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Industrial pollution and vegetable farming in Sharada Industrial Layout of Kano Municipal Area Council

Ikenna Ugonna Uzonu
Society for Life Improvement and Development, Abuja, Nigeria
E-mail: ijkuzonu@gmail.com

Abstract

This work examined the effects of industrial effluents on surface water used for vegetable irrigation in Kano City of Kano State. As the population of Kano increases, more demand is placed on these industries for products thus leading to the generation of large volumes of effluents that are discharged directly into nearby streams without treatment. The usage of this surface water for vegetable irrigation by a significant number of vegetable farmers is a matter of major concern due to the presence of pollutants. Some of the field measurements were carried out *insitu* while others were taken to the laboratory for analysis. Groundwater samples were taken from a borehole and two hand-dug wells while surface water was taken from point of discharge and two other points along the Challawa River which is the main source of water for vegetable irrigation. Composite soil samples were taken from four points within the vegetable farms. The Federal Environmental Protection Agency and the Federal Ministry of Environment standards were used as baseline standards for limits. Results show that presence of Fe, Pb, Mn, Cr and Cd were found to be above the FMEnv limits in the soil, the presence of SO_4, Cu and K were also found to be above the FMEnv limits as well in groundwater while BOD, NO_2 and Cr were above the FEPA limit for surface water. Some of the recommendations include constant monitoring for the presence of heavy metals in soils and irrigation water and that the need for the construction of both primary and secondary treatment plants has become essential.

Keywords: Effluents, heavy metals, farmers, industrial layout, industrial pollution, municipal council, irrigation, vegetable farming, Kano

1. Introduction

The increasing population in Kano has led to a rapid urbanisation and industrialisation. Sharada being one of the industrial layouts houses 40 industries (16 wet and 24 dry industries); the wet includes foam, leather, chemical and pharmaceutical industries. These industries beside all positive effects on daily life, they have a deep impact on the agricultural environment. A consequential indiscriminate discharge of large volume of effluents comes from these industries. These effluents discharged from the industries that eventually end up in the Challawa River have a dense concentration of vegetable farmers using them for irrigation from point of discharge till they mix with the River.

Pollution through irrigation has attracted considerable attention. Irrigation water quality classification is therefore important for enhancing the use of available water resources. The irrigation water quality depends on a number of factors for its successful application and beneficial uses (Hussain et al, 2010). These factors include soil type, crop selection, climatic conditions, and irrigation methods. Others are drainage conditions of the area, fertilizer use, farm management practices and irrigation water. Metalliferous mining and processing, dumping of wastes and industrial effluents as in the case of Kano, often produce severe heavy metal pollution (Baker et al., 1994). The term “heavy metals” refers to any metallic element that has a relatively high density and is toxic or poisonous even at low concentration (Lenntech, 2004). “Heavy metals” is a general collective term, which applies to the group of metals and metalloids with atomic density greater than 4 g/cm3 or 5 times or more, greater than water (Nriagu and Pacyna, 1988).

Heavy metals of widespread concern to human health are mercury, cadmium, lead, arsenic, chromium, copper, and zinc (Mason, 1996).

Plants have developed highly unique mechanisms to take up, translocate, and store these nutrients. Estimation of the migration capacity of any pollutant in the natural environment is considered to be an essential stage for forecasting the ecological situation. The process of heavy metals accumulation in agricultural crops is especially interesting because it contributes or introduces toxic elements into the human food chain especially vegetables.

Consumption of heavy metals through vegetable food therefore can cause accumulation of disease causing organisms, producing serious health hazards such as injury to the kidney and liver (Abou- Arab et al., 1999). Special attention should thus be paid to these unsafe health elements and to most consumed agricultural crops (Stobart et al., 1985). The increasing discharge of industrial effluents into the environment unchecked has been fingered to posing serious danger to the water resources and the health of people of Sharada. Since this polluted and unchecked effluent from the industries is used for irrigation of vegetable crops within the industrial layout and beyond, heavy metals and anions may enter the food chain thereby exposing consumers of these vegetable crops to an accumulation of these unsafe metals over time. Of primary concern are uncooked vegetables dishes such as salad and those vegetables used for garnishing other meals.

This study therefore looks at the health implication of using water polluted by the industrial effluents for irrigation of vegetables in Sharada Industrial Layout of Kano.

