Ground Water Recharge Capacity of Port Harcourt Metropolis

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ABSTRACT:

A study was carried on the ground water recharge capacity of Port Harcourt Metropolis with the view to establishing parameters for efficient groundwater management of the area. Samples were randomly collected from six different test wells of the Metropolis during the rainy and dry season i.e. 10.30 pm in the night to 6.30 am in the morning. The result obtained showed that recharge was more during the rainy season than the dry season. The area covering Mile 1 through Diobu extending into Rumuokoro and its environs had the highest recharge level of 2.62 meters in the rainy season and 0.97 meters during the dry season. The area covering Port Harcourt township extending into part of old G.R.A followed with recharge level of 2.52 meters and 2.20 meters for the rainy season and dry season respectively.

The area covering marine base through eastern by pas showed recharge capacity of 1.42 meters and 1.2 meters for rainy and dry season respectively. Other areas i.e. Trans Amadi and Abuloma axis, and artillery recorded 1.02 meters and 0.82 meters, 0.82 meters: and 0.74 meters for rainy season and dry season respectively. In each circumstance, water depth was measured to determine the draw down due exploration and recharge. It was observed that Diobu axis had the highest level of recharge: while the second highest level of recharge was recorded from Borokiri and Port Harcourt township axis. The influence of the Prim Rose creek that flows through this part of the metropolis is responsible for the high recharge, which also goes to for marine base sample points. Trans amadi and artillery recorded low level of recharge because of geographical location especially trans amadi which on the high contour plain of 19'. This encourages run off water into the surrounding environment while the rate of percolation, which eventually gets to the river table is less. Artillery axis has the lowest level of recharge because perched aquifer exist there which of course which disallows ground water from flowing through that axis. The study includes a computer model which will help in monitoring the ground recharge level at different parts of the metropolis during the time frame of 10:30pm – 6:30 am.

Keyword: Ground water, Recharge Capacity, Port Harcourt Metropolis

INTRODUCTION

Water occupies a unique position in the life of man and other living things. It is the ambition of mankind to conserve and protect this valuable gift of nature. Storage of water in lakes, ponds and reservoir for a number of beneficial uses is a standard practice world over (Alade, 1978).

Water scarcity is a major problem in the Port Harcourt metropolis. Trying to find a solution to the problem, has resulted in the excavation of tube-wells and borehole construction in the area.

According to Etu-Efeotor (1981) all aquifers in the Port Harcourt Metropolis fall under Benin Formation which is made of up thick sands and gravels. The sand-shale intercalation in the area suggest a multi-aquifer system.Lithologically the Benin formation (Oligocene Recent) is made up of sands which are mostly medium to coarse grained, moderately sorted with local lenses of fine grained, poorly cemented sandy or silty clay. Base on this formation we can clearly see that the water recharge level in various part of Port Harcourt metropolis will be different and hence the importance of this journal. The journal will disclose various part of Port Harcourt and their water recharge level.

LIRTERATURE REVIEW

A high percentage of 72% of the available water in South America is utilized for agriculture 18% goes to the potable water sector and 10% to industries, Ecuador, Chile and Uruguay have the highest water extraction for agriculture, while Venezuela and Colombia have the lowest (Iptrid, 2003).

Water resources problem in Africa has been intractable by the fact that:

- Water resources are managed on sectional basis and there is little interaction and co-ordination between sectors
- There is lack of good, consistent and stable water policies which has affected both management, sustainability and investment.
- About 20% of the population in the world still lack potable water while more than 30% do not have sanitation services
- There is inadequate investment on maintenance and rehabilitation of water resources management and infrastructure.
- The first and disorganized way in which new land is being incorporated into agriculture is a threat to the already fragile environment (FAO, 2003)

Adequate local food production, on its own relies heavily on availability of water for irrigation, most of which comes from ground water that must be recharged for sustainable development., importation of food stuff involves * virtual water* and the decision to import or produce food must be based on the efficient use of the resource (water) which become, virtual if obtained from the imported food (Jacob, 1999).

Groundwater which is depletable is a precious source of potable water in Port Harcourt Metropolis and so must be conserved through a balanced use –management. The availability of groundwater depends on the level of rainfall, soil type and topography of an area. These factors are brought together as recharge coefficient or capacity for the quantification of available groundwater (Bayless, 1997).

Base on petrographic analysis, Oteri (1991) concluded that the rocks are made up of about 95 – 99% quartz grains, Na^+ k mica, 1 -2.5% feldspar 0.5 – 10% and dark colored minerals 2.3%. This composition allows easy permeability of water to water table or aquifer.

Rainfall is reasonably high in Port Harcourt Metropolis with an annual range of 3500 – 400mm, while run-off is also high and is estimated to reach 90% through humid condition

(Kampsax, 1985)

This will definitely help to increase the ground water level through permeability.

