AN ASSESSMENT OF SURFACE WATER QUALITY OF LOWER USUMA DAM / DUTSE ALHAJI IRRIGATION SCHEME (F.C.T.) ABUJA

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A THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,IN PARTIAL FUFILMENT OF THE REQUIREMENT FOR THE AWARD OF POST GRADUATE DIPLOM IN SOIL AND WATER ENGINEERING.

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CERTIFICATION

The project has been read, cross checked and Approved by the under-signed as meeting Post Graduate Diploma requirement of the Department of Agricultural Engineering, Federal University of Technology Minna.

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DATE

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HEAD OF DEPARTMENT

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EXTERNAL MODERATOR

DATE.

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DEDICATION

I hereby dedicate this project to my parents, my honourable friend **ALHAJI ILIYASU** and my Beloved ones.

ACKNOWLEDGEMENT

In the name of Allah, the beneficent, the merciful. All Glory be to Allah the most wise and all knowing. I thank Allah for moving me up again in the pursuit of knowledge by making it possible for me to finish my Post Graduate Diploma. I deem it very necessary to start by expressing my profound appreciation to my humble project supervisor in person of Dr. N. A. Egharevba for his untiring effort to see to the correctness of this project. He is indeed a gentleman. My appreciation goes to Dr. A. Adgizi H.O. D. Agric Engineering and all the lecturers in the department particularly Engineer Bashir Mohammed for his kind assistance and hospitality. His effort and contribution towards the success of this project is unquantifable. I will further extend my appreciation to my parent and guidance Alhaji Abubakar Sule for his unflinching support in so many ways beyond words description regarding the task of accomplishing this project.

My sincere and special gratitude goes to my dynamic friend Alhaji Iliyasu Al-Amin for his endless financial assistance. He has always stood by my side undergoing all the difficulties encountered during this work just to see to the success of this project. He is indeed a friend. I remain grateful. And may Allah reward him abundantly (Amin)

I can not forget to drop my inner most appreciation to my dear and beloved Amina A. for all her support and words of encouragement. She is indeed very dear to me and I thank her. Finally I say thank you to all those who share one idea or the other during the course of this project.

ABSTRACT

An assessment of the surface water of lower Usuma dam in respect to its quality, quantity and availability for dry season irrigation farming was conducted. Samples of the water were collected from three different points at 2 periods of intervals with the aim to ascertain the physico-chemical properties of the water in terms of quality and quantity.

Bearing the importance of water to human life, it was found that the water board management allow about 0.3m 3/S of water to flow from the dam site through the natural route of the river for the benefit of the people around the area. This quantity of water when evaluated translate to be very sufficient for not only irrigation farming but also for domestic use.

The physico-chemical test in the laboratory indicates that the water generally have low electrical conductivity which shows that irrigation can be carried out with most crops with little likelihood of soil salinity developing.

The PH value in S1and S3 are alright except in S3 where it calls for caution as it level could build-up the acidic content of the soil. The level of nitrate and phosphate are generally alright and fit for both irrigation farming and domestic uses

CHAPTER ONE

1. INTRODUCTION

1.1 INTRODUCTORY NOTES

Agriculture is the world largest water user in terms of volume, it is also a relatively low value, low- efficiency and highly subsidized water user. But the irony is that irrigation agriculture is expected to produce much more in the nearest future. According to a recent estimate, agriculture will use 19% more water to meet the food requirement or demand of the ever-increasing population.

Rain-fed agriculture accounts for most of the food and fibre grown within the area of study, the impact of seasonal variation of climate and of course the existence of the river USUMA allows continuous food production under natural condition before the construction of the dam. Hence, dry season irrigation farming must continue if food production is to be sustained and therefore, the assessment of surface water quality and quantity of the lower USUMA DAM cannot be over emphasis.

1.2 DESCRIPTION OF STUDY AREA

1.2.1 LOCATION

The study area is basically the lower Usuma Dam Ushafa environs Dutse Makarata and Dutse Alhaji in Bwari area Council of the Federal Capital Territory Abuja.

1.2.2. CLIMATE

The climate of the area is not too far to that of middle belts of Nigeria. The rainy season last between 190-200 days, with annual rainfall of about 1500mm with August- September recording the highest rains of 400mm. Mean monthly temperature is marched at 37^0c and lowest in August at 24^0c.

1.2.3. GEOLOGY

The geology of the area is characterized by rock formations of igneous, metamorphic and sedimentary origin/trails including valley(s) and records available shows that the formation contains good acquifer

1.2.4 ECONOMIC ACTIVITIES

The people's major occupation within this area is farming. The land is arable for the cultivation of food such as Yam, rice, Guinea corn, maize, vegetable and fruits. In the dry season after harvest, people in the inland valleys engage in irrigation farming along the riverbanks before the sitting and construction of the dam in the area.

1.3 THE GENERAL OBJECTIVE

The general objective is to determine the suitability of surface water of the Usuma dam in respect to its quality, quantity and availability for dry season irrigation farming within the area.

1.4 SPECIFIC OBJETIVE

The specific objectives are to

(i) Assess the physico-chemical properties of the water resource in the lower Usuma dam.

(ii) Determine the suitability of the surface water resource for irrigation in Dutse Makarana, and Dutse Alhaji.

(iii) Proffer corrective measure and management practice for irrigation.

(iii) Proffer corrective measure and management practice for irrigation.

1.5 JUSTIFICATION

Having known that the Rainfed agriculture accounts for most of the food and fibre grown in Nigeria. The season impact of variations of climate on farming allow no continuous production thereby making dry season irrigation farming a must and necessity in view of the ever increasing population of the society.

The people has practiced irrigation farming on substance scale for a long time and with time, improvement can be made in different aspect to increase output. Hence, a sound knowledge of the quality and availability of the water to be used and its suitability for crop grown and the soil being used is of extreme importance. Thus, irrigation water must be sufficient in order to meet the crop or this may be harmful to the soil being cultivated.

1.6 SCOPE OF STUDY.

The scope of this studying is limited only to the lower Usuma dam and Dutse Alhaji environs. The water samples were collected form three (3) different sports viz-viz (a) from the reservoir (b) Down shore of the dam and (c) off-area where the irrigation farming is talking place. This exercise was carried out at 3-interval period of time.

