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RESEARCH ARTICLE

Water Cycle Hydro Recharge Evaluation for the Reservoirs of the Lithosphere, Atmosphere, and Hydrosphere in Ozoro, Nigeria

Okolotu, G. I.[1], Nwadiolu, R.[2], Akwenuke, O. M.[3], &, Oluka, S. I.[4]

[*1]Department of Agricultural Engineering, Southern Delta University, P.M.B. 05., Ozoro, Delta State, Nigeria

[2]Department of Agricultural Extension, Southern Delta University, P.M.B. 05, Ozoro, Nigeria

[3]Department of Civil and Water Resources Engineering, Southern Delta University, P.M.B. 05., Ozoro, Delta State, Nigeria

[4] Department of Agricultural and Bioresource Engineering, Enugu State University of Science and Technology, P.M.B.01, Enugu, Nigeria

Corresponding Author

ABSTRACT

The earth main three spheres of lithosphere, atmosphere and hydrosphere receive water in various forms otherwise recharges which enable the continuous water cycle as they release certain water quantities to another receiving end. Water is a major resource for man existence. Without water, most functions become incapacitated. For instance there can be no agriculture without water, no natural cooling systems at required parts of earth (especially soils and air), no adequate naturally available oxygen for human breathing without the water - H_2O release of the molecule, etc. For more understanding and appropriation of water status and resources in and out of the reservoirs of the various naturally classified sphere types, this experimental evaluation involving soil and water surveillance and analysis of the selected region *was carried out. The volume recharges of the lithosphere (obtained from rainfall volume intake), atmosphere (obtained from evaporation and transpiration hydro intake), and, hydrosphere (obtained from Infiltrated hydro volume intake) in the study region were obtained and evaluated. Results obtained showed that the minimal, average and maximum hydro recharge for lithosphere (9 mm/day, 830 mm/day, and 3988 mm/day), atmosphere (2 mm/day, 8 mm/day, and 9 mm/day), and, hydrosphere (94500 m^3/day, 8715778 m^3/day, and 30544500 m^3/day) respectively were attributed to the hydro reservoirs within the water cycle of the region. Information of this earth - environment - water - concern are of necessity, requiring impacts from both local and higher levels, as water remain a top most vitality for human existence and functions.*

Keywords: Water Cycle; Hydro Recharge; Lithosphere; Atmosphere; Hydrosphere

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I. Introduction

The planet earth also known as "terra', and, more so 'Sol III" possess three component parts which forms its sphere nature. And water presence in these various spheres makes the earth outstanding among other known planets, and places. The natural mechanisms of water recharge to various spheres specifically fuel the earth hydrogen and oxygen necessary for different functions. The recharge enabling movement gave birth to the water cycle on earth. Though water cycle may extend to inter planet hydro recharge and beyond, this work focused on, hydro recharge to the lithosphere from the atmosphere, hydro recharges to the atmosphere from the lithosphere, and, hydro recharge to the hydrosphere from the lithosphere.

Water cycle is the water movement mechanism that ensures the continuous flow of waters in various forms at various parts of the earth as a whole. This cycle keeps various functions running including agriculture and others.

Water cycling in flow and outflow the atmosphere ident the weather pattern significant aspect (GPM-NASA, 2025), in and out of the lithosphere is that of weather, solar and soil aspect, while, in and outflow of hydrosphere involves soil aspect majorly. The water cycle is characterized with no beginning point as well as no end, with respect to its processes like evaporation, transpiration, condensation, precipitation, infiltration, percolation, storage, and runoff (CEPD-NOAA, 2025). The processes may not follow a set trend of occurrence depending on prevalence. Rain, a part of the water cycle involves a two way hydro movement mechanism of rain water falling directly to recharge the soil, and the evaporation of water liquid molecules moving upward recharging the atmosphere and eventually falling in return to recharge the land as rain (Okolotu, and Oluka, 2022).

Hydro Recharge refers to the inward movement of water in a specific location at a specific time. Understanding the water recharge processes like the timing, location, and rates is useful for various purposes (Smerdon, 2017). The soil moisture replenishes almost every 1 year, the global wetland water replenishes almost every 5 years, the lake water time of residence takes almost 17 years, water in the atmosphere replenishes every 16 days on average, and, groundwater replenishment may take over 1400 years in low societal development areas (CEPD-NOAA, 2025). These values statistically highlight the potential recharges in the lithosphere, atmosphere, and hydrosphere.

