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MICROENVIRONMENTAL ANALYSIS OF HOUSING DEVELOPMENT AND BIOPHYSICAL ENVIRONMENT IN ENUGU URBAN

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ABSTRACT: *This research carried out an empirical analysis of housing development and microenvironment biophysical elements in Enugu Urban. An experimental and Survey Research design was adopted. The questionnaire was used to represent the survey research method while the area of the practical experiment was used by the researcher to represent the experimental research method. The population of this study comprises of the various housing developments in the three Local Governments Area that make up Enugu Urban – which is Enugu East, Enugu South, and Enugu North. These locations are geo-referenced given that these three local-government areas give the study a wider and more balanced coverage. Taro Yamane's Statistical formula was applied to determine the sample size for the study which gave n (the desired Sample Size) as 380, which was rounded off to the nearest Hundredth, making n the desired sample size = 400. The major findings of the study were that on average, housing development contributes negatively and significantly to water quality in Enugu urban (p = .003< 0.05). The experimental results revealed the physic-chemical and elemental characteristics of the water sample for the selected respective estates. Secondly, it was also discovered that on average, housing development contributes significantly to soil quality deterioration in Enugu urban (p = .007 < 0.05). The experimental dimension revealed that total organic carbon, ph, organic matter, and fixed carbon yielded average values that confirmed that housing development adversely affects soil quality in Enugu Urban for the period under analysis. It is therefore the recommendation of this study that Wastes that are pushed into waters could be turned into wealth with some research on recycling. Secondly, water pollution is not easy to solve. It is necessary that all hands must be on deck to fight it. This means that aside from controlling housing development, both government and citizen's cooperation are needed to reduce water pollution to the barest minimum. Since water contamination comes from many different sources and has many numerous effects, every aspect of water pollution needs to be addressed. To sustain and improve soil quality in Enugu state, there is also the need for supported active research into waste minimization strategies, waste avoidance technologies, cleaner production processes, and zero-emission concepts.*

KEYWORDS: Microenvironmental Analysis, Housing Development, Biophysical Environment

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INTRODUCTION

After food, housing is the second most important human necessity. It is an essential component of human settlement that has a significant influence on man's quality of life, health, welfare, productivity, economic development, and environmental sustainability (Nweze, 2015). As a result, housing has a multiplier impact on human civilization and economic growth. Despite the importance of housing, a considerable part of the population in most developing nations lacks access to good housing at a reasonable cost (Sengupta & Sharma, 2016).

The issue of urbanization is one of the world's facilitators of housing, particularly in Africa. Africa is the world's most urbanizing region, with half of the people living in cities (UN-Habitat, 2017). Africa's transition to the urban 'age' is expected to be the world's shortest. African countries have long faced the challenge of managing urban development, and they continue to struggle with limited financial resources, urban governance transformation, investing in urban infrastructure, managing the urban environment, providing social services, and dealing with climate change adaptation and mitigation (Clement, 2019).

Enugu's housing development rate is on par with that of its comparable states. This is guided and supported by the necessity for shelter as well as the welfare and financial benefits that come from renting it out to prospective renters and inhabitants (Attamah, 2016). The biophysical impact and effect of such housing construction and activities in the state, on the other hand, is not being adequately addressed, and this is seen as an environmental concern. This is due to the fact that housing construction has a proclivity to exacerbate environmental deterioration (David, 2018).

