Western Delta University Journal of Natural and Applied Sciences (WDUJNAS).
Vol. 1 (1) September 2021

DAILY WATER CONSUMPTION IN DELTA STATE AS FACTOR FOR GROUNDWATER RESOURCE MANAGEMENT

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Abstract

There is increasing water demand in Delta State as a result of increasing population and improvement in living standard. Over 95% of inhabitants' water use comes from groundwater; therefore, increase in water demand will amount to increase in withdrawal from groundwater basin. Hence, this research was carried out to estimate the volume of water consumed per person per day in Delta State, as basis for groundwater resources management. Questionnaires were developed and distributed to households in the state to elicit information on the volume of water consumed per day. 1000 questionnaires were distributed across 25 local government areas of Delta State, and of these, 930 questionnaires were retrieved. Retrieved questionnaires were analyzed using descriptive statistics. Results indicate that volume of water consumed per person per day in Delta State is 79.45litres. Therefore, as population and water demand increases in Delta State, time may come when withdrawal from groundwater basin will exceed safe yield resulting in overdraft. Hence, it is recommended that; rate of abstraction from the aquifers be minimized through efficient use of water resources in the state and areas designated as recharge zones should be protected from construction of permanent structures like roads and housing.

Keywords: Groundwater, Withdrawal, Overdraft, Groundwater Management.

INTRODUCTION

The inhabitants of Delta State that depends on groundwater for their daily water use is well over 95% (Ejovi, 2012). This is attributed to the fact that other sources of water in Delta State such as; rainfall and river are polluted and such cannot meet their water consumption needs. National Population Commission (2017), stated that population in Delta State is increasing at 4% annually. Similarly, there is a projected 283% increase in urban water demand in Sub-Saharan Africa by 2050 due to improve standard of living and industrialization (World Bank, 2012). Hence, demand for groundwater resources in Delta State will continue to increase as the years go by. Therefore, managing the groundwater resource so as to make it sustainable is vital to the wellbeing of the inhabitants of Delta State. Allowing the groundwater resource to be exploited without managing it may spell doom, since overexploitation will lead to overdraft with the attended environmental, economic and social consequences in terms of adverse impacts on water quantity, quality, land subsidence, and surface water depletions as presently happening in other parts of the world (Alley; Reilly; and Franke, 1999).

Quantifying the volume of water consumed per person per day in Delta State will form a veritable ground for call for groundwater resources management. Though it could be argued that water is a renewable substance, it is only so when carefully controlled usage, treatment, and release are followed (United States Geological Survey, USGS, 2014). When increase in population and water demands leads to increasing water withdrawal from the groundwater basin, at a rate faster than its replenishment, water then become non-renewable. Like timber, our activities can impact the availability of water and its quality despite the water cycle and water's natural ability to renew itself. The timber though a renewable substance, if felling these trees do not respect the time limit for the plant re-growth, then timber ceases to be renewable, this in practical sense means, if we fell these trees faster than it can naturally replenish itself there will not be enough trees to fell as timber and the location will suffer the environmental, economic and social consequences (Greentumble, 2017).

Therefore, this research is targeted at estimating the volume of water consumed per person per day in Delta State as basis for groundwater resource management. In carrying out this research; questionnaires were developed and distributed to inhabitants of the state, across the twenty-five (25) local government areas. Data were analyzed using descriptive statistics to arrive at estimated volume of water consumed per person per day in the state.

STUDY AREA/METHODOLOGY

Delta State is oil and agricultural producing state of Nigeria, situated in the region known as the South-South geo-political zone (figure, 1). According to figure 1, the state comprises of 25 local government areas. Delta State has a population of 2,570,181 in 1991 and 4,098,391 in 2006 censuses respectively, representing four (4) percent increase annually and a projected population of 5,663,360 persons in 2016 (Nigerian Population Commission, 2017). The study area lies approximately between Longitude $5^{0}00$ and $6^{0}.45'$ East and Latitude $5^{0}.00'$ and $6^{0}.30'$ North (figure 1). It is bounded in the north by Edo State, the east by Anambra, Imo, and Rivers States, and west southeast by Bayelsa State, and on the southern flank is the Bright of Benin which covers about 160 kilometers of the state's coastline (Delta State Government, 2017).

