



# The influential concepts of recharge and flow rate approach in evaluation of water quality

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## General Note

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## ABSTRACT

The study is to evaluate selected heavy metals migration of chosen wells in the groundwater zone serving as water bearing aquifer of Abalama Community in Asari-Toru L.G.A, Rivers State taking Well A as control well and point of migration of water quality parameters to be simulated. The experimental and simulated heavy metals assessed are within WHO standards of acceptability limited. Used simulating matrix model to simulate the migration of heavy metals in this investigation is considered useful in monitoring and simulate groundwater quality of the research area.

**Keywords:** Abalama Community, Heavy metal, flow rate, Recharge, Matrix method

## 1. INTRODUCTION

The danger caused by the contamination of the environment with heavy metals is very destructive due to industrial and sewage sludge applications to our environment there by becoming a major factor to the speedy increase of heavy metal to our area, in addition, it is also noted that the occurrence of heavy metals in industrial and urban waste water brings about the pollution of water and soil. Existence of heavy metals leads to solemn threat to human health and ecological environment. Metals occurring as effluent are cadmium, arsenic, chromium, lead, zinc, mercury and copper caused by heavy metals or metals. Rocks, through weathering process causes natural levels of heavy metals.

Furthermore, organic contamination of water bodies has a added load of heavy metals to groundwater source which can be accredited to sewage and industrial waste. Metals such as copper and zinc in sewage mostly become bound to the sediments of the estuary. The said metals at this point are not biodegradable and persist in the environment. Groundwater may be contaminated due to either point of source or diffuse sources. In a farmyards area where there are wells, there is always possibility of wastewater runoff and other agricultural contaminants entering the groundwater directed or percolation process.

Investigation in this research is carried out to ascertain the circulation of heavy metals parameter in the selected wells in Asari-Toru local government area groundwater been influenced flow rate.

## 2. MATERIALS AND METHODS

### 2.1. Simulation Model Concept.

Research revealed that at this point of the assessment, the unconfined groundwater model can be used in this research taking Abalama community as a reference point. Therefore, if the flow is considered to be in x- dimensional and steady state with a hydraulic conductivity (k) in distributing or studying groundwater interaction of heavy metals. Then the Laplace equation is

$$\frac{d^2 H}{dx^2} = 0 \quad (1)$$

Recharge is the ratio of rainfall amount that sooner or later finds its way into the bearing aquifer due infiltration processes and then influence water level.

If recharge is R, then

$$\frac{dq}{dx} = R \quad (2)$$

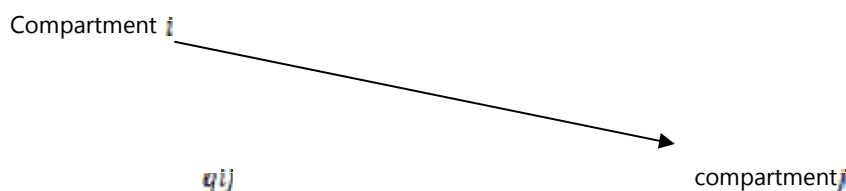
Solving Equation(1) and substituting Equation(2) into the solution. Finally gives:

$$q = \frac{k}{2L} (H_R^2 - H_0^2) + \frac{R}{2} (l - 2x) \quad (3)$$

Equation (3) is equation for flow with the effect of recharge.

### 2.2. Formulation Pattern of Discretization of Flow Groundwater

Considering compartment i and compartment j as show below representing flow groundwater movement from i to j having a flow rate  $q_{ij}$ . In simulation of compartment model of a substantial system, we theoretically isolate the system into different numeral of little components between which material is to distribute.