1.1 Study area

Sharada is within the Kano Municipal Area Council and one of the three major industrial sites of Kano State which are all now within the heart of Kano City. The area has been sandwiched by pockets of residential settlements. It is situated within the Sahelian region of Nigeria at an altitude of 481m above mean sea level; at latitude 11^{o} 57’ 34.0” and longitude 008^{o} 30’ 39.5” It is dominated by the Hausa/ Fulani tribes with Islam as the dominant religion. Some of the livelihood means include farming, civil service and trading. The climate is semi-arid characterized by two predominant climatic conditions annually: hot and long dry season (October – April) - warm, humid and short wet season (May - September). The highest monthly temperature of 36.6 - 39.2°C is experienced between of March and May while the average monthly temperature can be as low as 13.4°C between November and February. The average range of sunshine hours is between 6.88 in March to about 8.57 hours per day in November with approximately average of 7.71 sunlight hours for each day. The mean annual rainfall is about 510 – 1000mm in the project area. The mean relative humidity for the region ranged from 52.8% to 78.6% during the rainy season.

Some of the trees found in the area include Acacia Albida spp, Acacia Nitotica spp, and Acacia Seyal spp. Most of these trees adapt to drought conditions through long tap roots, leathery leaves, and tiny leaves. With the exception of Acacia Al bida which retain their green leaves throughout the year, the other trees shed their leaves during the dry season. Some of the vegetables include Onion (Alium cepa), Lettuce (Lactuca sativa), Okra (Hibiscus esculentus) and Carrot (Daucus carota)

Industrialisation of Sharada has caused the growth of residential settlements to spring up and sandwich the factories without any form of regulation by the relevant authority. Trunks A and B roads are seen all over the area encouraging mechanised vehicular transport means like buses, taxis and tricycles. Tanneries and textile industries are the most prominent industries with a great influence on the economy of Kano. These industries have been identified as hubs of high potential for foreign exchange as well as provision of direct and indirect employment to residents of Kano and Nigerians at large. Other prominent industries located within these industrial estates include plastics; paints; food and beverages; chemicals and pharmaceuticals; foam and mattresses; furniture; iron and steel and bottling companies.

