ASSESSMENT OF WATER QUALITY OF OYAN RESERVOIR IN OGUN STATE, NIGERIA FOR IRRIGATION PURPOSES

***UGBOAJA, V.C[1]., UGBALA, E.N[1]., , AND ALAYANDE, W[1].**
National Water Resources Institute Kaduna[1]
*Email: sirvinchi@yahoo.com, Tel: +234 (0) 8036070804 * (corresponding author)*

ABSTRACT
This study was carried out to evaluate the water quality of Oyan reservoir for irrigation purpose. Water samples were collected from thirtytwo (32) different locations along the reservoir i.e. upstream, midstream and downstream for the determination of sixteen (16) physicochemical parameters following standard methods, based on these analyses, some irrigation parameters like magnesium content(MC), sodium absorption ratio(SAR), residual sodium carbonate (RSC), permeability index (PI), Kelly's index(KI), and sodium percent(SP) were calculated following standard equations. The results ranged from 7.1 to 8.5pH, 135.8 to 148.7µmhocm^{-1}, 86.91 to 95.17mgL^{-1}TDS, and 26.6 to 40.2NTU turbidity, 28.0 to 28.8^{0}C temperature to 65 mgL^{-1} total hardness, 11.7 to 16.8 mgL^{-1}Cl^{-}, 0.0 to 1.433 meqL^{-1} $HCO^{-}_{3,}$ 0 to 1.667meqL^{-1}CO_3^{-2}, 0.1976 to 1.198meqL^{-1}Ca^{2+}, 0.196 to 0.783 meqL^{-1} Mg^{2+}, 0.058 to 0.216meqL^{-1}Na^{+},0.064 to 0.082meqL^{-1} K^{+}, 3.1 to 8.5mgL^{-1} $PO^{-}_{4}{}^{3}$, 0.2 to 1.08mgL^{-1} NO_3^{-},0.01to 0.08mgL^{-1} SO_4^{2-} ,21.89 to 74.64meqL^{-1}MC, -0.462 to 1.414meqL^{-1}RSC, 0.079 to 0.3168meqL^{-1}SAR, 12.12 to 147.92meqL^{-1}PI,11.02to 24.44meqL^{-1}SP and 0.054 to 0.238meqL^{-1}KI. Based on the guideline by FAO (Food and Agricultural Organization) interpretation of water quality for irrigation, the results of analyses and assessment of water quality from Oyan reservoir revealed that they are suitable for irrigation purposes.

KEYWORDS: *Irrigation, Water quality, Oyan, Reservoir*

INTRODUCTION

Water is one of the most important available substances on the Earth. . The most widely used definition of water quality is "the chemical, physical and biological characteristics of water, usually in respect to its suitability for designated use" when water quality assessment reveals that a water body does not support its designated uses, then it is considered impaired, impairments result from two major categories of water pollution: point source or non-point source pollution. Both natural processes and human activities influence the quality of surface water and ground water. Water naturally contains dissolved substances, non-dissolved particulate matter and living organisms; indeed, such materials and organisms are necessary components of good quality water, as they help maintain vital biogeochemical cycles. The quality of irrigation water has a significant effect on the soil salinity, growth and yield of agricultural crops. In general, water used for irrigation always contains different concentrations of dissolved salts which are generated naturally (precipitation rate, weathering of rocks and dissolving of other salt sources) or anthropological i.e. domestic and industrial sources (Jarvie et al, 1998).

Poor quality of irrigation water affects both soil quality and crops production adversely (Bello, 2011) therefore, the study of irrigation water quality has become essential because it shows whether the quality of the water is suitable for irrigation and does not cause formation of saline or alkaline soils in addition to being an indicator of whether this kind of water cause toxicity to plants and crops.

Regardless of it source, irrigation water contains some dissolved salts (Michael, 1985). The amount and characteristics of these dissolved salts depend on the source and chemical composition. The concentration and proportion of these dissolved ions among other things determine the suitability of water for irrigation (Ajayi et al, 1990). The suitability of water for irrigation varies according to crops, types, permeability of soil and climate.

The concentration and proportion of these dissolved ions among other things determine the suitability of water for irrigation (Ajayi et al 1990). Irrigation water quality is generally judged by some determining factors such as sodium absorption ratio (SAR), residual sodium carbonate (RSC), and electrical conductance (EC) (Richards, 1954). Along with the above indicators, some additional indices to categorize the surface water for irrigation like magnesium content (MC), Kelly's index (KI), total hardness (TH), permeability index (PI) sodium percent (SP), should be studied.

The most important criterion that needs to be considered when assessing the quality of irrigation water are salinity, permeability, toxicity ions, and other problems, such as the high bicarbonate concentration, suspected abnormalities indicated by an unusual pH of the water and excessive nitrogen in water. (Ayres and Westcot, 1994):

Therefore, the objective of the present study was to evaluate the physicochemical status of the water in Oyan dam and hence to ascertain it suitability for irrigation purpose.