Delta State is located in the tropical rainforest region of Nigeria and there are rainfalls almost all year round. The major source of water is the groundwater which they access through boreholes and hand-dug well. Besides boreholes, other sources of water include; rainwater and river water. The water use in the state is mainly for domestic purposes.

Delta State is major oil producing state. Refinery as well as petrochemical plant and a host of foreign multi-national oil exploration and servicing companies and some of Nigerian counterparts are located in the state at Warri (NigeriaGalleria, 2015). These provide employment to inhabitants of the state. There are also large portion of the population that is civil servants and artisans. Agricultural activities are predominant in the rural area with farmers majorly into fishery and food crop production.

Furthermore, residences in the state were randomly selected for interviews and observations were made across the state. Questionnaires were also developed and distributed to households in the study area to acquire information on the volume of water they consumed per day per household. One thousand (1000) copies of questionnaires were produced and distributed to households in Delta State. Forty (40) questionnaires were randomly distributed to households in urban and semi urban settlements of each local government area of the state. Additionally, questionnaires were allowed to remain with the householder/respondent(s) for a period of one month before it is retrieved by the researcher. The one-month period was given to allow for in-depth study and observation of water consumption pattern of the household before responding to questions in the questionnaire. Nine hundred and thirty (930) questionnaires were retrieved. The number declined because some respondents misplace questionnaires given to them. Returned questionnaires were analyzed and results recorded (Table, 1).

SUPPLY AND USES OF WATER RESOURCES

Only a tiny fraction of the planet's abundant water is available to us as fresh water. Over 97 percent by volume is found in the oceans and is too salty for drinking, irrigation, or industry, except as coolant (Miller, 2003). However, most of the less than 3 percent that is fresh water is locked up in ice caps or glaciers, in groundwater too deep to be access. Thus, only about 0.014 percent of the earth's total volume of water is easily available to us as soil moisture, usable groundwater, water vapour, and lakes and streams. This means that if the world's water supply were only 100 liters, our usable supply of fresh water would be only 0.014 liter (Christopherson, 2006).

Fortunately, the available fresh water amounts to a generous supply. Moreover, this water is continually collected, purified, recycled, and distributed in the solar-powered hydrologic cycle.

Water use varies considerably around the world, depending on its availability and the degree of industrialization of the area. However, use can be classified into four broad categories: (1) domestic use, (2) agricultural use, (3) industrial use, and (4) in-stream use. It is important to remember that some uses of water are consumptive, while others are non-consumptive.

GROUNDWATER RESOURCE MANAGEMENT

Groundwater basin management according to Todd and Mays (2005), is the protection of natural recharge and use of intentional recharge; planned variation in amount and location of extraction over time, use of groundwater storage conjunctively with surface water from local and imported sources, and protection and planned maintenance of groundwater quality. Therefore, if the basin is managed to achieve these goals as defined above, groundwater overdraft will be reduced and water supplies of good quality will be sustain (Termium-Plus, 2015). Consequently, the key concern of managing groundwater resource is to maintain a sustainable long-term yield from aquifers (Alley; Reilly and Franke, 1999).

Going further, Galloway; Alley; Barlow; Reilley, and Tucci, (2003), stated that groundwater management practices include the engineering, economic, and political factors that affect the locations, rates, and timing of imposed hydrologic stresses to the groundwater system such as groundwater withdrawals, artificial recharge, and so forth. Eventually, legal and political forces may prompt renewed scientific investigation of the groundwater system for the purpose of improved management of the resource.

Alternative groundwater management strategies according to Galloway et al (2003), include the following general approaches:

1. Use of sources of water other than local groundwater by shifting the local source of water,

either completely or in part, from groundwater to surface water, or by importing water from outside river-basin or groundwater system boundaries.