Biophysical degradation, which deteriorates both urban and rural environmental quality, is a serious issue in Nigeria. However, the problem in an urban context has reached dangerous proportions as a result of fast urban population increase, among other considerations, which has exacerbated urban environmental management. Studies undertaken by Payne (2017), Basorun (2016), and Diogun (2016) are some instances of studies that support this assertion. The situation in Enugu is no different. The rate of disintegration in Enugu's biophysical environment grew frightening. This was corroborated by a PRODA research that spanned the years 2000–2019 and it was discovered that housing construction had a negative influence on the state's environmental sustainability (PRODA, 2019). Given the influx of people into the state, housing building needed to keep up, particularly in the cities. As a result, the rate of housing building in Enugu has kept pace with that of its counterpart states. The need for shelter, welfare, and the financial benefits of renting it out to prospective tenants and residents inform and sponsor this. Housing development and the quality of the biophysical environment have been found to have a negative relationship in empirical and experimental investigations. Examples of such experimental studies are ones conducted by Abraham (2018), Gregory (2019) and Bernard, Shaw and Vivian (2017).

The vegetation, water quality, soil quality, and air quality comprise the biophysical environment. Throughout the development life cycle, housing development activities have an impact on the biophysical environment (Aluko, 2017). This has resulted in a number of negative consequences, such as permanent changes to the natural environment, the accumulation of pollutants in the atmosphere, deforestation, soil instability/erosion, water pollution, noise pollution, increased humidity, air pollution, solid and liquid waste. Because of

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this problems, this study is motivated to investigate on the impacts of housing development in Enugu Urban and recommend measures to minimize them.

Objectives of the Study

1. To ascertain the impact of housing development on the water quality of Enugu Urban.
2. To determine the impact of housing development on the soil quality of Enugu Urban.

LITERATURE REVIEW

Microenvironment and Biophysical Environmental Elements

The biophysical environment comprises both living (bio) things like plants and animals and non-living (physical) items like rocks, soils, and water. The atmosphere, hydrosphere, lithosphere, and biosphere comprise the biophysical environment. The atmosphere encompasses all of the gases that surround the globe as well as everything that happens in them, such as solar heat, weather, smog and haze, climate, and acid rain. The hydrosphere is the region of the planet that is made up of water in all of its forms, including flowing water, ice, and water vapour. The lithosphere refers to the rocks and soils that make up the earth's crust, as well as how our continents originate and wear away. The biosphere is the zone of the earth and adjoining parts of the atmosphere in which plants and animals exist (David, 2020).

Ecosystem Impact

In light of a large number of ongoing building construction projects, the ecosystems impact of construction has become an important issue (Zolfagharian, 2012). These adverse environmental impacts include waste, noise, dust, solid wastes, toxic generation, air pollution, water pollution, bad odour, climate change, land use, operation with vegetation and hazardous emissions. Air emissions are generated from vehicular exhaust and dust during construction (Kaur & Arors, 2012). These emissions include Co2, No2 and So2 (Li et al., 2010). Figure 1 is a pictorial demonstration of the ecosystem impact of environmental construction.

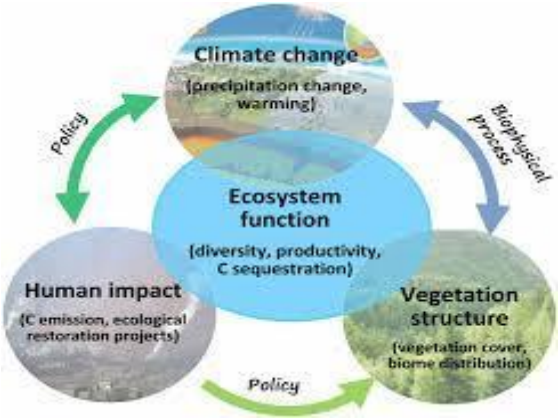

Figure 1: Ecosystem Impact of Building Construction

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Noise emissions are generated as a result of various construction equipment, air compressors and vehicles. The construction equipment and other sources will generate noise within the range of 70 to 120 DB within the vicinity of the construction site. Wastes are generated from construction activities, labor camps, sewage treatment plants, and other sources. The solid waste generated during the operational phase is categorized as biodegradable, recyclable, inert/recyclable and hazardous. Out of the total waste generated, 50% of it would be biodegradable, 20% of the waste would be recyclable, 30% would be inert and it is assumed that a small quantity (0.3%) of it would be hazardous waste. Wastewater is generated from construction activities, sewage, commercial activities, and other sources (Kaur & Arora, 2012).