STUDY AREA

The Oyan River Dam is located in Abeokuta North local government area of Ogun State in the West of Nigeria, about 20 km North West of the state capital Abeokuta. The dam crosses the Oyan River, a tributary of the Ogun River. It is used primarily to supply raw water to Lagos and Abeokuta, but has potential for use in irrigation and power generation.

MATERIAL AND METHODOLOGY

SAMPLE COLLECTION AND ANALYSIS

The procedure for sampling was adopted from Prabu (2009). A total of thirty two (32) grab water samples, were collected at different locations. Global coordinates of each sampling location were recorded with the help of global positioning system (Gamin GPS 78 SC) from Oyan dam on the 28 September to 22nd October, 2017. The collection was done at the depth of 20-30 cm directly into one litre clean plastic bottles and placing them into sample transport box (cooler) containing ice pack in order to maintain the integrity of the sample collected prior to analyses.

Field meter were checked and calibrated according to manufacturer's specification.
Temperature, pH, electrical conductivity, turbidity, and salinity of the water samples were measured in situ using water quality meter model WQC-24. The water samples were analyzed for alkalinity, total hardness, bicarbonates, carbonates, calcium hardness and magnesium hardness, calcium, magnesium phosphates, sulphates, fluorides and nitrates at the field using Wagtech photometer 7100, while chloride was determined titrimetrically using standard method as detail in (Aneja, 2005) at

Central Water Board lab Kaduna, and Sodium and potasium was determined using thermo scientific ice 3000 atomic absorption spectrophotometer (AAS) model.. Total dissolved solids (TDS) was calculated by using the formula TDS = EC X 0.64 (Lloyd & Heathcote, 1985).