The water sources in the Niger – Delta complex and particularly Port Harcourt and its environs, share numerous dense network of creeks, rivers and streams. These drain the town and provide an abundance of surface water which percolates into the ground to recharge the ground water zone which consist of shallow continental deposit and a coastal zone of marine deposits. The first aquifer is unconfined and generally exists throughout Port Harcourt metropolis. It extends to a depth of 60 – 70 meters below the ground level while the second is up to 150 -200 meters and occupies a small part of the metropolis.

Etu- Efeotor, (1981) went further to elaborate on the northern zone of shallow aquifer of the study area (about 60m) which consist of continental deposits. This zone of aquifer is localized in the upland areas around Elele in Port Harcourt axis.

METHODOLOGY

The study area of this research is the Port Harcourt metropolis which for the purpose of this research was divided into six zones namely Borokiri axis and its environs, Old Port Harcourt township extending into bundu water front and marine base, Old g.r.a extending through government house and its environs, Artillery through Nkporo and Rumuodara, Trans amadi industrial layout extending into abuloma and finally Diobu axis which covers from mile 1 – 6.

Source of Data

A recognizance survey of the study area was undertaken which resulted in the division of Port Harcourt Metropolis into six zones. Thirty (30) test wells were identified in the metropolis during the preliminary study. In the each of the six zones a test well in use was randomly selected for the research, six of the thirty wells were not in use at the time of this research. The selected wells were marked out as sample points 1 – 6. The preliminary study showed that the wells were used from 6.30 am till 10.30 pm every day, for the purpose of accurate data readings were taken at 10.30pm, 12.30am, 2.30am, 4.30am and 6.30am just before the beginning of the daily use of the wells.

Measurement was taken for twelve (12) weeks for both dry and rainy seasons.

Sampling

Depth of the water surface in the test wells were read by attaching a weight to the calibrated fiber tape and dropping it until it touches the water when it becomes lighter to the hand. The point of contact of the weight (Metal bolt) with water was noted when the buoyancy of the weight is felt by the hand as it touches the water.

Data Analysis

Data were collected from six (6) different sample zones at five different periods ranging from 10.30pm in the night to 6.30am in the morning, during the rainy and dry seasons. The recharge divided by the number of hours in between the period sample was collected to represent the rate of recharge.

The recharge capacity was obtained using the formulae:

$$Qr = \frac{h2-h1}{t}$$

Where Qr = Recharge capacity

$h2$ = Initial water level

$h1$ = Final water level

t = time

Sharma, (1986)

The difference between the night and morning readings represent the recharge over the number of hours between 10.30pm when the first reading was taken and 6.30am when the last reading is taken

The readings were taken from the bottom of the well to the water surface at different times (10.30pm – 6.30am) which represent the recharge level.

RESULTS / DISCUSSION

Table 1 Marine Base and its Environs extending into Eastern By-Pass

SEASONS							
DRY				**RAINY**			
Time (Hrs)	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**	**Time (Hrs)**	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**
10:30pm	1.17	0	0	10:30pm	1.33	0	0
12:30am	1.18	0.01	5.0×10^{-3}	12:30am	1.38	0.05	2.5×10^{-2}
2:30am	1.20	0.02	1.0×10^{-2}	2:30am	1.40	0.02	1.0×10^{-2}
4:30am	1.21	0.01	5.0×10^{-3}	4:30am	1.41	0.01	5.0×10^{-3}
6:30am	1.22	0.01	5.0×10^{-3}	6:30am	1.42	0.01	5.0×10^{-3}

Table 2 Port Harcourt Township Extending into Part of Old GRA and its Environs

SEASONS							
DRY				**RAINY**			
Time (Hrs)	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**	**Time (Hrs)**	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**
10:30pm	0.23	0	0	10:30pm	1.16	0	0
12:30am	0.46	0.23	11.5×10^{-1}	12:30am	1.87	0.26	1.30×10^{-1}
2:30am	1.95	1.49	7.45×10^{-1}	2:30am	2.15	0.28	1.40×10^{-1}
4:30am	2.05	0.10	5.0×10^{-2}	4:30am	2.30	0.15	7.50×10^{-2}
6:30am	2.20	0.15	7.5×10^{-2}	6:30am	2.52	0.22	1.10×10^{-1}

Table 3 Borokiri Axis Extended into Bundu Waterfront

SEASONS							
DRY				**RAINY**			
Time (Hrs)	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**	**Time (Hrs)**	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**
10:30pm	1.36	0	0	10:30pm	1.61	0	0
12:30am	1.39	0.03	1.5×10^{-2}	12:30am	1.87	0.26	1.30×10^{-1}
2:30am	1.45	0.09	4.5×10^{-2}	2:30am	1.95	0.08	4.0×10^{-2}
4:30am	1.51	0.06	3.0×10^{-2}	4:30am	2.07	0.12	6.0×10^{-2}
6:30am	1.55	0.04	2.0×10^{-2}	6:30am	2.52	0.45	2.25×10^{-1}

