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SCRUTINY OF GEOPOLYMER-LATERITIC SOIL USING CLUSTER AND PIPER PLOT STATISTICAL AIDS

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ABSTRACT

The strength of a fine-grained lateritic soil from three (3) different localities on Abuja – Lokoja road where road failure happen was treated with rice husk ash (RSA), cement and sodium silicate activator (SSA), with varying percentage examined by means of Atterberg, Compaction and triaxial shear tests. The result showed that Conductivity has the highest mean (144.67µS/cm) and followed by TDS (94.00mg/l) while salinity recorded the lowest (0.057mg/l). Also, TDS recorded the highest Standard deviation (1.10mg/l).This was followed by TSS (0.75mg/l) while salinity recorded the least value of (0.0006mg/l). Further, all the parameter of the water samples examined are within the maximum permissible limit of construction works standards. Also correlation analysis for CBR and UCS shows a positive correlation (between the CBR, RHA and the OMC which indicate a direct relationship between the variables.A significant correlation was found to exist between Geopolymer and Kaolin clay powder (r = 0.95, α = 0.05).

KEYWORDS: ***Construction material, Sodium silicate, Geopolymer, Kaolin clay, Abuja.***

INTRODUCTION

Buildings made of earth materials are the most common inexpensive accommodation since earth materials are readily accessible almost anywhere on earth (Pooria et al.2021; Xu et al. 2021; Zhu et al. 2020). It has been initiate that lateritic soils are in general good construction materials, and for that reasonare commonly utilized in construction (Adbullahi2021; Wattez2021; Rivera et al. 2020). Chemical improvement or stabilization is the reform of properties of a locally accessible soil, in order to improve its engineering performance. The two most frequently utilized chemical stabilization techniques are cement and lime stabilization (Venkatesh2021; Adeyanju et al. 2020; Wang et al.2020). On the other hand, owing to the Carbon Dioxide (CO_2) emissions generated during the manufacturing of aforesaid soil improvers or stabilizers, which contribute to greenhouse gases, other soil enhancers are being sought out and suggested (Zhu et al. 2020; Abdullah et al. 2020). An unconventional to stabilizing soil is via introducing geopolymer materials as well as activators. The multivariate statistical approach is a technique which deals with data that consist of of sets of quantities or a number of individuals or objectsvariables as declared by Achienget al., (2017). Multivariate approach can aid simplification and cataloguing of big data sets, and also suitable for drawing significant suppositions as observed by Bodrud-Dova et al. (2016). Amongst the multivariate statistical approaches, the hierarchical cluster scrutiny or analysis (HCA) and principal components scrutiny or analysis (PCA) are mostly used in feature studies. In cluster scrutiny or analysis (CA), the data cluster is distributed into groups in terms of the connexions and dissimilarities.

Pearson connexion coefficient measures the linear correlation among X and Y. Based on Cauchy-Schwarz disparity, it has a value ranges from +1 to -1, where 1 is total positive linear connexion(Ahmed et al. 2018; Achieng et al. 2017). Meanwhile, a piper plot comprised of three sections: a ternary illustration in the lower left signifying cations (sodium plus potassium, magnesium, and calcium), a ternary illustration in the lower right signifying anions (carbonate plus bicarbonate, chloride, and sulphate), and a diamond map in the

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middle which is a matrix alteration of the two ternary illustrations. Each sample is standardised to one hundred (100) that is sum of cations equal to one hundred, and sum of anions equal to one hundred), so that the comparative concentrations are on a percentage basis. Furthermore, the durov'splotvalidates that there are collaboration means of two or more differentfacies that occurred in soil surface system (Ogwueleka and Igibah2020; Igibah and Apagu2019).

2. LITERATURE REVIEW

2.1 Concept of Rice Husk

Rice with botanica name of *Oryza sativa* L, is a main source of food for billions of populace and among the major crops on earth (Dheyab et al. 2019; Alshaba et al. 2018; Wen et al. 2019). It covers around one percent (1%) of the earth's surface. Rice husk or fibre(RH) is an economical byproduct of rice processing that was separated from rice grain during the rice refining process. It is testified that, for every one ton of rice manufactured, roughly 0.23 tons of RH is produced. In the paddy foliage ofNigeria with a land region of approximatelyninety-one (91) millionshectares for arable and manufactured a total of three million (3,000,000)tonnes of rice grains yearly (Rahgozar and Saberian2018; Roychand2021; Rivera 2020).

The quantity of husksproduced is twenty percent (20%) of three million (3,000,000)tonnes which is six hundred thousand (600,000)tonnes.The key components and physical features of RH are tabulated in Table 1.

Despite the factthat some of this husk is transformed into end products such as panel boards and activated carbon, supplementary cementing material and insulating material, however, like many other agricultural byproducts, the industrial usages of this biomass are still limited with little economic value (Seyhan et al. 2020; Saberian e al. 2020; Khasib and Daud2020). Hence, it is very vital to find pathways to fully utilize the RH and an intense investigation scrutiny is presently undertaken globally to ascertain potential applications as well as develop economically feasible methods for these usages on a commercial scale (Sharma et al. 2019; Tan et al. 2019; Teing et al. 2019).

Table 1: Properties of rice

Properties	**Rice Husk**	**Physical properties**
Components (%)		
Cellulose	25-35	Particle size (μm) – 26.64
Hemicellulose	18-21	Surface area (m^2/g) – 0.92
Lignin	26-31	Density (g/cm^3) – 1.00
Silica (SiO_2)	15-17	
Solubles	2-5	
Moisture content	5-10	

2.2 Geopolymers obtained Kaolin clay

Kaolin, also named china clay is a soft white clay that is a vitalfeature in the manufacturing of paper, rubber, paint, porcelain, and many other products (Amiri and Emami2019; Chang and Cho 2019).