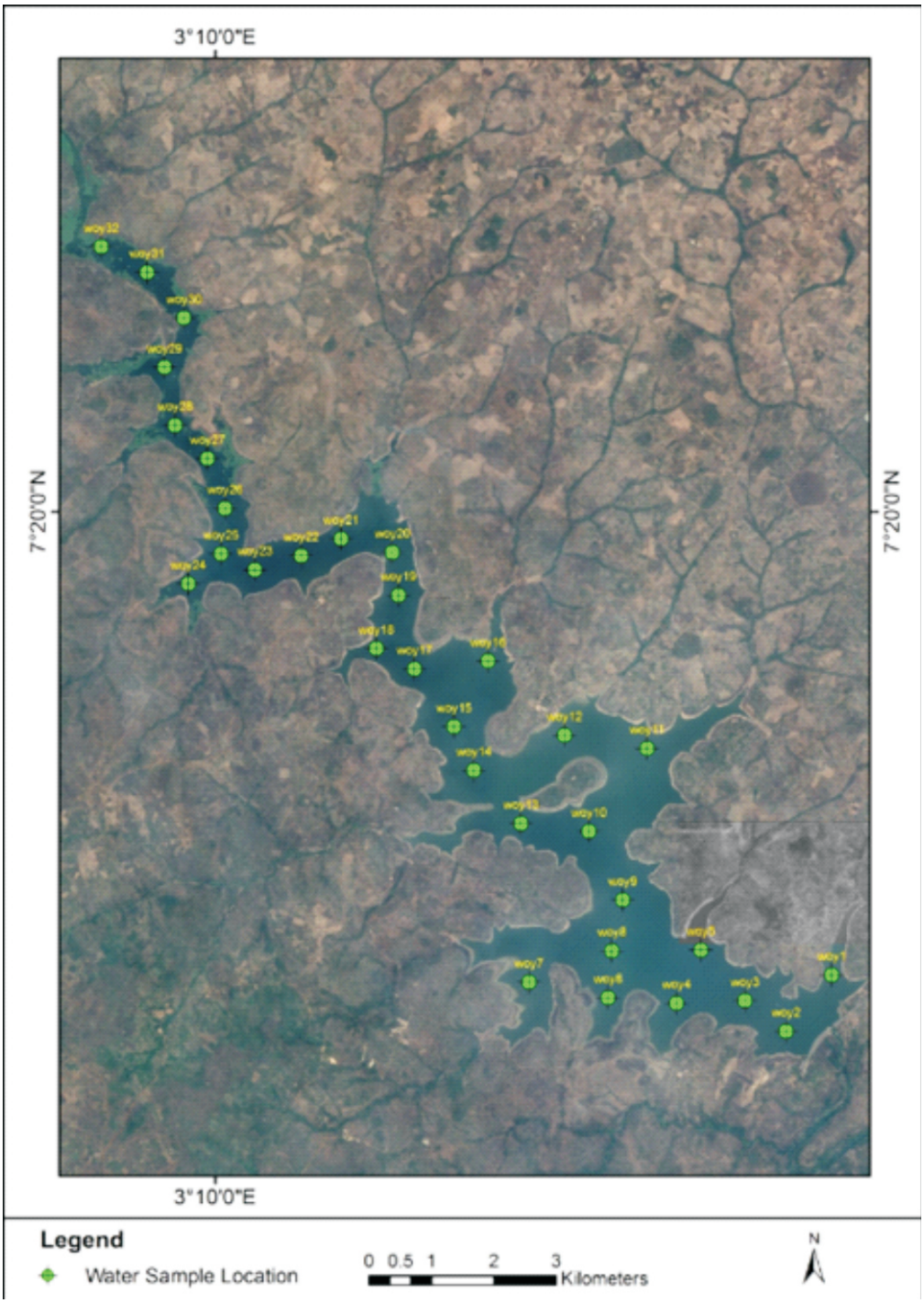

Fig1: Oyan reservoir showing sampling location.

Based on the result of physicochemical analyses, irrigation quality parameters like magnesium content, sodium absorption ratio, residual sodium carbonate, sodium per cent, kellys index and permeability index were also calculated as follows:

Magnesium content: Magnesium content of water is considered as one of the most important qualitative criteria in determining quality of water for irrigation. Magnesium content is calculated by the following formula.

Mg content= $[Mg^{2+}/ (Mg^{2+}+ Ca^{2+})]$ 100 (Concentrations are in meq/L)

Sodium absorption ration (SAR): Sodium absorption ratio is an important parameter to determine the suitability of irrigation water and is calculated by the following formula.(Richard 1954)

$SAR= Na+ /\sqrt{[(Ca^{2+} + Mg^{2+}) /2]}$ (Concentrations are in meq/L)

Residual sodium carbonate (RSC): The concept of residual sodium carbonate (RSC) is employed for evaluating high carbonate waters and is calculated by the formula(Todd,1980, and Raghunath, 1987) given below.

$RSC= (CO_3^{2-} + HCO_3^-) – (Ca^{2+} + Mg^{2+})$ (Concentrations are in meq/L)

Permeability index (PI): Permeability index is calculated by the method suggested by Todd, and Raghunath, 1987). PI is used to evaluate the sodium hazards of irrigation water, where all concentrations are expressed in meq/L as;

$PI = [(Na^+ + HCO_3^-) / (Ca^{2+} + Mg^{2+} + Na^+)]$ 100

Kelly index (KI): The waters with an index value over 1 are assessed as unsuitable for irrigation (Kelly, 1963). Kelly index was calculated by using Equation below,
$KI= [Na^+/Ca^{2+}+Mg^{2+}]$ (Concentrations are in meq/L)

Sodium Percentages (SP): Wilcox (1955) describes the method of calculating the sodium percentages where all concentrations are expressed in meq/l as;
$Na\ \% = [(Na^+ + K^+) / (Ca^{2+} + Mg^{2+} + Na^+ + K^+)]$ 100

RESULT AND DISCUSSION

Table1, the results of the physicochemical analysis carried out on the various water samples collected from Oyan reservoir.

