Hospital Water Demand/Consumption: A Case Study of Ahmadu Bello University Teaching Hospital, Shika.

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Abstract
This work provides basis of understanding groundwater potential of the Ahmadu Bello University Teaching Hospital, Shika, the water demand and requirement for supply. The moderate resistivity values obtain shows the water bearing zones ranges from one point to the other. The water potential of the area is good though, the volume varies from point to point depending on the conductivity, thickness, and aquifer characteristics. Shika hospital is located on Metamorphic (Gneiss) with maximum thickness of water bearing soft rock of 30 m. The two interconnected aquifers, the Soft Overburden and the Fractured Crystalline Aquifers stores good quantity of water. The groundwater flow directions of this area which stores water is that the water flow away to recharge the surface water. Solution to water problem in the study area is to rely on surface water via overhead tanks and the use of groundwater for emergency situation. Water demand of the Hospital is 154 m^3/d. Total water demand of the hospital is 438.39(m^3/d) and Unit water per day per bed is 0.877(m^3/d). The Hospital Static Groundwater Resources 494,350m^3, Total Dynamic Groundwater Resources 58,518.1m^3/a and Utilizable Dynamic Groundwater Resources 29,259.05m^3/a or (80.16 m^3/d). The water demand /requirement using WHO (2005) standard is 77,000 lpcd (77m^3/d). The unit water demand per bed per day of Shika hospital is 0.877 m^3/d. The coefficient of surface runoff of the study area is 0.18, base flow (infiltration) 0.1, and total runoff 0.28. The annual volume of surface runoff for ABU Teaching Hospital Shika is 1,039,209 m^3/a. Total surface water resources of the study area is 1,918,636 m^3/a. Proper planning is fundamental to protection, conservation and constant water supply. ABUTH water supply has been from boreholes, Zaria and Ahmadu Bello University (ABU) water works. Therefore, with proper management, ABUTH should not experience water scarcity. All the storage tanks both ground and overhead should be reactivated and sluice valves replaced and/or serviced with good chamber for proper security to minimize usage, wastage and delivery of water to different department of the hospital through its water distribution network pipeline while its groundwater resources should be a supplementary water sources because a hospital should have constant water supply and ABUTH should not be an exception.

Keywords: Water consumption, demand, Utilizable, Dynamic Groundwater Resources, Surface

INTRODUCTION

Water demand for Ahmadu Bello University Teaching Hospital, Shafa (ABUHT) is organized in accordance with Schoeneich 2003 and 2004 proposal. Water supply is an essential requirement for all people. Determining how much is needed is one of

the first steps in providing that supply. Providing enough water to meet everybody's needs may be difficult in the short term so water can be made available in stages. Continuous checking including talking to the various users of the supply (especially women) will enable limited resources to be focused effectively. Providing water is never free, the water needs to be collected, stored, treated, and distributed. Providing too much water from a limited source may deprive people elsewhere of water and have adverse environmental and health impacts. Collecting basics information like how many people are living in a place? How much does each individual use? Establishing the population to be supplied may not be easy but consulting community leaders, administrators, making direct counting, average number of people per house, and census record can give various estimates of the population. In order to have a representative figure we do not rely on one figure but compare independent assessments because some time, we could have displaced people moving about thereby changing the population.

Supplying water does not mean it is having the desired impact. Simply supplying as much water as possible is not the best solution. When more than the basic quantity is available; any additional water will eventually need to be disposed. Even if plenty of water is provided there may be other limits to its use, such as the time taken for people to travel and queue to get it (World population and fresh water use 1940 – 2000, World water day 2005). If more time is taken to collect water, the amounts they collect reduce (UNESCO 2003, 2007 and UNEDP 1991, 1992). The amount of storage facilities near the water point reduces the need to transport water.