In its natural state be made of principally the mineral kaolinite, which, beneath the electron microscope, is seen to compriseapproximately hexagonal, platy crystals ranging between point one (0.1)micrometre to ten (10)micrometres or even larger as illustrated in Figure 1.

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Figure 1: Rice husk and Kaolin clay.

3.0 ANALYSIS RESULTS

3.1 Descriptive statistics

Figure 2a & b.and Table 2, describes the physicochemical parameters of water used in analysis cement, RHA, KCP and geopolymer mixtures on the Atterberg limit, compaction, CBR and UCS characteristics of the soils tested. The result showed that Conductivity has the highest mean (144.67µS/cm) and followed by TDS (94.00mg/l) while salinity recorded the lowest (0.057mg/l). Also, TDS recorded the highest Standard deviation (1.10mg/l).This was followed by TSS (0.75mg/l) while salinity recorded the least value of (0.0006mg/l). Further, all the parameter of the water samples examined are within the maximum permissible limit of construction works standards.

3.2 Cluster Analysis (Using Squared Euclidean distance)

Result from Figures 3detect similarity groups between the lateritic soils and geopolymer. Two statistically significant clusters are formed for AtterbergC1 and C2, which yielded two groups of similarity between the sampling sites. CBR, compaction, UCS and Triaxial test represented are presented as A and B. Temporal cluster analysis was used on standardized log-transformed data sorted by season. CA was performed using squared Euclidean distances as a measure of similarity (Agashua and Ogbiye2018; Abdullahi et al. 2020; Igibah et al. 2020).

3.3 Impact ofCorrelation Analysis (Atterberg limit, compaction, CBR and UCS)

The laboratory experimental results analysis forthis research work was carried out usingCorrelation analysis as the primary statistical tooland statistical package for social science (SPSS)as statistical software packages for statisticalanalysis.Correlation analysis is a statistical technique toquantify the dependence of two or morevariables (Ahmed et al. 2018; Amiri and Emami2019). The purpose of a correlationanalysis is to determine whether there is arelationship between sets of variablesCBR,RHA, and OMC or UCS, RHA, and OMC and the Outcomes of correlation are summarized in Table 3.Inference was based on the strength tests(CBRsoakedand UCS) results gotten from cement, RiceHusk Ash (RHA), kaolin clay powder and geopolymer mix stabilized soil other than thoseobtained from RH.Each of the parameters pair were calculated using Pearson's correlation coefficients as displayed in Table 4. A significant correlation was found to exist between Geopolymerand Kaolin clay powder ($r = 0.95$, $\alpha = 0.05$).

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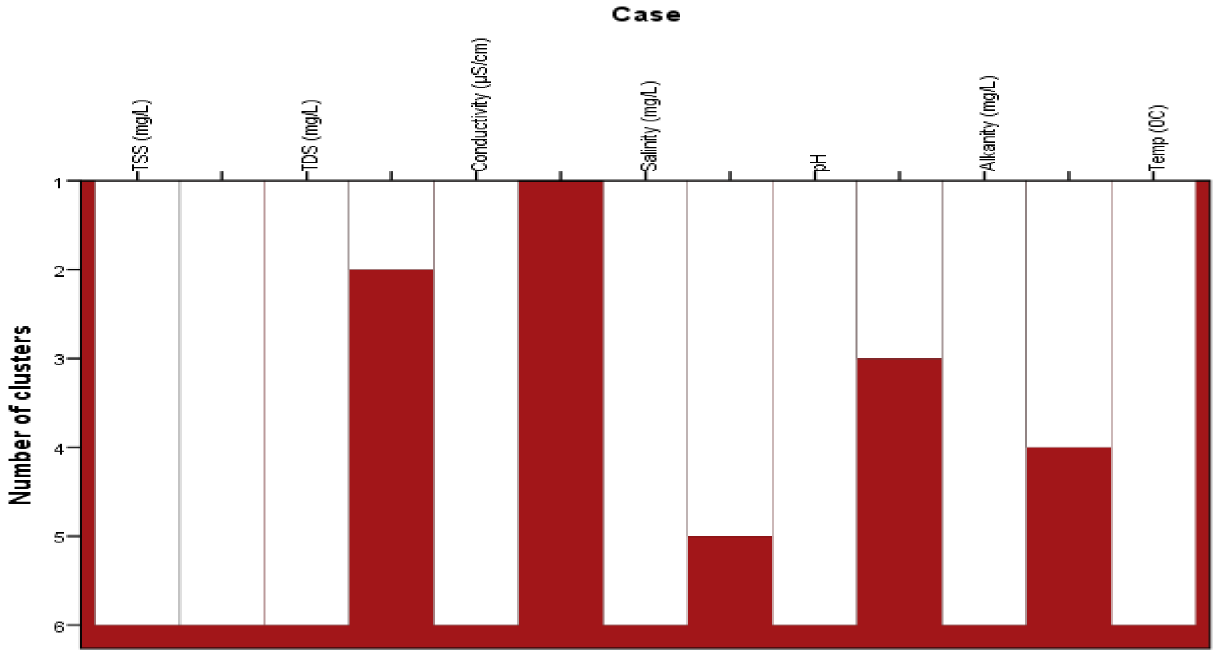

Figure 3: Numbers of clusters for water test

Table 3: Relationship between UCS, cement, RHA, KCP and OMC (H_1: there is significant relationship between, CBR, OMC and geopolymer).