CHAPTER TWO

LITERATURE REVIEW

QUALITY OF WATER

2.1 COMPOSITION OF WATER .

The quality of natural water depends upon its content of impurities. Water itself is an associated liquid consisting of hydrol H_2O, dihydrol $(H_2O)_2$, Trihydrol $(H_2O)_3$, hydrogen and hydroxyl irons H^+ and OH:

The impurities in water occur in three progressively finer state of subdivision, suspend colloidal, and dissolved which are of significance in that they influence the methods required for the removal of the impurities. The total amount of solid impurities in water is obtained by the unfiltered water if evaporated and the residue weighed. The result is expressed in parts per million by weight, and it included suspended colloidal and dissolved solids.

A suspension is a dispersion of solid particles that are large enough to be removed by filtration on settling. Such particles are macroscopic and contribute turbidity to the water. The concentration of suspended matter in water is measured by its turbidity or by suspended solid analysis. The Turbidity is its capacity of absorbing and is measured by the concentration of fine silica in ppm, which produces an equivalent effect. The suspended solids content of water is the concentration in ppm by weight of solid matter removal from the water by filtration through a filter paper.

The suspended solid determination widely for concentration suspensions such as savage but is difficult to apply to relatively clear water and therefore is not commonly used in routine water analysis.

A colloid, or solution is a finely divided dispersion of one material called the dispersed is another called the dispersion medium. An aqueous suspension colloid is a water solution of solid particles that are too small to be removed effectively by ordinary filters and which are so small that they exhibit Brownian motion (ie they diffuse) and the electric charges on their surface are large enough in comparison with their mass of cause the particle to repel one another when they are more within the sphere of action of each other charges. The electric charge is due to the presence of adsorbed boron on the surface of the solid, and the material of the particle and PH value of the liquid determines the sign of the charge (Vaughan (1980).

Most of the substance that occur in natural water are shown in table 1. All these substances do not occur in single water, and their concentration varies widely for different waters. Some substances of sanitary significance occurring in water because of artificial contamination, such as phenols and cyanides are not specifically included in the table.

2.1 <u>ALKALINITY AND HARDNESS</u>

The Alkalinity of water represents its content of OH or of other ions that combine with H^+ upon the addition of acid. The most important of these other irons on Hco_3, which is usually present in considerable quality.

In alkalinity waters, normal carbonate CO_3 is a source of alkalinity since it forms Hco_3 upon the addition of acid. Birate, silicates and phosphates

also cause alkalinity, but they are usually not present in natural waters in appreciable quantities. Alkalinity is measured by Hitrution with acid.

TABLE 2.1: **SUBSTANCE OCCURRING IN NATURAL WATERS**

JB AN 'E	SUSPENDED	COLLODAL	DISSOLVED		
			NOT LONIZED	POSITIVE IONS	NEGA TIVE IONS
	Clay, And other in organic soils	Clay, silica (SiO_2) Iron acid (Fe_2O_3) Aluminum (Al_2O_3) Mangne acid (MnO_2).		Calcium Ca^{++}(40) Magnesium mg^{++} (23.3) SodiumNa^{+} (923) Potassium K^{+} (39.1) Iron FeH (55.8) Magnesium Mn^{+} (54.9) Hydrogen H^{+}(1)	Bicarbonate HCO_3(61) Sulphate 50_4 (96) Chloride cl- Nitrate NO_3 (62) Cabonate CO_3 (60) Hydroeyl OH^{-} (17) Silicate $HsiO_4$ (77.1) H_2BO_3 (60.8) Phosphate $HPO\text{-}_4$ (97) Iodide I^{-} (126.9) Fluoride F^{-} (19)
f rgan c	Organic soil (top soil) decomposing	Vegetable colouring matter organic	Vegetable colouring matter organic wave,	Anmonium $NH4^{+}$ Hydrogen	Nitrate, N03 Nitrite, N03 Hydroxyl,O

in	organic wastes	wastes	anmonia, NH_4O_3, carbonic acid H_2CO_3, other organic acids	H+	H Bicabonate, HCO_3 Other organic acids.
			Free carbon dioxide, co2 oxygen, 02 Nitrogen,N2 hydrogen,H2 hydrogen Sulphate H2, Methane, cH4 Sulphurdioxide So_2 Amenomia NH_3 Odorivector.		
vin rga sm	Fish life Algae, Diatoms, Minute Animals	Bacteria, Viruses Algae Diatoms Minute Animals.			

Source:(Todd T.C. , 1972)

The amount of acrial required to bring the water to PH_4 expressed in PPM of equivalent to $caco_3$ is called thoful, or methyl orange alkalinity. If the water is alkaline, the amount of acid required to bring the ptt down to 8 expressed in ppm of equivalent is $caco_3$ called the phenolphthalein. They are indicator that have significant colour changes at about PH_4 and PH_8 respectively.

Before analyzing the quality of this surface of the lower Usuma dam in respect to irrigation, it will be interesting know what exactly the term "irrigation". "Irrigation" as the term implies generally means the application of water to soil for the purpose of supplying the moisture essential nutrient for plant growth. However, a more inclusive definition is that irrigation is the application of water to the soil for any number of the following eight purposes:-

1. To add water to soil to supply moisture essential for plant growth.
2. To provide crop insurance against short duration of droughts.
3. To cool the soil and atmosphere, thereby making more favourable environment for plant growth.
4. To reduce the hazard of frost.
5. To wash out or dilute salts in the soil.
6. To reduce the hazard of soil piping
7. To soften tillage pens and clods
8. To delay bad formation by evaporation cooling.

2.2 QUALITY OF IRRIGATION WATER

Whatever may be source of irrigation water, viz, river, canal, tank, open well or tube well; some soluble salts are always dissolved in it. However, the nature and quality of dissolved salts depends upon the source of water and its course before use. The main soluble constituents in water are calcium, magnesium, sodium and sometimes potassium as cations and chloride,, sulphate, bicarbonate and sometimes carbonate as anions. However, ions of other elements such as lithium, silicon, bronze etc and

Organic matters are present in minor quantities. These elements usually do not affect the quality of irrigation water as far as the total salts concentration is concerned, but some ions such as sodium, molybdenum, and fluorine, if absorbed by plants in excessive amounts may prove harmful to the animal life when taken by then through drinking water, feed or forage. Among the soluble constituents, calcium, magnesium, sodium, chloride, sulphate, carbonate and baron are of prime importance in determining the quality of water for irrigation, water and its suitability for irrigation purposes. However, other factors as textures, structure of the soil, its drainage characteristics, nature of the crop grown and climatologically conditions is/are equally important in determining suitability of irrigation water in agriculture.