SID	LAT..	LON	TEM	pH	TUR.	CON	TDS(	DO(	HAR	ALK	NO_3^-	PO_4^-	Cl^-	Na	K	Mg	Ca	HCO_3	CO_3^{2}	SAR	RSC	PI	KI	SP	MgC
OY 1	7.266	3.256	28.4	8.5	31.5	144.1	92.2	5.8	45	40	0.98	5.3	12.9	0.140	0.073	0.372	0.758	0.164	1.000	0.186	0.034	23.93	0.124	15.87	32.90
OY 2	7.258	3.249	28.6	8.3	30.2	143.8	92.0	7.8	40	40	1.38	10.8	11.7	0.190	0.082	0.392	0.719	0.667	0.667	0.255	0.223	65.88	0.171	19.66	35.27
OY 3	7.263	3.243	28.7	7.9	38.5	143.9	92.1	8.3	50	40	1.48	13.1	12.9	0.134	0.076	0.390	0.599	0.333	1.000	0.191	0.344	41.62	0.136	17.50	39.44
OY 4	7.262	3.233	28.5	7.7	29.2	143.5	91.8	10.2	50	62	2.06	19.6	11.7	0.166	0.072	0.667	0.319	1.200	0.867	0.236	1.081	118.6	0.168	19.42	67.60
OY 5	7.270	3.237	28.5	7.9	28.8	143.7	92.0	15.0	55	45	1.34	12.1	15.6	0.100	0.074	0.294	0.798	0.500	1.000	0.136	0.408	50.35	0.092	13.79	26.89
OY 6	7.263	3.223	28.6	7.9	28.7	142.0	90.9	14.0	50	50	1.40	11.5	12.9	0.109	0.070	0.431	0.559	0.667	1.000	0.155	0.677	70.57	0.110	15.32	43.54
OY 7	7.265	3.212	28.5	7.9	26.6	146.3	93.6	5.8	65	55	1.60	10.4	12.8	0.129	0.074	0.783	0.499	0.167	1.667	0.161	0.551	20.94	0.100	13.63	61.08
OY 8	7.270	3.224	28.6	7.9	29.9	144.1	92.2	9.8	50	40	1.56	13.4	11.7	0.122	0.072	0.685	0.299	0.667	0.667	0.174	0.349	71.26	0.124	16.44	69.59
OY 9	7.277	3.225	28.5	7.9	38.2	142.8	91.4	5.3	45	38	1.48	22.6	13.5	0.131	0.073	0.196	0.699	0.267	1.000	0.196	0.372	38.81	0.147	18.61	21.89
OY 10	7.287	3.221	28.4	8.0	32.7	143.7	92.0	6.4	40	45	1.34	52.4	12.9	0.142	0.074	0.333	0.699	0	0.667	0.198	-0.365	12.12	0.138	17.32	32.29
OY 11	7.299	3.229	28.4	7.5	33.6	145.0	92.8	7.7	65	40	1.28	12.1	12.9	0.058	0.075	0.333	0.739	1.000	0.333	0.079	0.262	93.65	0.054	11.02	31.09
OY 12	7.301	3.217	28.6	7.3	33.2	136.0	87.0	8.5	55	35	1.90	18.0	12.9	0.137	0.073	0.431	1.198	0.167	1.000	0.152	-0.462	17.20	0.084	11.44	26.47
OY 13	7.288	3.211	28.5	7.9	39.6	136.1	87.1	9.4	45	60	1.60	20.0	16.6	0.137	0.073	0.392	0.499	0.333	1.667	0.205	1.109	45.75	0.153	19.06	43.97
OY 14	7.296	3.204	28.6	7.6	37.6	136.0	87.0	9.5	45	65	1.54	20.0	14.1	0.152	0.073	0.353	0.399	0.833	1.333	0.248	1.414	108.9	0.202	23.02	46.92
OY 15	7.302	3.201	28.8	8.0	32.1	136.8	87.6	8.4	40	40	1.40	18.0	12.9	0.131	0.073	0.587	0.200	0.333	1.000	0.208	0.546	50.55	0.166	20.52	74.64
OY 16	7.312	3.206	28.4	8.0	33.4	137.6	88.1	8.7	45	35	1.30	15.9	13.8	0.115	0.072	0.352	0.399	1.167	0	0.188	0.415	147.9	0.153	19.96	46.86
OY 17	7.311	3.195	28.6	8.0	40.2	140.0	89.6	5.3	50	60	1.55	13.5	12.9	0.168	0.073	0.584	0.299	0.667	1.333	0.190	1.116	79.37	0.190	21.42	66.11
OY 18	7.314	3.190	28.6	8.0	36.5	148.6	95.1	8.5	50	40	1.94	19.5	15.6	0.174	0.072	0.351	0.599	0.467	0.867	0.253	0.383	57.01	0.184	20.60	36.97
OY 19	7.321	3.193	28.6	8.0	35.2	144.1	92.2	6.5	55	30	1.82	22.0	13.0	0.211	0.075	0.584	0.299	0.667	0.333	0.317	0.116	80.18	0.238	24.44	66.11
OY 20	7.327	3.192	28.6	7.4	40.0	144.5	92.5	6.3	50	43	1.70	25.1	13.4	0.153	0.072	0.351	0.599	1.433	0	0.222	0.483	143.8	0.161	19.12	36.97
OY 21	7.329	3.185	28.6	7.3	28.7	144.2	92.3	8.2	60	35	1.74	18.0	14.8	0.169	0.072	0.749	0.299	0.833	0.333	0.233	0.119	82.35	0.161	18.66	71.43
OY 22	7.327	3.179	28.6	7.4	35.0	144.0	92.2	8.4	55	45	1.68	18.0	11.7	0.164	0.072	0.333	0.599	0.500	1.000	0.177	0.568	60.60	0.176	20.26	35.75
OY 23	7.325	3.172	28.5	7.4	32.3	137.3	87.9	8.2	50	60	1.08	17.0	12.7	0.174	0.073	0.418	0.699	0.667	1.333	0.232	0.883	65.13	0.155	18.10	37.43
OY 24	7.323	3.163	28.7	7.3	30.3	137.4	87.9	10.4	55	55	1.28	15.4	15.3	0.158	0.070	0.486	0.499	0.500	1.333	0.226	0.848	57.57	0.161	18.82	49.35
OY 25	7.327	3.168	28.5	7.3	32.1	138.2	88.4	9.8	50	55	1.30	12.5	12.7	0.154	0.069	0.411	0.399	0.500	1.333	0.243	1.023	67.82	0.191	21.59	50.75
OY 26	7.334	3.169	28.0	7.3	35.0	140.0	89.6	10.1	50	40	1.40	12.1	13.2	0.174	0.066	0.445	0.499	0.333	1.000	0.253	0.389	45.37	0.184	20.30	47.14
OY 27	7.341	3.166	28.3	7.2	36.5	141.0	90.2	10.4	45	50	1.35	11.8	13.8	0.168	0.068	0.387	0.599	0.333	1.333	0.239	0.681	43.46	0.170	19.3	39.23
OY 28	7.346	3.161	28.4	7.3	31.2	140.0	89.6	9.7	48	55	1.55	13.0	14.5	0.159	0.069	0.431	0.549	0.500	1.333	0.227	0.853	57.85	0.162	18.85	43.99
OY 29	7.354	3.159	28.0	7.6	35.1	138.1	88.4	9.5	50	35	1.30	12.8	13.7	0.166	0.064	0.411	0.579	0.633	0.533	0.236	0.176	69.14	0.168	18.87	41.54
OY 30	7.361	3.162	28.6	7.1	33.3	141.2	90.4	9.9	55	40	1.38	12.1	16.8	0.163	0.064	0.380	0.559	0.800	0.533	0.237	0.394	87.38	0.173	19.44	40.48
OY 31	7.368	3.157	28.6	7.3	33.4	148.7	95.2	10.6	60	54	1.40	11.6	13.9	0.216	0.070	0.370	0.699	1.133	0.667	0.296	0.731	105.0	0.202	21.14	34.64
OY 32	7.372	3.150	28.5	7.3	30.1	135.8	86.9	10.6	60	68	1.44	14.8	11.8	0.143	0.065	0.411	0.559	1.400	0.867	0.205	1.296	138.6	0.147	17.63	42.39