Lithosphere is the planet earth outer layer sphere containing majorly land. Lithosphere is the component terrestrial with landmasses primarily of solids, like the islands and continents (Atlas, 2022). Lithosphere is also known as geosphere, and identifiable as the earth outer layer with the most rigidity, and solid constituent comprising of brittle mantle and crust (Hanif *et al*., 2020). Due to its mechanical firmness structure, it is the natural befitting base for man habitation. It is classifiable into two types of oceanic (under sea land) and continental lithosphere (off sea soil layers). Hydro recharges of identifiable liquid forms exist in the pores of this sphere until they make way to either the atmosphere or the hydrosphere. A typical example of the lithosphere with types is presented in figure one (1) below:

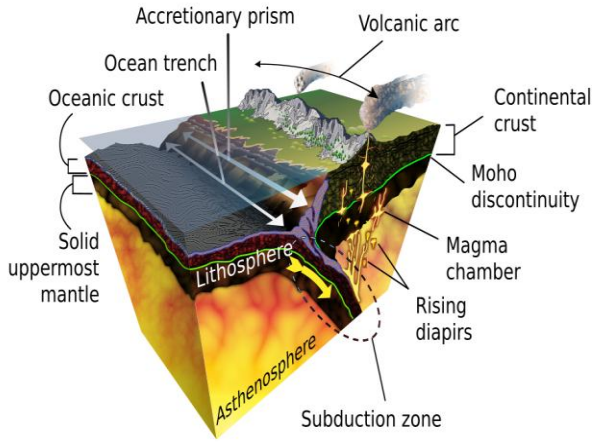

Figure 1: Lithosphere with types (Wikipedia, 2025)

Atmosphere is the surrounding gaseous space of the planet earth, and those of other places of such order of body. It refers to the air environment with gases including vaporized water from a specific place of the entire earth environment. It is the uppermost part of the earth spheres. The atmosphere occupy extensively about 75 miles or around 120 km, above the earth surface, with troposphere, mesosphere, stratosphere, and, thermosphere as the main layers (AGCI, 2025). The lower most atmosphere otherwise troposphere possess around 80% of the entire atmospheric mass, with nitrogen, oxygen, and argon gases dominantly containing about 99% of the mass of the atmosphere, around the estimate 5.14 × 1021g (Schlesinger, and Bernhardt, 2020). The atmosphere contains nitrogen (78%), oxygen (21%), and, a major trace gas otherwise argon (<1%) and other trace gases of greenhouse gases like carbon dioxide, water vapor, nitrous oxide, methane, and ozone (<1%) (AGCI, 2025). Here, hydro recharge in form of tiny gaseous matter exist until they become heavy enough to return downward, possibly to the lithosphere or hydrosphere (where open surface waterbody exist) or to the hydrosphere passing through the lithosphere. An exemplary description of the atmosphere with layer attributes is presented in figure two (2) below;

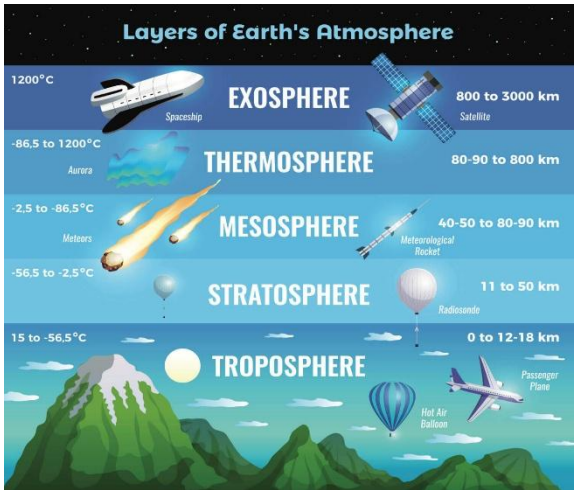

Figure 2: Atmosphere layered (FDF, 2022)

Hydrosphere refers to all earth waters. Hydrosphere is also known as aqua-sphere referring to liquid water, solid water, and vapor water in a place as well as in dissolved constituents (Speight, 2020). It is one of the three main types of sphere on planet earth. The hydrosphere of earth is about four billion years in existence (Wikipedia, 2024). This sphere possessively records the highest hydro storage reserve on earth. Hydro recharge to the earth hydrosphere is measurable with respect to volume in cubic meter per day. Examples of the hydrosphere on earth are presented in figure three (3) below;

