Akpan Paul P, et. al. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 11, Issue 9, (Series-III) September 2021, pp. 01-06

RESEARCH ARTICLE OPEN ACCESS

Varying Contaminant Volume Influence on Diesel Retention in Niger Delta Soil

Akpan Paul P. [1],Ugwoha Ejikeme[2] Uyoh Francis U. [3] Nwikina Biamene B.*[1], and Uebari Luton S.[4]

(1)Department of Civil Engineering, Kenule Beeson Saro-Wiwa Polytechnic, Bori,Rivers State, Nigeria.
*(*1)Department of Civil Engineering, Kenule Beeson Saro-Wiwa Polytechnic, Bori,Rivers State, Nigeria.*
(2)Department of Civil Engineering, University of Port Harcourt, Choba, Rivers State, Nigeria.
(3)Department of Surveying and Geoinformatics, Kenule Beeson Saro-Wiwa Polytechnic, Bori,Rivers State, Nigeria.
(4)Department of Mechanical E ngineering, Kenule Beeson Saro-Wiwa Polytechnic, Bori,Rivers State, Nigeria.

ABSTRACT
This research is aimed at monitoring the influence of contaminant volume on the retention of diesel spill in the Niger Delta soil. The objectives are to monitor the retention of diesel at given soil depths and varying contaminant volumes; develop a 3D model that will describe the retention of diesel in unsaturated soil zone at different spill scenarios. Diesel spill causes problems when retained in soil which includes, contamination of soils, bioaccumulation of hydrocarbon in humans resulting to carcinogenesis and mutagenesis, extinction of plants and animals. Response surface method was used to generate the experimental design. XLSAT software was used to develop diesel retention model. Results showed that standardized coefficient of the contaminant volume is the highest in developed model at 0.5; it implies that increased quantity of diesel spil1 would result in simultaneous increase in the quantity of diesel spill retained in Niger Delta soil. Furthermore, the 3D model developed revealed that more diesel spill would be retained in the soil with increased quantity of spill. Hence, increased diesel spill spell more doom to the soil. Ministry of environment in alliance with Niger Delta Development Commission, NOSDRA and other sister agencies should adopt the developed model in diesel oil spill reclamation projects.

KEYWORD: 3D Model, Diesel, Niger Delta soil, Gas Chromatography, Retained Concentration

---

Date of Submission: 10-09-2021 Date of Acceptance: 24-09-2021

I. INTRODUCTION

Diesel fuel sometimes is retained in soil whenever spill occurs. The retained diesel in soil possess some constrain in soil which includes soil and ground water contamination(Ericson, 2017), destruction of animals and plants (Richard , John, Sarah, Lawrence, Jackson, Matthew, Julianne, Sandro and Dale, 2017), acute and chronic infection of humans living in the contaminated zones (Ruben , Oksana , Chen., Einav ,Tirza and Yosef ,2018), destruction of aquatic lives(Zock, 2017), destruction of the ecosystem. (Bautista, and Rahman, 2016), extinction of plants and animals (Laffon, Pásaro and Valdiglesias,2016). Oil spills in Bori are mainly caused by accidents, ruptured of pipelines and spillages caused by loss of containment (UNEP report, 2011). Diesel is the major petroleum products used in the polytechnic, banks, hotels, restaurants and eateries due to lack of power in the area (Otu and Oloidi,2018; Oluwaniyi ,2018). Hence, it is used as petroleum product for this research. Oil spillages deteriorate soil properties and impair plant growth (Fowzia and ANM2018).

The work of Obire and Nwaubeta (2018) described the effects of refined petroleum hydrocarbon on the physiochemical and biological characteristics of soil. Brakorenko and Korotchenko, (2016), Richard , John, Sarah, Lawrence, Jackson, Matthew, Julianne, Sandro and Dale, (2017), Aniefiok, Thomas, Clement, Ekpedeme and Iniemem (2018), Mohammadi, Dehestani, Aff, Shooshpasha and Asadollahi, (2015) discussed on the impact of petroleum products on soil. Sharma, Muskan, Ojha . and Shukla, (2018) worked on the effect of contaminant transport in soils. These scholars did not consider monitoring the influence of contaminant volume on the retention of diesel

fuel in a typical Niger Delta soil. Hence, the need of this research to close the identified gap.