Variable	N	Mean	Std Dev	r-cal	P-value	Remark
Stabilizer	6	441.97	191.88			
Cement	6	64.06	21.63			
RHA	6	74.07	25.21	0.980	0.003	Reject H_0
KCP	6	358.20	145.04			

3.4 Water quality assessment (Piper, Ternary, Durov and Schoeller plots)

Figures 4-7the polar class and wind, piper diagram ternary, surfer and contour, shows that the Stations 1, 2 and 5 are dominant in sodium chloride type of water. The station 3 is dominant in the Calcium–chloride type of water, while station 4 is dominant in mixed type of water, which means no cations and anions exceeds 50%. Also, the results revealed that 43.7% of the samples could be classified as S04-Cl-Ca - Mg type, 20.2% of the samples as S04 - Cl-CO3 HC03-Ca-Mg type and 37.1% of the samples as Mg - Ca type. Studies including Achieng et al. (2017) and Ogwueleka and Igibah (2019) also found comparable results by identified major water types and their ionic composition of different water samples. The calcium sulphatee and calcium–chloride are rich in these regions because the parent rock are of Fissile Hornblende Biotite gneiss and Charnockite, which have composed of sodium and calcium rich minerals. (Igibah and Tanko2019; Wen et al. 2019).

Durov'sand scatter diagram aids in the clarification of the evolutionary styles and the hydrochemical processes happening in the surface water system and can show mixing of various water types, converse ion exchange and ion exchange. The results from Figures 8& 9reveals water in the box 1 as carbonated group which symbolizes water rich in Ca-HCO_3, HCO_3-CO_3 and TDS thus revitalizing. The water from the center of the plain is positioned in triangle 1 and 2, rich in Ca-Cl plus Mg-SO_4 which triggering ion exchange and dissolution of vaporize minerals.

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CONCLUSION

The statistical analysis for CBR and UCS shows a positive correlation (between the CBR, RHA and the OMC which indicate a direct relationship between the variables. A significant correlation was found to exist between Geopolymer and Kaolin clay powder (r = 0.95, α = 0.05). Piper plot diagram shows the Stations 1, 2 and 5 are dominant in sodium chloride type of water. The station 3 is dominant in the Calcium–chloride type of water, while station 4 is dominant in mixed type of water, which means no cations and anions exceeds 50%. Also, the results revealed that 43.7% of the samples could be classified as S04-Cl-Ca - Mg type, 20.2% of the samples as S04 - Cl- CO3 HC03-Ca-Mg type and 37.1% of the samples as Mg - Ca type which is good for construction purposes. The Durov's diagram demonstrates that there are collaboration processes of two or more various facies that happened in water system. The water from the center of the plain, is positioned in triangle 1 and 2, rich in Ca-Cl plus Mg-SO_4 which triggering ion exchange and a dissolution of vaporize minerals and make the water suitable for road works. Based on the EDAX as well as SEM outcomes the new produced gel-like cementitious compounds of sodium aluminosilicate hydrate (N–A–S–H) were assumed to be the major cause of strength improvement. The XRD results also revealed a general increase in the lateritic soil mineral peaks.

REFERENCES

1. *Pooria G, Mostafa Z, Nazanin M, Mohammad S, Jie L, Navid R. Shear strength and life cycle assessment of volcanic ash-based geopolymer and cement stabilized soil: A comparative study. Transportation Geotechnics 31 (2021) 100639.*
2. *Ogwueleka T C, Igibah E C. Hydrochemical interfaces and spatial assessment of Usuma River water quality in North-Central Nigeria, Scientific African, Volume 8, 2020, e00371, ISSN 2468-2276, https://doi.org/10.1016/j.sciaf.2020.e00371*
3. *Xu Zifang, Ye Dongdong, Dai Tao & Dai Yan (2021) Research on Preparation of Coal Waste-Based Geopolymer and Its Stabilization/Solidification of Heavy Metals, Integrated Ferroelectrics, 217:1, 214-224, DOI: 10.1080/10584587.2021.1911314*
4. *Abdullah H. Cyclic behaviour of clay stabilised with fly-ash based geopolymer incorporating ground granulated slag. TranspGeotech 2021;26: 100430.*
5. *Wattez T. Interactions between alkali-activated ground granulated blastfurnace slag and organic matter in soil stabilization/solidification. TranspGeotech2021;26:100412.*
6. *Venkatesh N, Mallikarjuna R, Sudheer R, Rama C. Strength and durability characteristics of GGBS geopolymer stabilized black cotton soil 2021 Materials Today: Proceedings 43(4), DOI: 10.1016/j.matpr.2021.01.939.*
7. *Adeyanju Emmanuel, OkekeChukwueloka Austin, Akinwumi Isaac and BusariAyobami (2020). Subgrade stabilization using Rice Husk Ash-Geopolymer (GPHA) and Cement Klin Dust (CKD).*
8. *Wang, S.; Xue, Q.; Zhu, Y.; Li, G.; Wu, Z.; Zhao, K. Experimental study on material ratio and strength performance of geopolymer improved soil. Constr. Build. Mater.* ***2020****, 267, 120469. [CrossRef]*
9. *Zhu, Y.; Chen, R.; Lai, H. Stabilizing Soft Ground Using Geopolymer: An Experimental Study. In Proceedings of the CICTP 2020,*
10. *Abdullah, H.H.; Shahin, M.A.; Walske, M.L. Review of Fly-Ash-Based Geopolymers for Soil Stabilisation with Special Reference to Clay. Geosciences* ***2020****, 10, 249. [CrossRef]*
11. *Rivera, J.F.; Orobio, A.; Mejía De Gutiérrez, R.; Cristelo, N. Clayey soil stabilization using alkali-activated cementitious materials. Mater. Construcción****2020****, 70, 211. [CrossRef]*
12. *Zhu, Y.; Chen, R.; Lai, H. Stabilizing Soft Ground Using Geopolymer: An Experimental Study. In Proceedings of the CICTP 2020, Xi'an, China, 14–16 August 2020; American Society of Civil Engineers (ASCE): Reston, VA, USA; pp. 1144–1155.*
13. *Dheyab, W.; Ismael, Z.T.; Hussein, M.A.; Huat, B.B.K. Soil Stabilization with geopolymers for low cost and environmentally friendly construction. Int. J. Geomate****2019****, 17, 271–280. [CrossRef]*
14. *N. Wen, Y. Zhao, Z. Yu, M. Liu, A sludge and modified rice husk ash-based geopolymer: synthesis and characterization analysis, J. Clean. Prod. 226 (2019) 805–814. https://doi.org/10.1016/j.jclepro.2019.04.045.*
15. *A.A. Alshaba, T.M. Abdelaziz, A.M. Ragheb (2018). Treatment of collapsible soils by mixing with ironpowder. 3737–3745. https://doi.org/10.1016/j.aej.2018.07.019.*
16. *M.A. Rahgozar, M. Saberian, J. Li, Soil stabilization with non-conventional eco-friendly agricultural waste materials: An experimental study, Transp. Geotech. 14 (2018) 52–60. https://doi.org/10.1016/j.trgeo.2017.09.004.*
17. *Roychand R. Development of zero cement composite for the protection of concrete sewage pipes from corrosion and fatbergs. ResourConservRecycl 2021; 164:105166.*
18. *Igibah C, Agashua L and Sadiq A (2020). Influence of hydrated lime and bitumen on different lateritic soil samples: Case study of Sheda-Abuja, Nigeria. IJET, 1-7.*