2. Changing rates or spatial patterns of groundwater pumpage to minimize existing or potential unwanted effects.
3. Control or regulation of groundwater pumping, through implementation of guidelines, policies, taxations, or regulations by water-management authorities. These imposed actions may include restrictions on some types of water use, limits on pumpage volumes, and establishment of critical aquifer hydraulic heads or gradients of hydraulic heads that may vary in time and space.
4. Artificial recharge through the deliberate introduction of local or imported surface water, whether potable, reclaimed, or waste-stream discharge, into the subsurface for purposes of augmenting or restoring the quantity of water stored in developed aquifers. Options include; (1) enhanced natural recharge – improving the infiltration and recharge of naturally available, local sources of fresh water (such as precipitation, stream, lakes), commonly by induced recharge from surface waterways; (2) induced infiltration from engineered impoundments (basin spreading) – diversion and putting water in pond at the land surface in reservoirs constructed in geologic deposits where subsurface infiltration rates are adequate and in locations conducive to replenishing the developed aquifers; and (3) direct-well injection – delivery and introduction of water by gravity drainage or positive-pressure injection in wells.
5. Conjunctive use of groundwater and surface water through the coordinated and integrated use of the two sources of water to optimize use of the resource and to prevent or minimize adverse effects of using a single source.
6. Conservation practices, techniques, and technologies that improve the efficiency of water use to ensure optimum long-term economic and social benefits.
7. Reuse of wastewater and treated wastewater for non-potable purposes such as irrigation of crops, lawns, and golf courses.
8. Managed short-term (time scale of months and years) increases and decreases in subsurface storage in the groundwater reservoir or unsaturated zone to accommodate annual and multiyear climate-induced shortages and excesses of surface-water runoff and storage. During periods of excess surface water runoff and when surface water impoundments are at or near capacity, surplus surface water can be stored in aquifer systems through artificial recharge. Conversely, during droughts, increased groundwater pumping can be used to offset

shortfalls in surface water supplies.

FINDINGS

Data collected through questionnaires was analyzed using equation 1, and results recorded in table 1. Volume of water consumed per household per day *(w)* is estimated using equation 1:

$$W = \sum_{n=1}^{930} \left(\frac{Size\ of\ Tank}{Householder(s) + Other\ Users)\ X\ No.\ of\ Days\ Water\ Last\ in\ Watertank} \quad --(1) \right)$$

Table 1: Average volume of water consumed per person per household per day (*w*) (Litres) for 930 households

100	56	87	63	25	150	100	64	36	42	71	20	63	32	188	156
22	83	44	111	69	86	174	222	71	60	48	125	36	46	83	111
56	182	160	61	71	69	83	61	32	29	20	64	100	71	89	42
56	56	71	167	200	188	214	63	63	50	42	100	83	94	133	50
56	83	22	133	86	95	95	28	300	39	34	27	200	71	89	42
100	63	87	56	100	156	188	21	32	36	150	25	42	102	56	67
23	22	83	41	69	125	167	27	71	60	60	50	63	25	150	67
43	71	64	71	56	56	63	83	100	42	87	46	83	56	56	48
156	83	56	23	136	42	63	18	65	67	21	56	36	200	71	42
100	167	50	20	87	42	100	83	63	43	86	150	125	67	48	50
50	23	100	44	57	48	67	48	44	100	139	150	119	18	36	41
222	74	39	125	174	60	22	90	48	56	56	43	63	83	100	42

Depleted aquifer systems can be viewed as potential subsurface reservoirs for storing surplus imported or local surface water.