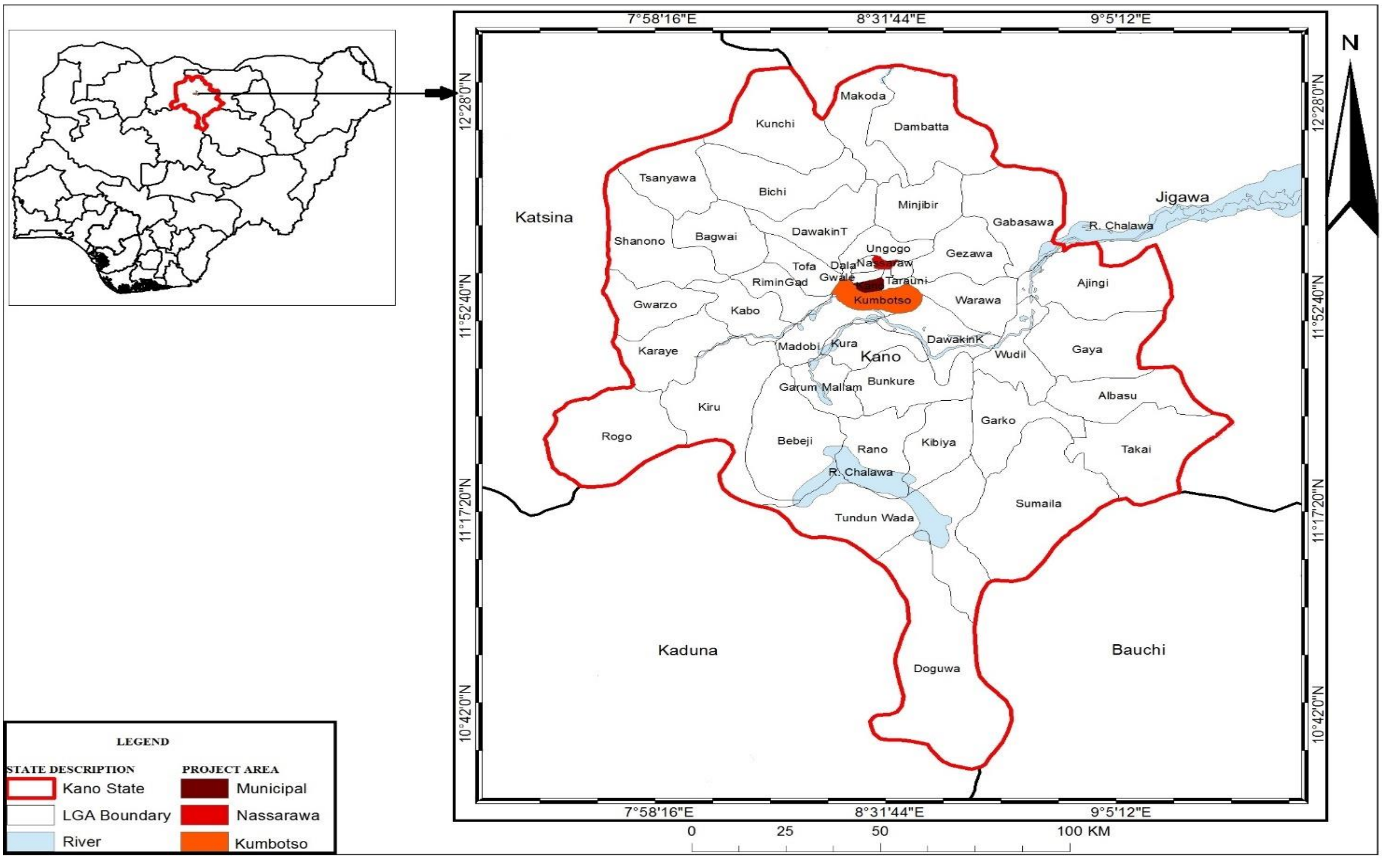

Figure I: Kano State showing the three industrial zones.
Source: Field Survey, 2019

2. Materials and methods

A reconnaissance was carried out to the industries in the study area to get approval for Key Informant Interview and physical inspection of their facilities. This was followed by field data gathering. Some of the measurements were carried out in situ like water temperature, pH, conductivity and colour; while the rest were analysed at a laboratory. Ground water samples were obtained from one borehole and two hand-dug wells found in the area while surface water samples were obtained from point of discharge and two other points along the Challawa River (which is the source of irrigation for most farmers). Each water sample was collected in two different plastic containers; the first preserved with acid was used to test for physicochemical parameters while the second had no acid and used to test for BOD, COD, DO et cetera. The Federal Environmental Protection Agency (FEPA) limit for aquatic life was used as a standard for surface water while Federal Ministry of Environment (FMEnv) standardised limits for drinking water was used for ground water. Composite soil samples were collected from 4 points; 0 – 15cm (top soil) and 15 – 30cm (sub soil) depths respectively from four points in the study area. The soil results were compared to the FMEnv limits. Focus Group Discussion was also administered to farmers in the study area to extract some salient points from them.

3. Results and Discussion

3.1 Soil

Plants must acquire not only macronutrients (N, P, K, S, Ca, and Mg) to grow and complete their cycle, but also the essential micronutrients such as Fe, Zn, Mn, Ni, Cu, and Mo (Lasat, 2010). The process of heavy metals accumulation in agricultural crops is especially interesting because it contributes or introduces toxic elements into the human food chain. Contamination can occur, in the case of metals and some organic chemicals, through absorption from the soil, the environmental conditions, type of plant and agricultural practices (quantity of water applied) (Jimenez, 2006).

Table 1: Soil characteristics of the study area

Parameters & Units	Methodology	SHD 1	SHD 2	SHD 3	SHD 4	FMEnv limit
pH @25^{0}C	Electrometric	7.71	7.81	7.27	7.80	6 - 9
Temp.^{0}/C	Thermoelectric	26.5	26.5	26.5	26.6	<40
E.C. µS/cm^3	Electrometric	502	1981	1151	1003	1000
M.C %	Gravimetric	2	90	164	26	_
V mg/kgDW	Colorimetric	ND	ND	ND	ND	0.01
T. Nitrogen %	Colorimetric	0.02	0.07	0.005	0.002	_
Aval Phosphorus	Colorimetric	0.055	0.0009	0.0005	0.00021	_
SO_4^{-2} mg/kgDW	Colorimetric	26.7	22.9	22.1	21.9	500
NO_3^- mg/kgDW	Colorimetric	7.0	5.9	7.7	6.7	20
Ni mg/kgDW	Colorimetric	ND	0.07	ND	ND	0.05
Fe^{2+} mg/kgDW	Colorimetric	604.06	618	532.6	520.12	1.5
Ca^{2+} mg/kgDW	Colorimetric	18.03	16.84	35.0	9.55	150
Pb^{2+} mg/kgDW	Colorimetric	6.20	6.56	0.001	0.033	0.05
Zn^{2+} mg/kgDW	Colorimetric	2.55	2.64	ND	7.101	5
Cu^{2+} mg/kgDW	Colorimetric	0.912	0.95	0.005	ND	0.1
Mg^{2+} mg/kgDW	Colorimetric	23.90	27.53	29.10	29.55	50
Mn^{2+} mg/kgDW	Colorimetric	9.10	11.38	9.27	9.22	0.05
K^{2+} mg/kgDW	Flametric	8.4	55.8	50.6	33.0	_
Na^{2+} mg/kgDW	Flametric	3.4	31.1	24,8	3.7	200
Cl^- mg/kgDW	Colorimetric	15	17	35	16.1	250
Cr mg/KgDW	Colorimetric	0.001	1.20	1.01	0.42	0.01
Cd mg/KgDW	Colorimetric	0.31	0.34	0.39	0.004	0.01
As mg/KgDW	Colorimetric	ND	Nd	ND	ND	0.2
PO_4^- mg/KgDW	Colorimetric	0.96	0.81	0.81	0.51	5
Co mg/KgDW	Colorimetric	0.05	0.07	ND	ND	_
Organic Matter%	Gravimetric	25	24	20	35	_
Oil & Grease		1.2	1.15	0.23	0.62	_