Journal DOI: 10.36713/epra0412 ISSN: 2277–7741
International Journal of
Asian Economic Light (JAEL) – Peer Reviewed Journal
SJIF Impact Factor (2021): 7.32 Volume: 10 | Issue: 1 | April 2022

19. *Rivera J. Fly ash-based geopolymer as A4 type soil stabiliser. TranspGeotech2020;25:100409.*
20. *Seyhan F, Sedef D, Gülgün Y and Jamal M. (2020). Characteristics of Engineered Waste Materials Used for Road Subbase Layers. KSCE.*
21. *Saberian M, et al. Application of demolition wastes mixed with crushed glass and crumb rubber in pavement base/subbase. ResourConservRecycl 2020;156: 104722.*
22. *Abdullah, H.H.; Shahin, M.A.; Walske, M.L.; Karrech, A. Systematic approach to assessing the applicability of fly-ash-based geopolymer for clay stabilization. Can. Geotech. J. **2020**, 57, 1356–1368. [CrossRef]*
23. *Khasib, I.A.; Daud, N.N.N. Physical and Mechanical Study of Palm Oil Fuel Ash (POFA) based Geopolymer as a Stabilizer for Soft Soil. Pertanika J. Sci. Technol. **2020**, 28, 149–160. [CrossRef]*
24. *Abdullah, H.H.; Shahin, M.A.; Walske, M.L. Geo-mechanical behavior of clay soils stabilized at ambient temperature with fly-ash geopolymer-incorporated granulated slag. Soils Found. **2019**, 59, 1906–1920. [CrossRef]*
25. *Sharma, P.K.; Singh, J.P.; Kumar, A. Effect of Particle Size on Physical and Mechanical Properties of Fly Ash Based Geopolymers. Trans. Indian Inst. Met. **2019**, 72, 1323–1337. [CrossRef]*
26. *Tan, T.; Huat, B.B.K.; Anggraini, V.; Shukla, S.K.; Nahazanan, H. Strength Behavior of Fly Ash-Stabilized Soil Reinforced with Coir Fibers in Alkaline Environment. J. Nat. Fibers**2019**, 1–14. [CrossRef]*
27. *Dheyab, W.; Ismael, Z.T.; Hussein, M.A.; Huat, B.B.K. Soil Stabilization with geopolymers for low cost and environmentally friendly construction. Int. J. Geomate**2019**, 17, 271–280. [CrossRef]*
28. *Teing, T.T. Effects of Alkali-Activated Waste Binder in Soil Stabilization. Int. J. Geomate**2019**, 17, 82–89. [CrossRef]*
29. *N. Wen, Y. Zhao, Z. Yu, M. Liu, A sludge and modified rice husk ash-based geopolymer: synthesis and characterization analysis, J. Clean. Prod. 226 (2019) 805–814.https://doi.org/10.1016/j.jclepro.2019.04.045.*
30. *Amiri E, Emami H. Shear strength of an unsaturated loam soil as affected by vetiver and polyacrylamide. Soil Tillage Res 2019;194:104331.*
31. *Agashua Lucia O and OgbiyeAdebanji S (2018). Influence of Cement, Bitumen and Lime on Some Lateritic Soil Samples as Pavement Material. IOP Conf. Series: Materials Science and Engineering 413 (2018) 012012 doi:10.1088/1757-899X/413/1/012012.*
32. *Agashua Lucia O, IgibahEhizemhen C and Sadiq, Abubakar. (2018). The Impact of Bituminous additive on Lateritic Soil with Varying Percentage for long lasting soil stabilizer.*
33. *Bodrud-Doza, A.R.M. Towfiqul Islam, F. Ahmed, S. Das, N. Saha, S. M. Rahman, "Characterization of Groundwater Quality Using Water Evaluation Indices, Multivariate Statistics and Geostatistics in Central Bangladesh," Water Science 30, pp. 19–40, 2016*
34. *Achieng A, P. Raburu, EKipkorir, SNgodhe, KObiero, J Ani-Sabwa. "Assessment of water quality using multivariate techniques in River Sosiani, Kenya" Environmental Monitoring and Assessment, vol 189, pp 28-37, June 2017.*