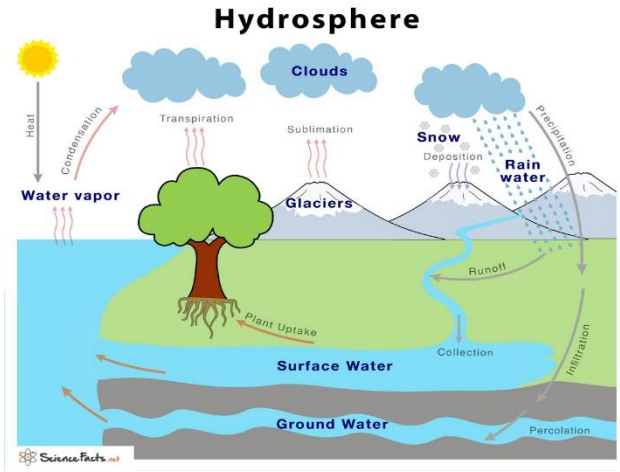

Figure 3: The hydrosphere (SF, 2023)

II. Materials

This research study base was Ozoro. Ozoro is situated in Isoko north geographical section of delta state, in Nigeria, West Africa. Isoko north possess about 477 square kilometers of land area (Enuku, and Akpoyovwere, 2023). Other materials include the rain gauges, evaporimeter, satellite sensory device, mobile digital system, underground hydro indicator, *etc*.

III. Methods

The work encompass 2024 soil and water surveillance and analysis of the selected region. The rainfall data manually obtained using mounted rain gauges of standard type, were used in attaining the hydro recharges to the lithosphere. Evaporation and transpiration records obtained using portable evaporimeter were combo-deployed in the acquisition of the hydro recharges to the atmosphere. And, through land area survey of the study region, the land area was measured prior surface horizontal distance contained, used in conjunction with rainfall values with consideration of the land infiltration status, the hydro recharges to the hydrosphere were deduced. These were achieved following due processes of volume inflow rate into the three classified spheres.

IV. Results

The obtained results are presented in figures four (4) to seven (7), and tables one (1) to three (3) below;

The results of Ozoro land area are presented in figure four (4) below:

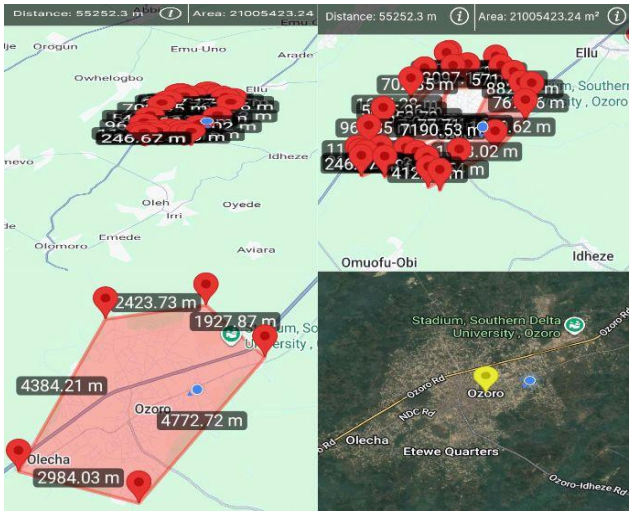

Figure 4: Results of Ozoro land area

The results for rainfall, evaporation, transpiration, groundwater recharges are presented in table one (1) below;

Table 1: Results obtained for the water cycle hydro parameters of the various spheres

S/N	Date (day)	Hydro Recharge to the Lithosphere	Hydro Recharge to The Atmosphere		Hydro Recharge to the Hydrosphere		
		Rainfall Recharge, (mm)	Evaporation Recharge (mm/day)	Transpiration Recharge (mm/day)	High Infiltrated Underground Water Recharge of Ozoro (m^3/day)	Moderate Infiltrated Underground Water Recharge of Ozoro (m^3/day)	Underground Water Recharge of Ozoro, (m^3/day)
1	25/03	252	6	2	3175200	2116800	2,646,000
2	26/03	139	7	1	1751400	1167600	1,459,500
3	04/04	809	6	2	10193400	6795600	8,494,500
4	18/04	1455	7	1	18333000	12222000	15,277,500
5	29/04	888	6	2	11188800	7459200	9,324,000
6	30/05	1,949	6	2	24557400	16371600	20,464,500
7	31/05	1,949	6	2	24557400	16371600	20,464,500
8	10/06	2,909	6	2	36653400	24435600	30,544,500
9	21/06	2,509	5	2	31613400	21075600	26,344,500
10	24/06	1,358	6	2	17110800	11407200	14,259,000
11	25/06	176	6	2	2217600	1478400	1,848,000
12	27/06	339	6	2	4271400	2847600	3,559,500
13	28/06	733	6	2	9235800	6157200	7,696,500
14	03/07	1,727	6	2	21760200	14506800	18,133,500
15	05/07	482	5	2	6073200	4048800	5,061,000
16	08/07	452	6	2	5695200	3796800	4,746,000
17	10/07	2,558	5	2	32230800	21487200	26,859,000
18	11/07	1,115	5	2	14049000	9366000	11,707,500
19	15/07	2,097	6	2	26422200	17614800	22,018,500
20	16/07	179	5	1	2255400	1503600	1,879,500
21	17/07	33	6	2	415800	277200	346,500