The amount and kind of salts present will determine the suitability of water for irrigation. With poor water quality, various soil and cropping problems can be expected to develop. Special management practices may then be required to maintain full crop productivity.

The problems that results from using poor quality irrigation water among others include:-

(A) Salinity- This is the accumulation of salts in the crops root zone to the extent that the yield are affected. It reduces the water intake by crop.
(B) Permeability- this is when the rate of water infiltration into and through the soil is reduced by the effect of specific salts or lack of

salts in the water to such an extent that the crop is not adequately supplied with water and yield is reduced.

(C) Toxicity- this occurs when certain constituents in the water are taken up by the crop and accumulated in amounts that result in reduced yield. Constituent such as boron, chloride and sodium.

(D) Miscellaneous- various other problems related to irrigation water quality occur with sufficient frequency and should be specifically noted.

2.3 <u>THE IRRIGATION SYSTEMS</u>

The followings are the types of irrigation systems: -

(A) Open systems – Gravitational flow (sub – surface irrigation)

(B) Closed systems- Pressurized flow (Drip and Sprinklers)

Irrigation water is conveyed in either the open or closed systems. Hydraulically, the two methods are similar, however they are found to be very effective in flow of water. Yet, these systems of irrigation is dependent on the following factors:-

1. The nature of crops.
2. Crop growth circle.
3. Climatic condition
4. Type and condition of soil
5. Filled application efficiency
6. Conveyance efficiency
7. Water quality

CHAPTER THREE

3.0 METHODAND MATERIALS.

3.1 PREAMBLE

This part of the work deals with the procedures, precautions and problems encountered or likely to be encountered and the solutions during the course of this project.

Generally, having known that the lower Usuma Dam was originally a river whose route traced from Npape in Abuja, passes through smaller villages as Dutse, Makaranta and Alhaji, Kubwa, Kuchi, Tungan- Maje up to Gwagwalada. It is expected that people living along and within these areas mentioned would be placed at a difficult situation if the water should be completely blocked. Thus, this project is aimed at knowing the quality of the surface water and the quality in respect to irrigation scheme and probably for domestic usage for the people mentioned above.

3.2. COLLECTION OF WATER SAMPLES FOR EXAMINATION

Samples of water were collected at three (3) different spots and at three intervals of time. The samples were collected in 3 sterile bottle sample. The 3 bottles were labeled based on the point at which the water sample was collected. The samples were collected with the aim of chemical test to ascertain the quality of water for domestic and irrigation purpose.

The samples collected were taken to the laboratory on getting to Minna, to be processed. Since, it was not possible to conduct the entire test on the same day, the samples were placed in the refrigerator to avoid contamination.

3.3 PHYSICAL EXAMINATION

This deals with the determination of colour, turbidity and odour and other physical factors capable of defacing the water such as solid content of water physical properties cannot be completely overlooked in relation to chemical composition of water.

This parameters indicates acceptability or otherwise of water to the consumer as they are widely used to establish its quality

3.3.1 APPERANCE

The appearance of water simply refers to the way the water looks, appearance of water can be affected by the level of impurities which the water contained, eg humus, vegetables, peat, iron, manganese and perhaps industrial waste such as dye.

All the listed contaminants are capable of impacting colour to the water, which will in turn, makes it not authentic for usage. The appearance of water is determined by visual means. Hence, water sample can be assigned its appropriate term either clear or not clear.

3.3.2 TASTE AND ODOUR.

Taste and odour depends on actual contact of the stimulating substance in the appropriate human receptor cell. The sense of odour is closely related to of taste. In fact, it's normally correct to suggest that most taste in water is really a sensation of smell.

There are four sensation of taste, "Sour, Sweet, Salty and Bitter" taste, all other sensations are of odour, although not necessarily noticed until the water is in the mouth. Some taste in water is however, unrelated to odour and this includes the blackishness associated with the relative amount of dissolved salts (sodium chloride or magnesium phosphate). Odour and taste are recognized as quality factors which affect water in several ways, either acceptability of drinking water, aesthetics recreational waters e.t.c. Determination of taste and odour is still based on subjective judgment given by panel tasters. It is also limited in application as a contaminated water sample may be too dangerous of taste tasting. That is why the samples collected, were not tasted, though no odour was perceived in the samples at least in the slightest for which the human smelling organ can attempt.

3.4 PRE-TREATMENT OF WATER SAMPLES

Before, treatment of the samples, the samples were kept in an air-conditioned room as to maintain room temperature, not exceeding 25^0c. The reason of doing this was to reduce microbial activities as much as possible to the bearest minimum. Immediately sampling exercise was over and pre-treatment accomplished, water samples were conveyed to the laboratory for series of physico-chemical analysis.

3.4.1 LABORATORY ANALYSIS OF WATER SAMPLES.

As soon as sampling was accomplished, water samples were taken to the laboratory for the chemical analysis. Those parameters that can affect the quality of irrigation water were noted. The parameters being analysed in the laboratory includes;

- PH value (acidity) alkalinity determination at temperature of 250c
- Total dissolved solids (TDS).
- Proportions of sodium (Na+) and ions to other cations such as calcium (ca+) and magnesium (mg+).
- Hardness and Bicarbonate (Hc03) concentration.

The sample were also made to go through further analysis to determine salt containing compounds. Eg sulphate (80_4), chloride (ct), Bicarbonate (Hco_3).

Water samples were also tested for micro element levels considering the toxic effect that might hinder the performance of crops if found to be in large amount in irrigation water. Eg Iron Fe^{2+}, Manganese (Mn^{2+}), Boron e.t.c. Analysis for hardness and electrical conductivity were also performed on the water samples.

3.4.2 METHOD OF ANALYSIS

During the water samples analysis, it was beared in mind the F.A.O and WHO guideline and procedures as specified by water and waste water Analysis Association 8^{th} Edition.

Electrical conductivity meter was used to determine the following physical parameter on site.

These include temperature O^c

Total dissolve Solids (TDS) mg/l.

Electrical Conductivity in uhos/cm.

A multi -parameter machine called spectrophotometer was used in analyzing and determining of water concentration and all other parameter.

3.4.3 WATER MEASURMENT PROCEDURE

Power Connection:

The 12V DC adaptor was plugged into the Dc socket. And the adaptor was plugged into the outlet. The meter is on by pressing the ON/OFF button.