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APPENDIX

Table 2: Descriptive analysis for water test

		Temp (0C)	pH	Conductivity (µS/cm)	TDS (mg/L)	TSS (mg/L)	Alkanity (mg/L)	Salinity (mg/L)
N	Valid	6	6	6	6	6	6	6
	Missing	1	1	1	1	1	1	1
Mean		26.7833	6.3667	144.6667	94.0000	91.8333	53.0000	.0570
Std. Deviation		.11690	.05164	.51640	1.09545	.75277	.63246	.00063
Variance		.014	.003	.267	1.200	.567	.400	.000
Skewness		-.668	-.968	-.968	-1.369	.313	.000	.000
Std. Error of Skewness		.845	.845	.845	.845	.845	.845	.845
Kurtosis		-.446	-1.875	-1.875	2.500	-.104	2.500	2.500
Std. Error of Kurtosis		1.741	1.741	1.741	1.741	1.741	1.741	1.741
Range		.30	.10	1.00	3.00	2.00	2.00	.00
Minimum		26.60	6.30	144.00	92.00	91.00	52.00	.06
Maximum		26.90	6.40	145.00	95.00	93.00	54.00	.06

Table 4: Correlation of water samples used for geopolymer stabilization

		Temp (0C)	pH	Conductivity (µS/cm)	TDS (mg/L)	TSS (mg/L)	Alkanity (mg/L)	Salinity (mg/L)
Temp (0C)	Pearson Correlation	1	.883	.221	.000	.417	.271	.541
	Sig. (2-tailed)		.020	.674	1.000	.411	.604	.268
pH	Pearson Correlation	.883	1	.250	.354	.343	.000	.612
	Sig. (2-tailed)	.020		.633	.492	.506	1.000	.196
Conductivity (µS/cm)	Pearson Correlation	.221	.250	1	.354	.857	-.612	.612
	Sig. (2-tailed)	.674	.633		.492	.029	.196	.196
TDS (mg/L)	Pearson Correlation	.000	.354	.354	1	.243	-.866	.577
	Sig. (2-tailed)	1.000	.492	.492		.643	.026	.230
TSS (mg/L)	Pearson Correlation	.417	.343	.857	.243	1	-.420	.840
	Sig. (2-tailed)	.411	.506	.029	.643		.407	.036
Alkanity (mg/L)	Pearson Correlation	.271	.000	-.612	-.866	-.420	1	-.500
	Sig. (2-tailed)	.604	1.000	.196	.026	.407		.312
Salinity (mg/L)	Pearson Correlation	.541	.612	.612	.577	.840	-.500	1
	Sig. (2-tailed)	.268	.196	.196	.230	.036	.312	

a. Listwise N=6

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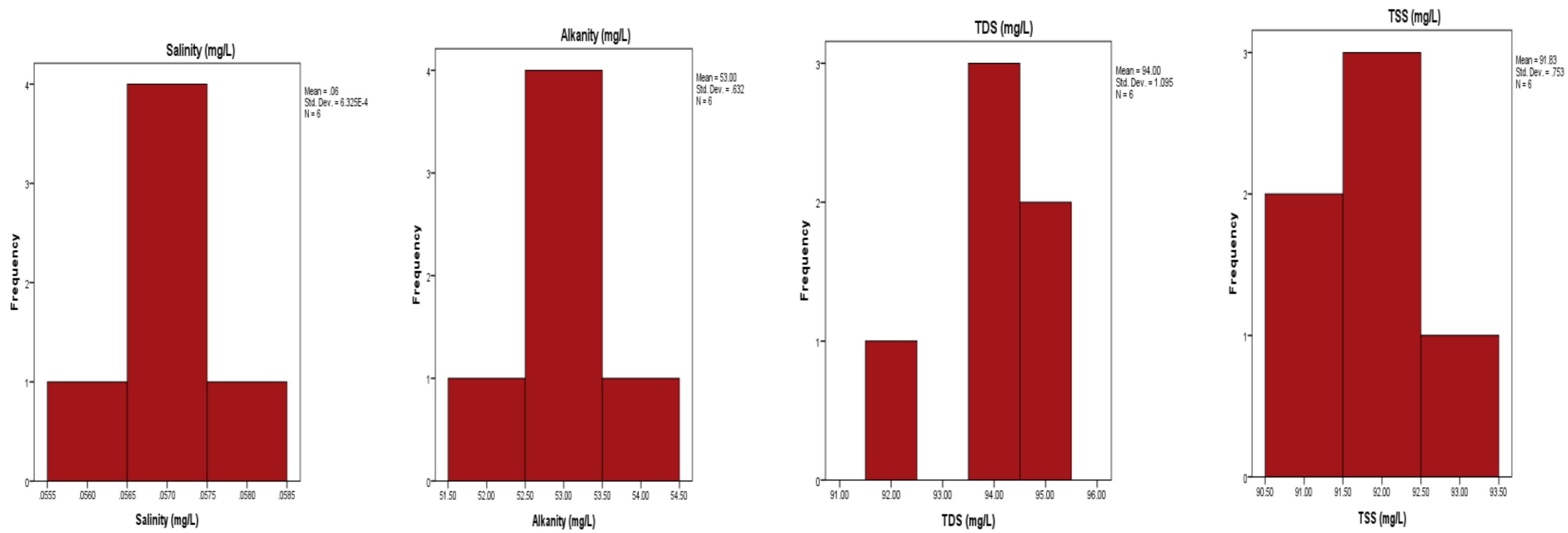

Figure 2a: Histogram showing Salinity, Alkalinity, TDS and TSS of water utilized for analysis.

