GROUNDWATER QUALITY AND RELATED WATER BORNE DISEASES IN DASS TOWN, BAUCHI STATE, NIGERIA

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ABSTRACT

This study examined 20 randomly collected water samples, using 75ml sterilized bottles from private and public wells with mean depths of 3.91m and 6.23m respectively, and boreholes/pump bores of 12 to 25m deep in Dass town in December, 2010. Laboratory analysis were carried out at Gubi dam Water Treatment Plant, Bauchi, using standard procedures to determine the concentrations of physical, chemical and biological properties of the samples in line with WHO and SON standards. Results reveal that pH, total dissolved solids (TSD) and Nitrates were within WHO and SON limits, while Manganese, Calcium carbonate (total water hardness) and E-coli concentrations exceeded the safe standards by 600%, 1035% and 274% respectively. E-coli cfu decreased with depth of wells and distance from pit latrines. The excessive concentrations of these parameters seem to be related to the reported cases of water borne diseases in the town at the time of the research. It was recommended among others that governments should take urgent steps to safeguard and protect public sources of potable water supply through her relevant water and health institutions to serve as part of the dividends of democracy to the people.

Keywords: *Boreholes, private wells, public wells, E-coli, Mai Anguwa, coli form count unit (Cfu)*

INTRODUCTION

Water is a basic environmental resource that covers about 79% of the earth surface. It is accessed by man through its storage facilities on the surface, underground and in the atmosphere. Groundwater is an important source of freshwater stored in aquifers. Aquifers are permeable, pervious and porous rocks with connected pore spaces that allow water to flow through them. Aquifers can either be confined or unconfined. In confined aquifer, water flow is restricted but it flows freely in the unconfined aquifer. Groundwater is replenished by infiltration and percolation of precipitation; and from seepage of stream water into the ground storage system (Press and Siever, 1985; Strahler, 1973, Ward, 1974).

Water as a universal solvent reacts with minerals in rocks and changes its constituents as it seeps through the aquifer. When these changes occur beyond set limits, groundwater is considered to be polluted or contaminated by the element or substance in it. Sandhyarami (2009), regards groundwater pollution as "a change in the properties …due to the contamination by microbes, chemicals, hazardous substance and other foreign particles", that may have been added naturally or by man (Harter, 2003)Groundwater refers to the water that is stored in the pervious, porous and permeable rocks referred to as aquifers, everywhere in the world.

Depending on the rock type and formation, groundwater is found in the ground within the depth of 100meters and in some places up to 1000 meters deep. A great percentage of people worldwide use this source of water for their agricultural, domestic and industrial purposes (Press and Siever, 1985). Groundwater quality assessment examines "the chemical, biological and physical qualities of the water", including temperature, turbidity, colour, taste and odour (Thomas, 2003). But the major concerns are usually with the chemical and biological parameters and their health implication on the environment. The world Health Organization (WHO) and the Standard Organization of Nigeria (SON) (Table 3) have set limits for the specified amount of elements or substances that can be permitted in potable water because of their negative impacts on peoples' health status.

Residential areas contaminate groundwater through improper storage and disposal of household chemicals and wastes into landfills, dump sites, latrines and graveyards where they decay and are moved into aquifers by rainwater (Harter, 2003; Sandhyarami, 2010 and Lenntech, 2010). Shallow aquifers are most susceptible to such high risks of groundwater contamination from the overlaying unsaturated zones (David, 1996). These pollutions can be reduced through proper waste disposal management practices. Hence, public potable water supplies should be tapped from deep aquifers because they are relatively free from contamination (Press and Siever, 1985).

Pollutant represents any biological, chemical and physical residue present in the groundwater in excess of WHO and SON limits, that may be harmful when consumed. Groundwater pollution can result from the contamination through physical, chemical or biological processes facilitated by man or nature. Water Quality describes the amount of biological, chemical and other residues in a sample of 75ml, with specific reference to WHO & SON standards. The depth and rock structure determines how easily or fast water can be contaminated by pollutants. Groundwater gets polluted when it comes in contact with either the point or non-point pollution sources. Point pollution areas includes, municipal landfills, leaky sewer lines, spills from industrial waste, underground injection wells, latrines and grave yards. The non-point sources of pollution includes, spray of fertilizers, pesticides and herbicides on agricultural land and through acid rain (Press and Siever, 1985).

Groundwater has been the major source of domestic and industrial water for the people of Dass town for decades. The pressure on the resource is increasing due to population growth in the area. As a result, governments have responded to the demand by providing additional wells and boreholes to supplement the shortage of potable drinking water. Kabiru (2006) observes that the aquifer of the area has the potential to provide sufficient water for the Dass community. The high population density and the prevalence of pit latrines can facilitate contamination of the shallow groundwater sources leading to incidents of water borne diseases like abdominal disorders, typhoid fever, dysentery and urinary track infectious that are common in the town. The concept of groundwater pollution has been defined differently by many scholars. According to Abage et al. (1987) groundwater is said to be polluted when the changes in the water constituents is not desirable and have harmful or negative effects on a specific use.

