IMPACT OF AGRICULTURAL INPUTS ON POTABILITY OF WATER IN ILORIN CATCHMENT AREA

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ABSTRACT

An investigation was carried out on available water sources on the campus of the National Centre for Agricultural Mechanization (NCAM), Ilorin and its surrounding communities to ascertain the extent of their pollution. Nine water sources were sampled during the rainy season of 2008; these samples include both surface and underground water sources. All sources were sampled on three different occasions and analyzed in a standard laboratory. The results of the analysis, compared with the World Health Organization (WHO, 2006) Drinking Water Quality Standards, showed that the activities of NCAM had no significant effect on the quality of the downstream water sources. It also showed that upstream sources are highly polluted and not potable until adequate treatment is applied. The results also revealed that NCAM borehole stood the best of all the sources, both from the chemical as well as the bacteriological stand point. As at the time of sampling, five water sources were not potable due to their bacteriological state. Some chemical constituents were also found to be above the Maximum Permissible Limit (MPL), most of which do not have a direct effect on the health of their consumers, but may also be given the necessary treatment to improve on their quality.

Keyword: Water sources, Pollution, Water quality, Water quality standards, Potability

1. INTRODUCTION

Water is essential for the sustenance of life, and a satisfactory (adequate and safe) supply must be accessible to all. Improving access to safe drinking water can result in tangible benefits to health; therefore every effort must be made to achieve a drinking water quality as safe as practicable (WHO, 2006). Water shortages already exist in many parts of the world with more than a billion people without access to adequate drinking water. As the world population increases, water need also increases; however as a result of human activities, water resources are decreasing, polluted and still used unconsciously (Kilic, 2020). Water sources are either surface, e.g. river, stream, etc. or underground, e.g. well, borehole, etc.

The provision of reliable and clean water supplies is an essential element in improving the quality of life of rural populace. Water quality is the physical, chemical and biological characteristics of water in relationship to a set of standards. Water is considered polluted if some substances or condition is present to such a degree that the water cannot be used for a specific purpose. Olaniran (1995) defined water pollution to be the presence of excessive amounts of a hazard (pollutants) in water in such a way that it is no long suitable for drinking, bathing, cooking or other uses. Pollution is the introduction of a contamination into the environment (Webster.com, 2010). The presence of National Centre for Agricultural Mechanization (NCAM), Ilorin, a Centre whose activities include testing of tractors, use of fertilizers and agro-chemicals and other mechanization activities such as irrigation and processing of crops may impair negatively on the quality of water around its catchment.

Pollutants entering surface waters during precipitation events are termed polluted runoff. Daily human activities result in deposition of pollutants on roads, lawns, roofs, farm fields, etc. When it rains or there is irrigation, water runs off and ultimately makes its way to a river, lake, or the ocean. Ilorin and its surrounding rural communities are blessed with different sources of water, both surface and underground, but due to human activities within and around these target communities, these water sources are polluted to varying degrees.

Impurities resulting from man's activities may be classified into five (5) groups, i.e. wastes of animal or human origin, run-off from farms in which case fertilizers and pesticides are included. Also included are domestic sewage, such as bathing or washing water, industrial wastes or accident pollution such as that resulting from discarded engine oil.

The quality of water is usually considered in terms of its physical, chemical and bacteriological parameters. The impact of drinking water quality cannot be over-emphasized. It ranges from massive outbreak of communicable diseases to chronic infections which may lead to death. Investigations carried out by Olla and Ahaneku (2004) concluded that most of the water sources analyzed for quality test in Ilorin were not fit for consumption mainly due to their bacteriological status. This was not unconnected with the unprotected nature of the water sources.

The parameters for water quality are determined by the intended use. Furthermore, it has been generally observed that most physical properties are manifested when some chemical elements are present in excess. Common physical properties like taste, odour, colour, temperature, turbidity, etc. 'may be first alarm signal' for a potential health hazard and they play an important role in the consumers' evaluation of drinking water.

The increasing use of artificial fertilizers, the disposal of wastes and changes in land use are the main factors responsible for progressive increase in nitrate levels in groundwater (WHO, 1998). Therefore, NCAM's presence is a likely contributor to high nitrate concentration in water sources within its environ due to high dosage application of nitrogenous fertilizers on NCAM farmlands.