**Figure 1** Formulated connection between two Compartments Well Groundwater

Let the entries  $S_i$  in the  $n \times 1$  matrix  $S$  defined the laboratory concentration of heavy metals at initial state and  $EC$  present the responding distributed heavy metals in groundwater.

$$\text{Therefore, } S = \begin{pmatrix} S_A \\ S_B \\ S_C \end{pmatrix}, \quad C = \begin{pmatrix} EC_A \\ EC_B \\ EC_C \end{pmatrix} \quad (4)$$

Characterize groundwater parameter ( $i$ ), let say that  $s$  is the state of parameter of the groundwater tested. The  $n \times 1$  matrix  $c$  is the estimated distributed groundwater parameter over time. This show that  $s$  and  $c$  are related by

$$EC = G S_{ij} \quad (5)$$

In general,

$$\begin{aligned} EC_A &= Q_{AA}S_A + Q_{AB}S_B + \dots + Q_{An}S_n \\ EC_2 &= Q_{BA}S_A + Q_{BB}S_B + \dots + Q_{2n}S_n \\ EC_n &= Q_{n1}S_A + Q_{n2}S_B + \dots + Q_{nn}S_n \end{aligned} \quad (6)$$

$(Q_{ij})$  is known as flow rate coefficient matrix. Considering that the sum of the entries in any column the transfer coefficient is equal to 1.

Developed Equation (5) is the used to simulation the interaction of heavy metals concentration of groundwater upon the influence of recharge.

### 2.3. Method of Data Collection

Water samples from Abalama Community wells in Asari-Toru, L.G.A., Rivers State, Nigeria were collected from the groundwater source serving selected area and were labeled as AW0, AWE1, AEW2, AEW3 and AEW4, respectively for Abalama for better identification of water specimens collected. Water samples collected in each well were put in cleaned plastic bottles bagged in polyethylene bags with ice block and moved immediately to be examined in the laboratory so as to determine the heavy metals concentration.

### 2.4. Data Analysis

**Table 1:** Analytical method for heavy metal parameters

S/ No	Parameters	Analytical approach	WHO Standard
1	Ammonium (mg/l)	APHA 4500 NH <sub>3</sub>	1.50
2	Arsenic (mg/l)	APHA 3111B	0.06
3	Manganese (mg/l)	APHA 3111B	0.50
4	Nitrate (mg/l)	EPA 3521	10.0
5	Reactive Silica (mg/l)	APHA 4500 SiO <sub>2</sub>	0-0.30
6	Total Mercury(mg/l)	APHA 3111B	0.04
7	Copper (mg/l)	APHA 3111B	1.0
8	Cadmium (mg/l)	APHA 3111B	0.10
9	Lead (mg/l)	APHA 3111B	0.10
10	Cyanide (mg/l)	APHA 4500 CN	0.07
11	Selenium	ASTMD 3859	0.01
12	Zinc (mg/l)	APHA 3111B	3.0

## 2.5. Well Assessment Evaluation

Well evaluation was carried out to generate required parameter needed for the research such as water table elevations of the wells. Elevations of water table of interest were completely generated after several weeks of research.

## 3. RESULTS AND DISCUSSION

Circulation of heavy metal parameters for Abalama wells due to recharge and flow rate were estimated using created predictive Equation (6). Taking R (Recharge) = 0.2mm/day =  $2.0 \times 10^{-4}$ m/d ( $R/2 = 1 \times 10^{-4}$ m/d).

For water bearing aquifer of Abalama, water zone, sand/coarse is given as  $k = 62.5$ m/day =  $7.23 \times 10^{-4}$ m/sec, flow rate based on groundwater gradient from control well to others. The summary of results of heavy metals distribution using Eqn.(6) gives;

**Table 2** Well A, Experimental and simulated results of heavy metal water quality

Parameters	EC,0	EC,1	EC,2	EC,3	EC,4	SR,0	SR,1	SR,2	SR,3	SR,4
Lead(mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate(mg/l)	4.57	2.66	4.0	2.54	3.40	1.78	1.39	1.11	0.69	1.19
Zinc(mg/l)	0.06	0.10	0.22	0.11	0.05	0.03	0.07	0.06	0.05	0.08
Ammonium (mg/l)	0.06	0.03	0.04	0.07	0.06	0.03	0.04	0.06	0.06	0.07
Reactive Silica (mg/l)	15.51	14.35	15.02	15.00	14.70	9.13	9.23	9.32	8.48	9.15
Manganese (mg/l)	0.11	0.01	0.02	0.06	0.90	0.12	0.01	0.19	0.33	0.15
Total Mercury (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Selenium (mg/l)	-	-	0.01	0.01	0.01	-	-	0.01	0.01	0.01
Cadmium(mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Arsenic (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Cyanide (mg/l)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Copper (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