Table2 Descriptive Statistics Result For Physicochemical and Irrigation Parameters for Oyan Dam Water Quality

S/N	PARAMETER	UNIT	AVERAGE	RANGE	STANDARD DEVIATION
1	Temperature	^0C	28.51	28.0 – 28.8	0.19
2	Turbidity	NTU	33.40	26.6 – 40.2	3.79
3	Electrical Conductivity	μScm^{-1}	141.5	135.8- 148.7	3.83
4	pH		7.7	7.1- 8.5	0.38
5	Total dissolved	mgL^{-1}	90.57	86.91-95.17	2.347
6	Dissolved oxygen	mgL^{-1}	8.84	8.84-15.0	2.162
7	Total hardness	mgL^{-1}	50.89	40-65	6.86
8	Total alkalinity	mgL^{-1}	46.72	30-68	6.42
9	Phosphate	mgL^{-1}	16.39	5.3-52.4	9.72
10	Sulphate	mgL^{-1}			
11	Nitrate	mgL^{-1}	1.49	0.98-2.06	0.26
12	Chloride	mgL^{-1}	13.49	11.7-16.8	1.42
13	Carbonate	$meqL^{-1}$	0.906	0- 1.667	0.449
14	Bicarbonate	$meqL^{-1}$	0.620	0-1.433	0.383
15	Sodium ion	$meqL^{-1}$	0.150	0.058-0.216	0.035
16	Potassium ion	$meqL^{-1}$	0.072	0.064-0.082	0.004
17	Calcium ion	$meqL^{-1}$	0.554	0.1976-1.198	0.223
18	Magnesium	$meqL^{-1}$	0.440	0.196-0.783	0.145
19	Kelly index (KI)	$meqL^{-1}$	0.15531	0.054-0.238	0.041884
20	Residual sodium carbonate (RSC)	$meqL^{-1}$	0.531781	-0.462-1.414	0.466642
21	Sodium absorption ratio(SAR)	$meqL^{-1}$	0.210981	0..079-0.3168	0.052462
22	Permeability index (PI)	$meqL^{-1}$	69.3375	12.12-147.92	36.91
23	Sodium per cent (Na %)	$meqL^{-1}$	18.4725	11.02-24.44	3.250809
24	Magnesium content	$meqL^{-1}$	45.0225	21.89-74.64	14.74105

^0C

Table3: Classification of water quality parameter from Oyan dam for agricultural purposes using food and agriculture organization (FAO) guidelines of United Nations