WHO (1984) identified more than 600 organic contaminants in drinking water. Safe drinking water is the birthright of all humankind – as much a birthright as clean air. The majority of the world's population, however, does not have access to safe drinking water. This is certainly true in most parts of Africa and Asia. Even in relatively advanced countries such as India, safe drinking water is not readily available, particularly in rural areas. One reason safe drinking water is of paramount concern is that 75 percent of all diseases in developing countries arise from polluted drinking water (TWAS, 2002). Water-borne and water related diseases are among the most serious health problems in the world today, thus, the cost to the world economy is staggering. Microbial pollution includes bacteria, protozoa, and viruses that are common in the natural environment, as well as those that come from human sources (Field and Pitt, 1990; Mallin et al., 2000).

The objectives of this study are to identify and analyze the quality of water from different sources at NCAM, Ilorin and its surrounding communities; determine the effects of NCAM activities on the downstream water sources; evaluate the level of impurities in the available water sources and suggest ways of amelioration. The study will also provide a water quality database for NCAM and the surrounding communities, which may be useful for future research work.

2. MATERIALS AND METHODS

2.1 Brief Description of Study Area

All water sources were located in and around the National Centre for Agricultural Mechanization (NCAM). NCAM is located about 20 Km to Ilorin city of Kwara State, Nigeria. has an estimated average terrain elevation of 470 m above sea level and lies between Latitudes $9^0$50’ and $8^0$24’ and Longitudes $4^0$38’ and $4^0$3’East (Abdulkadir, 2016). Water sources such as NCAM borehole, NCAM well are within the NCAM premises, while NCAM rock-filled dam Is though within NCAM land area, but is along the path of Odomu river and downstream a concrete dam jointly owned by NCAM and Kwara State Water Corporation. Elerinjare dam raw water was sampled from the concrete dam, while the Elerinjare treated water was sampled from the treatment plant situated at the dam. Oyun rver sample was taken downstream NCAM, along the path of the dammed river. Samples like Jimba Oja well and borehole were sampled downstream NCAM very close to the Jimba Central Mosque.

2.2 Water Sources and Locations

Nine different water sources were sampled during the wet season of 2008 and analyzed for potability consideration. These sources include Idofian well, Elerinjare dam water (raw water), Elerinjare (treated water), Jimba-Oja Borehole, Jimba-oja Well, NCAM borehole, NCAM rock-filled dam, NCAM well and Oyun river. Idofian well is located upstream NCAM and it serves the community for drinking and laundry purposes. Elerinjare dam, also upstream NCAM, water from here is treated for supply to Idofian, NCAM and other communities. Treated water from this source was also sampled to know the state of the treated water consumed by the population served. NCAM rock-filled dam is a partly completed rock-filled dam, designed and constructed through direct labour in 2004 by NCAM Engineers. The dam is downstream the dam at Elerinjare. NCAM borehole is located on NCAM campus and serves as drinking water source for NCAM residents as well as staff living off the campus. NCAM well is a shallow well located in NCAM residential quarters. This is often times used for washing by the dwellers, but in case of scarcity, people may resort to it as a source of drinking water. Jimba-Oja borehole, located downstream of NCAM, it serves as drinking water source. Jimba-Oja well, also located downstream NCAM serves as drinking water source for cattle rearers who often take their cattle on open range. Oyun river is a river downstream of NCAM. The runoff from the dam at Elerinjare is emptied into this river. There are possibilities that the cattle rearers and some of the people of the local communities might consume the water. The location of these water sources are indicated in Fig. 1.

