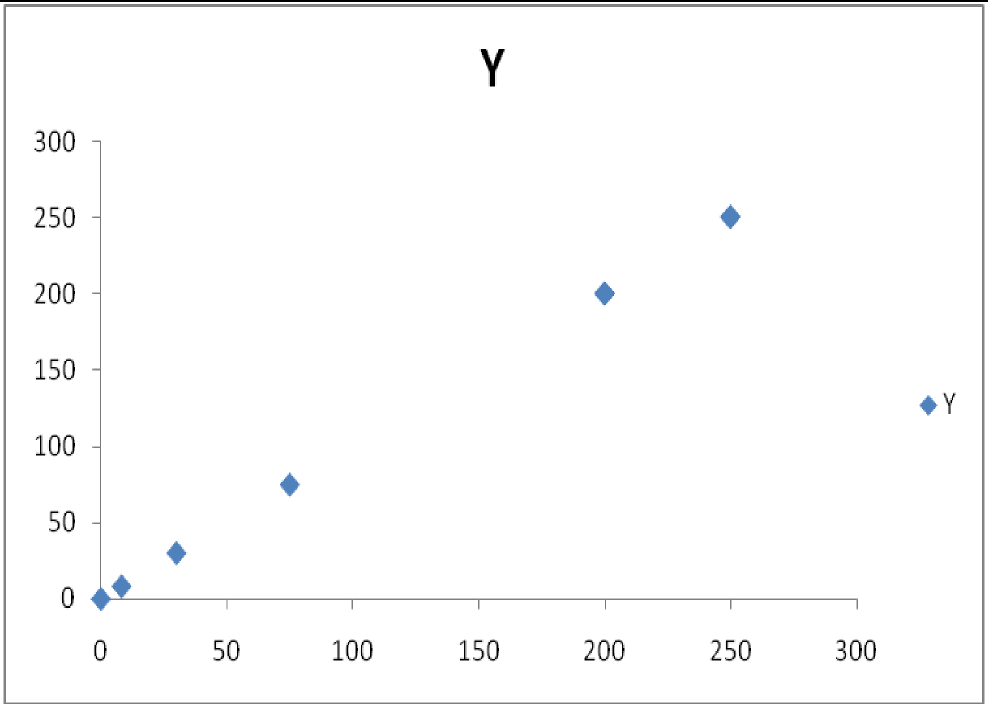

Figure 1: Graph of WHO against treated sample for physico-chemical parameters

Standard for Water Quality

Before any water is declared safe for drinking, it must meet the World Health Organization's Standard. Table 8 shows (WHO) drinking water quality standard. The test was carried out at NAFDAC Laboratory located at Agulu, Anambra State Nigeria.

Conclusion and Recommendations

The following conclusions were drawn from this research;

- The laboratory experiment it shows that Oji river is contaminated to some extent
- data analysis shows that Oji river is most economical for provision of portable water within the area
- Operation and maintenance is cheaper compared to that of borehole
- Appropriate laws should be put in place to reduce the rate of contamination of Oji river
- There will be creation of Employment through construction operation and maintenance of water treatment plant
- Increase in revenue generation for government through taxation of consumers.

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