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Analysis of Heavy Metals Contaminations in Kano River (Upstream, Midstream and Downstream)

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Abstract
The study analyses effects of heavy metals levels of heavy metals concentrations of Pb, Cd, Zn, CR , Ni, Co in the Kano River Drainage basin from its headstream, midstream up to the downstream and in both surface and groundwater and the water is used for may purpose including water supply, fishing and agriculture mainly irrigation. Based on above **pH** average water in the study area can be interpreted as slightly alkaline and still within permissible limits of all the three standards/guidelines. **EC** with above average also shows that all the water their values falls within the three guidelines. Samples from both surface and groundwater in the studied area have ranges and means of: **Co** ranges from **0.11-21.24 ppb** and average of **2.26 ppb** , Ni ranges from **0.26 - 37.01 ppb** and average of **7.37 ppb** , **Cu** ranges from **0.17 - 640.93 ppb** and average of **37.62 ppb**, **Zn** ranges from **15 - 408 ppb** and average of **115.03 ppb**, **As** ranges from **0.09 - 2.31ppb** and average of **0.62 ppb** ,**Pb** ranges from **0.16 - 834.38 ppb** and average of **29.82 ppb** , **Cr** ranges from **0.16 - 5557.35 ppb** and average of **419.58 ppb** ,**Cd** ranges from **0.04 - 1.64 ppb** and average of **0.21 ppb.** EC. It is therefore recommended that concentrations level in crops grown with these waters needs to be investigated. Again it is confirmed that probably this may be one of the reasons for the drop in fish catch from midstream up to the downstream especially in area like Wudil which is known for its fishing, Gadar Ringim and even Tarabu town in Kirikasamma local government of Jigawa state.
Keywords: Levels, Concentrations, Heavy metals, Surface water, and Midstream

1. Introduction

It is known that quality of water required depends on the purpose it is meant to serve (Todd, 1980, Egboka, 1986, Ezeigbi, 1998, Anudu, *et al*., 2008). Indeed, our daily activities from both domestic and industry release wastes and effluents in to our environment. Unfortunately these are being absorbed by soils and thereby taken by plants or into water bodies and the water is been used for irrigation. These effluents are in turn utilised by plants, this continues until it gets to man himself again through food chain resulting into problems of water contamination causing outbreaks of different kind of diseases like water borne or heavy metals in fact taken by man of cancer etc.

Distribution of heavy metals is governed by the properties of the metal and influences of environmental factors (Klifi and Hamza - Chaffai, 2010). It is known that 30 out of the 92 naturally occurring elements are potentially toxic to humans and these are caused by either natural or anthropogenic and of concern here is by industries rather called industrial discharge. It is also known that contamination chain of heavy metals follows a cyclic order: Industry, atmosphere, soil, water, foods and human. Although the toxicity is a function of concentrations but heavy metals even at a relatively low limits can cause adverse effect. This stressed the need especially in developed countries on the exposure, intakes and absorption by humans. Practical implication of this trend in developed countries led to impositions of new and more restrictive regulations (European Commission, 2006; Figuero, 2008). People that worked in the study area and they includes Tanko (1997) who found that the concentrations of calcium, magnesium, sodium, manganese, nitrate, chromium and lead varying spatially and seasonally in the rivers of Hadejia of the Kano region. Ejechi and Odun (1996) also noted and observed the loss of soil fertility, aquatic life and birds' population as a result of commercial and industrial waste deposited in the rivers of Challawa and Kano respectively. Another work was done by the Federal Ministry of Environment in 2001 (F.M.E.) that found Cd 0.007; Pb (0.014); Cr,(0.11); Fe, (0.6); Mn 0.01; Ca, (0.0) all in ppm near Kumbotso bridge.

In Kano industries discharge their effluents into the Kano River and drains there up to the Hadejia–Nguru wetland which is a wild refugee as well as one of the food baskets of Nigeria. The river flows from the foot slopes of the Jos Plateau and passes through Kano draining their residential and industrial effluents and carrying them to the influent Hadejia Nguru wetlands. This research focuses on determining the levels of concentrations of heavy metals (Cd, Co, Pb, Ni, Cr and As) in both groundwater and surface water from upstream, to midstream where the industries are located. It is also aimed to find whether the contamination caused by Kano metropolis reaches the Hadejia Nguru Wetlands.