Table 4 Artillery Axis into Rumuodara Extending into Okporo Road

SEASONS							
DRY				**RAINY**			
Time (Hrs)	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**	**Time (Hrs)**	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**
10:30pm	0.46	0	0	10:30pm	0.51	0	0
12:30am	0.54	0.08	4.0×10^{-1}	12:30am	0.62	0.11	5.5×10^{-2}
2:30am	0.62	0.08	4.0×10^{-1}	2:30am	0.72	0.10	5.0×10^{-2}
4:30am	0.70	0.08	4.0×10^{-2}	4:30am	0.80	0.08	4.0×10^{-2}
6:30am	0.74	0.04	2.0×10^{-2}	6:30am	0.82	0.02	1.0×10^{-2}

Table 5 Trans – Amadi Area Extended into Abuloma and its Environs

SEASONS							
DRY				**RAINY**			
Time (Hrs)	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**	**Time (Hrs)**	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**
10:30pm	0.74	0	0	10:30pm	0.82	0	0
12:30am	0.78	0.04	2.0×10^{-2}	12:30am	0.87	0.05	2.5×10^{-2}
2:30am	0.80	0.02	1.0×10^{-2}	2:30am	0.91	0.04	2.0×10^{-2}
4:30am	0.81	0.01	5.0×10^{-3}	4:30am	1.00	0.09	4.5×10^{-2}
6:30am	0.82	0.01	5.0×10^{-3}	6:30am	1.02	0.02	1.0×10^{-2}

Table 6 Mile 1 Diobu Extending into Rumuokoro Axis

SEASONS							
DRY				**RAINY**			
Time (Hrs)	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**	**Time (Hrs)**	**Height of H_2O level (m)**	**Recharge Level (m)**	**Recharge Capacity (m/h)**
10:30pm	0.87	0	0	10:30pm	2.24	0	0
12:30am	0.90	0.03	1.5×10^{-1}	12:30am	2.30	0.06	3.0×10^{-2}
2:30am	0.93	0.03	1.5×10^{-1}	2:30am	2.47	0.17	8.5×10^{-2}
4:30am	0.95	0.02	1.0×10^{-2}	4:30am	2.56	0.09	4.5×10^{-2}
6:30am	0.97	0.02	1.0×10^{-2}	6:30am	2.62	0.14	7.0×10^{-2}

Analysis of result obtained from the field measurements are summarized in table 4.1 – 4.9 and figures 4.1 – 4.6. The following discussion is based on the analysis of results obtained from the research with respect to the various zones that represents Port-Harcourt metropolis.

MARINE BASE EXTENDING TO ABULOMA AND IT'S ENVIRON

This zone covers marine base to Abuloma and its environs. The figure 4.1 shows that the recharge during the rainy season is more compared to that of dry season. During the dry season a recharge of 0.01m at recharge capacity of 5.0 x 10^{-3}m/h was recorded at 12:30am and rose to 0.02m 0.01m with recharge capacity of 1.0 x 10^{-2}m/h and 5 x 10^{-3}m^3/h at 2:30am and 4:30am respectively. The case was different during raining season when recharge of 0.05m (2.5 x 10^{-2}m^3/h) 0.02m (1.0 x 10-2m^3/h) 0.01m (5.0 x 10^{-3}m^3/h) and another 0.01m (5.0 x 10^{-3}m^3/h) were observed of 12:30pm, 2:30am, 4:30am and 6:30am respectively. The average level of recharge during the rainy seasons is as a result of the rivers that flow through this part of the metropolis. Kampsax (1985) in their ground water research showed that this type of zone fails under a perch aquifer which recharges the ground water slowly and temporary, this resulted to the poor recharge in this zone.

It is important to note that the same recharge level and recharge capacity were observed at 4:30am and 6:30am (0.01m and 5.0 x 10^{-3}m^3/h) respectively for both dry and rainy season.

PORT HARCOURT TOWNSHIP EXTENDING INTO OLD GRA AND ITS ENVIRONS

The results here like the previous zone show a higher recharge during the rainy season than the dry season. This zone covers Port-Harcourt Township extending into part of Old GRA and its Environs. The recharge is high for both dry and rainy seasons. The graph shows that from 10:30pm to 12:30am a recharge of 0.23m with recharge capacity of 11.5 x 10^{-2}m^3/h was obtained and subsequently rose to 0.15m with recharge capacity of 7.5 x 10^{-2}m^3/h at 6:30am during the dry season. The graph shows that the highest recharge was attainted between 12:30pm and 2:30am with recharge capacity of 11.5 x 10^{-2}m^3/h, 74.5 x 10^{-2}m^3/h respectively, and least recharge was attained at 4:30am with recharge capacity of 5.0 x 10-2m/h and 6:30am with recharge capacity of 7.5 x 10^{-2}m^3/h. The recharge during the rainy season was higher than what was obtained during the dry season. The highest level of recharge during the rainy season was attained between 12:30am (13.0 x 10^{-2}m^3/h) and 2:30am (14.0 x 10^{-2}m^3/h). The average level of recharge in this zone could be as a result of the presence of sandy loam soil which allows easy percolation of the water into the ground.