Analysis as seen in table 1 shows that the presence of iron (Fe) exceeded it limits from the four sample points. The same is with manganese (Mn) but chromium (Cr) and cadmium (Cd) exceeded at three points while copper (Cu) and lead (Pb) exceeded at two points and its accumululation in plants can kill them except in onions followed by lettuce which can tolerate heavy accumulations of lead. Only zinc (Zn) exceeded at one point. Chromium has low solubility and strong retention in soils. It is also low in phytotoxicity and poses little risk since it is not taken up by plants. Lead is strongly adsorbed by soil colloids and translocated to plant shoots when in high concentration; it therefore poses minimal risk to consumers. Copper, manganese and zinc are phytotoxic at concentrations that pose little risk to human health. Cadmium poses human risk of bioaccumulation through the soil-plant-animal food chain (Drechsel et al, 2010)

3.2 Ground water

Table 2: Ground water parameters

PARAMETERS	GW 1 Gidan Maza HDW	GW 2 Gidan Maza BH	GW 3 Cikin Gari HDW	FMEnv STD – DRINKING WATER
pH @25^0C	6.5	7.4	7.1	6.5-8.5
Turbidity NTU	1.1	20	0.9	1.0
E.C. µS/cm	1700	1190	1000	500-1000
TSS mg/l	2.0	23.2	1.25	10
TDS mg/l	846	47	469	500
Alkalinity mg/l	110	48	80.2	100
BOD mg/l	2.0	7.0	3.0	0
COD mg/l	5.0	15.5	6.0	NS
DO mg/l	6.2	6.0	6.5	7.5
T. Hardness mg/l	150	62	90.6	200
SO_4^{-2} mg/l	61.3	60.3	61.4	0.05
NO_3^- mg/l	50	5.7	20.9	10
NO_2^-mg/l	1.0	0.02	1.90	1.0
NH_4 mg/l	13.4	0.29	10.0	1.0
Fe^{2+} mg/l	1.9	0.30	1.90	1.0
Pb^{2+} mg/l	0.001	Nil	Nil	0.05
Zn^{2+} mg/l	2.00	0.59	1.20	5.0
Cu^{2+} mg/l	0.99	0.90	0.97	0.1
Mg^{2+} mg/l	5.00	2.50	4.00	NS
Mn^{2+} mg/l	0.50	0.02	0.41	0.05
Ca^{2+} mg/l	20.90	10.00	15.00	75
As mg/l	0.001	ND	0.001	1.0
K^{2+} mg/l	84.3	14.6	70.9	10
Na^{2+} mg/l	73.5	6.4	49.0	200
Cl^- mg/l	27.70	29.0	35.5	250
Cr mg/l	0.60	0.050	0.005	0.05
HCO_3^- mg/l	90.1	40.10	50.5	NS
Cd mg/l	0.001	ND	0.0009	0.01
PO_4^- mg/l	0.02	0/07	0.125	500

The quantity and quality of groundwater depend on the geological formation of underlying strata, the size of aquifer and the site location. The groundwater is classified into four hydro-geological zones; confined aquifers, free flowing aquifers, main aquifers and the springs. Table 2 shows that the ground water is polluted significantly, however, the borehole is better than the hand dug wells. The three wells are contaminated with K^{2+} but the hand dug wells contain much higher K^{2+} than the borehole. The manganeese (Mn^{2+}) was found to be within the standard in the borehole but above in the hand dug wells. Copper and sulphate were also seen to be more than the recommended limit while nitate, ammonium and iron were beyond the limit in the hand dug wells but within the limit in the borehole. The TDS and alkalinity were found to be more in the first hand dug well. Turbidity and Electrical conductivity exceeded the limit in both the hand dug well and borehole of Gidan Maza. The vegetable farmers claim that apart from the stench the effluent from the plastic industries and tanneries exude, this effluent has also found its way to ground water. They claim it has been a long time they stopped drinking from any ground water source.