RESEARCH METHODOLOGY

Research Design

An experimental and Survey Research design was adopted. The questionnaire was used to represent the survey research method while the area of practical experiment was used by the researcher to represent the experimental research method.

The population of this study comprises the various housing developments in the three Local Governments Area that make up Enugu Urban, which are Enugu East, Enugu South and Enugu North. These locations are geo-referenced given that these three local-government areas gives the study a wider and more balanced coverage.

Taro Yamane's statistical formula was applied to determine the sample size for the study which gave n (the desired sample size) as 380, which was rounded off to the nearest hundredth, making n = 400.

Activities: Samples of water and soil were collected from the various site locations in the three local government areas and were tested in the lab at PRODA, Enugu. The measurements of relevant air quality parameters were also analyzed.

Sources of Data

The data used for the study was extracted from two sources namely primary and secondary sources.

RESULTS AND ANALYSIS

Methods of Laboratory Analysis of Physico-chemical Parameters

Water Analysis

The water sample was collected from 11 randomly selected rivers in Enugu urban area, with acid-washed and oven-dried polyethylene bottles. Temp, pH, electrical conductivity, and dissolved oxygen were determined on-site with recalibrated text meter.

The sample was divided into two and labelled: for metal analysis and for other analysis. Samples from metal analysis were acidified with 1.5ml conc. HN03/litre of the sample. The

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polyethylene bottles were corked, kept in ice-filled plastic boxes and transported to PRODA where they were kept in a refrigerator at 4°C prior to analysis.

Soil Analysis

The soil sample was carried out with a drill on a layer of 0–30cm. Composite samples were obtained from the points corresponding to the angles of an unspecified triangle. Sub-samples of soil (2–3kg) taken from each site were mixed and conditioned in polyethylene bags at ambient temperature prior to metal analysis.

The soil was air-dried in a clean room and crushed to obtain the fractions ranging from 0.1µm to 2mm. Standards for total digestion by fluorohydrin and perchloric acid were used for metal element determination. 1.0g of dried soil was digested with a mixture of HCl04 and HF (1:1 v/v). The solution was boiled and evaporated close to dryness on a hot plate at 160°C. The residue was diluted in HCl 2% and filtered before analysis for the determination of metals. All samples were analyzed at PRODA Enugu.

Impact of Housing Development on Surface and Underground Water Quality

Experimental Results

Table 1: Water Sample Analysis

	Values in (Mg/l)							
Sample ID	**CU**	**Pb**	**Cd**	**Cr**	**Ars**	**Co**	**Ni**	**Hg**
Fidelity Estate Ebeano Tunnel Sample 1	Nil	6.32	0.22	Nil	0.44	Nil	0.52	0.002
Riverside Housing Estate Abakpa	0.07	3.76	0.23	0.04	0.14	Nil	0.10	0.002
MiriochaAbakpa	0.05	4.81	0.26	0.02	0,73	0.68	0.22	0.004
Maryland Estate Location 1	0.20	5.20	0.25	0.03	Nil	0.63	Nil	0.005
Fidelity Estate Spring Control 1	0.02	5.54	0.24	Nil	0.53	0.40	0.06	0.002
Bethel Estate Emene, PRODA	0.10	5.32	0.22	Nil	Nil	0.51	Nil	0.002
Ekulu River OrieEmene	0.05	3.52	0.26	0.01	0.54	0.31	0.53	0.005
Maryland Estate Location 2	0.18	1.17	0.25	0.30	1.55	0.66	0.88	0.002
Asata River Okwuosa	0.02	6.01	0.25	Nil	Nil	0.42	1.04	0.002
Abakpa Control Well Water	Nil	5.58	0.30	0.32	0.91	0.58	0.46	0.002
Ekulu River, Coal City Emene	Nil	3.74	0.26	0.32	0.52	0.57	0.45	0.003
W.H.O.	1	0.01	0.003	0.05	0.05	0.01	50	0.001