Parameter	Sample range	FAO guidelines	Classification	% of sample compliance
Kelly index(KI)meqL^{-1}	0.054 - 0.238	< 1 >1	Safe and suitable unsuitable	100% _
Residual sodium carbonate (RSC) meqL^{-1}	-0.462 – 1.414	<1.25 1.25 – 2.5 >2.5	Excellent Good poor	100% _ _
Sodium absorption ratio (SAR)	0.079 -0.3168	0-10 10-18 18-26 >26	Excellent Good Fair poor	100% _ _ _
Permeability index (PI)meqL^{-1}	12.12 – 147.92	Class1>75% Class2 25%-75% Class3 <25%	Excellent Good Unsuitable	34.4% 53.1% 12.5%
Sodium percent (Na %) meqL^{-1}	11.02 – 24.44	0-20 20-40 40-60 60-80 >80	Excellent Good Permissible Doubtful unsuitable	71.9% 28.1% - _ _
Electrical conductivity (EC)µScm^{-1}	135.8-148.7	<250 250-750 750-2250 >2250	Low salinity(Good) Medium salinity(moderate) High salinity(poor) Very high salinity(very poor)	100% _ _ _
Ph	7.1 - 8.5	6.5-8.4	Normal range	100%
Chloride(Cl^-)mgL^{-1}	11.7 – 16.8	<70 70-300 >300	suitable Moderate suitable unsuitable	100% _ _
Bicarbonate meqL^{-1}	0.033-0.41	<1.5 1.5-8.5 >8.5	Suitable Moderate Unsuitable	100% _ _
Total dissolved solid(TDS) mgL^{-1}	86.91- 95.17	<450 450-2000 >2000	Suitable Moderate unsuitable	100% _ _
Magnesium content(MC)meqL^{-1}	21.89 – 74.64	<50 >50	Suitable Unsuitable	75% 25%

The analytical and statistical results of the water quality parameters of the irrigation water samples of the studied location are given in table 1 and table 2 while table 3 shows the recommended guidelines for the interpretation of water quality for irrigation.

The water quality for irrigation is considered using the following indexes:

Electrical Conductivity (EC):
The most influential water quality guideline on crop productivity is the water salinity hazard as measured by electrical conductivity. Electrical conductivity or the total dissolved solids (TDS) analysis could be used in monitoring the salinity of water because the conductance is a strong function of the total dissolved ionic solids, as EC increases, the less water is available to plants even though the soil may appear wet because plants can only transpire "pure" water, usable plant water in the soil solution decreases dramatically as EC increases. According to FAO 2000 and Ayers and Westcot 1994 irrigation water is considered good to be used when EC < 250µScm^{-1} and TDS <450mgL^{-1} In this study, the electrical conductivity ranges from 135.8 to 148.7µScm^{-1} with an average value of 141.5µScm^{-1} and total dissolved solids (TDS) ranges from86.91to 95.17mgL^{-1} with an average value of 90.57mgL^{-1}as compared to Gurara dam and Sabke dam with average values of TDS 45.34mgL^{-1} and 47.49mgL^{-1} so water of Oyan dam can be considered safe for irrigation purpose.

Alkalinity:
The alkalinity of natural waters is due to salts of carbonate, bicarbonates, borates, silicates and phosphates along with hydroxyl ions in Free State. The weathering of rocks is the potential source of alkalinity. Alkalinity in excess of alkaline earth metal concentrations is significant in determining the suitability of water for irrigation. Bicarbonates and carbonates ions combined with calcium or magnesium will precipitate as calcium carbonate ($CaCO_3$) or magnesium carbonate ($MgCO_3$) when the soil solution concentrates in drying conditions. The concentration of calcium and magnesium decreases relative to sodium and the sodium absorption ratio index will be bigger or increase. This will cause an alkalizing effect and increase the pH. Therefore when water analysis indicates high pH level it may be a sign of high content of carbonate and bicarbonates ions. High alkalinity imparts a bitter taste, harmful for irrigation as it damages soil and hence reduces crop yields (Sundar et al, 2008). In this present study the alkalinity of the water from Oyan dam ranges from 30 to 68 mgL^{-1} with an average value of 46.72mgL^{-1} from table 2 above, which is within the permissible limit (WHO, 2011) of 500mgL^{-1} also as compared to Gurara dam with an average value of 24.11mgL^{-1}hence, indicating excellent water for irrigation.

Chloride:
The most common toxicity is from chloride (Cl^-) is not adsorbed or held back by soils, therefore it moves readily with the soil water, is taken up by the crop, moves in the transpiration stream, and accumulates in the leaves. If the chloride concentration in the leaves exceeds the tolerance of the crop, injury symptoms develop such as leaf burn or drying of leaf tissue. Normally, plant injury occurs first at the leaf tips (which is common for chloride toxicity), and progresses from the tip back along the edges as severity increases, excessive necrosis (dead tissue) is often accompanied by early leaf drop (FAO, 1985). In this present study, the chloride (Cl^-) concentration obtained ranges from 11.7 to 16.8 mgL^{-1} with an average 13.48 mgL^{-1} table 2 above, The values obtained for Chloride did not

exceed the permissible limits (FAO, 2000) of 700 – 300 mgL^{-1} indicating excellent water for irrigation purposes for crop growth and development.