- The meter performs an L C D self-diagnostic test by displaying a full set of figures.
- It then shows a scrolling C 100 massage

- P1 then appears on the secondary LCD TO inform that the parameters measurement can be performed.
- The programmes number is then selected by using the prgrammes button.
- Then the procedure for each parameter was adopted.

CALCIUM

Adoptation of the standard methods for water and waste water 18th Edition. Calmagite method. The reaction between ca and reagents causes a red tint in the sample.

CHLORINE

The EPA recommended DPD method 330.5 was used. The reaction between the chlorine and the DPD reagents causes a pink tint in the sample. The result is obtained in mg/l.

MAGNESIUM

Adaptation of the standard methods for the examination of water and waste water 18th edition – EDTA colorimetric method. The reaction between mg and reagents causes a violet tint the sample.

IRON

Adaptation of the phenaproline EPA method 315 B for natural and treated waters. The reaction between iron and reagents causes an orange tint in the sample.

NITRATE

Adoptation of the cadmium reduction method. The reaction between nitrate – Nitrogen and reagents causes an amber tint in the sample.

Dissolved Oxygen- Adaptation of the standard methods for the examination of water and waste water 18th Edition, axide modified winkler method. The reaction between dissolved oxygen and the reagents causes a yellow tint in the sample.

PH-Adaptation of the Phenol red method. The reaction with the reagents causes a red tint in the sample.

PHOSPHATE – adaptation of the standard methods for the examination of water and waste water (18th edition), amino acid method . The reaction between phosphate and reagents causes a blue tint in the sample.
Turbidity, temperature and conductivity – These were determined with the conductivity meter that displays their readings automatically.

Sulphate, Potasium, sodium.
Here, Lovibond Manikin test was employed.
Tablets corresponding to the required estimate of the parameters was chosen and the computation was carried out leaving the result in mg\l.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 DISCUSSION OF RESULTS

This section of the study work project will deal with the analysis of results obtained from the laboratory of the water samples collected from the dam site.

The objective of this chapter is to analyse the laboratory results of the sample and compared it with the world Health Organization standard recommended for public and agricultural use.

TABLE 4.0 AND TABLE 4.1.1 shows the laboratory results of the water sample while Table 4.1.2 and Table 4.1.3. and Table 4.1.4 shows the average means computed for the three samples of S1, S2, and S3 respectively.

Similarly table 4.2.0 and table 4.2.1 are the corresponding requirements table guidelines for both domestic and irrigation of the world health standard.

TABLE 4.0 LABORATORY RESULTS SOF SAMPLES APRIL MONTH

1.	SOURCE OF WATER SAMPLE	DAM RESERVIOUS S1	NATURE ROUTE OF THE RIVER S2	IRRIGATION POINT S3
2	Date of Samples	8/4/2002	8/4/2002	8/4/200
3	Date of Analysis	11/4/2002	11/4/2002	11/4/2002
4	PH	7.6	6.4	6.6
5	Nitrate (N03) MglL Phosphate (PD3) MglL Potassium (R+) MglL	7.97 2.9 1.8	17.4 4.6 8.6	13.5 9.2 4.8

	Sodium (Na+) MglL Calcuim (C92+) MglL Magnesium (Mg2+) MglL	1.5 5.2 0.37	4.1 32 0.78	6.7 12.9 0.53
6	Chloride (Ct) MglL Sulphate (S02)4 MglL Bicarbonate ($HC0_3$) MglL Iron	7.8 13.33 28.0 0.4	17.8 28.3 34.7 0.2	19 10.2 30.0 0.12
7	Colour NTU Electrical Conductivity (Umhos/cm Hardness (MglL) TDS (MglL) Dissolved Oxygen (MglL) Faecal Coliform (Cuf/ML)	1.9 1.7 1.51 21.0 4.2 7.0	12.5 15.9 3.2 68.0 2.1 34.0	15.8 6.8 2.2 71.0 1.8 58.0
8	Temperature D^C	32	30.6	28.5

TABLE 4.1.1 LABORATORY RESULTS SOF SAMPLES MAY MONTH

1.	SOURCE OF WATER SAMPLE	DAM RESERV IOUS S1	NATURE ROUTE OF THE RIVER S2	IRRIGATI ON POINT S3
2	DATE OF SAMPLING	13/5/2002	13/5/2002	13/5/2002
3	DATE OF ANALYSIS	16/5/200	16/5/200	16/5/200
4	pH	7.4	6.2	6.9
5.	TEMPARATURE 0^{C}	31.0	27.6	30.0
6.	(a) NITRATE ($N0_3$) mg/l	4.5	13.5	19.7
	(b) PHOSPHATE ($P0_3$) mg/l	2.0	3.7	12.7
	(c) POTASIUM (K^+) mg/l	1.76	9.9	5.2
	(d) SODUIM (Na+) mg/l	1.9	6.2	5.8
	(e) CALCUIM (Ca^{2+}) mg/l	3.6	24.0	37.0
	(f) MAGNESUIM (MG^{2+})	0.4	0.65	0.39
7.	(a) CHLORIDE (Cl) mg/l	7.9	17.4	20.02
	(b) SULPHATE ($S0^{2-})_4$ mg/l	18.56	32.67	18.5
	(c) BICARBNATE (HCO3) mg/l	32..0	43.0	23.8
	(d) IRON (FE^{2+})mg/l	0.32	0.2	0.1
8.	(a) COLOUR NTU	2.0	13.7	18.0
	(b) ELECLTRICAL COND	3.1	13.6	9.7
	(c)HARDNESS (MG K)	2.81	4.9	3.4
	(d) T DS (MGL)	13.0	56.0	83.0
	(e) DISSOLVED OXYGEN	4.6	2.0	1.4

	(MG/L)			
	(f) FAECAL COLIFORM (CUF)	5.0	56.0	73.0

4.1.2 AVERAGE MEAN OF S.1)

TABLE RESULTS DAM RESEVOUR SAMPLE

PARAMETER (S)	S1	S1	MEAN
PH	7.6	7.4	7.5
Temperature OC	32	31	31.5
Colour NTU	1.9	2	1.95
Electrical (Conductivity	1.7	3.1	2.4
Calcuium (MglL)	5.2	3.6	4.4
Sodium (MglL)	1.5	1.9	1.7
Potassium (MglL)	1.8	1.76	1.78
Sulphate (MglL)	13.33	18.56	15.945
Chloride (MglL)	7.8	7.9	7.85
Bicarbonate (MglL)	28	32	3.0
Nitrate (MglL)	7.97	4.5	6.6235
Phosphate (MglL)	2.9	2	2.45
Iron (MglL)	0.4	0.32	0.36
Magnesium (MglL)	0.37	0.4	0.385
Hardness (MglL)	1.51	2.81	2.16
TDS (MglL)	21	13	17
Dissolved Oxygen (MglL)	4.2	4.6	4.4
Faecal Coliform CFU/mc)	7	5	6