People use water for wide variety of activities. Some are more important than others an example, having a few litres of water to drink a day is more vital than washing clothes but people will need to wash if skin diseases are to be prevented and physiological needs met. Each effective additional use has health and other benefits. People needs are not always predictable. For example, the need to wash sanitary towels or to wash hands and feet before prayer may be felt to be more important than other uses. In this research people of the study area where discussed within in other to know their priorities. Different population also has their specific need such as using water for anal cleansing. Different genders also have their priorities woman having their concern on house hold needs and men on livestock, girls needing water to wash during menstruation and boys wanting to go for swim. Water spillage and leaks also need to be taken into consideration. Hot or windy weather may increase people individual needs. To establish how much an individual need having some of the above differences in mind (UNEP 1989, World Bank 1993, United Nation 2003, and 2006). The Ahmadu Bello University Teaching Hospital Complex (ABUTH) started as Institute of Health in 1967 in accordance with statute 15 of the Ahmadu Bello University (A.B.U) law (Amendment Act Schedule 16) by the then Interim Common Services Agency (ICSA) of the former

Northern Nigerian Government Federal Ministry of Health (2002). The objectives of setting up the institution were to provide health care services, training and conduct research. When the then Northern Region Government was dissolved on 1st April 1968 and the six Northern States were established, ABUTH formally came into being with the following constituent Institutions: ABU Teaching Hospital, Zaria plus Tuberculosis (TB) Annex, ABU Teaching Hospital, Kaduna (Old and New) , ABUTH, Malumfashe, Orthopaedic Hospital, Dala – Kano, Medical Auxillary Training School, Kaduna, School of Nursing, Zaria, School of Midwifery, Kaduna, School of Hygiene, Kano, Some Urban and Rural Dispensaries in Zaria and Kaduna.

GEOLOGY OF THE ABUTH (STUDY AREA)

Geological setting, Hydrology/ Hydrogeology of ABUTH

The study area has 11 boreholes and over two (2) hand dug wells. The correlation provides information on the geology of the area. There is soft overburden and crystalline complex. The soft overburden has minimum thickness of 15.0m and maximum thickness of 30m. 22.5m consist of eolian silt at the top and alluvial sand below. The soft overburden aquifer consists of alluvial sand which Baba 2007 called Older Alluvial Aquifer to distinguish it from the Recent Alluvial Aquifer in the Kubanni River Valley. The thickness and extent of the Older Alluvial Aquifer is over 15 meters. The regolith aquifer and the fractured crystalline aquifer, as in every crystalline basement area, the regolith aquifer is developed as a result of intense and prolonged *in situ* chemical weathering. The extent chemical weathering and hence thickness of the regolith depends on the basement rock. On metamorphic rocks the thickness is up to 30 metres, with depth to water table at the end of dry season about 6 metres, making thickness of the water saturated interval up to 24 metres. It means, that on metamorphic rocks water is easily accessible for well sinkers, with no risk of sinking an abortive hand dug well, and if a well is technically properly constructed it yields water perennially in quantities sufficient for rural water supply. Water table typically throughout the year occurs at shallow levels of less than 10 m to 15 m with the wells being mostly seasonal. In the fractured crystalline aquifer water is found both in the variably weathered/transition zone and in the fractures, joints and cracks of the crystalline basement. The fractured crystalline aquifer unlike the regolith aquifer is highly permeable, with the water being contained within the fractured zones.

Geophysical survey report of the Shika area

The **ABEM Tetrameter SAS 300C** was the equipment used for the geophysical survey. The Vertical Electrical Sounding (VES) data shows thin compact sand top layer overlaying thick lateritic bed above the aquifer horizon. The resistivity of the top layer is the range of 108 to 151.ohm-m. The result suggests favourably groundwater conditions. The VES results

were obtained and these were improved upon using microcomputers interpretation program. Reliable inference is made from the known geological characteristics of the area. The visual observation of the generated curves and parameter from Geoelectric Sections interpreted from the VES curves could be grouped as comprising of three district layers. These include the top, laterites /silty clay, the gravely sand/weathered transition zone of the Basement rocks. The prospect for water in the area is above average due to the weathered/fractured nature of the formation. Considering the establishing geoelectric parameters as well as topographic, geologic and hydro geological implications, groundwater potential of the study area could be considered as reasonably encouraging borehole development.