Sandyarami (2009) defines groundwater pollution as the change in the properties of groundwater due to contamination by microbes, chemicals, hazardous substance and other foreign particles. Harter (2008) defined groundwater pollution from the human dimension as undesirable change in the groundwater quality resulting from human activities. Based on the three (3) definitions above; groundwater can be polluted by natural and artificial means (Table 1). Abimbola et al. (2006) assessed groundwater quality in Abeokuta area using ringed and un-ringed wells in relation to hydrogeologic characteristics, distance to possible sources of pollution and depth to groundwater level. The results reveal that the chemical components with Ca_{2++} and HCO_3 ion met the standards set by WHO but the bacteriological aspect had E. coli concentrations within the range of 14 to 180 per ml, indicating that groundwater pollution by man has negatively impacted on the groundwater resources.

This research is significant in that it assesses the potable groundwater supply sources and their likely effects on the human health. The findings would provide baseline data that may be useful to the people and the Government towards improving the quality of potable groundwater supply sources in Dass. This study focuses on examining groundwater quality used for domestic purposes in Dass town in relation to some reported illnesses and death that are often linked to witchcraft in the area which tend to create serious social problems and tension in the community. Specifically, is sought to examine,

- i The depth to sources of potable groundwater supply
- ii The Quality of the water at various depths
- iii The Possible pollutants and their sources.
- iv The relationships between depths to source of potable water, the pollutants and people's health.

To achieve these objectives, the following research questions were formulated.

- i. What are the depths to sources of groundwater in the study area?
- ii. What is the quality of water at depths to water sources?
- iii. Is there any relationship between the pollutants and depths?
- iv. What are the types of contamination and their health implications on the people?

MATERIALS AND METHODS

Dass town in Dass local government area of Bauchi State in the Northeastern part of

Nigeria was selected for the study. Dass town, the headquarters of Dass Local Government Area is located in the south-western part of Bauchi State on latitude $10^{o}00'$N and longitude $9^{0}32'$E, (Fig 1). Dass town comprises two villages of Bununu and Bundot. Water samples were analyzed at Gubi dam laboratory for three groups of 9 parameters as results are presented on Table. The required data for this research were depth to water table; 75ml of water samples from the wells/borehole, site/ location, type of wells, distance of wells to possible pollution points (meters).

Depth specifies the distance from the ground surface to the water-table in a given area at the time of sampling. The climate of the study area is characterized by the Guinea Savanna dry and wet seasons. The Continental Air Mass influences the area from November to March when the cold dry dusty harmattan wind is experienced in Northern Nigeria (Ileoje, 2009). Temperatures in the area are relatively high with mean annual of 32^{o}Celsius (Ayoade, 2009) (Fig 2 & Table 2). Diurnal Temperature range lies between 8 -100 Celsius, influenced by katabatic and Anabatic winds of the surrounding hills and the Jos Plateau during the night and morning hours (Ayoade, 2005; Table 3 & Fig 2). It receives rainfall for about 6-7 months in the year, starting from April to October (Table 3 & Figs 3) and has 5-6 months of dry season (November to March). Annual rainfall is about 1000mm, largely influenced by the SW Maritime Air Mass and its location on the leeward side of Jos Plateau. Hence, it has the lower rainfall than Jos Plateau (Ayoade, 2005).

Stratified random sampling was used to select sample sites in each stratum of the target population. Thus, 3 samples were selected from pump fitted boreholes; 1 from motorized boreholes; 5 samples from public wells, and 11 wells from the private household wells in the quarters. Wells and bore holes were the sample of water obtained for the study. The water samples were analysed at Gubi Dam laboratory in Bauchi State. The water sample was in 75ml of coli form count unit (Cfu). Both private and public wells were also considered for the study. Private well is a well that is constructed, maintained and exclusively used by a household for domestic water supply. Public well is a well that is constructed and maintained by the government, that is, accessible to the public for water supply.

Table 1: Research Parameters Investigated.

S/N	Chemicals	Physicals	Biological
1	PH	Temperature	Total coli form
2	Total dissolved solids (TDS)	Turbidity	
3	Conductivity		
4	Manganese		
5	Nitrate		
6	Total hardness		

RESULTS AND DISCUSSION

The number of wells and boreholes in Dass town at the time of research wAS 742, (718 wells and 24 boreholes) (Table 6). The wells are grouped into private household wells located in compounds and Public wells (Government own) (DLG, 2009). There are 43 concrete lined public wells distributed across the town with 26 in Bununu and 17 in Bundot (DLG, 2009). The water is fetched with the "guga" (in Hausa) a locally made 3 - 5 liters container that is lowered into the well with a rope. Bore holes were also grouped into motorized (9) and pump (15) (Table 6). The motorized boreholes are strategically located on the outskirts of the town near the Fadama areas. Hand pump fitted boreholes (Pump bores) are scattered in various parts of the town, serving public institutions, schools and hospitals. Nine are in primary school areas and one (1) each in General Hospital, Emir's Palace and central mosque. The other 3 are located in residential areas of Sarkin Arewa, Gyamas and Abuja area of the town (DLG, 2009).