Sodium absorption ratio:
The suitability of water for irrigation purposes can be determined by sodium absorption ratio values because it measures alkali/sodium hazard to crop. If irrigation water is high in sodium ion and low in calcium ion the ion – exchange complex may be saturated with sodium ion. This might lead to the destruction of the soil structure due to the dispersion of the clay particle (Todd, 1980; Joshi et al, 2009) and consequently could reduce the plant growth. In addition, studies have shown that excess salinity reduces the osmotic activity of plants (Subramani et al, 2005; Ishaku et al 2011) in the study area, the value of SAR ranges from 0.079 to 0.3168 $meqL^{-1}$ with an average of 0.210981 $meqL^{-1}$ from table 2 and 3 above, since the values are generally less than 3 (FAO, 2000) it is regarded as excellent for irrigation practice. The water can be used for irrigation on almost all soil types with no danger of the development of harmful level of sodium hazard.

Residual sodium carbonate (RSC):
RSC represents the amount of sodium carbonate and sodium bicarbonate in water when total carbonate and bicarbonate levels exceed total amount of calcium and magnesium. It is usually expressed as meqL-1 of sodium carbonate. Considering this hypothesis, Eaton proposed the concept of residual sodium carbonate (RSC) for assessment of high carbonate waters. The water with high RSC has high pH and land irrigated with such water becomes infertile owing to deposition of sodium carbonate; as known from black colour of the soil. Residual carbonate levels less than $1.25meqL^{-1}$ are considered safe. Waters with RSC of 1.25-2.50 $meqL^{-1}$ are within the marginal range and value more than $2.5meqL^{-1}$ is unsuitable for irrigation (FAO, 2000). In the present study RSC values are below $1.25meqL^{-1}$ from table 2and 3 above, so water of Oyan dam can be considered safe for irrigation purpose.

Magnesium content:
This is considered to be one of the most important qualitative criterion in determining the quality of water for irrigation (Gupta et al 2009) if magnesium is more than necessary in the water, there will be adverse effect on crops yields as the soil becomes more saline (Joshi et al 2009) magnesium of ratio <50% is suitable for irrigation while magnesium of ratio>50% is not suitable for irrigation purposes (Palwal.1972) results from the study areas shown that 75% of the water samples are below the permissible limit of <50% while 25% are greater than the permissible limit respectively from table 2 above, hence, on the average of value 45.0225 table 2 above, the water is very suitable for irrigation purposes.

Kelly index (KI):
Kelly index is one of the parameters used for the classification of water for irrigation purposes, sodium measured against calcium and magnesium was considered by Kelly (1963) for calculating Kelly index the values for the dam water ranges from 0.054 to 0.238 $meqL^{-1}$ with an average of 0.15531 $meqL^{-1}$ table 2 above. Hence, the values are within the permissible limit of < 1.0 table 2 above, and are therefore considered suitable for irrigation purposes irrigation whereas above 1 is suggestive of unsuitability for agricultural purpose due to alkali hazards (Karanth, 1987).

Permeability Index (P.I.):
The soil permeability is affected by long term use of irrigation water. Sodium, calcium,

magnesium and bicarbonate content of the soil influence it. Doneen evolved a criterion for assessing the suitability of water for irrigation based on the permeability index. Accordingly, waters can be classified as class I, Class II and Class III orders. Class I and Class II waters are categorized as good for irrigation with 75% or more maximum permeability. Class III water are unsuitable with 25% of maximum permeability. In the present study the value of the permeability index ranges from 12.12 to 147.92, with an average value of 69.3375% from Table 2 above. Hence water of Oyan dam ranges from excellent to good for irrigation quality Table 3 above.

Sodium percent (SP):

Sodium percent is another important factor to study sodium hazard, it is calculated as the percentage of sodium and potassium against all cationic concentration. It is also used for adjudging the quality of water for the use of agricultural purposes. The use of high percentage sodium water for irrigation purpose stunts the plant growth. Sodium reacts with soil to reduce its permeability. Sodium percent in water is a parameter computed to evaluate the suitability for irrigation. In the present study the value of the sodium per cent ranges from 11.02 to 24.44, with an average of 18.4725 $meqL^{-1}$ Table 2 and 3 above, Hence, it's within the permissible limit, indicating the water from Oyan dam to be suitable for irrigation purposes.

pH:

pH is an important parameter to measure the acidity or alkalinity of irrigation water. As shown in Table 2 and 3, the range values of pH for the water samples from the dam 7.1 to 8.5 are within the normal range which is between 6.5 to 8.4. Irrigation water outside the normal range of pH may cause a nutritional imbalance or may contain toxic ions (Prescod, 1985).

CONCLUSION

The main objective of this study is to evaluate the irrigation water quality of Oyan dam in Ogun state. Based on the guidelines for interpretation of water quality for irrigation, the results of analysis and assessments of water quality from Oyan dam revealed that they are suitable for irrigation purposes. However, water from the dam is of excellent quality and considered to be highly suitable without any restriction on the use.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to Research and Technical Service Department and Management of National Water Resources Institute Kaduna for the opportunity to participate in the Sedimentation Study of Oyan Dam.