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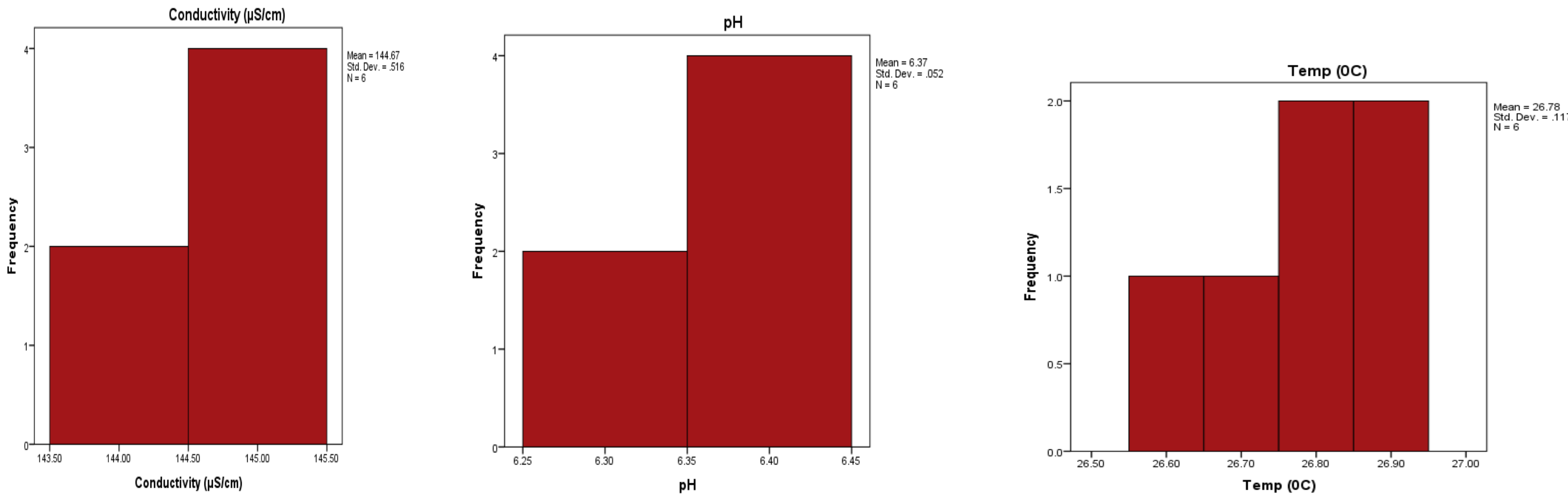

Figure 2b: Histogram showing Conductivity, pH and Temperature of water utilized for analysis.

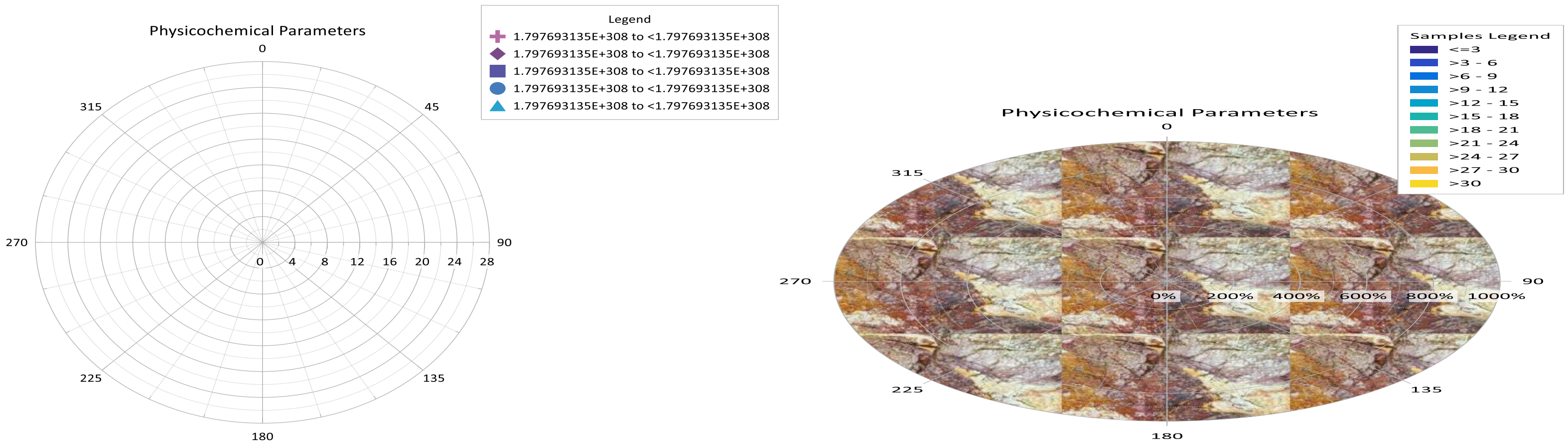

Figure 4: Polar class and wind plot of water analysis.