TABLE 4.1.3 AVERAGE MEAN OF S2 (ROUTE OF REVER) SAMPLE

PARAMETER(S)	S2	S2	MEAN
PH	6.4	6.2	6.3
Temperature OC	30.6	27.6	29.1
Colour NTU	12.5	13.7	13.1
Electrical (Conductivity	15.6	13.6	14.75
Calcium (MglL)	32	24	28
Sodium (MglL)	4.1	6.2	5.15
Potassium (MglL)	8.6	9.1	8.85
Sulphate (MglL)	28.3	32.67	30.485
Chloride (MglL)	17.8	17.4	17.6
Bicarbonate (MglL)	34.7	43	38.85
Nitrate (MglL)	17.4	13.5	15.45
Phosphate (MglL)	4.6	3.7	4.15
Iron (MglL)	0.2	0.2	0.2
Magnesium (MglL)	0.78	0.65	0.715
Hardness (MglL)	3.2	4.9	4.05
TDS (MglL)	68	56	62
Dissolved Oxygen (MglL)	2.1	2	2.05
Faecal Coliform CFU/mc)	34	56	45

TABLE 4.4.4 AVERAGE MEAN OF S3 (IRRIGATION POINT

SAMPLE

PARAMETER(S)	S1	S1	MEAN
pH	6.6	6.9	6.75
Temperature OC	28.5	30	29.25
Colour NTU	15.8	18	16.9
Electrical (Conductivity	6.8	9.7	8.25
Calcuium (MglL)	12.9	37	24.95
Sodium (MglL)	6.7	5.8	6.25
Potassium (MglL)	4.8	5.2	5.0
Sulphate (MglL)	10.2	18.5	14.35
Chloride (MglL)	19	2002	19.51
Bicarbonate (MglL)	30	23.8	26.9
Nitrate (MglL)	13.5	19.7	16.6
Phosphate (MglL)	9.2	12.7	1095
Iron (MglL)	0.12	0.1	0.11
Magnesium (MglL)	0.53	0.39	0.46
Hardness (MglL)	2.2	3.4	2.8
TDS (MglL)	71	83	77
Dissolved Oxygen (MglL)	1.8	1.4	1.6
Faecal Coliform CFU/mc)	58	73	65.5

TABLE 4.2.0 W. H. O. GUIDELINES FOR INORGANIC AND ASTHETIC QUALITY OF WATER FOR HEALTH SIGNIFICANCE CONCRERATION IN MG/LITRE

Chemical Constituent	Permissible Limits	Excessive Limits	Maximum Allowance Limits
Absenic	0.05	-	0.2
Abbestors	No Guideline	-	-
Barium	"	-	-
Berylium	"	-	-
Cadium	0.005	-	-
Chloride	200	400	-
Chromium	0.05	-	0.05
Cyanide	0.1	-	-
Flouride	1.5	-	-
	(It inclusdes both natural fluoride and deliberately added fluoride Local or Climatic)		
Lead	10.05	-	0.1
Mercury	0.001	100.0	-
Potassium	20.0	-	-
Sodium	200.0	200.0	-
Calcium	75.0	150.0	-

Magnesium	50.0	45.0	-
Nitrate	10.0	-	-
Nickel	-	-	-
Selenium	0.01	1.5	-
Copper	0.2	1.0	-
Iron	1.0	1.50	-
Manganese	0.3	1.0	-
Detergent	0.1	0.5	-
Solids, Total. Solids	No guideline, there should be no forming taste ro odour problems 1000	-	-

TABLE 4.2.1 GUIDELINES FOR INTERPRETATION OF WATER QUALITY OF IRRIGATION

	IRRIGATION PROBLEM		DEGREE OF PROBLEM	
		NO PROBLEM	INCREASING PROBLEM	SEVERE PROBLEM
1	Salinity – Affects water availability to crop Ec (mm hos/cm	<0.75	0.75 – 3.0	>3.0

2.	Permeability – Affects rates of infiltration of the water into and through soil	>0.5	0.5 – 0.2	<0.2
3.	Specific on toxicity – affects sensitive crop			
	(a) Sodium (Mg/l)	<3	3-9	>9
	(b) Choride (Mg/l)	<4	4-10	>10
	(c) Boron (Mg/l)	<0.75	0.75 – 20	>2.0
4.	Miscellaneous effects affect sensitive crops			
	(a) $N0_3$	<5	5- 50	>30
	(b) $HC0_3$ (Mg/l)			
	Over head sprinkling	<1.5	15- 8.5	>8.5

Source: Wescott (1970)

4.2. RESULT OF PHYSICAL ANALYSIS OF WATER SAMPLES

This deals with the determination of colour turbidity, taste, odor and other physical factors capable of defacing water such as total solids content of water. Physical properties of water are highly necessary in water usage especially for public and agriculture use. The clarity of water to the lay-man always render it portable. This parameters indicates acceptability in otherwise of water to the consumer as they are widely usual to establish it's quality.

COLOUR

Colour in water may originate from metallic impurities such as vegetables, humus, peal iron, manganese and industrial waster such as dyes. They are capable of impacting colour to water supply.

The colour of water might not have any effect on the quality of the water for agricultural purposes but might seriously affects the quality of water for public use.

The colour fo water can be determined by visual comparison with properly calibrated glass disc, standard colour solution with known concentration and visual means. The method adopted was the visual means method, it was observed that all the samples observed were clear and not objectionable in fact. In general the sample satisfy the recommended level by Health organizations.

TASTE AND ODOUR

Taste and odour depends on the actual contact of the stimulating substance with the appropriate human receptor cell. The sense of colour is closely related to that of taster in fact it's normally correct to suggest that most taste in water are really a sensation of smell.

There are four sensation of taste, sour, sweet, and bitter although not necessarily notices until the water is tasted in the month. Some taste in water are however unrelated to odour and this include the baseliners associated with the related amount of dissolved salts (sodium chloride or magnesium sulphate). Odour and taste are recognized as quality factors which affect water in several ways, either acceptability of drinking water, aesthetics of recreational water etc.s

APPERANCE

The appearance of water is closely related to colour of water. The colour of portable water is colourless and the appearance of portable water has to be clear and attractive according to world Health Organization, standard for domestic water. This was done by close observation of the samples collected at different sampling point.