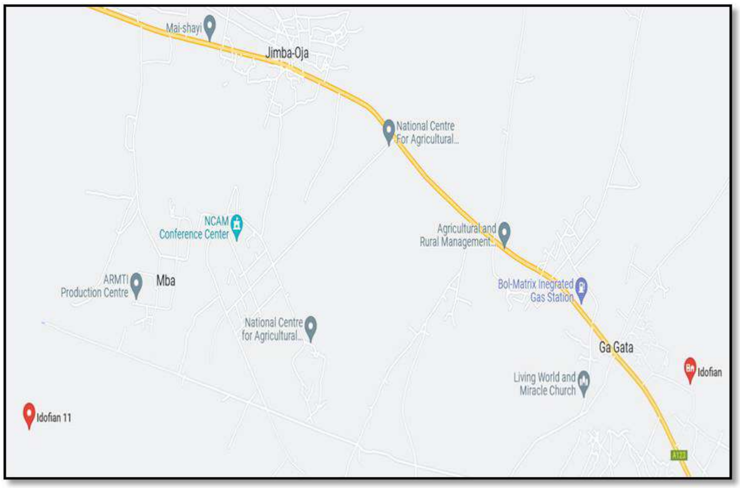

Fig. 1. Google Map of Part of Ifelodun Local Government Area of Kwara State Showing Sampling Points

Scale: 600m: 1 Km

2.3 Quality Analyses

Sampling was carried out with the aid of sterilized sampling bottles and quality analysis of all samples carried out in a laboratory. This entailed the physical, chemical and bacteriological analysis. The data was analyzed using descriptive statistics.

3. RESULTS AND DISCUSSION

3.1 Physico-Chemical Analysis

Table.1 shows the results of the physical and chemical analysis of the nine water sources sampled. When compared with the World Health Organization (2006) Standards, the results show the value of **colour** to be above the maximum permissible limit (PML) in four out of the nine sources, namely Elerinjare dam (raw), Oyun river, NCAM rockfill dam, and the Jimba-oja well samples with values of 26.67 ± 2.89, 23.00 ± 2.65, 22.33 ± 2.52 and 20.00 ± 2.00, respectively. **Turbidity** result showed that seven out of nine samples have their average turbidity values above the maximum permissible limit (MPL). These include Elerinjare dam (raw), Elerinjare (treated), Jimba-Oja shallow well, NCAM well, NCAM Rockfill dam, Idofian well and the Oyun river samples with average values of 9.50 ± 1.00, 5.43 ± 0.40, 11.00 ± 1.00, 6.33 ± 1.04, 8.83 ± 1.04, 5.17 ± 0.29 and 9.17 ± 0.76, respectively.

Magnesium value was observed to be in excess in all the samples tested in the three consecutive tests; averages were also above the MPL for all samples. The **iron** content of the samples taken from Elerinjare dam, Idofian well, Jimba-Oja well, NCAM dam, NCAM well and the Oyun river, with averages of 0.68 ± 0.08, 0.45 ± 0.05, 0.34 ± 0.01, 0.48 ± 0.03, 0.32 ± 0.03 and 0.62 ± 0.03, respectively were observed to be above the MPL. The **manganese** content of the samples from Elerinjare dam, NCAM Rockfill dam, Jimba-Oja well and the Oyun river, with averages of 0.37 ± 0.06, 0.33 ± 0.06, 0.24 ± 0.01 and 0.45 ± 0.13 was found to be above the MPL.

Lead was found to have exceeded the MPL only in the Elerinjare dam (raw) sample, with an average value of 0.12 ± 0.03. The **pH** of samples from Elerinjare treated water, Jimba-Oja borehole, Jimba-Oja well and NCAM well was found to be below the allowable range, with average values of 6.13 ± 0.12, 6.40 ± 0.00, 6.17 ± 0.12 and 6.47 ± 0.12, respectively. The samples from Elerinjare dam, Jimba-Oja well, NCAM dam and Oyun river were found to contain **Chromium** above the MPL. Their averages are 0.07 ± 0.01, 0.06 ± 0.01, 0.07 ± 0.01 and 0.06 ± 0.04, respectively. The implications of the result of the above quality analysis of all the water samples are as follows:

The high colour and turbidity values above the MPL have no health impact, but may not be acceptable by consumers. However, high turbidity levels may be associated with high levels of disease-causing micro-organisms On the other hand, it may cause discolouration of fabrics if used for laundry. Similarly, the excess magnesium in the samples has no health impact.