II. MATERIALS

The materials used for this research include, rain fall simulator, lysometer with a mesocosm., diesel, auger rig undisturbed soil collector, soil samples and RSM Excel Stat. Program.

III. METHODS

A simple laboratory experiment was done to monitor the influence of contaminant volume on retention of petroleum products in Niger Delta soil. The experiment conducted was designed and reported by Ugwoha et al. (2016) with little modifications. Soil samples were obtained using undisturbed auger rig soil collector with mesocosm. Rainfall simulator was used to mimic rainfall at varying intensity. The washouts were properly collected and recorded. Diesel was carefully extracted from contaminated soil and water samples. Finally the total petroleum hydrocarbons (TPH) were analyzed with GC-FID methods using a gas chromatography.

XLSAT software using RSM method of a full factorial design with 3 levels was used to generate the experimental runs required to monitor the influence of varying rainfall intensity in Niger Delta soil. It was used to optimize the output variables which in this case are the leached concentrations. The input variables were soil height (1000mm), diesel contaminant (50ml, 225ml and 400ml) and rainfall intensity ranging from 5mm/hr to 10mm/hr; since the soil depth is constant it was thus neglected. Nine observations/experimental runs were generated as presented in Table 1 below.

MODEL ASSUMPTIONS

The following assumptions were considered in development of the model.

i. It was a typical Niger Delta soil.
ii. The rain fall intensity was simulated to vary between 5mm/hr, 7.5mm/hr and 10mm/hr.
iii. The soil depth is 1000mm.
iv. The diesel contaminant volume vary from 50ml, 225ml and 400ml

IV. RESULTS AND DISCUSSIONS

The results are presented and discussed below.

Retained Concentrations of Total Petroleum Hydrocarbons (TPHS)

Generally, the concentrations of TPH retained increases with increased volume of contaminant and decreases with increased rainfall intensity as shown in table 1.

Table 1. Retained concentrations of TPH for various rainfall intensities and contamination volumes

Observation	Sort order	Run order	Repetition	Contam. vol	Rainfall intensity	Retained
Obs1	1	1	1	50	5	21.13
Obs2	2	2	1	225	5	27.63
Obs3	3	3	1	400	5	30.56
Obs4	4	4	1	50	7.5	15.1
Obs5	5	5	1	225	7.5	21.98
Obs6	6	6	1	400	7.5	556.17
Obs7	7	7	1	50	10	24.9
Obs8	8	8	1	225	10	21.24
Obs9	9	9	1	400	10	27.89

Discussion of the result in table 1

i. Generally, the concentrations of TPH retained increases with increased contaminant volume as shown in Table 1

ii. This implies that more diesel will be retained in the soil with increase diesel spill and less diesel will be retained with increased rainfall intensity due to the soil k/d factor (Yang, Yang, Duand Lei, 2018).