BOROKIRI AXIS EXTENDING INTO BUNDU WATER FRONT

The zone is made up of Borokiri and Extends into Bundu waterfront. The graph and table show that the recharge was more during the rainy season than the dry season. A total recharge of 0.91m with recharge capacity of 37.5 x 10^{-4}m^3/h was attained from 10:30pm to 6:30am during the rainy season. The highest recharge capacity of 22.5 x 10^{-2}m^3/h was attained at 6:30am, while the least recharge capacity of 4.0 x 10^{-2}m^3/h at 12:30am. The case was different during the dry season, the level of recharge and recharge capacity of 27.5 x 10^{-3}m^3/h which is different from what was obtained in rainy season. The last level of recharge of 0.03m with recharge capacity of 1.5 x 10^{-2}m^3/h was attained at 12:30am in the morning.

The high level of recharge during the rainy season at this zone is as a result of the porosity of the soil which allows easy permeability of water into the ground and subsequently the water table which ultimately recharge the ground water. It is also important to note that this particular zone from research conducted by NAFCON on ground water show that a rich aquifer exist in this zone. These zones also have the advantage of having prime creek flowing through it.

ARTILLERY AXIS INTO RUMUODARA EXTENDING INTO OKPORO

The zone is made up of Artillery, Rumuodara extending into Nkporo. As usual a higher recharge was observed during the rainy season than the dry season. The recharge capacity is low in this zone compared to the recharge level in zone 3 (Borokiri Through Bundu axis).

Recharge capacity of 4.0 x $10^{-2}m^3/h$, 4.0 x $10^{-2}m^3/h$, 4.0 x $10^{-2}m^3/h$, and 2.0 x $10^{-2}m^3/h$ was attain for 12:30pm, 2:30am, 4:30am and 6:30am respectively during the dry season. The highest level of recharge was obtained from 12:30am to 4:30am (4.0 x $10^{-2}m^3/h$) in the morning while the least recharge of 0.04m (2.0 x $10^{-2}m^3/h$) was attained at 6:30am in the morning.

According to Kampsax (1985) in a groundwater research carried out for National Fertilizer Company of Nigeria found out that this zone is situated on a rich aquifer which helps in recharging the groundwater. The zone is also rich with a sandy loam soil which allows percolation into the soil.

The difference between the recharge during the rainy and dry season is low because of the constant recharge by the aquifer during the dry season. The highest recharge during the rainy season occurred between 10:30pm and 12:30am with recharge and recharge capacity of 0.11m, and 5.5 x $10^{-2}m^3/h$ respectively. Recharge and recharge capacity of 0.10m (5.0 x $10^{-2}m^3/h$), 0.08 (4.0 x $10^{-2}m^3/h$) and 0.02m (1.0 x $10^{-2}m^3/h$) was attained during 2:30am, 4:30am and 6:30am respectively.

TRANS-AMADI AREA EXTENDING ABULOMA AND ITS ENVIRONS

This zone is made up of the entire Trans-Amadi Industrial layout extending into Oginigba and Woji Axis. Like other sample zones the rate of recharge here is more during raining season than the dry season. The table and graph show that the general rate of recharge is not impressive for both seasons.

During the dry season a recharge of 0.04m and 0.02m was observed between 12:30am and 2:30am with a recharge capacity of 2.0 x $10^{-2}m^3/h$ and 1.0 x $10^{-2}m^3/h$ respectively. The least recharge of 80.01m was attained at 4:30am and 6:30am with recharge capacity of 2.5 x 10^{-2}m3/h, 2.0 x $10^{-2}m^3/h$ and 4.5 x $10^{-2}m^3/h$ respectively.

CONCLUSION

The research has shown that recharge is more during the rainy season than the dry season in all the six sample points. The recharge capacity is also higher during the rainy season than the dry season. The reason is because of the percolation of water into the soil and finally the water table during rainfall.

The ground water resources of Port Harcourt metropolis as shown in the work varies from location to location in quantity and flow conditions. It is apparent that zone 3 which is made up Borokiri environs extending into Bundu water front has the highest recharge capacity which also indicate high flow rate in the metropolis. Consequently the location of high water demand industries must first consider this zone for appropriate resource allocation. However there is still need to match the water demand of such an industry to the recharge capacity of the area before the physical establishment.

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