**Table 3** Well B, Experimental and simulated results of heavy metal water quality

Parameters	EC,0	EC,1	EC,2	EC,3	EC,4	SR,0	SR,1	SR,2	SR,3	SR,4
Lead(mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate(mg/l)	4.21	2.28	3.94	2.41	3.00	1.45	1.00	1.03	0.33	1.07
Zinc(mg/l)	0.04	0.08	0.20	0.09	0.03	0.02	0.05	0.04	0.03	0.06
Ammonium (mg/l)	0.04	0.01	0.02	0.05	0.04	0.01	0.02	0.04	0.04	0.05
Reactive Silica (mg/l)	13.23	12.12	13.00	11.97	12.50	7.08	7.22	7.21	6.12	7.15
Manganese (mg/l)	0.09	0.04	0.05	0.06	0.70	0.08	0.03	0.07	0.66	0.14
Total Mercury (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Selenium (mg/l)	-	-	0.01	0.01	0.01	-	-	0.01	0.01	0.01
Cadmium(mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Arsenic (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Cyanide (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Copper (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

**Table 4** Well C, Experimental and simulated results of heavy metal water quality

Parameters	EC,0	EC,1	EC,2	EC,3	EC,4	SR,0	SR,1	SR,2	SR,3	SR,4
Lead(mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate(mg/l)	4.37	2.46	2.98	2.34	3.20	1.58	1.19	0.91	0.49	0.99
Zinc(mg/l)	0.04	0.08	0.02	0.09	0.03	0.01	0.05	0.04	0.03	0.06
Ammonium (mg/l)	0.06	0.03	0.04	0.07	0.06	0.03	0.04	0.06	0.06	0.07
Reactive Silica (mg/l)	15.31	14.15	14.92	14.98	14.68	8.93	9.03	9.03	8.28	8.98
Manganese (mg/l)	0.11	0.01	0.02	0.06	0.90	0.12	0.01	0.19	0.33	0.15
Total Mercury (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Selenium (mg/l)	-	-	0.01	0.01	0.01	-	-	0.01	0.01	0.01
Cadmium(mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Arsenic (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Cyanide (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Copper (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table 2 -4 presents the experimental and simulated heavy metals assessed for five different weeks for Abalama, Community. Heavy metal parameters of Abalama well A were used to simulate the migration of the considered water quality parameter to other well.

#### 4. CONCLUSION

The following conclusions can be drawn from the research.

- 1.The formulation model of flow rate generated using the one dimensional Laplace Equation and applying Darcy's law were useful in simulating heavy metals in the researched area as per the developed simulating matrix model of Equation (6) is considered.
- 2.Research essential parameters considered in the investigation are hydraulic gradient, hydraulic conductivity; assumed flow movement and recharge were used in simulating heavy metals circulation in the aquifer zone of interest.
- 3.The simulated and experimental results of the evaluated heavy metals are within agreeable limit of WHO standard pointing to the reliability of the concept used in the research which agreed with Ukpaka et al 2017.

#### Nomenclature,

$q$  = Flow rate, ( $m^3/day$ )

$K$  = Aquifer permeability, (m/day)

$y_R$  = Water table height for reference points, (m)

$y_0$  = Water table height for consideration points, (m)

$R$  = Recharge, (m/day)

$x$  = Any distance along the length, (m)

$l$  = Length apart between the communities, (m)

$EC_A$  = Heavy metal value for Abalama well A,(mg/l)

$EC_B$  = Heavy metal value for Abalama well B(mg/l)

$EC_C$  = Heavy metal value for Abalam well C, (mg/l)

$EC_D$  = Heavy metal value for Abalama well D, (mg/l)

$EC_E$  = Heavy Metal value for Abalama well E, (mg/l)

$C_F$  = Heavy Metal value for Abalama well F, (mg/l)

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