Relationship Between Retained Concentrations And Independent Variables

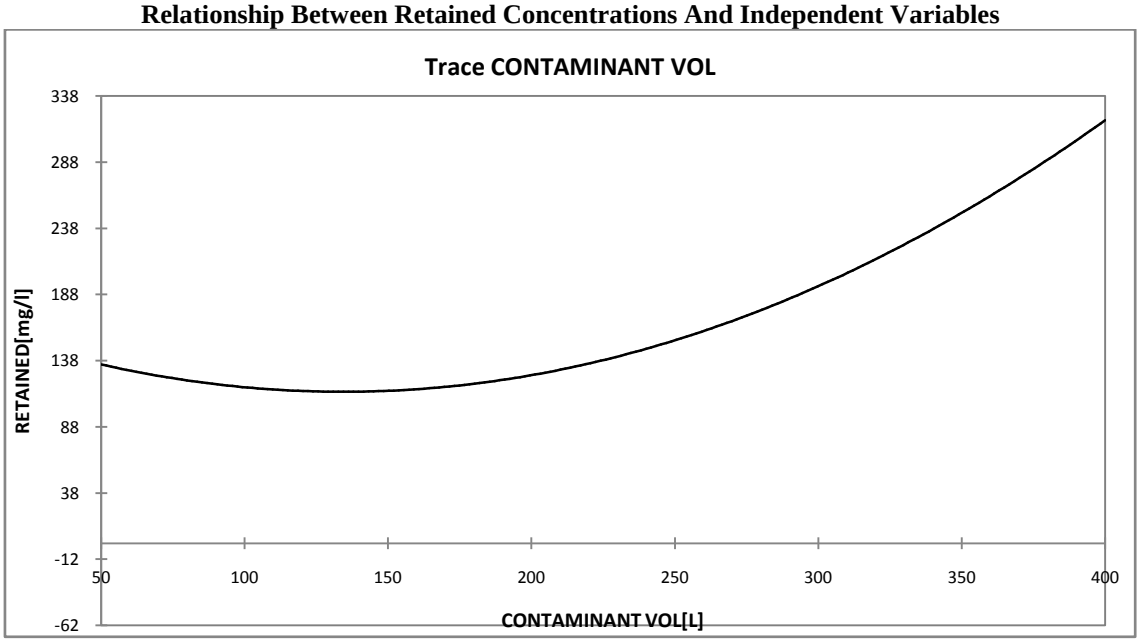

Figure 1. Retention Concentration through varying diesel trace contaminant volumes

Discussion of the result in figure 1

i. Increase in contaminant volume of diesel from 110ml to 400ml results in a simultaneous increase in retained concentration from 100mg/l to 800mg/l as shown in Figure 1

ii. It means that an increase in contaminant volume (diesel) will impact more in Khana soil Obire and Nwaubeta, 2018).

Retained Concentrations of Diesel

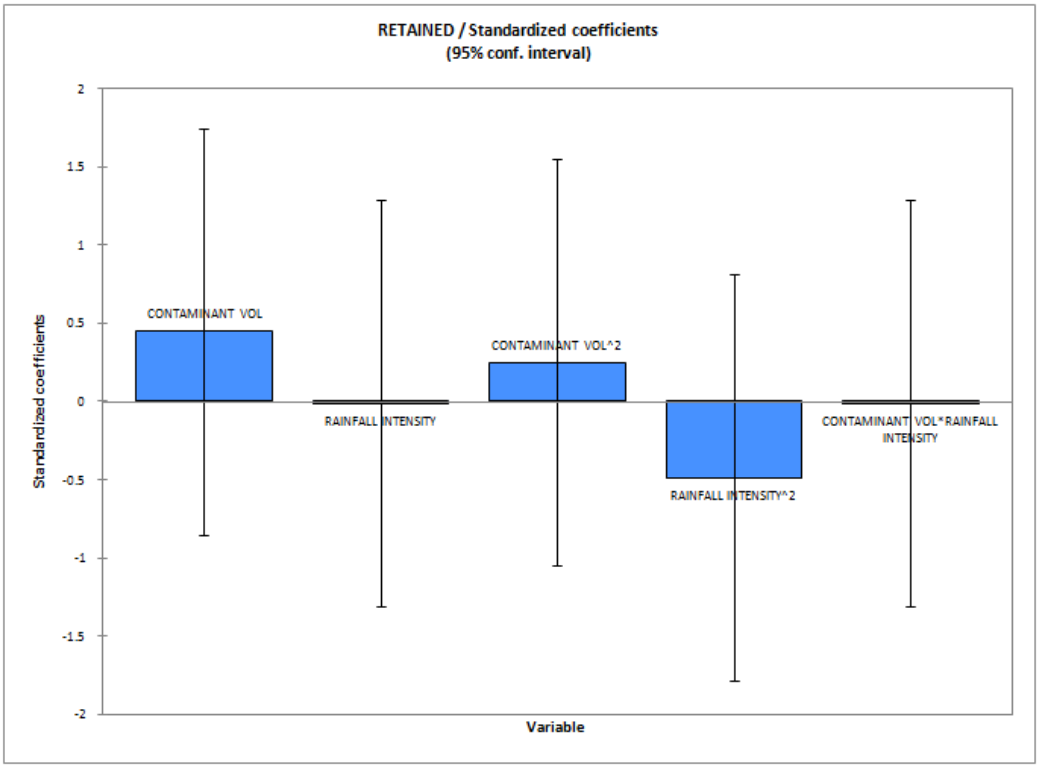

Figure 2. Wash out / Standardized coefficients

Discussion of the result in figure 2.

i. From figure 2, since the standardized coefficient of the contaminant volume in the model is the highest at 0.5, it implies that increase contaminant volume of the spilled diesel will result in increase quantity of retained diesel concentration in Niger Delta soil after any serious spill.