3.3 Surface water

Virtually all waters contain dissolved salts and trace elements, many of which result from the natural weathering of the earth's surface. In addition, drainage waters from irrigated lands and effluent from city sewage and industrial waste water can impact water quality. In most irrigation situations, the primary water quality concern is salinity levels, since salts can affect both the soil structure and crop yield. However, a number of trace elements are found in water which can limit its use for irrigation (Fipps, 2003).

Table 3 shows that effluent discharge into the surface water body caused it to be odourful. What welcomes any visitor within the study area is this pungent smell that comes especially from the tanneries. The Biochemical Oxygen Demand (BOD) was seen to be higher than the set limit showing that the water is polluted as a result of high microbial presence. The Dissolved Oxygen level can be seen to be high at the point of effluent discharge and this could pose a serious threat to aquatic life but good enough the measurements at the two river points shows a significant level of dilution good for aquatic life. Nitrates (NO2-) are seen to be above the limit at the three points but more at the downstream point; because other industrial effluents from Challawa industrial area emptied into the river at this point.

Table 3: Surface water parameters

PARAMETERS	SW 1 Challawa River Upstream	SW 2 Industrial Effluent	SW 3 Challawa River Downstream	FEPA STD – AQUATIC
Colour	Brownish	Very Turbid	Turbid + Debris	NS
Odour	Pungent	Odourful	Odourful	NS
Taste	Tasteful	Tasteful	Tasteful	NS
pH @25^{0}C	7.2	7.1	7.1	6.0-90
Turbidity NTU	99	250	85	NS
E.C. µS/cm	90	540	2000	NS
TSS mg/l	100	265.00	90.5	NS
TDS mg/l	42	273	905	NS
BOD mg/l	10.5	2.7	15.0	4.0
COD mg/l	40.5	620	35.2	NS
DO mg/l	4.5	7.5	4.0	6.8
T. Hardness mg/l	78	62.5	80	NS
SO_4^{-2} mg/l	55	57.6	47.7	NS
NO_2^-mg/l	0.10	0.59	3.0	0.06
Fe^{2+} mg/l	0.6	0.46	1.0	1.0
Pb^{2+} mg/l	0.001	1.28	0.001	0.01
Zn^{2+} mg/l	1.50	0.30	2.90	50
Cu^{2+} mg/l	1.00	0.09	2.00	NS
Mg^{2+} mg/l	7.50	17.35	8.00	NS
Ca^{2+} mg/l	30.0	12.5	35.0	NS
As mg/l	ND	ND	ND	0.6
Cr mg/l	0.97	11.22	11.02	0.02
Cd mg/l	0.002	ND	ND	NS

Conclusion

Vegetable consumption risk could be based on the analytical values of the land where it is grown and the water used for its irrigation. A consequence of the high global food demand, the biggest user of wastewater (treated or not) is agriculture (Jimenez and Asano, 2008). An important factor of the surface water bodies in Sharada and Challawa River especially is their availability all year round and this permits higher vegetable crop yields and increases the range of crops that can be irrigated. Vegetables being cultivated through irrigation in Sharada could be of significant benefit to the population in terms of a more balanced diet but this could also put this same population at a health risk as presence of some heavy metals have been well established both in the soil and irrigation water. These effluents in the surface water bodies are a source of high levels of heavy metals and organic toxic compounds (Abaidoo et al, 2009; Hamilton et al, 2006).

In vegetables, these heavy metals amass in the eatable parts (leaves and roots). Heavy metals in high concentrations or after prolonged dietary intake, can pose a significant health risk to humans, leading to various chronic diseases (Gupta and Gupta, 1998; Sharma and Prasad 2009). Other than safety concerns, excessive heavy metals also contaminate soils and affect crop growth and quality. Some metals, like Cu, Mn, Ni and Zn make crops function as a safety barrier in the food chain as they would stop growing or die before harvesting if content was excessive. It is noteworthy that the health risk is not only associated with the vegetable consumers but also with the farmers and their households.

This study therefore recommends that:

1. Constant monitoring of heavy metal concentrations in soils, irrigation water and crops remains essential to know the levels and devise strategies to minimize its contamination, hence reducing risks to human health.
2. Construction of primary and secondary treatment plants for these industries has become pertinent in order to stop the direct discharge of effluents directly into surface water bodies, hence ridding it of pollution.
3. Government could help to relocate theses farmers to different spots up-stream and subsidise their irrigation models.

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