The Ahmadu Bello University Teaching Hospital (ABUTH) coordinate 11^0 10' 25" N, 007^0 36' 20"E and 55.5 hectare (0.555 km^2 or 555,200m^2) was constructed with 4,000,000 M^3 of underground water tank made of steel. It presently has eleven boreholes, two in the residential quarters and nine in the administrative areas. Borehole number 3 (11^0 10' 26.8"N, 007^0 36' 16.2''E) has never been used since its completion in 2002. Borehole 1,2, and 5 has been in use and their water is piped to different part of the hospital through a new water distribution network which is different from the original water distribution network in the site plan of the hospital. Borehole 1 and 2 supplies water to the whole hospital while borehole 4 supplies water mainly to the laboratories of the hospital. National Water Resources Institute (GWR/HG-05(2/6) 2002 completion report of this borehole under the pumping test state that "the boreholes was test-run by constant discharge pumping test for a period of 3 hour using a Grundfos submersible pump with motor capacity of 1 x 220v I Hp. Maximum dynamic water level was 27.4m giving a total drawdown at 19.2m". Borehole 5 supplies water mainly to the wards. With the completion report by National Water Resources Institute to a reputable hospital Ahmadu Bello University, Zaria. The hydraulic conductivity is measured in length per time.

The Hydraulic Conductivity (K) of the core sample from the boreholes drilled in the premises of ABUTH is 5.787 x 10^{-3} m/s.

The boreholes completion report has it that all the five boreholes have the same pumping test result. If the total drawdown is 19.2m. It maximum dynamic water level 27.4m and static water level 8.2m, the area of the hospital is 555,200m^2(0.555km^2) (ABU 2004, and 2008). With 8.2m static water level there is 31.8m saturated zone. The volume of groundwater is 555,200m^2 x 31.8m = 17,655,360m^3.

Groundwater supply and monitoring shows that groundwater is pumped as from 4am or 5am for 8 hours, as from 2pm or 3pm for some hours not stated, and also from 9pm or 10pm for some hours not stated too. The borehole water is pumped 24 hours of the day into a ground level tank which is then pumped to an overhead steel tank coordinate 11^0 10' 17.5" N, 007^0 36' 25.9''E of 250,000 gallon capacity (1,136,500litres or 1,136.5m^3) fabricated and erected by

paramount construction company ltd. From the steel overhead tank, the water flows under gravity to other smaller overhead steel tanks. If the yield of the boreholes is 5.712m^3 that mean a borehole yield is 1.1424m^3 and when these boreholes are pumped 24 hours 493,516.8m^3 of water is pumped out of 17,655,360m^3 of the available groundwater 17,161,843.2m^3 will be remaining in a day and when this amount is pumped every day, the groundwater will be mined, submersible pumps burns, vegetation surfers/die, deforestation sets in, and the environment get highly degraded. Out of 17,655,360m^3 available groundwater 545m^3 of water will be withdrawn from the aquifer which will be enough for the hospital water demand consumption for a day if properly managed.

There are two major water reservoirs in the hospital. These two reservoirs are because the management wants to make water available in the hospital. Steel tanks (both ground level and overhead) of different capacity are installed almost everywhere in the hospital premises. The Chief Medical Directors (CMD) office popularly called the Aso Rock has two steel tank of 10,000litre each, Dialysis two steel tank each 11,000litres. Accident and Emergency has two each of 10,000 litres. Mortuary has four 6,000litre, 3,000litre 2,000litre, and 1,5000litre. The feeding centres two 10,000litre and 1,000litre.