1.1 Study Area

The study area covers the present Kano and Jigawa states occupying a land area of about 43,285Km^2 approximately 4.9% 0f whole Nigeria It lies within latitudes 10^0 45"- 12^0 30"N and longitudes 8^0 43"- 10^0 10"E. The river has a total length of 1,384 km, and its drainage basin is 15,341 Km^2. It is part of Lake Chad Drainage Basin. The River flows through normal non polluted areas of Nigeria, with exception to Kano metropolis, where from it drains most of its pollutants. Kano River flows from the foot of the Jos Plateau on the Pre-Cambrian rocks of the central Nigerian Crystalline Shield under the effluent regime. Passing through Kano Metropolis it drains its residential and industrial effluents, then, some 40 KM downstream Kano metropolis, enters the Borno Basin, changes its regime into influent one, and finally disappears in the sands and silts of the Chad formation in the Hadejia- Nguru Wetlands.

2.0 Material and Method

Wells and boreholes samples were collected with a clean plastic bucket (as recommended by Davies, 1994). Samples from Boreholes were pumped for several minutes with the view of flushing out stagnating water in pipe, in order to sample the water coming from the formation.

Water samples were taken into plastic bottle containers of 120 ml and were all rinsed two times with the sampled water before filling them. Before tightening them, field parameters instantaneously such as (temperature, pH, Electrical Conductivity, TDS depth of wells and elevations) were measured for all the collected samples.

Samples were then tightened and kept in a cooler with ice throughout the period of sampling. The bottles were clearly labeled. Water samples were taken randomly from different parts of the study area from the upstream side of the river in Ririwai up to the Hadejia- Nguru Wetland, ending in Turabu of Kirikasamma Local Government Area of Jigawa State. The samples were taken simultaneously and categorized into surface water and groundwater water samples, rock samples, and sediments from stream channel. All the samples were packaged and transported to the Institute of Environmental Engineering Laboratory of the Polish Academy of Science in Zabrze for the determinations of heavy metals in water, sediments and rocks. In the laboratory for the heavy metals determination in water samples Inductively Coupled Plasma Mass Spectrometry Model 300 was used. Global map per, Aqqa and Map Info software's were also used in producing maps of levels of concentration in water for the study area as well as in interpretations.

3.0 Results and Discussion

3.1 Result of the Field Measurements

Table 1 gives the values of the physical parameters measured in the field. The values of electrical conductivity (EC) ranges between 7 and 159US/cm with mean average of 29.5uS. whereas for pH values obtained ranges between 6.52 and 8.7 with an mean average of 7.17, temperature ranges from between 69.2 and 194 ^{0}F with mean total average of 88^{0}F. Elevations from the study area ranges between 343 and 880 masl with mean total of 472.69masl.

Based on above pH average water in the study area can be interpreted as slightly alkaline and still within permissible limits of all the three standards/guidelines. EC with above average also shows that all the water their values fall within the three guidelines.

3. 2 Heavy Metals in all Sample of Water (Both Surface and Groundwater)

All samples from both surface and groundwater in the studied area have ranges and mean of these listed: Co ranges from 0.11-21.24 ppb and average of 2.26 ppb , Ni ranges from 0.26 - 37.01 ppb and average of 7.37 ppb , Cu ranges from 0.17 - 640.93 ppb and average of 37.62 ppb, Zn ranges from 15 - 408 ppb and average of 115.03 ppb, As ranges from 0.09 - 2.31ppb and average of 0.62 ppb ,Pb ranges from 0.16 - 834.38 ppb and average of 29.82 ppb , Cr ranges from 0.16 - 5557.35 ppb and average of 419.58 ppb ,Cd ranges from 0.04 - 1.64 ppb and average of 0.21 ppb.

From above averages determined form the study area shows that all the waters are higher than the standards and guidelines which means the water is strongly polluted for domestic and even irrigation system of agriculture and the threat of the metals in water either consumed or for irrigation it means there is need for further research to determine also levels of these heavy metals in crops grown from these water in a way called biomagnifications in crops grown with these waters (table2).

Also the samples were categorized based on surface and groundwater into 3 on their locations of sampling points; upstream, midstream of and from Kano metropolis and then downstream after Kano metropolis up to the Hadejia Nguru wetland.

3.3 Groundwater

3.3.1 Upstream from Kano metropolis

Co, of range from 0.11 - 5.21 ppb and average of 1.34 ppb, Ni ranges from 2.03 - 21.86 ppb and average of 6.62 ppb, Cu, ranges from 1.86 - 25.49 ppb and average of 7.96 ppb, As ranges from 0.09 - 0.39 ppb with an average of 0.25 ppb, Cd, ranges from 0.33 - 1.64 ppb and average of 0.63 ppb, Pb, range from 1.8 - 30.04 ppb and average 7.69 ppb Cr ranges from 2.26 - 4.59 ppb and average of 3.58 ppb.