9. Use of brackish water through desalination to reduce dependency on fresh groundwater resources.

87	20	50	167	100	42	71	200	83	67	46	250	71	27	29	32
160	43	18	83	37	125	182	70	71	188	42	83	100	64	156	100
21	89	31	50	36	56	63	111	46	250	86	22	90	67	27	63
71	44	48	84	222	74	167	200	100	42	43	63	56	25	56	87
20	71	188	42	83	100	86	20	67	125	48	89	75	36	150	67
18	43	48	23	56	63	156	42	43	63	56	56	87	20	71	188
42	83	100	64	25	83	69	71	174	71	36	179	90	67	119	27
125	27	67	125	111	48	150	23	86	48	43	100	54	30	50	83
67	36	50	222	179	111	60	41	44	60	67	125	46	71	48	101
174	71	36	56	87	150	63	32	64	50	43	36	20	71	42	63
42	100	150	71	182	139	67	52	70	83	39	56	37	61	18	32
42	43	67	56	188	25	89	42	100	71	56	83	156	200	20	71
42	86	22	222	179	111	60	90	67	125	83	41	44	63	69	27
101	100	71	56	188	25	150	63	63	167	100	21	67	56	43	36
71	61	29	56	37	61	18	182	139	67	23	83	48	83	63	32
63	63	167	100	21	100	56	87	50	67	56	43	36	71	83	36
67	18	150	125	75	57	33	43	56	50	43	56	80	20	42	50
100	42	50	63	200	167	71	67	83	43	89	71	21	56	56	156
42	56	67	23	74	119	41	67	125	167	27	71	91	60	102	250
179	99	156	83	56	23	136	42	63	18	65	67	48	56	56	67
20	71	43	188	21	32	36	150	25	63	87	56	100	156	250	208
200	38	44	83	114	50	93	143	300	83	77	67	74	75	64	71
43	67	20	63	50	42	100	83	63	56	56	71	167	156	125	188
36	71	74	44	119	111	67	86	174	222	71	91	48	63	20	167

				9	1			4	2						7
100	42	89	71	200	36	32	21	188	156	100	56	250	179	99	20
29	111	214	56	182	160	61	71	69	83	61	32	56	56	71	64
71	67	150	25	63	63	56	100	156	188	89	29	54	75	80	36
87	18	50	167	89	36	48	150	33	30	21	125	83	71	44	63
67	86	67	83	69	167	27	71	71	60	36	32	21	89	188	156
100	56	63	63	25	150	67	71	64	71	136	63	65	56	42	71
48	61	23	56	56	52	101	179	61	167	63	67	71	150	71	200
100	42	43	63	56	25	56	87	20	83	69	71	174	71	60	41
60	36	119	27	99	179	67	125	64	156	100	21	89	32	50	36
56	63	167	63	67	71	150	71	43	36	80	150	48	100	57	44
50	83	50	48	33	46	32	200	100	21	89	32	36	56	63	167
63	67	71	150	71	50	100	46	250	86	22	63	71	222	60	42
44	48	101	60	74	167	114	48	46	29	33	48	75	125	150	44
18	67	80	20	44	57	71	167	90	67	119	27	250	74	83	69
27	125	86	22	63	71	56	83	156	200	56	188	25	87	63	167
100	21	67	71	100	61	29	56	136	83	48	83	63	65	18	99
160	56	71	23	63	32	64	50	43	36	71	100	56	87	150	63
63	167	100	21	174	71	71	167	27	250	60	74	83	46	119	67
36	71	48	71	100	56	87	50	83	156	83	20	71	42	63	32
64	89	42	42	71	65	18	99	160	56	56	136	23	150	52	70
83	39	156	200	20	71	42	50	71	48	188	23	32	48	89	36
89	100	54	50	200	67	150	100	42	89	64	32	25	188	56	71
63	100														

Imputing the questionnaires data analyzed by equation 1 and recorded in table 1, into equation 2, volume of water consume per person per day in Delta State($\overline{C}$), can be estimated:

$$\overline{C} = \frac{\sum_{i=1}^{n} V}{n} = \frac{w1 + w2 + w3 + \cdots + wn}{n} \text{ ------- (2)}$$

Where: $\overline{C}$= Estimated volume of water consumed per person per day
V = Total volume of water consumed per person per household per day
n = Number of household
w= Volume of water consumed per household per day
V = 73890litres and
n = 930.

Therefore, $\overline{C} = \frac{73890}{930}$
= 79.452 litres
= 80 litres (approximately).

Estimated volume of water consumed per person per day ($\overline{C}$) in Delta State is 80litres approximately.