High concentration of iron observed in samples from Elerinjare dam, Idofian well, Jimba-Oja well, NCAM rock fill dam and the Oyun river also has no negative health impact on the consumers. High manganese content of samples from Elerinjare dam, Jimba-Oja well, NCAM dam and the Oyun river is of concern as it has a health impact on their consumers, and may lead to neurological disorder. Similarly, excess lead observed in Elerinjare dam sample could cause any of the following diseases: cancer, interference with vitamin D metabolism, defect in infant mental development and toxicity to the central and peripheral nervous systems. Presence in excess of chromium in samples from Elerinjare dam (raw), NCAM dam, Jimba-Oja well and the Oyun river is a signal to cancer infection by the consumers.

Table 1.Results of physico-chemical analysis of water samples

PARAMETERS	ELERINJARE DAM (RAW)		ELERINJARE DAM (TREATED)		IDOFIAN WELL		JIMBA-OJA BOREHOLE		JIMBA OJA WELL	
	AVE	STD DEV	AVE	STD DEV	AVE	STD DEV	AVE	STD DEV	AVE	STD DEV
Phenolphthalein alkalinity (mg/l)	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.00	±0.00
Methyl Orange alkalinity (mg/l)	61.67	±2.89	50.00	±0.00	65.00	±0.00	55.00	±0.00	48.33	±5.77
Total hardness (mg/l)	48.00	±0.00	39.67	±3.51	53.33	±2.31	60.00	±0.00	71.67	±4.73
Ca2+ hardness (mg/l)	28.00	±0.00	24.67	±1.15	32.00	±0.00	36.00	±0.00	41.67	±2.08
Mg2+ hardness (mg/l)	20.00	±0.00	14.67	±2.31	21.33	±2.31	24.00	±0.00	26.67	±1.15
Ca2+ (total) mg/l	11.20	±0.00	9.60	±0.00	12.80	±0.00	14.40	±0.00	17.07	±0.92
Mg2+ (total) mg/l	8.60	±0.00	6.10	±1.35	9.33	±0.23	9.20	±0.00	10.77	±1.39
CO2 (mg/l)	6.17	±1.26	2.17	±0.29	4.17	±0.58	3.67	±1.76	4.50	±0.87
CL-(mg/l)	6.17	±0.29	3.67	±0.29	2.50	±0.50	3.50	±0.50	3.67	±0.58
Fe2+ (mg/l)	0.68	±0.08	0.15	±0.05	0.45	±0.05	0.25	±0.05	0.34	±0.01
Cu2+ (mg/l)	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.00	±0.00
Mn2+ (mg/l)	0.37	±0.06	0.06	±0.01	0.19	±0.01	0.18	±0.03	0.24	±0.01
Pb2+ (mg/l)	0.12	±0.03	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.00	±0.00
F-(mg/l)	0.06	±0.01	0.03	±0.01	0.05	±0.02	0.03	±0.01	0.05	±0.01
SO42- (mg/l)	9.83	±0.58	11.63	±0.71	7.57	±0.40	9.50	±0.00	7.73	±1.27
NO3-(mg/l)	4.57	±0.12	0.33	±0.15	0.58	±0.16	0.12	±0.03	0.93	±0.23
PO4-(mg/l)	1.00	±0.36	0.03	±0.05	0.20	±0.05	0.37	±0.64	0.14	±0.01
Na+ (mg/l)	0.93	±0.49	0.23	±0.08	0.93	±0.25	0.53	±0.47	1.08	±0.23
K+ (mg/l)	0.53	±0.06	0.13	±0.03	0.80	±0.00	0.57	±0.06	0.93	±0.12
Total solids (mg/l)	319.33	±4.16	209.33	±12.86	195.67	±3.51	179.33	±3.06	323.33	±15.53
Dissolved solids (mg/l)	276.00	±7.21	185.33	±7.02	174.67	±7.02	162.67	±1.15	315.00	±7.55
Suspended solids (mg/l)	43.33	±4.16	22.67	±5.03	24.67	±3.06	16.67	±2.31	22.00	±2.00
COD (mg/l)	4.47	±0.42	5.20	±0.40	2.67	±0.42	3.33	±0.50	3.33	±0.31
Turbidity (NTU)	9.50	±1.00	5.43	±0.40	5.17	±0.29	4.33	±0.29	11.00	±1.00
pH	6.77	±0.06	6.13	±0.12	6.73	±0.06	6.40	±0.00	6.17	±0.12
Color (HU)	26.67	±2.89	6.33	±1.15	7.67	±1.15	6.33	±0.58	20.00	±2.00
Dissolved O2 (mg/l)	3.73	±0.50	4.47	±0.31	2.27	±0.50	2.67	±0.31	2.87	±0.31
BOD (mg/l)	3.13	±0.42	1.13	±0.12	1.57	±0.35	0.67	±0.12	1.57	±0.21
Conductance (µS)	86.47	±0.51	92.94	±3.10	82.13	±5.55	90.16	±0.45	82.43	±0.92
SiO2 (mg/l)	11.17	±0.76	7.43	±0.90	24.33	±1.53	30.00	±2.00	18.17	±0.29
NH3 (mg/l)	0.04	±0.00	0.00	±0.00	0.01	±0.00	0.00	±0.00	0.01	±0.00
Cr2+ (mg/l)	0.07	±0.01	0.00	±0.00	0.05	±0.05	0.00	±0.00	0.06	±0.01
Zn2+ (mg/l)	0.32	±0.03	0.04	±0.04	0.13	±0.03	0.03	±0.06	0.11	±0.02
Oil and Grease (mg/l)	0.55	±0.09	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.00	±0.00
Phenol (mg/l)	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.00	±0.00