Two each in all the hospital wards (female medical, female surgical, male surgical, male medical, children medical and surgical wards) making ten steel tank of various. In the hospital promises there are lots and lots of steel tanks, some in use, and some not in use. The steel tanks in the premises are estimated at 100,000liter. Note most of the tanks in the wards are overhead tanks. Borehole 3, coordinate 11^0 10' 13.5", 007^0 3'6 27. "9 elevation 692m; borehole 4, coordinator 11^0 10' 20.4, 007^0 36'18.3" elevation 709m and borehole 6, coordinate 11^0 10 26' 8", 007^0 36' 16.2" elevation 700m. In 2003 three additional boreholes where added borehole 1, coordinate 11^0 10' 15.7" elevation 711m, borehole 2, coordinate 11^0 10' 17.9", 007^0 36'21.3" elevation 704m, and borehole 5, coordinate 11^0 10' 23.6", 007^0 36' 15.1" elevation 702m. In 2009, three boreholes where added. Borehole X, Y and Z coordinate 11^0 10' 14.7", 007^0 36' 23.6" elevation 702m, coordinate 11^0 10' 22.3", 007^0 36' 14.8" elevation 701m and coordinate 11^0 10' 27.4", 007^0 36' 13.6" elevation 699m.

Using Walter 1977 dry season 212 days, the water lost to evaporation is 47,700,000 gallons (47,700m^3) US gallon 2.63 or 2112 acre ins" convert into metric system of measurement corresponds to depth of evaporation 216,796.5m^2 242,820m^2= 0.893m per 212 days' hydrological dry season (Meteorologist 2008, Meteorological data IAR 1995-2005).

CALCULATION OF WATER RESOURCES OF ABUTH

ABUTH at present state/activities: The ABUHs are spread out between Kaduna, Zaria in Kaduna State and Malumfashi in Katsina State, a distance of about 120km radius around Zaria. The administrative Headquarters located on the main campus

of ABU in Samaru Zaria (ABUTH Diary 2002). Its permanent site is near Shika along Sokoto road. Work on the site started April 1978. The permanent site was constructed by New Nigeria Construction Company (NNCC) and all the mechanical plumbing work of the Hospital was done by Hademec Ltd. The hospital permanent site has 547 beds and a capacity of 1220 beds spread as follows: ABUTH, Zaria 513 beds, ABUTH, Kaduna 577 beds and ABUTH Malumfashi 130 beds. It was commissioned for IN patient clinical services by Former President **Olusegun Obasanjo** on the 11th November 2005 (ABUTH News Bulletin 2007). General OUT patient services and 24 hours Accidents and Emergency services (ABUTH Diary 2002). Day to day management of the Hospital complex is rested with The Chief Medical Director who is the Chief Executive. The Chairman, Medical Advisory Committee (MAC) and Head of the Directorate of Clinical Services, Training and Research and the Director of the Administration (AD) head the directorate of the Administration and services departments who also serves as secretary to the Board of management and as well Head of the Administration Department.

Population and water demand/ consumption in ABUTH, Shika: Let assume that all the Staff of ABUTH lives within the Hospital premises and its staffing pattern by cadre. The total number of ABUTH Shika Staff is 2,605. Baba (2007) calculated the unit water consumption/demand of students in the medical student hostel as 100 litres per day per person (100 lpcd) Table 1. Since the experiments were made under continuous water supply, water demand is close or same as water consumption. It determined that women use more water than men. The average water a man uses per capital daily from the experiment is 95litres while the average for women is 100litres.

The water demand/consumption of the medical student hostel in Shika: The Medical Student Hostel Asma'u and Aliyu Mustapha in Shika within the ABUTH premises have five boreholes, three within the male hostel and two in the female hostel. Only two of the five boreholes are functioning producing 3,500litres of water per hour during the raining season and about 1,000litre of water per hour during the dry season. The other three boreholes have never functioned since they were drilled due to poor borehole development. In the female hostel only, borehole number 3 (11^0 10' 15.2" and 7^0 36' 06.8" elevation 703) is functioning and in the male hostel only borehole number 2 (11^0 10' 17.8" and 7^0 36' 07.9" elevation 604) is functioning. The number of student officially in the medical student hostel in Shika is 936, number of staff 15 and the number of student by head count and number of bed space is 797. Official number of bed space plus head count and total number of hostel staff is 1,748.