Table 2: Sources of pollution to groundwater sources

	Anthropogenic Sources	
Natural sources	***Point sources***	***Non-point sources***
Dissolved solids and chloride Iron and manganese Nitrate and nitrogen Acid rain and other Contaminants in snow and dry fallout	Waste disposals land fills. Septic tank system. Surface impoundments Injection wells, Mining oil well-brines, underground storage leakages, latrines, grave yards, feedlots.	Spray of pesticides, herbicides and fertilizers on Agric activities

Table 3: Bauchi Five Years Mean Temperature 2006 - 2010

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temp °C	19.2	35.2	37.6	38.4	36	33	30.8	29.4	30.6	33.2	38.8	28.6

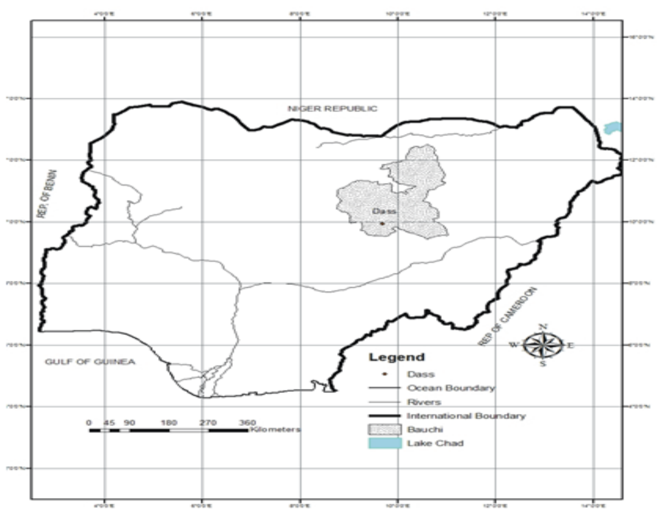

Figure 1: Map of Nigeria showing the study area

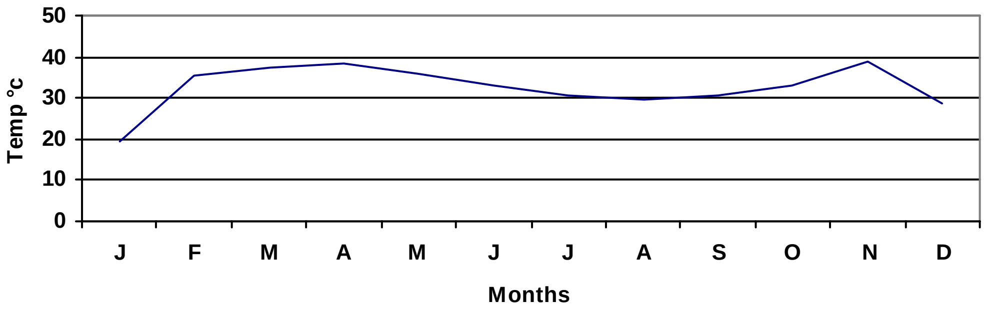

Fig 2: Bauchi Five Year Mean Temperature ***Source:*** Nigeria Meteorological Agency Bauchi

Table 4: Bauchi Five year Mean monthly Rainfall 2006 - 2010

Month	J	F	M	A	M	J	J	A	S	O	N	D	Year Total
Rainfall mm	0	0.14	0	46.4	86.8	208.4	241	353.6	228.9	81	0	0	1246.24

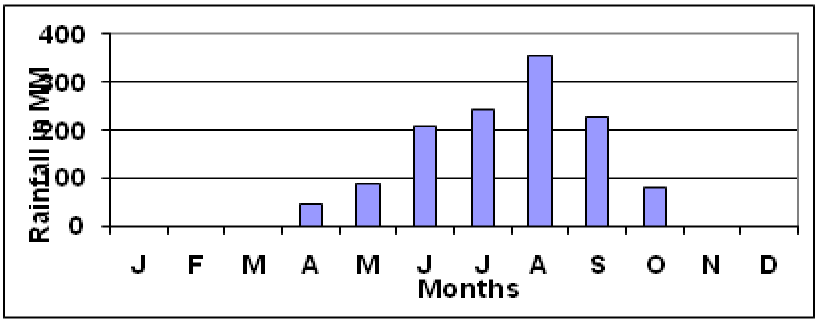

Fig 3: Bauchi Five Year Monthly Mean Rainfall (2006 - 2010)
Source: Nigeria Meteorological Agency Bauchi

Hydrogeology: Dass town is situated on the geology comprising partially fractured granite, diorite, migmatite and gneisses generally referred to as the Basement Complex rocks. These plutonic crystalline rocks are highly pervious and permeable due to penetrating cracks, faults and fissures. These rocks belong to Precambrian to early Paleozoic age (Udo, 1970). An analysis of logs of four borehole shafts (Fig. 4) reveal a topsoil layer (2 - 3m), a weathered granite section (6 - 13m), a widely varying fractured granitic zone of 4 - 14m overlying the Basement geology. These sections suggest the high potentials of the Basement rocks to store water at various levels in the ground (aquifer). Hence, many private wells obtain water mainly from the topsoil and the upper layers of the weathered mantle ranging between 2.6 - 5 meters deep. This shallow layer is also intensively used locally for the disposal of human and related household refuse into latrines and waste disposal pits. Unfortunately, about 90% of the people depend on this shallow and mineral deficient source of groundwater for general domestic use and consumption.