Table 1.Results of physico-chemical analysis of water samples contd.

PARAMETERS	NCAM WELL		NCAM BOREHOLE		NCAM DAM		OYUN RIVER	
	AVE	STD DEV	AVE	STD DEV	AVE	STD DEV	AVE	STD DEV
Phenolphthalein alkalinity (mg/l)	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.00	±0.00
Methyl Orange alkalinity (mg/l)	55.00	±0.00	63.33	±2.89	65.00	±0.00	68.33	±2.89
Total hardness (mg/l)	60.00	±0.00	43.33	±1.15	44.00	±0.00	41.33	±2.31
Ca^{2+} hardness (mg/l)	33.33	±2.31	20.67	±1.15	24.00	±6.93	22.67	±6.11
Mg^{2+} hardness (mg/l)	26.67	±2.31	22.00	±0.00	16.00	±0.00	16.00	±0.00
Ca^{2+} (total) mg/l	13.33	±0.92	8.47	±0.42	11.20	±0.00	10.13	±0.92
Mg^{2+} (total) mg/l	9.47	±0.23	8.93	±0.12	7.20	±0.00	7.20	±0.00
CO_2 (mg/l)	4.67	±0.58	3.17	±0.76	5.17	±0.58	5.50	±1.00
CL^-(mg/l)	3.17	±0.29	2.33	±0.29	4.67	±0.76	5.00	±1.00
Fe^{2+} (mg/l)	0.32	±0.03	0.18	±0.03	0.48	±0.03	0.62	±0.03
Cu^{2+} (mg/l)	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.00	±0.00
Mn^{2+} (mg/l)	0.15	±0.05	0.10	±0.00	0.33	±0.06	0.45	±0.13
Pb^{2+} (mg/l)	0.00	±0.00	0.00	±0.00	0.02	±0.02	0.03	±0.03
F^-(mg/l)	0.03	±0.01	0.05	±0.01	0.01	±0.01	0.01	±0.01
SO_4^{2-} (mg/l)	8.50	±0.50	8.00	±0.00	10.50	±0.87	10.67	±0.76
NO^{3-}(mg/l)	0.07	±0.03	0.04	±0.01	3.20	±0.40	3.50	±0.44
PO_4^-(mg/l)	0.37	±0.46	0.17	±0.29	0.77	±0.21	1.07	±0.15
Na^+ (mg/l)	0.40	±0.30	0.20	±0.26	0.68	±0.25	0.70	±0.26
K^+ (mg/l)	0.43	±0.06	0.23	±0.06	0.52	±0.18	0.53	±0.15
Total solids (mg/l)	198.67	±8.33	190.00	±2.00	310.00	±3.46	324.67	±5.03
Dissolved solids (mg/l)	178.67	±4.62	172.00	±0.00	274.00	±2.00	284.00	±3.46
Suspended solids (mg/l)	20.00	±4.00	18.00	±2.00	36.00	±4.00	40.67	±3.06
COD (mg/l)	3.80	±0.20	2.80	±0.40	3.87	±0.31	4.07	±0.50
Turbidity (NTU)	6.33	±1.04	4.17	±0.29	8.83	±1.04	9.17	±0.76
pH	6.47	±0.12	6.73	±0.06	6.80	±0.00	7.00	±0.17
Color (HU)	11.00	±6.08	5.67	±0.58	22.33	±2.52	23.00	±2.65
Dissolved O_2 (mg/l)	3.13	±0.23	2.07	±0.31	3.53	±0.50	3.80	±0.53
BOD (mg/l)	2.13	±0.31	0.67	±0.12	2.53	±0.23	2.87	±0.31
Conductance (µS)	79.75	±0.53	83.83	±0.43	89.56	±0.87	90.52	±1.30
SiO_2 (mg/l)	20.83	±1.26	15.50	±0.87	10.33	±1.04	11.50	±1.50
NH_3 (mg/l)	0.00	±0.00	0.00	±0.00	0.03	±0.00	0.04	±0.00
Cr^{2+} (mg/l)	0.04	±0.00	0.00	±0.00	0.07	±0.01	0.06	±0.04
Zn^{2+} (mg/l)	0.00	±0.00	0.00	±0.00	0.23	±0.03	0.25	±0.00
Oil and Grease (mg/l)	0.00	±0.00	0.00	±0.00	0.17	±0.03	0.25	±0.05
Phenol (mg/l)	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.00	±0.00