If the number of student officially is 936 and head count of the same student is 797. By physical counting OUT patient bed is 449 which correspond to the official number. The total number of usable bed is 3,285 and 3,160 instead of 13,470. The

management says they keep low number of both IN and OUT patient to be able to maintain clean environment as water scarcity is there major problem. Most importantly the Hospital does not even know their water demand /consumption as they do not have record of their water usage. Therefore, to know the Hospital water demand/consumption the population of the Hospital has to be known and its unit water demand also for effective water account of the Hospital. All the Hospital water (both surface and ground) have to be accounted for. Baba (2007) calculated unit water demand /consumption as 100litres per day per person (0.1/m^3/d/capital). The population of the Hospital is 2605 for staff, average population of OUT patient is 11,874, average population of the IN patient is 9,653. Now let assume each patient have at least 10 visitors in a day this will bring the total population of the Hospital to 217,875 while the unit water demand/consumption is 100Lpcd (Baba, 2007). The Hospital water consumption is therefore 217,875 X 100 = 21,787,500Lpcd (21787.5 m^3/d/capital)

WHO (2005) and Dublin (1992) water requirement standard as indicate that all people have safe access to a sufficient quantity of water for drinking, cooking, personal and domestic hygiene people, with public water points sufficiently close to shelters to allow use of the minimum water requirement collect at least 15 lpcd at each water collection point. At least 0.125litres is collected per second and there is at least one water collection point per 250 people. The maximum distance from any shelter to the nearest water point is 500 meters (World Bank 1993, United Nation 1992, and WHO 2005). WHO (2005) and WHO Regional Office for South – East Asia (2005) guidelines for individuals is as stated below:

- Minimum survival allocation: 7Lpcd (Sustainable for only a few days)
  - Drinking: 3 –p 4Lpcd.
  - Food preparation, clean-up: 2 – 3Lpcd
- Minimum term allocation: 15 – 20Lpcd (Sustainable for a few months)
  - Drinking: 3 -4Lpcd
  - Food preparation, clean-up: 2- 3Lpcd
  - Personal hygiene: 6- 7Lpcd
  - Laundry: 4 – 6Lpcd
- Other needs
  - Health Centres: 5litres per out – patient; 40 – 60litres per in – patient.
  - Hospital (with laundry facilities): 220 – 300litres per bed
  - Schools: 2litres per student: (10 – 15litres per student if water – flushed toilets)
  - Feeding centres: 20 – 30litres per person
  - Camp Administration: (staff accommodation not included) 5Lpcd
  - Staff accommodation: 30Lpcd
  - Mosques: 5litres per visitors
  - Sanitation (hand – washing, cleaning latrines etc.): depends on technology.
- Livestock and Agriculture
  - Cattle, Horses, Mules: 20 – 20litres per head
  - Goats, Sheep, pigs: 10 – 20litres per head
  - Chickens: 10 – 20litres per 100
  - Vegetable gardens: 3 – 6litres per square metre

Actual values depend on many variables (such as culture practices and climates) that should be assessed by specialists.

Using WHO (2005) water requirement standard indicates that per day for an IN patient is 60litres + 10 Muslim visitors (50litres) + water used by the relations of the patient (person taking care/looking after the patient) is 7Lpcd + laundry made by the patient relation 6Lpcd + the relation personal hygiene 7Lpcd is = 130Lpcd.

Table 1: Summary of the unit water demand in Ahmadu Bello University Teaching Hospital, Shika

Water consumers		Quantity (lpcd)	Number	Volume (m^3/d)
Resident	Per IN – patient	100	543 beds	54.3
	Per student in the hostel	100	936 students	93.6
	Per resident of the local residential flats	100	154 occupants with defendants	15.4
				163.3
Day – time	Medical doctors not leaving in the hospital premises			
	Administrative staff and other staff not leaving in the hospital premises	10	2441 out staff	12.2
	Student not leaving in the hospital premises	10	200 students	2
	Persons visiting IN – patient	10	7 visitors per day per bed (3801 visitors daily)	38.01
	OUT – patient	10	206 OUT – patients	2.06
				54.27
Mortuary		100	30 corpses	3
Fire fighting		0		0
Swimming pool		150		0.15
Water for laboratories		100	6 laboratories	0.1
Total water demand of the hospital				438.39
Unit water per day per bed				**0.877**