3.3.2 Midstream groundwater

Co, of range from 0.16 - 1.82 ppb with an average of 0.61 ppb, Ni ranges from 2.75 - 9.15 ppb and average of 5.50 ppb, Cu, ranges from 5.27 - 64.95 ppb and average of 23.03 ppb, As ranges from 0.09 - 1.58 ppb and average of 0.47 ppb, Cd, ranges from 0.04 - 0.09 ppb and average of 0.05 ppb, Pb, range from 2.62 - 834.38 ppb and average 80.63 ppb Cr ranges from 2.86 - 16.4 ppb and average of 7.41 ppb.

3.3.3 Downstream Groundwater

Co ranges from 0.6 - 21.24 ppb and average of 5.20 ppb, Ni ranges from 2.29 - 37.09 ppb and average of 11.47 ppb, Cu, ranges from 3.32 - 640.93 ppb and average of 137.55 ppb, Zn ranges from 15 - 124 ppb and average of 75.2 ppb, As ranges from 0.09 - 2.27 ppb and average of 0.64 ppb, Cd, ranges from 4.73 - 192.69 ppb and average of 48.43 ppb, Pb, ranges from 2.18 - 42.69 ppb and average 12.91 ppb, Cr ranges from 1.83 - 80.18 ppb and average of 42.51 ppb.

3.4 Surface water

3.4.1 Upstream Kano River

Co, ranges from 0.14- 9.7 and average of 2.43 ppb, Ni ranges from 2.17 - 4.76 ppb and average of 3.01 ppb, Cu, ranges from 1.79 - 4.83 ppb and average of 2.80 ppb, Zn ranges from 32 – 95 ppb and average of 55.6 ppb, As ranges from 0.24 - 0.36 ppb and average of 0.31 ppb, Cd, ranges from 0.09 - 0.54 ppb and average of 0.24 ppb, Pb, range from 2.3 - 6.17 ppb and average 3.44 ppb, Cr ranges from 2.69 - 3.69 ppb and average of 3.27 ppb,

3.4.2 Midstream (Kano metropolis)

Co, with range between 1.41 - 5.39 ppb and average of 3.87 ppb, Ni ranges from 5.35 - 22.76 ppb and average of 13.98 ppb, Cu, ranges from 6.02 - 113.38 ppb and average of 55.89 ppb, Zn ranges from 59 – 242 ppb and average of 117 ppb, As ranges from 0.12 - 2.31 ppb and average of 1.26 ppb, Cd, ranges from 0.09 - 0.54 ppb and average of 0.24 ppb, Pb, range from 3.93 - 17.69 ppb and average 10.19 ppb, Cr ranges from 61.38 - 5557.4ppb and average of 2353.7 ppb.

3.4.3Downstream Kano River

Co, of range from 0.25 - 1.93 and average of 1.23 ppb, Ni ranges from 0.26 - 4.59 ppb and average of 2.89 ppb, Cu, ranges from 0.17 - 7.17ppb and average of 3.6 ppb, Zn ranges from 62 – 118 ppb and average of 88 ppb, As ranges from 0.33 - 0.67 ppb and average of 0.52 ppb, Cd, ranges from 0.04 - 0.08 ppb and average of 0.06, Pb, range from 0.16 - 5.13 ppb with an average 2.41 ppb. Cr ranges from 0.16 - 30.88 ppb and average of 9.08 ppb.

Form above results of levels obtained from up streams, midstream and downstream shows that the greater impacts starts from midstream and in surface water has reached up to the downstream and this is not only to the surface but even the downstream which is influent groundwater is also polluted with these heavy metals.

4.0 Conclusions and Recommendations

The study brings the light of hydro geochemistry of water in the Kano River drainage basin. Both surface and groundwater from upstream (background non polluted), midstream (pollution area) and downstream (extent of pollution) shows that the pollution has reached up to the downstream. Levels in both waters show that the falls to higher side and pass the guidelines and standards in both surface and groundwater in the study area. Also based

on pH and EC water is slightly alkaline but still within tolerable limits and EC. It is therefore recommended that concentrations level is also needed to be found in crops grown with these waters. Again it is confirmed that probably this may be one of the reasons for the drop in fish catch from midstream up to the downstream especially in area like Wudil which is known for its fishing, Gadar Ringim and even Tarabu town in Kirikasamma local government of Jigawa state. Levels of high concentrations can be seen from figures 2-13 showing the areas with highest levels from results obtained in from the analysis using Global Mapper.