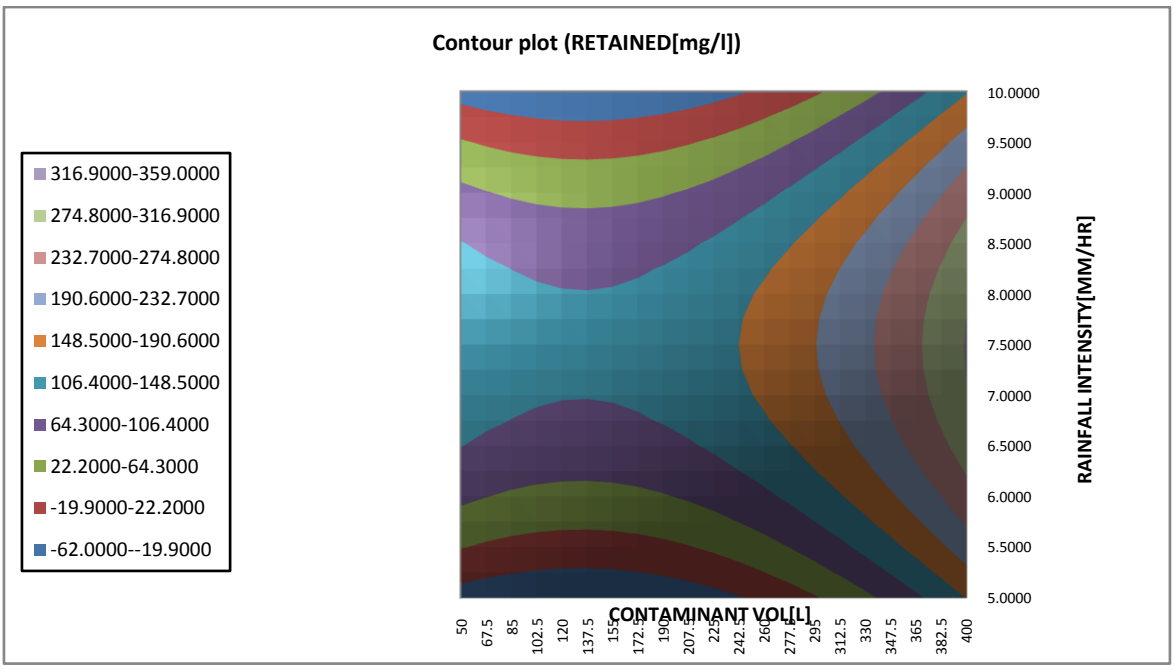

Figure 3. Contour plot (Retained [mg/l])

Discussion of the result in figure 3.

i. The 2D contour map of figure 3 showed the top view of the developed model.

ii. The least contaminant volume spans within the range of -62 to 19.9 mg/l while the highest contamination spans with the range of 316.9 to 359 mg/l