The sample collected at S2 and S3 did not show clear appearance but sample S1 was observed to be clear and attractive. The appearance of this sample conformed to the recommended standard by (W. H. O.)

4.3.2 RESULTS OF CHEMICAL ANALYSIS AND THE SUITABILITY THE WATER SAMPLE FOR IRRIAGATION PURPOSES OF WATER SAMPLE.

Chemical characteristics tend to be more specific in nature than some of the physical parameters which depends on climate, they are this more useful in assessing the properties of a sample. Chemical composition of ground water depends on the characteristics of the serology of the area where the samples were taken.

Chemical materials that may be discharged into a receiving water may be classified into organic pollutant, where organic materials may be defined as compounds containing a carbon alonis undesirable results from the discharge to inorganic materials which include charges in the PH of water caused by salts and toxity caused by heavy materials (Furman 1962).

Few of the elements were analysed using spectrophotometer analyzer. The elements analysed include PH, nitrate, sodium, potassium sulphate, iron, calcium etc

Irrigation water has been classified as excellent, Good, Permissible, Doubtful or Unsuitable depending on their percentage sodium, the electrical conductance and Boron concentration. The classification is shown below on the table (WILCOX 1955).

TABLE 4.2.2. QUALITY CLASSIFICATION OF WATE FOR IRRIGATION

BORON Mg/l

WATER CLASS	% SODIUM	SPECIFIC CONDUCTANCE 0 S/cm	SESSITIVE CROPS	SEMI ANT CROPS	TOLERANT CROP
Excellen	<20	<250	<0.33	<0.067	<1.00
Good	20-40	250-750	0.33-0.67	0.67-1.33	1.00-2.00
Permissi	40 – 60	750 – 2000	0.69 –1.00	1.33 – 2.00	2.00 – 3.00
Doubtfu	60 – 80	2000 – 3000	1.00 – 1.25	2.00 – 2.50	3.00 – 3.75
Unsuita	>80	>3000	>1.25	>2.50	>3.75

SOURCE: (WILCOX 1955)

Before the chemical equation is computed the values have to be covered to their respective unit. The table below shows the conversion factors for the chemical equivalence of the element.

CONVERSION FACTORS FOR CHEMICAL EQUIVALENT

(Concentration in Mg/L times the conversion factor yield concentration in)

CHEMICAL CONSTITUENTS	CONCERSION FACTOR
Bicarbonate $HC0_3$	0.01639

Calcium Ca^{2+}	0.04990
Carbonate $C0^{2-}$	0.03333
Chloride C+	0.02821
Magnesium Mg^{2+}	0.08226
Manganese Mn^{2+}	0.03640
Nitrate $N0_3$-	0.01613
Phosphate $P0_4$-	0.03159
Potassium K+	0.02557
Sodium Na+	0.04350
Sulphate $S0_4^{2-}$	0.02082

SOURCE: HEM (1970)

THE COMPUTATION OF PERCENTAGE SODIUM AND SODIUM ADSORPTION RATIO (SAR)

The concentration of sodium in irrigation water is important to be noted because sodium reacts with soil to reduce its permeability. Sodium content is usually expressed in terms of present sodium percentage and soluble.

Hence

$$\% \ Na = \frac{Na + K}{Ca + Mg + Na + K} \times 100\ \%$$

expressed in mg Equivalent per litre

And sodium adsorption rate (SAR)

$$SAR = \frac{Na}{Ca + Mg/2}$$

expressed in mg equivalent per litre.

TABLE 4.2.4: EVALUATION OF THE SAMPLE WATER FOR IRRIGATION

SAMPLE	EC Mhos/c	Ca2+ Mg/l	Mg 2+ Mg/l	Na+ Mg/l	SAR	% Na	Water Class
S_1	2.4	0.22	0.03	0.07	0.198	28.64	Excellent
S_2	14.75	1.40	0.06	0.22	0.257	23.60	Good
S_3	8.25	1.25	0.04	0.27	0.0336	23.69	Good

NOTES:

S1 - Water Sample from the Dam Reservoir

S2 - Water Sample from the Natural River Route

S3 - Water Sample from the Irrigation Area.

From the results obtained after the evaluation of the water sample for irrigation the water samples (S1, S2 and S3) can generally be said to be good for irrigation purpose.

Hence the chemical analysis for the water samples follows.

PH VALUE

The PH value indicates the degree of acidity or alkalinity. The PH value below indicates acidic concentration while PH value above indicates the alkaline character of the water.

However, the PH value represents the hydrogen iron (H^+) concentration in water. It is also the logarithm of the reciprocal of the hydrogen iron concentration.

From the result of water analysis, the mean PH value of sample S_1 and S_3 shows that the water is good for irrigation farming while S3 may need to be processed.

NITRATE (NO_3) CONCENTRATION

This is the chemical form in which nitrogen is absorb to taking in by plants in the soil. From the result analysis, all the 3 samples falls within the range of 5 – 20 Mg/l and these has fallen within the W. H. O. standard of 45 Mg/l for agricultural and public use. It means that all the samples are fit for irrigation and domestic use.

PHOSPHATE ($P0_4$) CONCENTRATION

This is the chemical form of phosphorous when in solution. And phosphorous is one of the 3 primary nutrients largely required by plants for growth. Water analysis shows a very high rate of phosphorous content and this has fallen within the permissible limits of the standard.

POTASSIUM (K^+) CONCENTRATION

This is one of the primary nutrient elements required by plant for morphological performance in the field. Although, some times, it is considered to be toxic simply because, in the elemental state, it reacts violently with moisture to liberate hydrogen and form potassium hydroxide (K0H) which is extremely caustic in nature. It affect public water and too much of its elements affect agriculture too.

The toxicity of potassium compound is almost equivalent to that of the anion. Much of potassium finals its use into the environment because of the weathering of natural materials such as rocks and ones (Piowes 1962)

From the result of the water analysis, the mean of the 3 samples indicates that potassium concentration is appreciable as it falls within the W. H. O. Standard value of 0.0001 – 100 mg/l which are the permissible limits.

SODIUM (Na+) CONCENTRATION

Sodium has the ability to destroy soil structure and it is capable of building up salts in the soil. Therefore, it is undesirable element in irrigation particularly in large quantity.