Relief and Landforms: The relief of the area lies between 700m - 900m ASL, with an undulating terrain of hills and ridges, covered with boulders of the weathered Basement Complex rocks that were exposed by erosion. Towards the south and east, the hills are surrounded by extensive pediments that are partly covered by marshes.

These plains and marshes (fadama), situated between the hills and ridges are fertile depositional zones intensively used as farmlands (Iloeje, 2009).

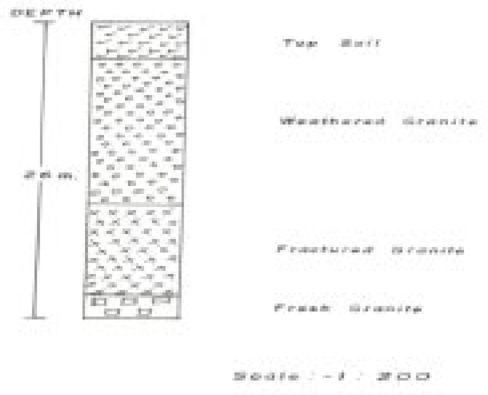

Fig. 4 : ROCK PROFILE IN THE SHAFT OF DABARDAK BORE HOLE IN DASS.

Soil and Vegetation: The soils are mainly clay loams that graduate into the sandy loam and gravelly soil towards the hillslope. Recent alluvial soils are found around the fadama and on the flood plains. Generally, the soils are immature, dark and rich in humus in the "A horizon" and laterites occur in the "B horizon" (Udo, 1970). The vegetation is the Guinea Savannah type, with shady trees and shrubs showing fresh leaves and 2m tall grasses abound in the rainy season. During the dry season the environment gets patchy and dry with trees and shrubs shedding leaves to conserve water (Iloeje, 2009) and developed resistance against the dry weather and bush burning. Major trees are locust bean, Ashiwali, Tamarind and host of herbs and shrubs (Udo, 1970 and Iloeje 2009)

Human Environment: The heterogeneous population of Dass town as at 2010 is estimated to be about 45,465 people. That is about 22% of the total population of the local government area (NPC, 2009). It comprises indigenous ethnic groups like Jarawa (49%), Bankalawa (29.3%) and Barawa (12%), Fulani (6%), Sayawa and Ngas (0.7%), Pyem (0.6%) Igbo and Yoruba constitute 1.6% of the population (DLG, 2009). The major religions in practice are Islam (78%) and Christianity (22%). The Muslims are the predominant people living in the town (DLG, 2007).

Socio-economic Activities: About 90% of the population engage in rained agriculture, irrigation and mix farming (Udo, 1982). Crops grown mostly for domestic use and commercial purposes are maize, groundnut and rice. Fattening of cattle, sheep and goats for sale are also practised. The population is mixture of farmers, traders, artisans, hunters and civil servants (Udo, 1982 and DLG, 2009).

Table 5: Wells and Boreholes Distribution in the Study Area

Source	Wells				Boreholes				
Village Area	Private	%	Public	%	Pump	%	Motorized	%	Total
Bununu	555	74.8	26	3.5	10	1.3	2	0.3	593 (79.9%)
Bundot	120	16.1	17	2.2	05	0.7	7	0.9	149 (20.1%)
Total	675	90.9	43	5.8	15	2	09	1.2	742

Table 6: Sampled Water Chart

S/N	Bununu Quarters	Private Well	Public wells	Pump boreholes	Motorized boreholes
S1	Sarkin Bam	1	-	-	-
S2	Sabon Layi	1	-	-	-
S3	Sarkin Bai	1	-	-	-
S4	Sarkin Noma	1	-	-	-
S5	Katuka (Abuja)	-	1	-	-
S6	Danlawal	1	-	-	-
S7	Sarkin Arewa	-	-	1	-
S8	Dawaki	1	-	-	-
S9	Gyamas	-	1	-	-
S10	Kufai	1	-	-	-
S11	Nasarawa	1	-	-	-
S12	Sarkin Bal	1	-	-	-
S13	Waziri Mazadu	-	-	1	-
S14	Sarkin Noma II (A/W)	-	1	-	-
Totals		9	3	2	-
	Bundot Quarters				
S15	Unguwan Madaki	-	1	-	-
S16	Bazingra	1	-	-	-
S17	Nasarawan Bundot	1	-	-	-
S18	Sarkin Arewa	-	1	-	-
S19	General Hospital Dass	-	-	1	-
S20	Bayan Tasha	-	-	-	1
Total		2	2	1	1
Sample Size		11	5	3	1

Problem of measuring distance to some possible sources of water pollution were encountered due to some intervening obstacles like buildings. This problem was solved by application of mathematical and surveying principles of circumventing obstacles. There were also cultural barriers such as barring strangers from entering matrimonial homes but this was overcome by consulting the ward heads (Mai Anguwa).