DISCUSSIONS

Data derived from the questionnaires are analyzed using equation 1 to give estimated volume of water consumed per person per household (V), and result recorded in table 1. Values recorded in table 1 was thereafter computed using equation 2 to arrive at estimated volume of water consumed per person per day ($\overline{C}$). Consequently, volume of water consumed per person per day in the study area ($\overline{C}$) is 79.45 litres or 80 litres approximately. However, this is higher than the average volume of water consumed per person per day in Nigeria (36litres) (Data360, 2014). The reason being that, the study area is a watered environment and because there is high proximity to source of water supply and the relatively low cost of accessing groundwater owing to the high water table, people have access to water which allow for increased usage. This agrees with Obeta and Chukwu (2013), who stated among others that the demand for water in Nigeria is influenced by the amount the consumers are called upon to pay and the distance and relative accessibility to the source of water supply. Furthermore, data retrieved from questionnaires, interviews and personal observation also shows that inhabitants of the study area rely on groundwater for their water use.

CONCLUSION

Over 95% of inhabitants of Delta state depends on the groundwater resources for their daily water use. To access groundwater, they drill boreholes wherever there is space and need for water resource. However, with population currently growing at four (4) percent annually and water demand projected to increase by 283 percent by 2050 (National Population Commission, 2017; World Bank, 2012). There will be increase in groundwater consumption and by extension withdrawal. This could make groundwater withdrawal exceed safe yield in the near future.

Consequently, groundwater resource management policy that is tailored toward the peculiarities of study area's environmental, economic and social realities must be put in place to avoid overdraft and/or early identification of overdraft, for it to be effectively manage.

Thus, for successful groundwater resource management, it is recommended that;

- Rate of abstraction from the aquifers be minimized, through efficient use of water resources.
- Areas designated as recharge zones should be protected from construction of permanent structures like roads and housing.
- Reliable databases and regular monitoring programmes be put in place to appraise changes in both quality and quantity of the groundwater resource.
- Finally, constant enlightenment on issues related to water and environment should be done.

REFERENCES

Alley, W.M.; Reilly, T.E. and Franke, O.L. (1999). Sustainability of Groundwater Resources. *U.S. Geological Survey Circular* **1186**, Denver, CO.

Christopherson, R.W. (2006), *Geosystems: An Introduction to Physical Geography*, (6th Edition). New Jersey, U.S.A: Pearson Education, Inc.

Data360 (2014). Average Water Use per Person per Day. Retrieved from: www.data360.org/dsg.aspx? 24th September, 2016.

Delta State Government (2017). Delta State the Big Heart of the Nation. Retrieved from: www.deltastate.gov.ng (15th Dec. 2020).

Ejovi, K. (2012). Groundwater; a Preferred Source of Water in Delta State; (B.Sc Project) Abraka, Department of Geography and Regional Planning, Delta State University (Unpublished)

Galloway, D.L., Alley, W.M., Barlow, P.M., Reilley, T.E., and Tucci, P. (2003). Evolving Issues and Practices in Managing Groundwater Resources: Case Studies on the Rate of Science; *U.S. Geological Survey*, Circular **1247**: pp. 5-9.

Greentumble (2017). Why is Water Considered Renewable Resource, Retrieved from: www.greentumble.com/why-is-water-considered-a-renewable-resource (01/07/2017).

Miller, G.T. (Jr.) (2003), *Living in the Environment*, (9th Edition), Pacific Grove, Brooks/Cole Inc.

National Population Commission (2017), *City Population*, Retrieved from: www.citypopulation.de/php/nigeria-admin.php?adm/id=NG (15th Dec. 2017).

Nigeria Galleria (2015). Delta State of Nigeria: Nigeria Information and Guide. Retrieved from:www.nigeriagalleria.com (29th December, 2016)

Obeta, M.C. and Chukwu, K.E. (2013). Water Supply and Demand in Nigeria. In Anyadike, R.N.C. and Obeta, M.C. *Water Resources Development and Management in Nigeria*. Lagos, Merit International Publications

Termium-Plus, (2015). *Deferred Perennial Yield*. Retrieved from: www.btb.termiumplus.gc.ca/.../alpha.eng (1st January, 2016)

Todd, D.K. and Mays, L.W. (2005), *Groundwater Hydrology*,(Third Edition). India, John Wiley and Sons.

United States Geological Survey, USGS (2014), Methods of Estimating Groundwater Recharge. Retrieved from: *www.water.usgs.gov/ogw/gwrp/methods/index* (1st October, 2015).