The sodium content in the water sample is between 1.7 – 6.25 Mg/l and this can be used safely for irrigation purpose as it falls within the W. H. O. standard of 3.0 Mg/l which is the permissible limit.

CALCIUM (Ca2+) CONCENTRATION

Calcium is very common environmental pollutant. From the table, it can be seen that sample S3 recorded the highest mean value of calcium, which is 24:95 Mg/l. The W. H. O. standard is 75 – 200 Mg/l which is the permissible limits. And from this standard, the calcium content for both domestic and agricultural purposes falls within the range and hence, it is okay for domestic use too.

MAGNESIUM (Mg^{2+}) CONCENTRATION

Magnesium is common water pollutant, which results to temporary hardness of water. The World Health Organization standard has a permissible limit of 30 Mg/l to 150 Mg//l. From the result shown on the table magnesium content is within the standard of the world health organization requirement.

CHLORIDE (Cl⁻) CONCENTRATION

This is considered to be an important element in water because its concentration determines the susceptibility of the water to pathogens that causes some water borne diseases in the system of man and lower animal that consume it. The permissible limit of chloride according to W. H. O. Irrigation purpose is 200 mg/l. hence in all the 3 samples; there is need for chloride to be treated before use for irrigation purpose.

SULPHATE (SO_4) CONCENTRATION

The same limit of 200mg/l that is desirable for chloride is also desirable for sulphate. All water samples show sulphate content far below this value, which indicates a food quality for irrigation purposes.

BICARBONATE (HCO_3) CONCENTRATION

From the results of the water analysis carbonates was observed to be in large quantity. However high concentration of bicarbonate ions may results in precipitation of calcium and magnesium carbonates from the soil solution, thereby in creasing the proportion of Na^+ (Sodium) ions. But for this result it can be concluded that the quantity of HCO_3 is not likely to cause any hazard.

IRON (Fe^{2+}) CONCENTRATION

Iron concentration of 0.5 Mg/l may be severed and may need to be corrected. This may be achieved by applying appropriate measures. The highest desirable level of iron is 0.1 Mg/l while the maximum permissible level is 1.0 Mg/l.

Iron has a chemical affect that could become a problem at the concentration of 0.1 Mg/l. It has the ability to cause rust in some sprinkler or overhead irrigation system.

From the result of the analysis, iron was found to be of 0.3 6MglL, 0.7 Mg/l and 0.11 mg/l, which appear to be severe. Therefore iron need to be treated before use for irrigation.

TOTAL HARDNESS

The permissible level of total hardness in any water is 500mg/l. And the highest desirable level of hardness, which in most cases comprises of calcium carbonate ($CaC03$) or magnesium carbonate mg/C03 and Bicarbonate ($HC03$) is 400 mg/l.

But from the result of the water analysis, total hardness is found to be very low which implies that the quality of water with regards to hardness is alright.

TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION

The acceptability and suitability of water resources for irrigation purposes is guided by the amount of total dissolved solids (TDS) present in the water. The osmotic pressure of the soil solution increase when the total dissolved solid is present in large quantities thereby, causing high soil moisture stress in the root zone which in turn hinder plant growth and subsequently affect crops yield.

The acceptable limit of TDS and PH value for suitability indicates that water containing TDS up or 400mg/l or less and a PH value below 8 are generally quite suitable for irrigation purposes.

However, the water sample result shows an appreciable quantity of TDS and thereby making it suitable for irrigation purposes.

ELECTRICAL CONDUCTIVITY

The electrical conductivity is use to measure salt concentration in any water. It measures the ability of any water to conduct electricity and this is expressed in Mhos/cm. Ec and salt concentrations are proportional to each other.
Below is the international values of electrical conductivity of water quality:-

GROUP 1 0 – 10 Mhos/cm

(a) Water samples can be used for irrigation with most crops as the samples have electrical conductivity with low salinity hazard.

(b) Little likelihood of soil salinity hazard.

(c) Leaching due to irrigation can handle pressure of salts (except in soils with extremely low permeability).

GROUP 2 200 – 400 Mhos/cm.

(a) Water sample can be used with moderate amount of leaching

(b) Salinity control required.

GROUP 3 400 – 800 Mhos/cm.

(a) Water samples cannot be used on soil with restricted drainage.

(b) Management of salinity control required.

GROUP 4 800 – 1600 Mhos/cm.

(a) Water sample not suitable for irrigation under ordinary condition

(b) Soil must be permeable, have good drainage.

(c) Irrigation water must be applied in excess to provide considerable leaching.

(d) Only tolerant crops yield satisfactorily.

However, the water sample analysis shows that, the samples fall within group one (0 –100 Mhos/cm.) ie water samples can be used for irrigation purpose and the electrical conductivity has a low salinity hazard.

4.4 SUITABILITY OF WATER SAMPLE FOR DOMESTIC USE.

As it was earlier stated, the PH indicates the degree of acidity or alkalinity of the water and from the result of water analysis, it could be seen that the mean of S_2 (water from the natural river) is below the range of the standard which means it has to be treated before it could be used for domestic purpose. But the result of S_1 and S3 which is 7.5 and 6.75 respectively falls within the

W.H.O. standard level for domestic use and as such it is okay and can be recommended for domestic use.

NITRATE CONCENTRATION

The nitrate concentration of the 3 water sample shows that S1 = 6.2 Mg/l. S2 = 15.45 Mg/l and S3 = 16.6 Mg/l and in comparison to the W.H.O. standard it can be said to be the nitrate concentration is within the required standard for both irrigation and domestic purposes.

CHLORIDE CONCENTRATION

Chloride concentration has earlier been identified to be of great importance. This is because it can contain pathogens, which are likely to cause certain diseases. Hence, it usefulness can be over emphasis. From the result S1, S2 and S3 indicate that the concentration of chloride is within the W. H. O. standard level of 200 Mg/l of permissible limit.

SODIUM CONCENTRATION

Since sodium has the capability of building up salts in the soil. It becomes necessary to check it concentration. From the water sample analysis conducted, it shows that all the 3 samples are within the W. H. O. standard of 20 mg/l permissible limit for domestic use and it is therefore recommended that it may be use for domestic purpose.

IRON CONCENTRATION

The recommended World Health Organisation for iron concentration in domestic water is between 1.0 – 1.5 Mg/l. And the water samples of the analysis indicate that the iron concentration is within the range of standard and therefore the water can be use for domestic purposes.