Depth to Groundwater and Distances to likely Source of Pollution: Table 7 shows that the sample mean depth to groundwater is 7.41m, the deepest source is the 25m borehole located at Bayan Tasha and the shallowest is a 2.6m private well at Nassarawan Bundot. The public wells are deeper with mean and shallowest depths of 6.26m and 4.6m respectively. The household wells are very shallow with minimum, maximum and mean depths of 2.6m, 5m and 3.91m respectively. The distance to the possible points of water pollution for the private wells was 9.22m while the minimum and maximum distances were 2.3m and 20.3m. Boreholes are the farthest from the pollution points because they are located on the outskirts of the town. Therefore, their mean distance to points of pollution is 39m while the public wells have mean distance of 20m. The temperature of the water samples ranges from 27.10 - 28.10°C; pH 6.38 - 8.5 and mean turbidity of 1.35 were all within or below the standards of WHO and SON. On the other hand, conductivity ranges from 333 - 3960 µS cm-1, total dissolved solids (TDS) mean was 733.8 mg/l and range of 166 mg/l - 1840mg/l partially exceeds the limits of WHO and SON pegged at 500mg/l. Manganese (Mn^{2+}) concentration ranges from 6.50mg/l - 0 mg/l higher than the standards set by WHO and SON at 0.50 and 0.20 mg/l respectively (Table 8B & Fig 4B).

Concentration of Nitrate (NO_{3-}) lying between 31.50 mg/l - 4.80mg/l is far below the standards of WHO and SON (50mg/l). Total water hardness measured as $CaCO_3$; was found to be exceedingly higher than the limits of WHO and SON, with values lying between 98.3mg/l to 1789mg/l, as against 150mg/l (Table 8A & Figs 4A & 4B). Total coli form count is perhaps the most worrisome parameter in the analysis because of its wide range of values from $\geq$2400cfu to 109cfu. This concentration gap exceeds the limits set by WHO and SON at 3cfu/100ml respectively. The relationship between the depths to source of water and two pollutants total coli form count and Manganese were used because of their prevalence in the area (Table 11).

Table 7: Depth to Water Table and Distance to the likely Source of Pollution

Sample	Locations	Depth(m)	Distance to Point Pollution Source (m)	Point Pollution Sources
			Household wells	
S1	Sarkin Bam	4	15.1	Latrine
S2	Sabon Layi	4.3	5.1	Latrine
S3	Sarkin Bai	3.8	2.3	Gutter
S4	Sarkin Noma	5	7.1	Latrine
S6	Danlawal	3.3	15.2	Latrine
S8	Dawaki	4.6	3.9	Latrine
S10	Kufai	3.4	11.5	Water Reservoir
S11	Nassarawa	4.2	2.6	Feed lot
S12	Sarkin Bal	4.4	11.5	Latrine
S16	Bazingra	3.4	20.3	Waste-disposal Pit
S17	Nassarawan Bundot	2.6	6.8	Latrine
	Group-Mean	3.91	9.22	
			Public wells	
S5	Katuka	7.3	10.2	Gutter
S9	Gyamas	4.6	9.4	Water Reservoir
S14	Sarkin Noma II A/Wakili	7	17.5	Gutter
S15	Unguwan Madaki	6.6	45	Latrine
S18	Sarkin Arewan Bundot	5.8	20	Latrine
	Group-Mean	6.26	20.42	
			Boreholes	
S7	Sarkin Arewa	16.8	4.3	Latrine
S13	Waziri Mazadu	12	28.1	Waste-disposal Pit
S19	General Hospital	20	53.2	Septic Tank
S20	Bayan Tasha	25	72.3	Waste- disposal Pit
	Group-Mean	18.45	39.48	
	Sample Mean	7.41	17.37	

Source: Fieldwork, 2011

Table 8A: Chemical Parameters Compared with SON and WHO Standards

Parameters	Mean value mg/l	SON mg/l	WHO mg/l
Total dissolved solids	733.8	500	500
Manganese Mn²?	2.07	0.20	0.50
Nitrate NO3?,	15	50	50
Total Hardness as CaCO3,	516.14	150	150

Source: Field investigation 2011

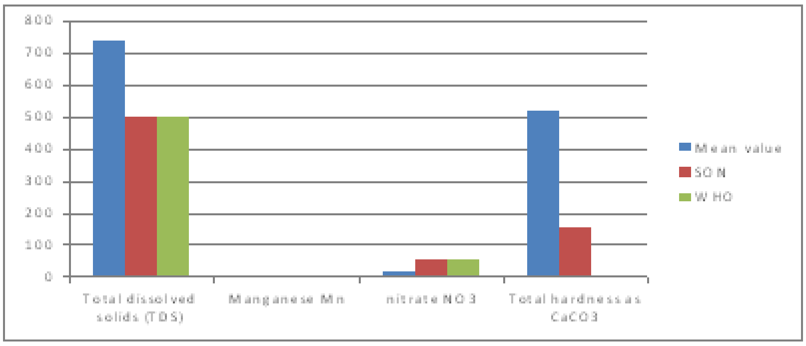

Fig. 4A: Mean values of chemical parameters compared with WHO and SON Standards

Table 8B: Manganese Compared with SON and WHO Standards (Fig 4B)

Parameters	Study Area mg/l	SON mg/l	WHO mg/l
Manganese Mn^{2+} (Mean Concentration	2.07	0.20	0.50