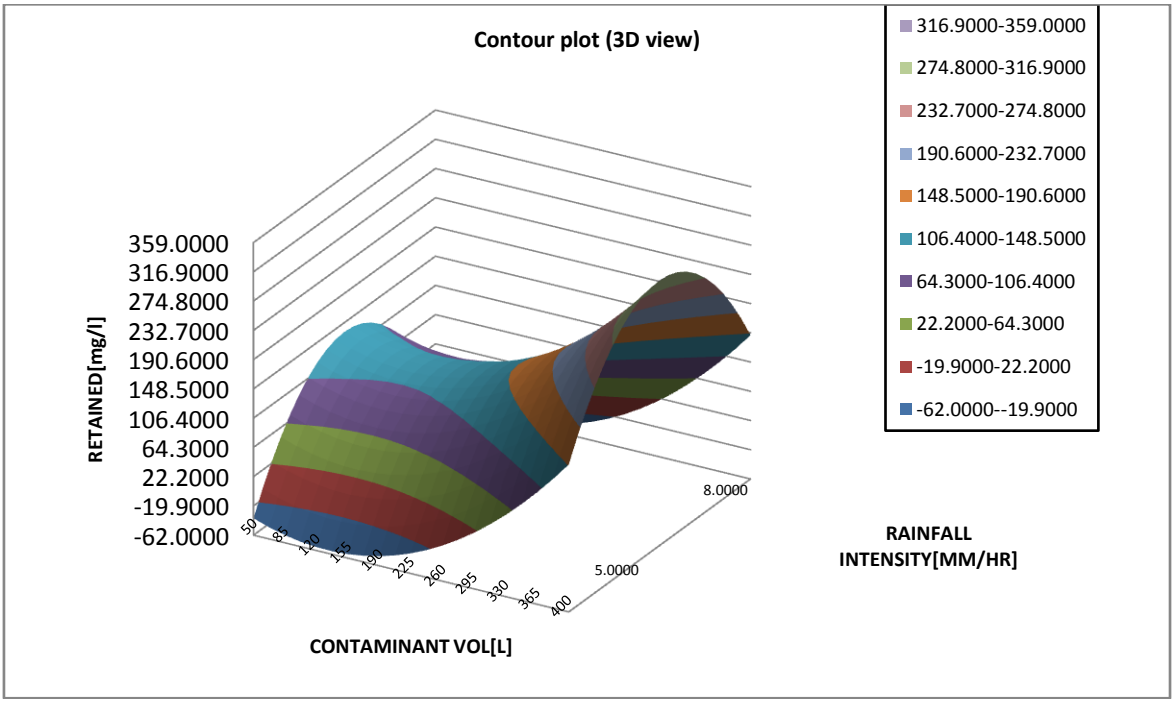

Figure 4. Contour plot (3D view)

Discussion of the result in figure 4

i. Figure 4 showed the 3D view of the developed model.
ii. The contour plot showed the highest and lowest leached concentration with a green and blue colour respectively. See the 3D view of the contour plot in figure 4.

V. CONCLUSION

Increased quantity of diesel spil1 would result in simultaneous increase in the quantity of diesel spill retained in Niger Delta soil due to the soil's k/d factor (Yang, Duand Lei, 2018).

Since the standardized coefficient of the contaminant volume is the highest in developed model at 0.5, it implies that increase contaminant volume of spilled diesel will result in increase quantity of retained diesel concentration in Niger Delta soil after any serious spill.

The developed 3D model in figure 4 showed that increased contaminant volume consequently result in increased retained concentration of diesel in soil.

VI. RECOMMENDATION

I recommend that Khana Local government in alliance with national oil spill detection regulation agency(NOSDRA) should implement the developed diesel retention concentration model as it will help to optimally reclaim diesel spilled contaminated land and satisfy ISO 14001:2015 requirements.

CONTRIBUTION TO KNOWLEDGE

In view of this research, best containment technique for cleanup of diesel contaminated soil in Niger Delta is achievable and it agrees with the implementation of environmental management system as per clause 5, 6,7, 8,9 and 10 of ISO14001:2015.

REFERENCES

[1]. Aniefiok E. I., Thomas A. H., Clement O. O., Ekpedeme R. A.&Iniemem J. I. (2018) Petroleum Hydrocarbons Contamination of Surface Water and Groundwater in The Niger Delta Region of Nigeria, *Journal of Environment Pollution and Human Health***. 2018**, 6(2), 51-61. DOI: 10.12691/jephh-6-2-2.

[2]. Bautista, H. & Rahman, K. M. (2016).Effects of Crude Oil Pollution in the Tropical Rainforest Biodiversity of Ecuadorian Amazon Region. *Journal of Biodiversity and Environmental Sciences.*8 (2): 249–254.

[3]. Brakorenko N.N. & Korotchenko T.V. (2016). Impact of petroleum products on soil composition and physical-chemical properties, *IOP Conference Series: Earth and Environmental Science*, 33 (1).

[4]. Chegenizadeh B. G. & Hamid N.,(2014). The Prediction of Contaminant Transport Through Soil: A Novel Two Dimensional Model Approach Amin. *J Civil Environ Eng* , 4(2).

[5]. http://dx.doi.org/10.4172/2165-784X.1000138.

[6]. *Ericson D.F.K.(2017).*Quality of Petroleum Products: A Case Study of Liberia (September 2015 to December 2015), *Journal of Natural Science Research*,7(24).