References

Anudu, G. K., Obrike, S. E and Onuba, L. N. (2008): Physico chemical quality of groundwater in Abagana and its environs, Anambra Basin, south-eastern Nigeria. International Journal of chemical sciences, Vol. 1, No. 2, pp. 296-301

Egboka, B.C.E. (1986): Hydrogeochemistry of shallow wells and surface waters of Owerri and its environs. Proc. 1st Symposium, NIWASA, pp 305 – 328

Ejechi, B.O. and Odun, O (1996): An investigation into the Event of Pollution of Some Nigeria's rivers. A Report submitted to Nigerian Environmental Study / Action Team.

Ezeigbo, H.I. (1998): Geological and Hydrogeological Influences on the Nigerian Environment. Journal of Nigeria Association of Hydrogeologist. Vol. 1, No. 1, pp38 – 39

European Commission (2006): Regulation (EC) NO.1881/2006. JO L364, 20.12.06, pp.5-24.

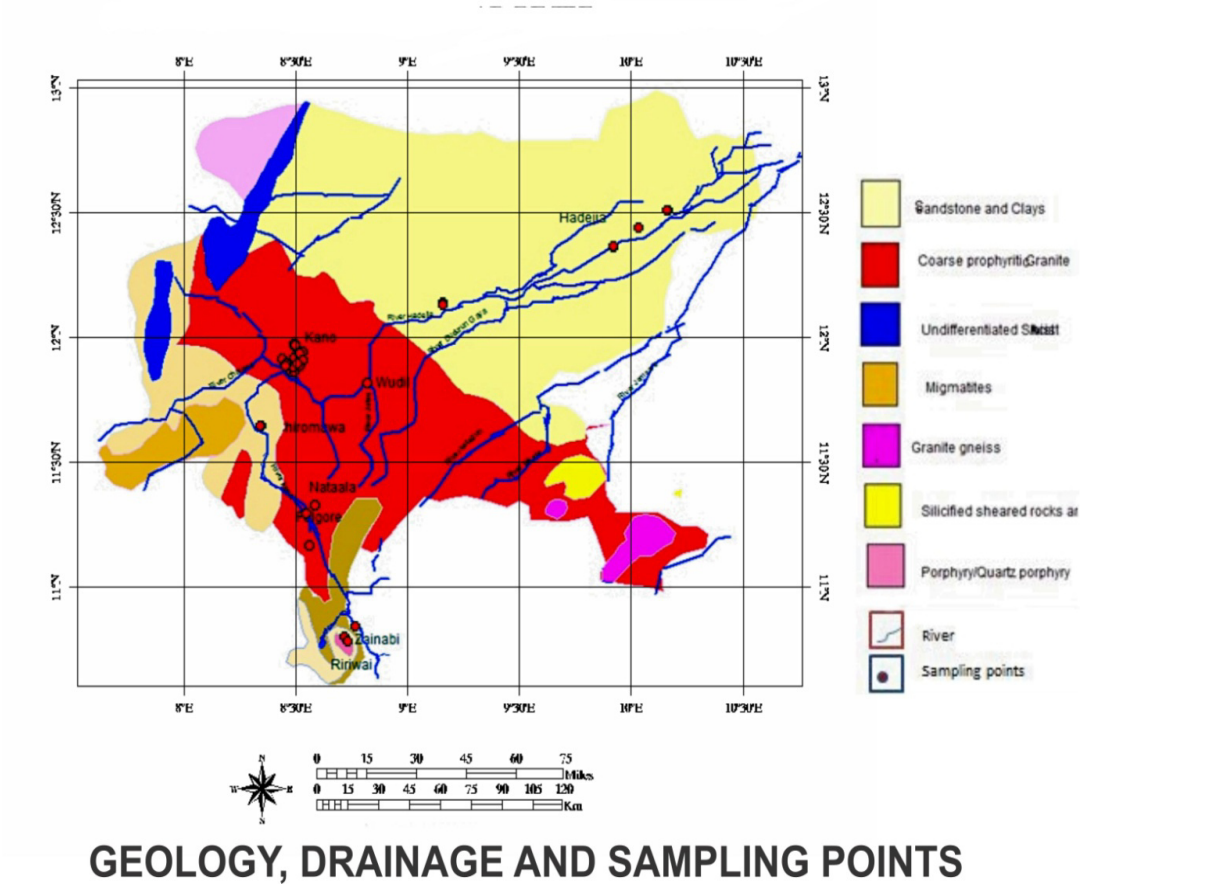
Figuero, E. (2008): Are more resistive food Cadmium Standards Justifiable Health Safety Measures or Optimistic Barriers to Trade? An answer from Economics and Public Health. Science of the Total Environment 389, pp.1-9

Federal Ministry of Environment (2001): Studies for Industrial Effluent Treatment Facilities in Kano. A preliminary Report. Report prepared by MAP Industrial and Environmental Audit and GMBH Germany.