Source: Field investigation 2011

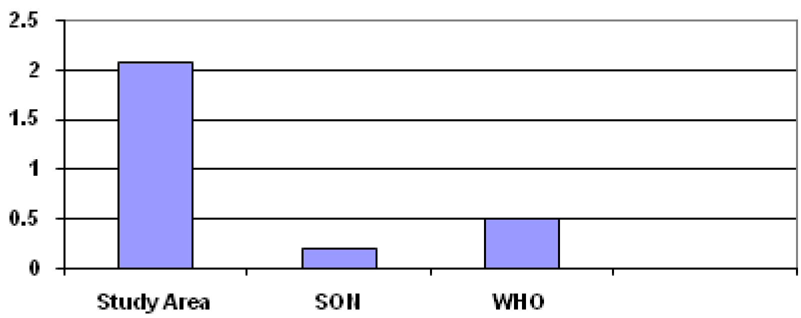

Fig. 4B: Concentration of Manganese in the Study Area compared with WHO and SON Standards

Table 9: Groundwater Parameter Statistics in Dass Compared with WHO and SON Standards

Parameters	Mean value	SON limit	WHO limit	WHO/SON Differences	% Difference
Temperature °C	27.87	Ambient	-	-	-
pH	6.81	6.5-8.5	6.5-8.5	Within	Within
Electrical conductivity, *µS cm²/l*	1482.9	1000	1000	482.9 above	148.29 above
Total dissolved solids(TDS) *mg/l*	733.8	500	500	233.8	146.76
Turbidity, *NTU*	1.35	5	5	Below	Below
Manganese, Mn^{2+}, *mg/l*	2.07	0.20	0.5	1.87/1.57	1035/414
Nitrate NO_{3-}, mg/l	15	50	50	Below	70 below
Total Hardness as $CaCO_3$, *mg/l*	516.14	150	150	411.14 above	344 above
Total Coli form *cfu*	?1818.15	3	-	?1815.15	605.06

Source: Field investigation 2011

Table 10: Parameter Concentration Difference (%) with SON in Groundwater in the Study Area

Parameters	% Difference with SON/WHO
Electrical conductivity, µS cm²1	48.29
Total dissolved solids(TDS) mg/l	46.76
Manganese, Mn^{2+}, mg/l	1035/414
Total Hardness as $CaCO_3$, mg/l	274.10
Total coli form *cfu*	605.06

Source: Field investigation, 2011

Table 11: Depth to Source of Water and Some Pollutants concentration in the Study Area

Sample	Locations	Depth (m)	Total Coli form cfu	%	Manganese, Mn^{2+}, mg/l	%
S1	Sarkin Bam	4	≥2,400	6.6	0.25	0.61
S2	Sabon Layi	4.3	≥2,400	6.6	1.21	2.90
S3	Sarkin Bai	3.8	≥2,400	6.6	1.00	2.42
S4	Sarkin Noma I	5	≥2,400	6.6	0	-
S5	Katuka (Abuja)	7.3	≥2,400	6.6	3.41	8.23
S6	Danlawal	3.3	≥2,400	6.6	4.76	11.51
S7	Sarkin Arewa	16.8	278	0.8	3.19	7.72
S8	Dawaki	4.6	≥2,400	6.6	6.50	15.72
S9	Gyamas	4.6	≥2,400	6.6	0.25	0.61
S10	Kufai	3.4	278	0.8	0.25	0.61
S11	Nasarawa	4.2	≥2,400	6.6	0.75	1.81
S12	Sarkin Bal	4.4	≥2,400	6.6	0.75	1.81
S13	Waziri Mazadu	12	348	1.0	0	-
S14	Sarkin Noma II (A/Wakili)	7	≥2,400	6.6	0	-
S15	Ungwan madaki, Bundot	6.6	1609	4.4	0	-
S16	Bazingra	3.4	≥2,400	6.6	0	-
S17	Nasarawan Bundot	2.6	≥2,400	6.6	0	-
S18	Sarkin Arewan Bundot	5.8	≥2,400	6.6	0	-
S19	General Hospital Dass	20	109	0.3	0.25	0.61
S20	Bayan Tasha	25	141	0.4	0.50	1.21
	Total	148.1	36363	100%	41.34	100%
	Mean	7.41	1818.2		2.07	

Source: Field work 2011

Distribution of Pollutants in Dass: Table 11 and Fig 5 show that total coli form has relationship with the depths, except at Kufai where the depth of 3.4m has coli form count of only 0.8% (278 cfu). About 70% recorded more than 2400 cfu each, while the rest of the boreholes recorded lower coli form cfu values between 109 - 278 cfu. At the General Hospital, the 20m borehole registered 109 cfu. The presence of Manganese in the area does not show any relationship with depths (Fig. 5). This relationship is clearly seen in the General Hospital, Bayan Tasha, Dan Lawal and Sarkin Arewa wells, where the depths and Manganese concentrations are 20m and 0.25mg/liter; 25m and 0.50mg/liter; 3.3m and 4.76mg/liter and 16.8m and 3.19mg/liter respectively. The shallowest water table of 2.6m at Nassarawan Bundot records no manganese ions in the water.