The Hospital water requirement per day for an OUT – patient is 5litre + 4 Muslim visitors 20litres + water used by the OUT – patient relation 7Lpcd is equal 30litres. The Hospital water requirement per day for Staff who lives outside the Hospital premises is 4Lpcd for drinking + personal hygiene 7Lpcd is equal 11Lpcd.

The Hospital feeding centre, water requirement per person is 30litres. The Hospital water requirement per day for Staff who lives in Hospital premises is 4Lpcd for drinking + 3Lpcd for food preparation and clean-up + 7Lpcd for personal hygiene + 6Lpcd for laundry + 25litre per 5 Muslim visitors are equal 45Lpcd.

The Hospital water requirement per day for staff dependent is 4Lpcd for drinking + 3Lpcd for food preparation and clean-up + 7Lpcd for personal hygiene + 6Lpcd for laundry +15litre per 3Muslim visitors is equal 35Lpcd.

Let assume water requirement per corpse in the Hospital is 25Litre and 100Litre per person per Research because water requirement for research in the Hospital laboratories is not known. Therefore, the average water requirement for the Hospital per IN patient 130Lpcd + OUT patient 32Lpcd + Staff living outside the Hospital 11Lpcd + per person in the Hospital feeding centre 30Lpcd + staff living within the Hospital 45Lpcd + Staff dependent living within the Hospital 35Lpcd + per corpse 25litres + 100Litres per person + research 25Lpcd is equal 433/9 = 48.1Lpcd

The amount of water needed by a person is the person water demand while the amount of water a person used is the person water consumption. It is very possible that water demand of a person can be different to his/her water consumption but Baba (2007) water demand and consumption were measured under constant water flow which made water consumption and the demand equal. Therefore, water consumption /demand multiply by the population give the Hospital water requirement. Water demand/consumption of the Hospital is 48.1Lpcd and population 217,875.

The Hospital water requirement is 48.1Lpcd x 217,875 = 10,479,787.5Lpcd or 10,479m^3/d/capital. The maximum distance from any Shelter to the nearest water point is 500 metres.

Using the World Health Organization (WHO 2005) standard for water requirement of a student the total water demand/consumption of the medical student in the hostel is 2litres but 15 litres per student with water flushed toilets which is what most of us use.

It is assumed that all variable such as climatic change and cultural practices are met because the water requirement standard is same for African (WHO 2005a and b, United Nation 2006).

Water requirement for a student with at least four (4) Muslim visitors in a day, who cooks, does her/his laundry and has exceptional personal hygiene is (5x4 =20 litres) + (15 + 30 = 45 litre) + (15 +6 = 21 litres) + (15 + 7 = 22 litres) = 108 litre. For a student who have at least four (4) Muslim visitors in a day, does not cook, does her/his laundry is (5x4 = 20 litre) + (15 + 30 = 45 litres) + (15 + 6 = 21litres) = 86 litres. For a student, who have at least three (3) Muslim visitors, does not cook, does her/his laundry is (5 x 3 = 15 litres) + (15 + 3 = 18 litre) + (15 + 7 = 22 litre) = 55 litres.

For a student who have no Muslim visitor, eat out, does not do he/his laundry is + (15

+ 3 = 18 litres) = 18 litres. For a student who have at no Muslim visitor but cooks is (5 x 5 = 25 litres) + (15 + 30 = 45 litres = 45 litres. The average water requirement of a student is 108 + 86 + 55 + 18 + 45 = 312/5 = 62.4 litres. The water demand/ consumption of a student is population multiply by water requirement = 1,748 x 62,4 litres = 109075.2 litres (109.08 m^3 /d/ capital).