Klifi, R. & Hamza-Chaffai, A. (2010): Head and Neck Cancer Due to Heavy Metal Exposure via Tobacco Smoking and Professional Exposure A review. Toxicology & Applied Pharmacology, 248, pp.71-88

Tanko, A. I. (1997): Industrial Waste Water Pollution and its Effects on Shallow Ground Water Sources in Metropolitan Kano. Paper presented at the 40th annual Conference of the Nigerian Geographical Association. Bayero University Kano, May 4-7, 1997.

Todd, D. K. (1980): Groundwater Hydrology. John Wiley and Sons Inc. New York. 2nd



GEOLOGY, DRAINAGE AND SAMPLING POINTS

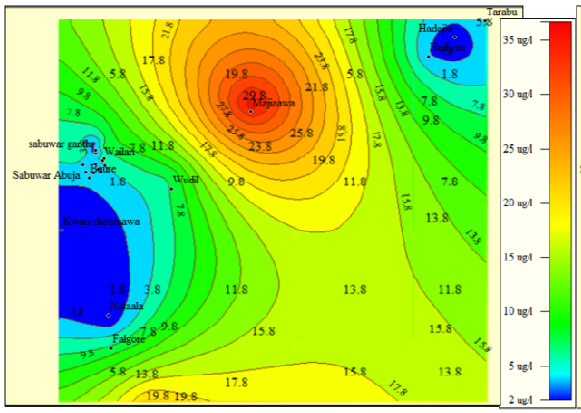
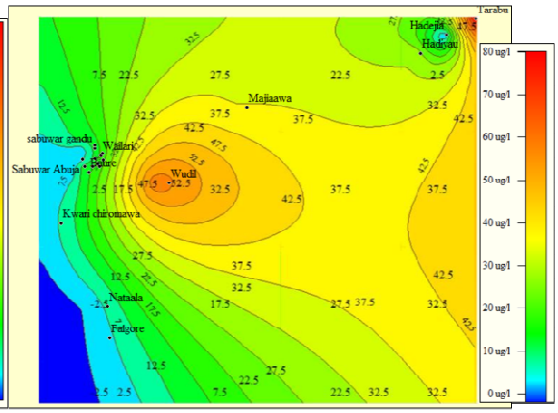


Fig.2 Ni in Groundwater



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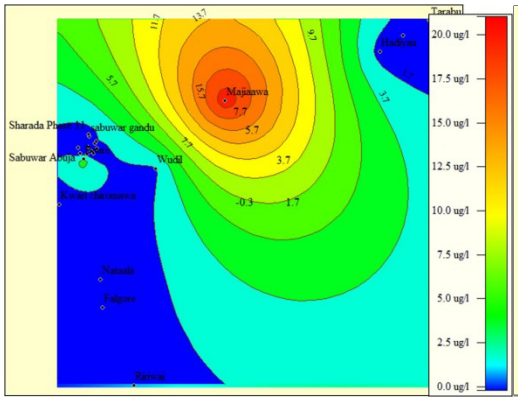