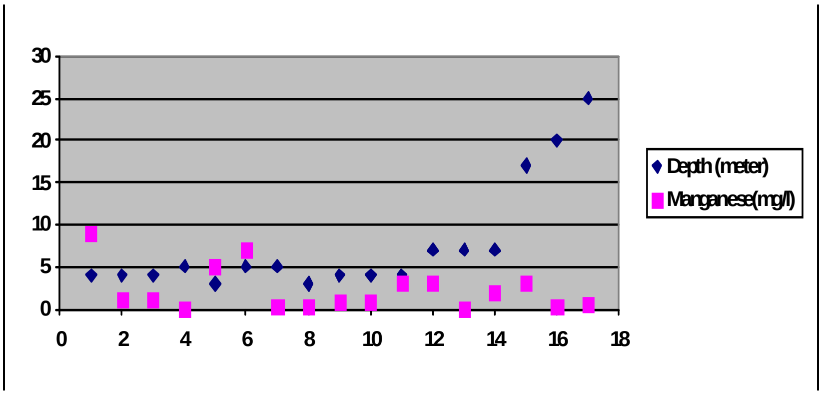

Fig 5: Relationship between Depth of Wells and Manganese Concentration in water

Table 12: Mean, Maximum, Minimum Depths and Distance to Possible Pollution Points

Variable	Private Household Wells		Public Wells		Boreholes/Pump Bores	
	Depth (m)	Dist to Pollution (m)	Depth (m)	Dist to Pollution (m)	Depth (m)	Dist to Pollution (m)
Minimum	2.6	2.3	4.6	9.4	12	4.3
Maximum	5	20.3	7.3	45	25	72.3
Sample Mean	3.91	9.22	6.26	20.42	7.41	17.37

Source: Computed from Table 11

Fig 6: Relationships between Depths, Distance to Point Pollution, Manganese and Coli form % Concentration in Dass Groundwater Supply Sources.

Figure 6 shows the relationship between depths of wells, distance to point pollution, Manganese and coli form concentration in Dass. The shallow wells show very high coli form concentration and the deepest water sources from the boreholes show low concentration of the coli form counts (cfu) at Sarkin Arewa borehole. The private wells that are located closer to latrines appear vulnerable to coli form concentration. This point is illustrated by the picture at Kufai. This shallow well (3.4m deep), located 11.5m away from the latrine presents one of the lowest coli form concentrations in the study area. This observation sharply contrasts with borehole at Sarkin Arewa at depth of 16.8m and coli form cfu of 278.

Table 13: Recorded Cases of Water Borne Diseases in Dass Town 2010

Disease	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cholera	0	0	0	0	1	0	10	45	36	20	2	0
Diarrhea	145	261	398	92	388	286	340	388	226	218	250	353
Dysentery	121	155	89	23	121	84	150	138	87	160	213	181
Typhoid	105	178	136	101	145	181	125	93	126	82	127	128

Source: Dass LGA PHC Disease Surveillance Unit

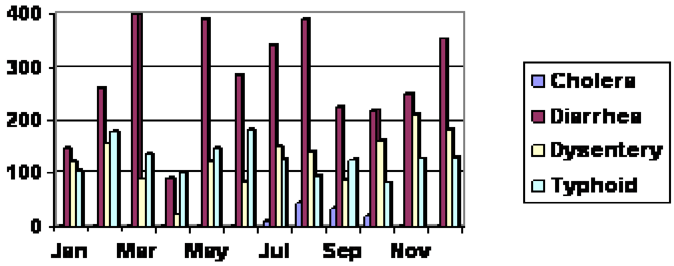

Fig 7: Monthly Records of Water Borne Diseases in 2010 in General Hospital Dass
Source: Dass LGA PHC Disease Surveillance Unit

Table 14: Recorded Cases Water Borne Diseases by Type in 2010 (Fig. 6)

Type of Disease	Recorded Cases
Cholera	110
Diarrhea	3345
Dysentery	1522
Typhoid	1527

Source: Dass LGA PHC Unit

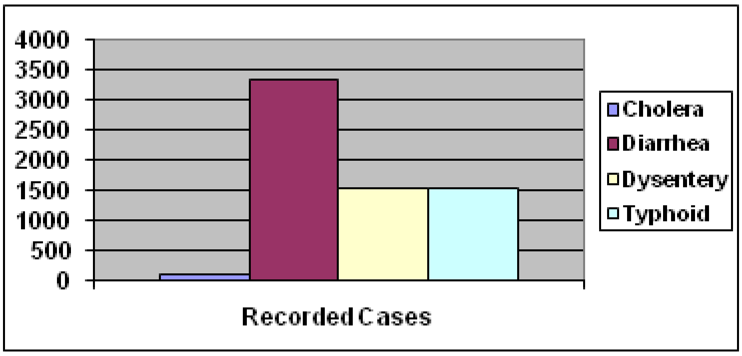

Fig 8: Annual Record of Water Borne Diseases by Type in 2010 General Hospital Dass

Source: Dass LGA PHC Unit

This study examined groundwater quality in Dass town in relation to the rising population (3.5/yr) and over dependence of the populace on groundwater sources using wells and boreholes. Groundwater can be contaminated by physico - chemical substances and biological organism picked up by water flowing through the rock matrix. The findings of this research reveal that groundwater in Dass town is sourced from depth ranging from 2.6m - 25m in the private and public wells/bore holes, at a mean sample depth of 7.4m. Grouping the wells into private, public wells and boreholes shows that the private wells are the shallowest with the range and mean of 2.4m and 3.91m respectively. This sharply contrasts with the statistics of the public wells with the range and mean depth of 2.7m and 6.26m.