[7]. Fowzia A. & ANM F.(2018). A Review on Environmental Contamination of Petroleum Hydrocarbons and its Biodegradation.*Int J Environ Sci Nat Res* 11(3): IJESNR.MS.ID.555811.

[8]. Jian L. , Omar B. W., Saeed M. A.& Sokrates T. P. (2018).Wettability Alteration and Enhanced Oil Recovery Induced by Proximal Adsorption of Na^{+}, Cl^{-}, Ca^{2+}, Mg^{2+}, and $SO2^{-}_{4}$ Ions on Calcite, *Journal of physical review Applied*, 10**,** 034064.

[9]. Laffon, B., Pásaro, E. & Valdiglesias, V. (2016). Effects of Exposure to Oil Spills on Human Health: Updated Review. *Journal of Toxicology and Environmental Health*, Part B. 19.1-24. 10.1080/10937404.2016.1168730.

[10]. Mohammadi A., Dehestani M., Aff. M. A., Shooshpasha I. & Asadollahi A. (2015). Mechanical Properties of Sandy Soil Stabilized with Modified Sulfur. *Journal of materials in civil engineering*, *27*(4).

[11]. Obire, O. & Nwaubeta, O. (2018).Effects of Refined Petroleum Hydrocarbon on Soil Physicochemical and Bacteriological Characteristics.*Journal of Applied Sciences & Environmental Management*, 6(1), June, pp. 39-44.

[12]. Oluwaniyi O. (2018). The role of multinational oil corporations (MNOCs) in Nigeria: more exploitation equals less development of oil-rich Niger Delta region, *Review of African Political Economy*, 45:158, 558-573, DOI: 10.1080/03056244.2018.1546687

[13]. Otu E.E. AND Oloidi W. (2018) Pollution Resulting from Oil Exploration and Plastic Disposal in Niger-Delta Nigeria Biodynamics And Artist's Recycling Methods as Control Measures, *Global Journal of Social Sciences*. (17): 31-40, DOI: https://dx.doi.org/10.4314/gjss.v17i1.4

[14]. http: www.globaljournalseries.com; Info@globaljournalseries.com

[15]. Richard K. K., John A. M., Sarah R. L., Lawrence S. E., Jackson W. B., Matthew D C., Julianne P., Sandro G.& Dale P S. (2017). Mental health indicators associated with oil spill response and clean-up: cross-sectional analysis of the gulf study cohort. 2.
[16]. http://www.thelancet.com/public-health.
[17]. Ruben G.,Oksana K.,Chen S.,Einav M.,Tirza D. &Yosef S. (2018). Impact of Oil-Spill Contamination on a Soil Bacterial Community: A 40-Year History of Rehabilitation in the Arava Valley, *Soil and Sediment Contamination: An International Journal , 27*(3).
[18]. Sharma P.K., Muskan M., Ojha C.S.P. & Shukla S.K. (2018). A review on groundwater contaminant transport and remediation, *ISH Journal of Hydraulic Engineering*, DOI: 10.1080/09715010.2018.1438213.
[19]. Ugwoha E, Nwankwo C and Okoronkwo C. Effect of Soil Type on the Fate of Kerosene Compounds in the Presence of Water and Ethanol. J Environ Stud. 2016;2(1): 8.
[20]. UNEP (2011). UNEP Ogoniland oil assessment reveals reveals extent of environmental contamination and threat to human lives. https://www.unenvironment.org/news-and-stories/story/unep-ogoniland-oil-assessment-reveals-extent-environmental-contamination
[21]. Yang M., Yang Y., Du X. & Lei Y (2018). Fate and Transport of Petroleum Hydrocarbons in Vadose Zone: Compound-specific Natural Attenuation. *Water Air and Soil Pollution*, 224(3) doi: 10.1007/s11270-013-1439-y.
[22]. Zock J. P. (2017). Some clues for studying long-term health effects of oil spills, *Journal of occupational and environmental medicine.*75, (3).
[23]. http://dx.doi.org/10.1136/oemed-2017-104687.

Akpan Paul P, et. al. "Varying Contaminant Volume Influence on Diesel Retention in Niger Delta Soil." *International Journal of Engineering Research and Applications (IJERA)*, vol.11 (9), 2021, pp 01-06.