Fig.4 Co in Groundwater

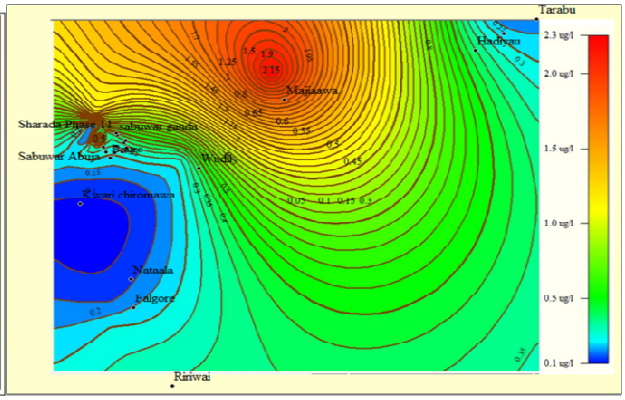

Fig. 5 As in Groundwater

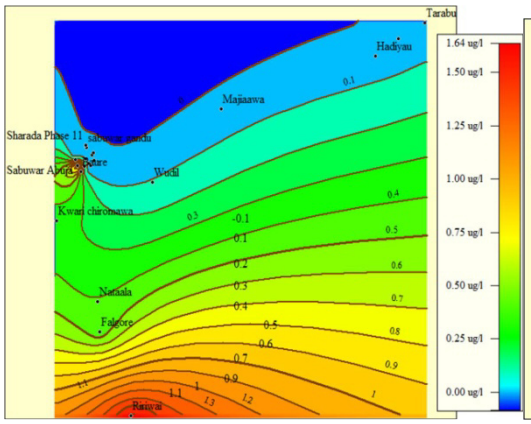

Fig.6 Cd in Groundwater

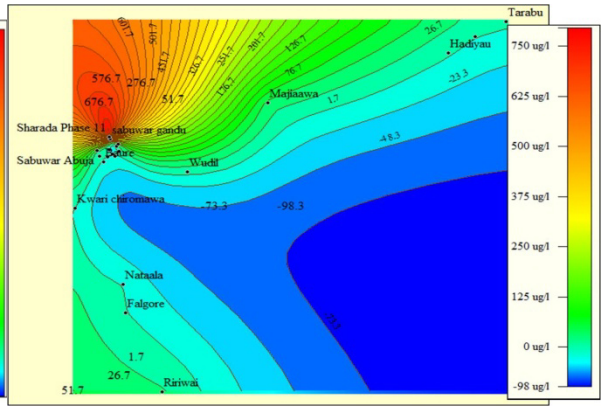

Fig. 7 Pb in Groundwater

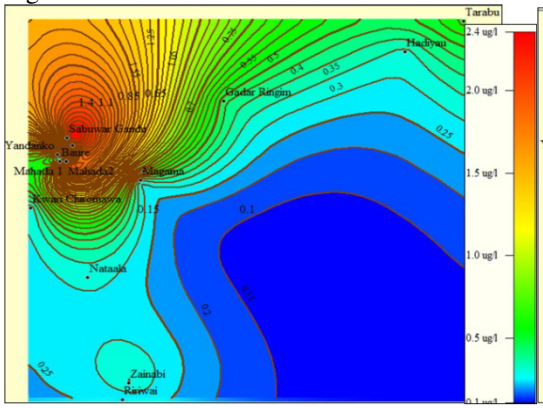

Fig.8 As level in surface water

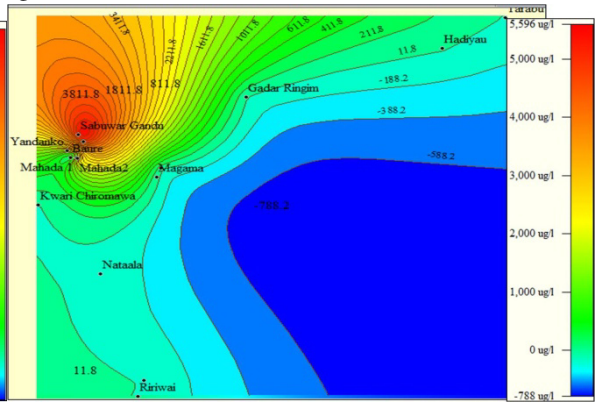

Fig.9 Cr levels in surface water

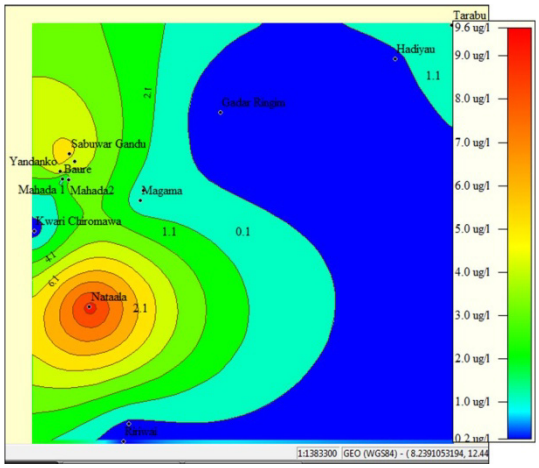

Fig. 10 CO levels in surface water

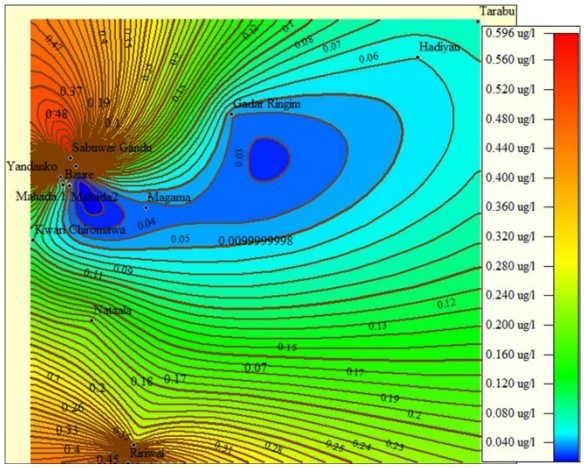

Fig.11 Cd levels in surface water

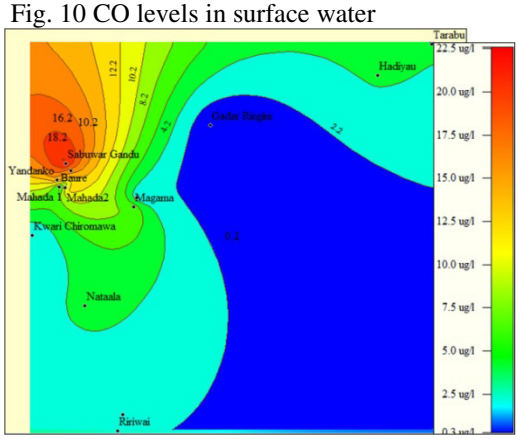

Fig.12 Ni levels in surface water

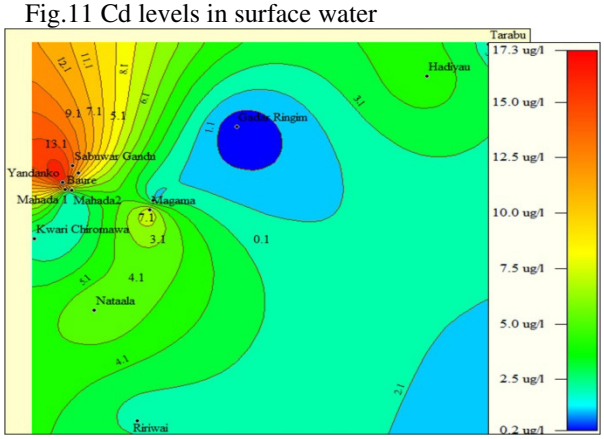

Fig. 13 Pb levels in surface water

Table1. Results of Field Measurements on Locations, Time, pH, TDS, Elevations and Depth to Water table from wells and boreholes where possible (BH; Borehole SW; Surface water from Kano river, HW; Hand dug wells)