REFERENCES

Ajayi, F.; Nduru, M. and Oningue, A. (1990). "Halting the salt that kills crops African farmer no.4, pp.10-12

Aneja, K.R. (2005). Experiment in microbiology, plant pathology and biotechnology. New age publisher, New Delhi pp.355 – 370

Ayres, R.S. and Westcott, D.W. (1985). Water quality for agriculture, FAO paper: irrigation and drainage, Rome no. 29, pp.174

Ayres, R.S. and Westcott, D.S. (1994). Water quality for agricultural, Irrigation and Drainage paper no. 29, FAO, Rome, Italy.

Ayres, R.S. and Westcott, D.S. (1999). Water quality for agricultural, 2nd Campina Grande: UFPB, FAO Irrigation and Drainage no. 29, pp. 218

Bello, S. (2001). Quality of irrigation water and soil characteristics of wetland in Sokoto

metropolis, unpublished B.Sc. project, department of soil science and agricultural engineering, Usman Danfodio University, Sokoto pp.69

Domenico, P.A. and Schwartz, F.W. (1990). Physical and chemical hydrology, Newyork, John Wiley and sons, pp.410

Eaton, F.M. (1950). Significant of carbonates in irrigation waters. soil science, vol.69, pp.123- 133

FAO, (2000). Corporate document repository, titled: Method of resource investigation.

FAO, (1985). Water Quality for Agriculture. Irrigation and drainage, Rome no. 29, pp.174

Gupta, P.; Vidhwakarma, M. and Rawtani, P.M. (2009). Assessment of water quality parameter of Kerwa dam for drinking suitability. International journal of theoretical and applied science, Vol.,1, no.2, pp.53-55

Ishaku, J.M.; Ahmed, A.S. and Abubarka, M.A. (2011). Assessment of groundwater quality using chemical indices and GIS mapping. Journal of Earth science and Geotechnical engineering, Vol., 1, no.1, pp.35-60

Jarvie, H.P.; Whitton, B.A. and Neal, C. (1998). Nitrogen and phosprous in East coast, British river, speciation, sources and biological significance. Journal of science of total environment. Vol., 210-211, pp.79-109

Joshi, M.D.; Kumar, A. and Agrawai, N. (2009). Assessment of the irrigation water quality of river Ganga in Haridwar district India. Journal of chemistry, Vol.,2, no.2, pp.285-292

Karanth, K.R. (1987). Groundwater assessment development and management, Tata-McGraw Hill publishing company limited, New Delhi

Kelly, W.P. (1951). Alkali soil, their formation, properties and reclamation 3rd edition, Reinhold publ., New york USA, pp.92

Kelly, W.P. (1953). Use of saline irrigation water. Journal of soil science, Vol., 95, pp.355- 391

Kelly, W.P. (1963). Use of saline irrigation water, soil science 95:4, pp.355-391

Lloyd, J.W. and Heathcoat, J.A. (1995). Natural inorganic hydrochemistry in relation to groundwater Clarendom press, Oxford, England

Micheal, A.M. (1985). Irrigation principles and practice, Vikas publishing house Ltd., New Delhi, India. Pp.702-720

Paliwal, K.V. (1972). Irrigation with saline water monogram, no.2, New series, New Delhi IARI pp.198

Pitchaiah, P.S. (1995). Groundwater, scientific publ. Jordhpur, Rajasthan, pp.304

Prabu, P.C. (2009). Impact of heavy metals contamination of Akaki river of Ethiopia on soil and metal toxicity on cultivated vegetables crops, EJEAFChe, 8(9), pp.818-827I

Prescod, M.B and FAO, (1985). Irrigation and Drainage Rome 47.

Richards, L.A. (1954). Diagnosis and improvement of saline and alkali soils, U.S. Department of agriculture hand book, Vol., 60, Washigton D.C.: USA, pp.160

Raghunath, H.M. (1987). Groundwater, Wiley eastern Ltd, Delhi: India. pp.563

Subramani, T.; Elongo, L.; and Damodarasany, S.R. (2005). Groundwater quality and its suitability for drinking and agricultural use in Chithar river basin, Tamil Nadu: India, Environ. Geol. Vol., 47, pp.1099-110

Sundar, M.L. and Saseetharan, M.K. (2008). Groundwater quality in Ccoimbatore Tami Nadu along Noyyal river, Journal of Environmental science Engineering 50(3): 187-190

Todd, D.K. (1980). Groundwater hydrology, 2nd edition, John Wiley and sons, Inc, New York pp.535

WHO 2004 Guideline for drinking water quality, 3rd edition, Geneva, Stwitzerland.

Pp.515
WHO (2011) Guideline for drinking water quality, 4th edition, Geneva, Stwitzerland.
Wilcox, (1955). Classification and use of irrigation water, US department of Agriculture