Baba (2007) water demand / consumption is 100 litres (0.1 m^3 /d/ capital) therefore for 1,748 students will be 1,748 x 0.1 m^3 = 174.8 m^3 which is 174,800 litre/day/capital.

The borehole yields 1,000litre per hour in dry season which means the borehole both in wet and dry season yields 84,000litre/day and 24,000litre/day respectively. Two boreholes out of 5 boreholes are functioning. All the boreholes in the student hostel and the hospital premises are tapping the same aquifer.

Availability of groundwater

Static Groundwater Resources in the ABU Teaching Hospital

The ABU Teaching Hospital, its area 5,477,595 m^2, is located in part on metasediments and in part on the metamorphic rocks (Baba, 2007). The part which is located on metasediments measures 803,153 m^2 while the part located on metamorphic equals to 4,674,442 m^2 Thickness of the soft overburden on the metasediments is on average 2 metres while on the metamorphic rocks on average 25 metres. Depth to groundwater table at the peak of dry season is 2 metres below ground level (bgl) and 5 m bgl for metasediments and metamorphic respectively. The Static Groundwater Resources in the Soft Overburden Aquifer, the part located on metasediments is: area (803,153m^2) x average effective porosity (0.028) x average saturated thickness of the aquifer (- 3m) = zero metres, sGWRt = 803,153 m^2 x 0.028 x 0 m = 0 m^3

Negative value (-3) means the Soft Overburden does not contain water and the water in the Fractured Crystalline is below its average saturation of 15 meter. Therefore, the Soft Overburden is zero and the water saturated thickness of the Fractured Crystalline is 12 metres.

The Static groundwater resources in the part of the Soft Overburden Aquifer located on the metamorphic rocks is: area (4,674,442m^2) x average effective porosity (0.028) x average water saturated thickness (20 m) = 2,617,680 m^3. sGWRt = 4,674,442 m^2 x 0.028 x 20 m = 2,617,680 m^3. Static groundwater resources in the Soft Overburden Aquifer of the ABU Teaching hospital, both on metasediments and on metamorphic are sGWRt = 0 m^3 + 2,617,680 m^3 = 2,617,680 m^3

The static groundwater resources in the part of the Fractured Crystalline Aquifer which is located on metasediments is: area (803,153m^2) x average effective porosity (0.00145) x average saturated thickness (12 m) = 13,980 m^3. sGWRt = 803,153 m^2 x 0.00145 x 12 m = 13,980 m^3

The static groundwater resources in this part of the Fractured Crystalline Aquifer which is located on metamorphic rocks is = area (4,674,442 m^2) x average effective

porosity (0.00145) x average saturated thickness (20 m) = 135,560 m^3.

The Static Groundwater Resources of the ABU Teaching Hospital, in the Soft Overburden Aquifer and in the Fractured Crystalline Aquifer is: Soft Overburden Aquifer on metasediments and on metamorphic (0 m^3 + 2,617,680 m^3 = 2,617,680 m^3), plus Fractured Crystalline Groundwater on metasediments and on metamorphic (13,980 m^3 + 135,560 m^3 = 149,540 m^3) = both aquifers (2,617,680 m^3 + 149,540 m^3 = 2,767,220 m^3)

CONCLUSION

Estimation of groundwater resources requires data on aquifer water level fluctuation and changes in water elevation with time. This work provides basis of understanding groundwater potential of the study area. The moderate resistivity values obtain shows the water bearing zones ranges from one point to the other. The water potential of the area is good though, the volume varies from point to point depending on the conductivity, thickness, and aquifer characteristics.