3.2 Bacteriological Analysis

Table 2 shows the average results of the bacteriological test carried out on all the water samples. All water samples showed the presence of coliform bacteria for the three tests carried out. With the exception of Elerinjare dam raw water sample, Idofian well, Jimba-Oja well and NCAM dam and the Oyun river samples, all other four samples were within permissible range. Four out of the nine sources also indicated the presence of E. coli for the three set of samples tested, while one indicated the presence of E. coli in the two out of the three samplings. This is an indication of faecal pollution of these water sources. The implication of the bacteriological result is that water sources, such as Elerinjare dam (raw), Idofian well, Jimba-oja well, NCAM dam and Oyun river are not fit for human consumption until shock chlorination is carried out to correct their bacteriological status. The population of coliform bacteria detected in the treated Elerinjare dam raw water is comparable to that of untreated water sources, unlike the case of NCAM borehole. This should not be so. It may not be unconnected with insufficient treatment at the treatment plant. Our reconnaissance survey revealed a bad state of the treatment plant. Such indicators include dirty clear water tank, leaking sedimentation tank, rusted pipes, abandoned heavy duty generator, among others.

Table 2. Bacteriological results of water samples

DESCRIPTION	COLONIES/cc ON NUTRIENT AGAR AT 320C IN 24 HRS	MOST PROBABLE NUMBER OF COLIFORM ORGANISMS IN 100cc	MOST PROBABLE NUMBER OF E.COLI PER 100cc
ELERINJARE DAM (RAW)	>300	180+	10
ELERINJARE DAM (TREATED)	37	14	NILL
IDOFIAN WELL	62	180+	2
JIMBA BOREHOLE	52	13	NILL
JIMBA WELL	70	20	2
NCAM WELL	47	19	NILL
NCAM BOREHOLE	18	5	NILL
NCAM DAM	>300	180+	4
OYUN RIVER	>300	180+	5

It can also be concluded that agricultural activities involving the use of agro-chemicals had no significant effect on the quality of water in and around NCAM as at the time of this study. This may be due to effective application of fertilizers and agro-chemicals on NCAM farm and that percolation of chemicals downstream NCAM is not significant.

4. RECOMMENDATIONS

It is recommended that people be given notice not to drink water from the affected sources. It is further recommended that two more samples from all sources be taken in the dry season to confirm their level of pollution. The sources of pollution of these water sources should then be traced and appropriate steps taken to improve the quality of the water from the affected sources in terms of treatment, source protection, or both.

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