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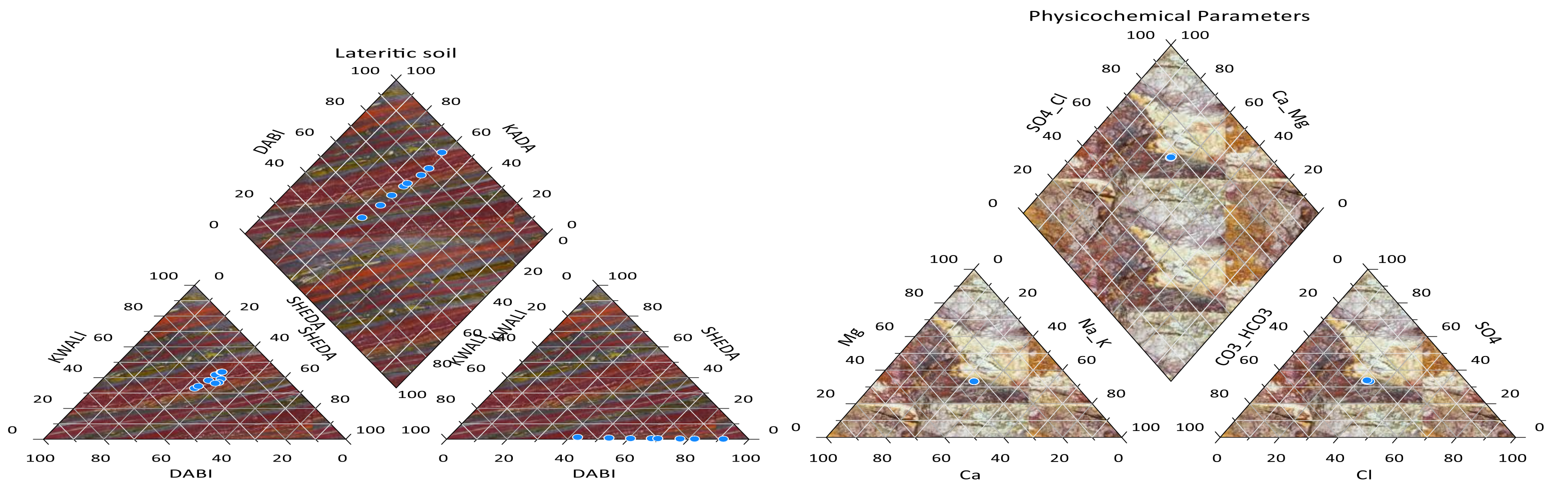

Figure 5: Piper diagram displaying the hydrological looks of the (a) lateritic soil, (b) water samples.

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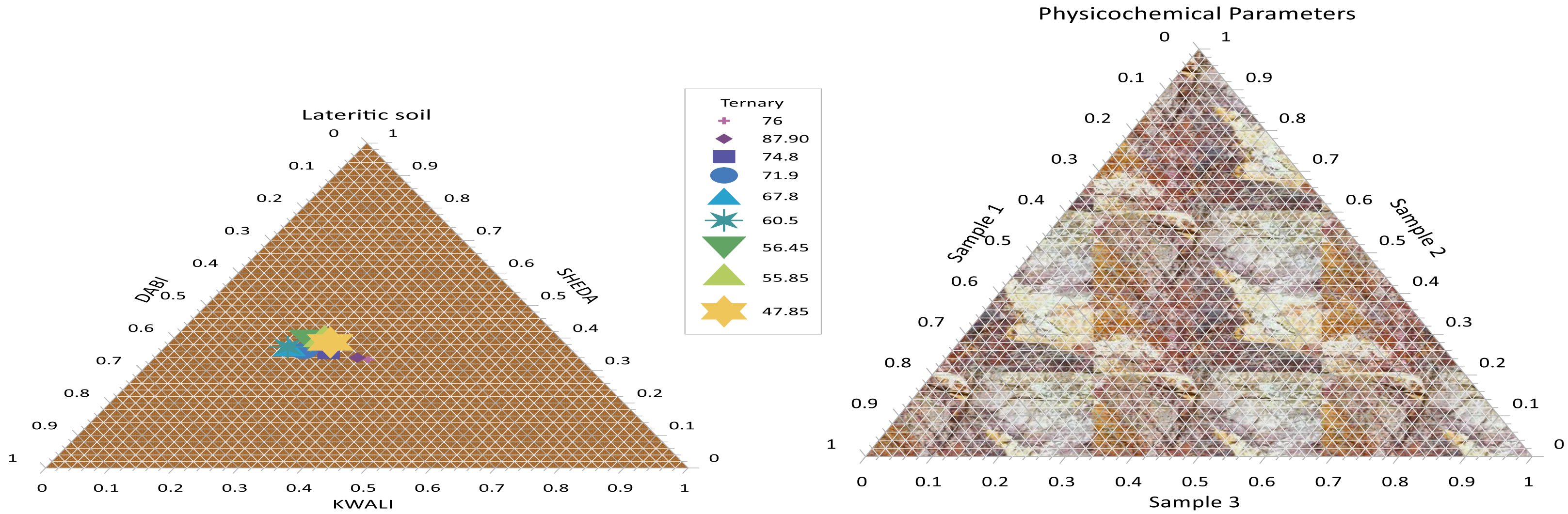

Figure 6: Ternary diagram displaying the hydrological looks of the (a) lateritic samples, (b) water samples.