Sample Number, Name of Location and Type	Locations	Time	Temp. (^{0}F)	pH	TDS	Elev. (m)	Depth
01. Ririwai BH	10^0 45’ 01.3’’N 08^0 43 49.2E	11:10 am	79.7	6.52	010	880	12.53
02. Ririwai (SW)	10^0 43’ 59.0’’N 08^0 44’ 41.1’’E	12:49pm	84.6	7.28	007	875	
03. Zainabi (SW)	10^0 47’ 43.2’’N 08^0 46’504’’E	3:00pm	84.5	7.28	020	616	
04. Falgore (BH)	11^0 07’36.7’’N 08^0 34’33.8’’E	8:52am	82.8	6.68	025	589.7	7 casing
05. Nataala (SW)	11^0 17’47.4’’N 08^0 35’58.8E	9.45	75.15	7.02	020	517.6	
06. Nataala (BH)	11^0 15’45.4’’N 08^0 33’54.2’’E	10:42am	83.0	6.63	019	554.5	
07. Ciromawar Kwari (BH)	11^0 37 27.8’’N 08^0 21’58.7’’E	1:00pm	83.9	6.54	011	468.1	
08. Chiromawa Kwari (SW)	11^0 37’27.7’’N 08^0 21’39.4’’E	1:25	74.3	7.38	007	459.8	
09. Baure (SW)	11^0 50’51.0’’N 08^0 29’ 39.2’’E	‘2:20pm	82.0	7.42	008	428.4	
010. Baure (BH)	11^0 50’46.1’’N 08^0 29 ‘39.6’’E	2:35	81.7	6.79	008	434.2	