The maximum depth of the boreholes is 25m with a mean of 7.41m. The findings reveals that the wells are situated close to pit latrines and other pollution points. The depth at which water is sourced for domestic and other purposes is relatively at the same depth range with the water table. This posseses a high risk of water contamination in the aquifers. The prevalence of water borne diseases in the town and its environs such as typhoid fever, diarrhea, dysentery, abdominal disorders and urinary tract infections may be related to the source of potable water in the town. Based on the research findings, there is a possible linkage between the groundwater sources and the common water borne diseases in the area. The analyses of water samples from wells and boreholes in relation to depth, distance to possible pollution zones has presented clues to the possible relationships between groundwater depth and coli form occurrence in the wells due to their shallowness and proximity to pollution points. A high concentrations of Manganese ions above 600% was observed and may be linked to neurosis and related illnesses as suggested by World Health Organization.

Analysis of the Pollutants in Relation to WHO and SON Standards: Groundwater quality standards set by World Health Organization (WHO) and Standard Organization of Nigeria (SON) specifies the amount of organic, physical or chemical substances that potable water should posses, beyond which the water is contaminated and hazardous for human consumption. Some of the substances found to have exceeded their concentration limits in Dass groundwater, serving as a major source of potable water are Calcium Carbonate ($CaCO^3$) and Manganese ions, E-coli (Escherichia coli) organism; electrical conductivity and Total Dissolve Solids (TDS) (Table 10). Total dissolved solids and electrical conductivity are less problematic in potable water. But calcium carbonate causes hardness in water and renders laundry services expensive and cumbersome. The over 270 % concentration of $CaCO^3$ ions observed to be above the recommended limits means that more soap and detergent will be needed during laundry services. Manganese (Mn^{2+}) presence in the water which was about 600% higher than set limits for potable water should be of concern. This amount is exceedingly high for human and environmental health.

There were also excessive quantity of E. coli form exceeding the national and international limits by1035% and 414% respectively. This high concentration of Mn^{++} is worrisome and should be of concern to health and water supply agencies in the town. It was also found that coli form cfu decreased with depth to source of groundwater and distance of well from pit latrines and related pollution points. The fact that groundwater can be contaminated in the aquifer is no longer in doubt because water can dissolve and transport large amounts of organic, soluble and solid substances within it (Press and Siever, 1985). Therefore the presence of various chemicals, organism and solid particles in groundwater only stresses the need to monitor and control potable water supply from ground sources regularly, using the national and international standards so as to guide against unwholesomeness consumption of poor quality water and its attendant health hazards (WHO, 1993). The presence of micro-organisms and manganese in the groundwater in Dass may be linked to the prevalence of water borne diseases such as typhoid and abdominal disorders. Neurosis and hallucinations in human can also be traced to overdose of neurotoxic elements in water such as Manganese ions (WHO, 1993).

The summary of the 2010 recorded cases of water borne diseases reveal that diarrhea tops the list, closely followed by typhoid, dysentery and cholera (Fig 7 & 8). The monthly records show that diarrhea, dysentery and typhoid occur all year round (perennial diseases), while cholera was occasionally reported in the rainy season (July to November) (Fig 7). However, it seems there is a reservoir of water borne diseases in the rural areas that can be redistributed to the cities through the contemporary high trends of rural - urban migration, especially, through the recruitment of house helps from the rural settings. Some collaborative efforts by governments to arrest this trend is urgently required. Therefore, there is the need to investigate other areas and put up a national action plan towards disaster risk reduction. Suffice to note that the amount of man-hours lost to malaria and these illnesses annually can be monumental and detrimental to the national economy.

CONCLUSION AND RECOMMENDATIONS

The failure to provide safe potable water to the rapidly growing rural and urban population nation wide is driving people into desperation. Hence, individuals are forced by these circumstances to extract groundwater at very unsafe location and depth. This trend needs to be checked, regulated and reversed through legislation and regular enforcement of environmental sanitation laws. The local, state and the Federal government agencies should coordinate and collaborate in the areas of sanitation and water supply so as to avert any outbreak of water borne diseases originating from rural communities. Based on the research findings and conclusions, it is recommended that people in the study area should:

a Boil and filter their groundwater before drinking.

b Observe and maintain basic environmental sanitation rules regularly.

c Sink deep wells at 100m from latrine and install concrete rings in the shafts, and cover them to avoid objects falling into the wells.

d Cultivate the habit of rain harvest as a source of drinking and laundry water in the rainy season.

e Treat groundwater sources regularly with chlorine, chlorine oxide and potassium permanganate ($KMnO_4$) to eliminate harmful organisms.

f Put pressure on governments to supply safe potable water as dividend of democracy, re-introduce house-house sanitary inspection to check the proximity of latrines to wells,

g The government can coordinate, monitor and maintain a hydrologic data bank for surface and groundwater resources.

Finally, the federal government should put up a national action plan to check the possible spread of water borne diseases and sponsor research in the rural areas on water borne diseases as a means of disaster risk reduction.

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