22	18/07	9	5	1	113400	75600	94,500
23	19/07	12	6	2	151200	100800	126,000
24	22/07	1,076	6	2	13557600	9038400	11,298,000
25	26/07	370	4	2	4662000	3108000	3,885,000
26	29/07	1,115	6	2	14049000	9366000	11,707,500
27	30/07	27	6	2	340200	226800	283,500
28	02/08	376	6	2	4737600	3158400	3,948,000
29	12/08	194	6	2	2444400	1629600	2,037,000
30	13/08	270	6	2	3402000	2268000	2,835,000
31	15/08	21	6	2	264600	176400	220,500
32	19/08	42	4	2	529200	352800	441,000
33	20/08	1,115	6	2	14049000	9366000	11,707,500
34	21/08	261	6	2	3288600	2192400	2,740,500
35	26/08	764	6	2	9626400	6417600	8,022,000
36	27/08	164	6	2	2066400	1377600	1,722,000
37	31/08	206	6	2	2595600	1730400	2,163,000
38	02/09	679	6	2	8555400	5703600	7,129,500
39	06/09	18	6	2	226800	151200	189,000
40	09/09	648	6	2	8164800	5443200	6,804,000
41	10/09	497	6	2	6262200	4174800	5,218,500
42	11/09	876	6	2	11037600	7358400	9,198,000
43	19/09	115	6	2	1449000	966000	1,207,500
44	23/09	330	6	2	4158000	2772000	3,465,000
45	27/09	194	6	2	2444400	1629600	2,037,000
46	02/10	1,324	6	1	16682400	11121600	13,902,000
47	04/10	21	6	2	264600	176400	220,500
48	7/10	1,418	6	2	17866800	11911200	14,889,000
49	09/10	173	6	2	2179800	1453200	1,816,500
50	11/10	2,103	6	2	26497800	17665200	22,081,500
51	14/10	3,988	6	2	50248800	33499200	41,874,000
52	22/10	1,903	6	2	23977800	15985200	19,981,500
53	30/10	352	6	2	4435200	2956800	3,696,000
54	29/11	55	7	1	693000	462000	577,500
Total	-	44,824	317	102	564,782,400	376,521,600	470,652,000
Av.	-	830	6	2	10,458,933	6,972,622	8,715,778

The results of the minimal, average, and maximal hydro recharges from the water cycle hydro parameters are presented in table two (2) below:

Table 2: The minimal, average, and maximal recharge values for the hydro parameters

S/N	Water Cycle Hydro Parameters	Minimal Recharge	Average Recharge	Maximum Recharge
1	Rainfall (mm/day)	9	830	3988
2	Evaporation (mm/day)	1	6	7
3	Transpiration (mm/day)	1	2	2
4	Underground Water Recharge (m^3/day)	94,500	8,715,778	30,544,500

The results of the minimal, average, and maximal hydro recharges to the various spheres are presented in table three (3) below:

Table 3: Minimal, average, and maximal values of hydro recharge to the various spheres

S/N	Sphere Type	Minimal Recharge	Average Recharge	Maximum Recharge
1	Lithosphere (mm/day)	9	830	3988
2	Atmosphere (mm/day)	2	8	9
3	Hydrosphere (m^3/day)	94,500	8,715,778	30,544,500

The chart of minimal, average and maximum hydro recharge in the lithosphere of Ozoro in Nigeria west africa are presented in figure five (5) below:

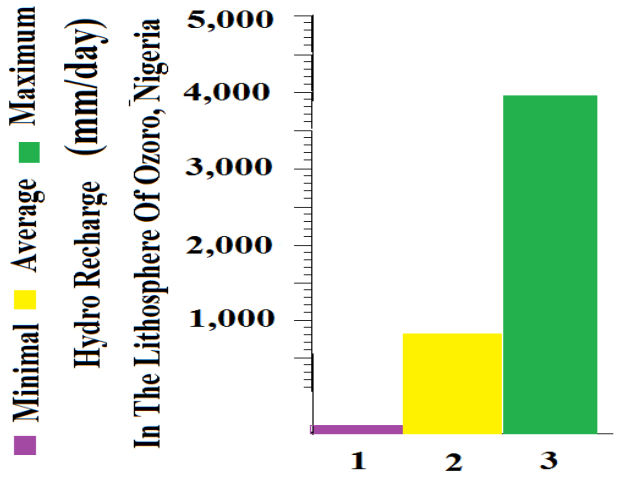

Figure 5: Lithospher Hydro Recharge

The chart of minimal, average and maximum hydro recharge in the atmosphere of Ozoro in Nigeria west africa are presented in figure six (6) below:

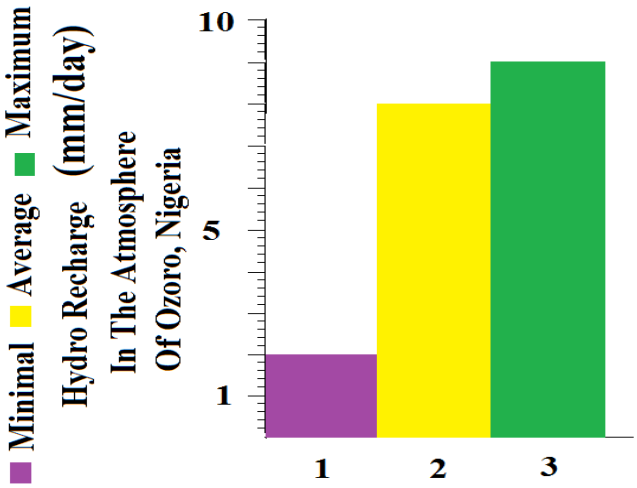

Figure 6: Atmosphere hydro recharge

The chart of minimal, average and maximum hydro recharge in the hydrosphere of Ozoro in Nigeria west africa are presented in figure seven (7) below;

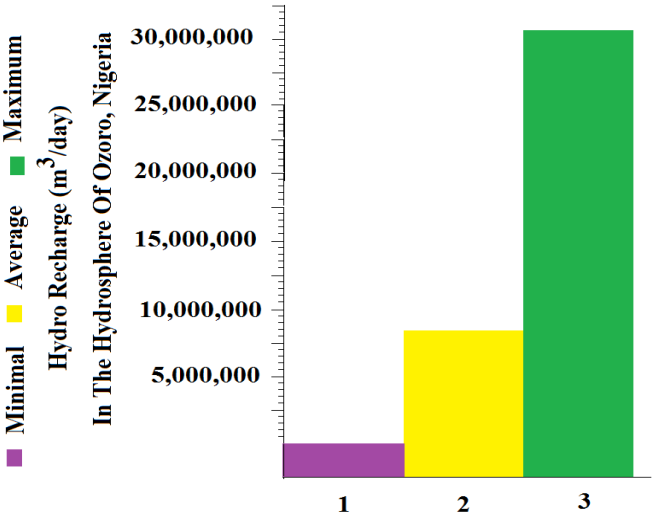

Figure 7: Hydrosphere hydro recharge.

V. Discussion

From land area survey result obtained, Ozoro as a whole had about 21 km^2. This 21 km^2 is a fraction of the 477 km^2 of the Isoko north land area reported in Enuku, and Akpoyovwere, (2023). This entails Ozoro land area amounting about 4% of the full Isoko north land area. The 21 km^2 Ozoro area includes about 1.3 km^2 of the previously referred to as the main Ozoro community associated to the native residency, at about few distance from the now Southern Delta University location.

These data are vital for adequate management of water resources. For example, at national level, the appropriate organization responsible for the dam water regulatory may be more inform on the groundwater capacity as well as general status for all concern areas locally, for efficient flood prevention. This will enable due appropriation of national dam water discharge capable of influencing flood at various local levels if not well managed. In all, these data availability are of necessity for both local and national disaster prevention, especially with respect to the environments of the land, water, and air. The necessity extend to agriculture and the rest, with respect to land use and other decision making.

VI. Conclusion

The minimal, average and maximum hydro recharge within the water cycle hydro reservoirs of the various spheres are: lithosphere (9 mm/day, 830 mm/day, and 3988 mm/day), atmosphere (2 mm/day, 8 mm/day, and 9 mm/day), and, hydrosphere (94500 m^3/day, 8715778 m^3/day, and 30544500 m^3/day) respectively in Ozoro, Nigeria.

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