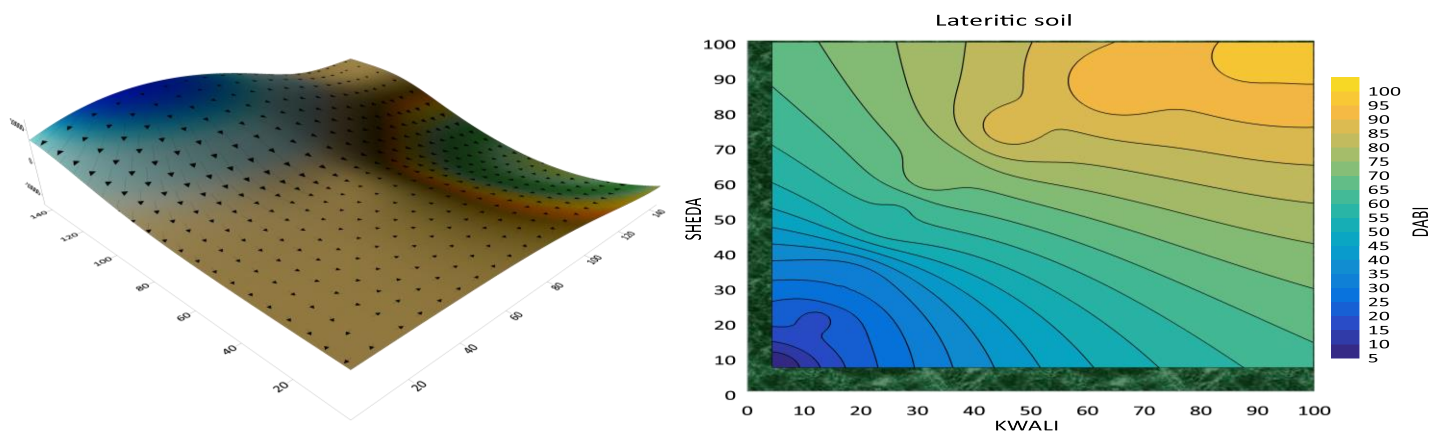

Figure 7: Surfer and contour of lateritic soil

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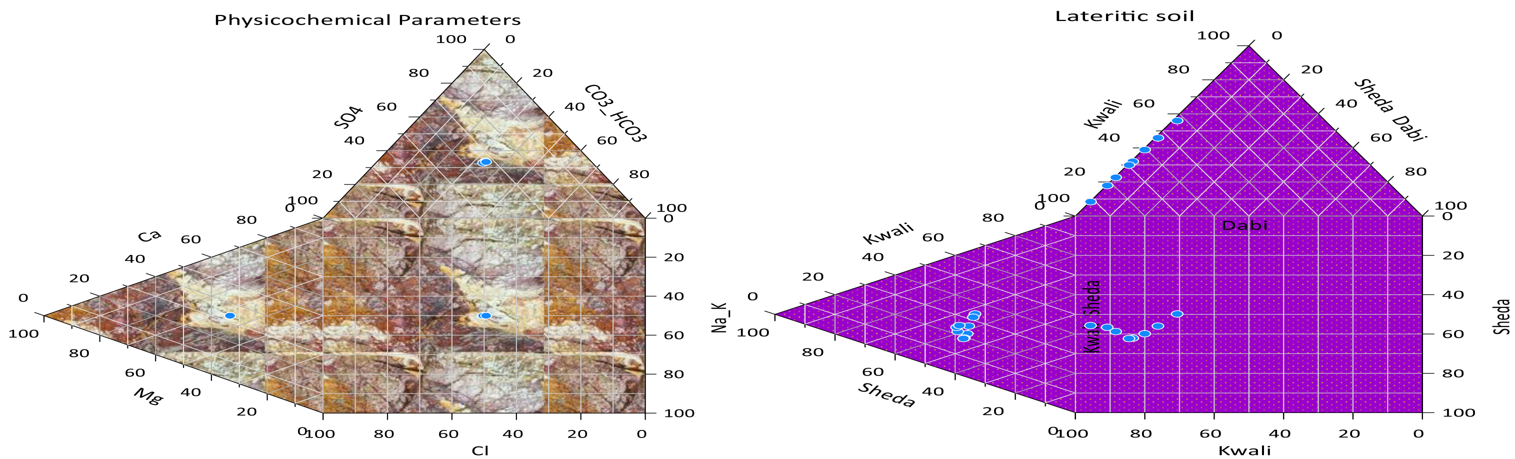

Figure 8: Durov displaying the hydrological looks of the: (a) water samples, (b) lateritic samples.

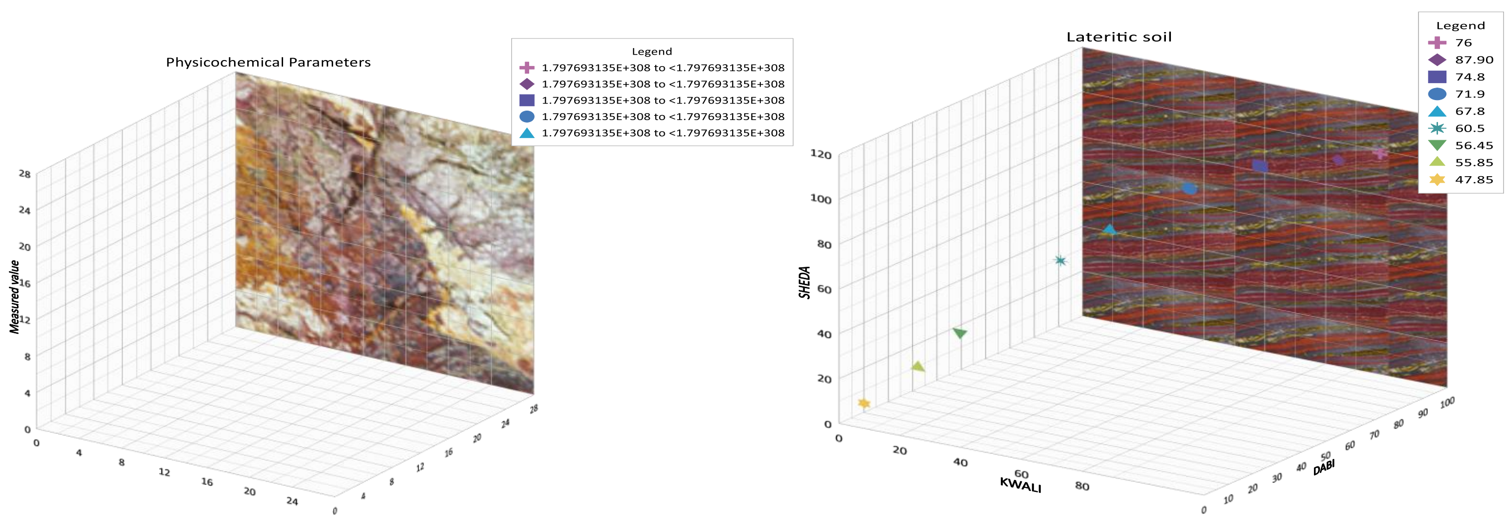

Figure 9: scatter diagram displaying the hydrological looks of the: (a) water samples, (b) lateritic soil.