Sample Number, Name of Location and Type	Locations	Time	Temp. (0F)	pH	TDS	Elev. (m)	Depth
011. Majiawa (BH)	12^0 08' 02.8''N 09^0 09'51.2''E	8:32	78.9	6.93	012	380.3	
012. Hadiyau (BH)	12^0 21'40.4''N 09^0 55'16.8''E	9:52am	85.2	6.78	017	357.8	
013. Hadiyau (SW)	12^0 21' 55.0''N 09^0 55' 12/1''E	10:05	75.2	7.44	010	346.9	
014. Tarabu (SW)	12^0 30' 40.4''N 10^0 09'45.8''E	11:20	86.5	7.67	013	343.2	
015. Tarabu (BH)	12^0 30' 42.2''N 10^0 09'41.6''E	11:32	84.8	6.78	012		
016. Gadar Ringim (SW)	12^0 07' 35.4''N 08^0 10'07.5''E	8:10	69.2	7.77	008	380.3	
017. Hadejia (BH	12^0 26'30.9''N 10^0 01' 59.2''E	12:25pm	86.0	6.78	013		
018. Wudil (SW)	11^0 47 '56.6''N 08^0 49'59.3''E	7:59	71.3	8.70	010	403	
019. Wudil (BH)	11^0 47' 56.8''N 08^0 49' 58.9''E	7:15	80.3	8.50	012		
020. Mahada (SW)	11^0 50'51.4''N 08^0 30' 34.7''E	9:00am	70.8	7.44	072	427.4	
021. Mahada (SW)	11^0 50' 43.2''N 08^0 30' 33.8''E	9;35am	72.4	8.15	008	427.2	
022. Magama (SW)	11^0 52'22.6''N 08^0 30'35.9''E	9:43	69.2	7.51	128		
023. Kaba (BH)	11^0 52'08.1''N 08^0 30'07.4''E	11:00	83.0	7.32	021	432.7	
024. Rigafada (BH)	11^0 54'10.5''N 08^0 30' 34.1''E	12:20	86.1	7.23	016	457.5	
025. Wailari Mosque (HW)	11^0 55' 06.5''N 08^0 32'21.5''E	12:45	82.9	6.73	036	448.7	
026. Sabuwar Gandu (BH)	11^0 57'07.3''N 08^0 30' 40.4''E	1:25pm	86.4 86.4	6.93	014	472.1	
027. Sharada phase 1(HW)	11^0 57'47.8''N 08^0 30'31.5''E	2:52	82.0	6.92	066	466.7	
028. Maikalwa Pri.Sch (BH	11^0 55' 42.5''N 08^0 32'42.5E	7:48am	79.5	7.27	070	453.0	
029. Wailari (SW)	11^0 55'25.1''N 08^0 32' 06.5''E	8.15	194	7.05	159	442.8	
030. Sabuwar Abuja (BH)	11^0 53' 59.4''N 08^0 27' 24.2''E	10:15	156	6.93	042	461.0	
031.Yandanko (SW)	11^0 52' 45.9''N 08^0 28'20.8''E	11:00am	71.2	7.20	010	434.8	
032 .Waratallawa (BH)	11^0 53'50.2''N 08^0 32' 54.3''E	4:20pm	154	7.08	026		
033. Tanburawa Mosque (BH)	11^0 52' 14.4''N 08^0 31'54.3''E	4:45pm	87.0	6.78	060	462.7	
034. Jan Farms (BH)	11^0 52' 54.4''N 08^0 31'21.8''E	5:05pm	194	7.45	067	440.2	
035. Rimin Zango BH)	11^0 52'15.3''N 08^0 28'05.3''E	10:35am	83.6	6.56	016	449.8	
036. Sabuwar Gandu (SW)	11^0 57'27.6N 08^0 30'48.2''E	1:25pm	86.4	6.93	014	472.1	

Table2. Summary and comparison of studied parameters in the studied water samples on heavy metals with WHO (2011), EPA (2004) and NIS (2007) Guidelines for drinking water

Parameter	Unit (ppb)	EPA (2004)	NIS (2007)	WHO (2011)	The Studied Area work (Range) ppb	Mean from the worked Area (ppb)	Remark
Co	ug/L				0.11 - 21.24	2.26	
Ni	ug/L	0.07	-	0.02	0.26 - 37.01	7.37	Above limit
Cu	ug/L				0.17 - 640.93	37.62	
Zn	ug/L	0.1	5	3	15 - 408	115.03	Above
As	ug/L			0.05	0.09 - 2.31	0.62	Slightly high
Cd	ug/L			0.005	0.04 - 1.64	0.21	Slightly high
Pb	ug/L	0.01	15	10	0.16 - 834.38	29.82	Above limit
Cr	ug/L				0.16 - 5557.35	419.58	

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