CHAPTER FIVE

5.0 OBSERVATION, RECOMMENDATION & CONCLUSION

From technical point of view, it has been observed that most of our surface water supplies are of satisfactory quality for irrigation purpose. This is based on the results of analysis conducted on two samples except in cases where Iron (Fe^{2+}), manganese (Mn^{2+}) and some other undesirable chemical substance were encountered. But, then this does not stop or prevent their sample or rather the sources of water use in the field as they are still observed to be within the permissible limits in terms of chemical composition.

At any rate it is recommended that water where Iron (Fe^{2+}) is observed to be relatively severe should be carefully monitored and if possible be given appropriate chemical treatment that would prevent the increase of iron build-up, if not drastically reduced.

Similarly, treatment with chlorine would help prevent further build-up of iron and sulphate concentration. The chlorination is also required to prevented the build –up of algae, growth, and some undesirable odour which are very predominant in the presence if Fe, and S

The pH of the water sample is generally okay but regular check of this parameter in irrigation waters is very important to prevent the possible problem if acidity or alkalinity.

Also, any abnormal crop development observed in the field even in the presence of optimum supplies of irrigation water by the officers, as field officers should be noted and possible ways of correcting it should be made so that such abnormality can be corrected at its early stage.

It was also observed that all water samples are spatially free from pathogenic organisms and found to be very safe. However, that if sample S_2 is colours do not commend than for direct human consumption. Hence, they must be treated or processed before they should be recommended or allowed for human consumption at rural level.

5.1 CONCLUSION

Since water has always been described as life and it plays a very important role in the activity of human endeavors, especially in agriculture, it is therefore recommended that dry season farming with irrigation water should be continuous and the quality control management practice of the water should also be a continuous exercise. Usually the irrigation programme is suppose to be carried out seasonally (dry season), but the capital involve sometime prevent people, hence people should be encourage to embark on such farming as is beneficial and profitable and it would boast or increase food production which in turn will be beneficial to the community as a whole.

RECOMMENDATION

I may wish to recommend to the authorities of Bwari Area Council to look into possible ways of assisting the people presently practicing irrigation farming in the area. These assistance may be in form of materials and technical, with the view to ensuring full utilization of the water resources.
Finally, since the Lower Usuma Dam surface water is found is be suit for irrigation, I do recommend to the people of Dutse Makaranta, and Dutse Alhaji to embark on dry season farming by fully utilizing the $0.3m^3$ /s of water that is constantly flowing into their farm stead.

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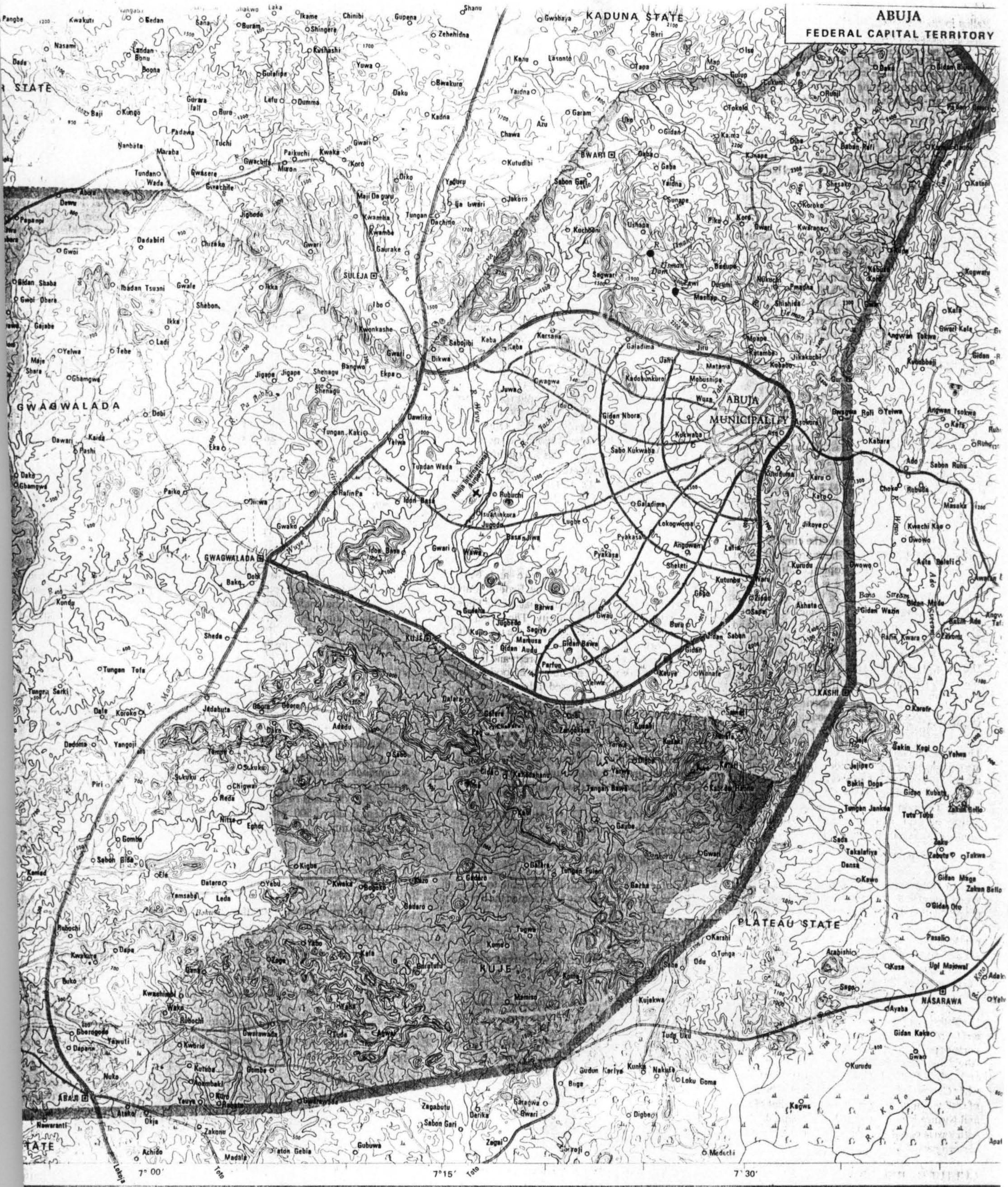

MAP OF ABUJA INDICATING RIVER USUMA