Water demand of the medical students is 93.6 m^3, Shika Hospital is 154 m^3/d/ respectively. The total water demand of the study area is 438.39(m^3/d). The water demand /requirement using WHO (2005) standard is 77,000 lpcd (77m^3/d). The unit water demand per bed per day of Shika hospital is 0.877 m^3/d while the coefficient of surface runoff of the study area is 0.18, base flow (infiltration) 0.1, and total runoff 0.28. The annual volume of surface runoff for ABU Teaching Hospital Shika is 1,039,209 m^3/a. Total surface water resources of the study area are 1,918,636 m^3/a. Shika, hospital is located on Metamorphic (Gneiss) with maximum thickness of water bearing soft rock of 30 m. The two interconnected aquifers, the Soft Overburden and the Fractured Crystalline Aquifers stores good quantity of water. Solution to water problem in the study area is to rely on surface water via overhead tanks and the use of groundwater for emergency situation. Utilizable Dynamic Groundwater Resources in the hospital are sufficient to meet water demand from the hospital but it should rely on surface water and its groundwater use as supplementary. The water network distribution map should be documented and handy with no direct connection to the water user/consumer expect through the use of an overhead water storage tank

References

Ahmadu Bello University (2004): *Report on the Present Situation and Perspectives of the Water Supply to ABU Samaru and Kongo Campuses, with Suggestions on the Protection of ABU Water Resources*. Presented to the Vice-Chancellor Professor Abdullahi Mahadi, by Ahmadu Bello University Water Resources and Supply Committee.

Ahmadu Bello University Zaria (2008): ABU committee on protection of the Kubanni Dam Drainage Basin: Report on results of Measurement of the Remaining Storage in Kubanni Impounding Reservoir and Proposal for Upgrading the Environment in Kubanni Drainage basin.

Ahmadu Bello University Teaching Hospital Diary (2002): Unpublished ABUTH Diary.

Ahmadu Bello University Teaching Hospital (2007): News Bulletin Focus on ABUTH Zaria Unpublished report.

Baba, A. (2007): *Surface and Groundwater Availability in Ahmadu Bello University Main Campus Samaru, Zaria*. Unpublished Master's thesis submitted to the Department of Geology Ahmadu Bello University.

Dublin National Conference on Water and Environment (1992): Chapter 18 of the 1992 UN Conference of Environment and Development in Rio de Janeiro.

Federal Ministry of Health (2002): focus on teaching Hospitals in Nigeria Unpublished report.

Meteorological Data IAR (1995-2005): Samaru Meteorological Observation Station, |Department of Soil Science, ABU Zaria.

Meteorologist-Raingauge Officer IAR 5-6 May 2008 and 12-13 May 2008.

Schoeneich, K. (2003): *Water Resources Management in Nigeria*. Paper presented at Abuja Geocongress 2003, Abuja, Nigeria.

Schoeneich, K. (2004): *Water Budget for Basin Development Authorities.* Paper presented at NMGS 40th Annual International Conference, in Maiduguri

UNEDP (1991): The state of the world environment May Nairobi Kenya.

UNEDP (1992): The Urban Environment in Developing countries, Environment and natural Resources Group and Urban Development Programmer, U.N N. Y

UNEP (1989): Environment effect panel report protocol (Nairobi, UNEP).

UNESCO and Green Cross International (2003): From potential conflict to co-operational potential: water for peace Japan.

UNESCO (2007): Groundwater Resources Sustainability Indicators. IAP – VI series on Groundwater No. 14.

United Nations (1992): Sustainable Development Agenda 21. United Nations Conference on Environment and Development, Rio de Jenerio, Brazil, 3rd -14th June. PP 1- 351.

United Nations (2003): Water for life, World Assessment Programme.

United Nations (2006): Water, a shared responsibility. The United Nations World Bank Development Reports 2.

Walter, M. W. (1977): The Length of the Rainy Season in Nigeria. Agricultural Meteorology, v. 18.

World Bank (1993): Water Resources Management. A World Bank policy paper Washington D.C. Pp 1-141.

World Population and fresh water use 1940 – 2000 online

World Health Organization (2005a): Technical note No. 9 Minimum water quality needed for domestic use in emergencies draft revised 07.01.05.

World Health Organization Regional office for south –earth Asia (2005b): Minimum water quality needed for domestic use. Technical Note No. 9.

World Water Day (2005): *Annan's Message*. The Guardian, Sunday, March 27, 2005, page 10.