Source: *Researcher's field work 2022*

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The physico-chemical and elemental characteristics of water samples collected from the sampled housing estates were reported in Table 1—the physico-chemical and elemental characteristics of the water samples for respective estates. On average, the Ph for the collective sampled estates yielded approximately 5.88. The average value for ES yielded 106.21, TDS yielded a mean value of approximately 92.73, the mean value for TSS yielded a striking value at the magnitude of 431, and TS yielded a mean value of 523.6. The average value of Nitrate was computed and it yielded a mean value of 2.20. The average total hardness of water was computed and it yielded a magnitude of 29.82. The C.L of the water characteristic yielded an average level of 24.46. The alkalinity and phosphate yielded average values of 123.63 and 312.07 respectively. Based on the analysis, one can conclude that housing development has a significant impact on the water quality of Enugu Urban. This reveals that these buildings and their construction process adversely affect the burnt environment of Enugu Urban.

Survey Results

Table 2: Perception of Housing Development on Water Quality

		Frequency	Percent
Valid	Very Significant	108	28.2
	Significant	157	41.0
	Average	68	17.8
	Insignificant	42	11.0
	Very Insignificant	8	2.1
	Total	383	100.0

Source: *Researcher's field work 2020*

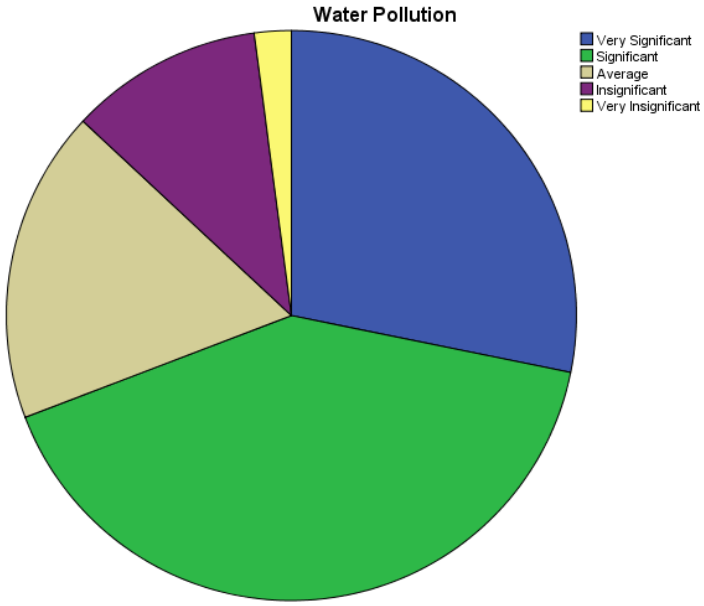

Figure 2: Graphical Representation of Public Perception on Water Quality

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Table 3: Result of One-Sample Test of Public Perception on Water Quality

	Test Value = 0					
					95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Water Pollution	8.789	382	.008	2.19843	2.0950	2.3019

Source: *Researcher's field work 2022*

The survey result and analysis carried out to estimate the impact of housing development on water quality in Enugu Urban are empirically displayed in Table 5.9 and Figure 6 respectively. It can be clearly deduced that 108 (28%) of the respondents indicated that the impact of housing development on water quality is very significant, 157 (41%) indicated that it is significant, 68 (17.8%) said it is average, 42 (11%) indicated that it is insignificant and just 8 (2.1%) indicated that it is very insignificant. Hence, on the average, the majority of the respondents agree that housing development has a significant impact on water quality in Enugu Urban. From the one-sample statistical analysis computed from the survey analysis, the t-test yielded $8.789 > |2|$. This entails that housing development significantly affects water quality in Enugu Urban.

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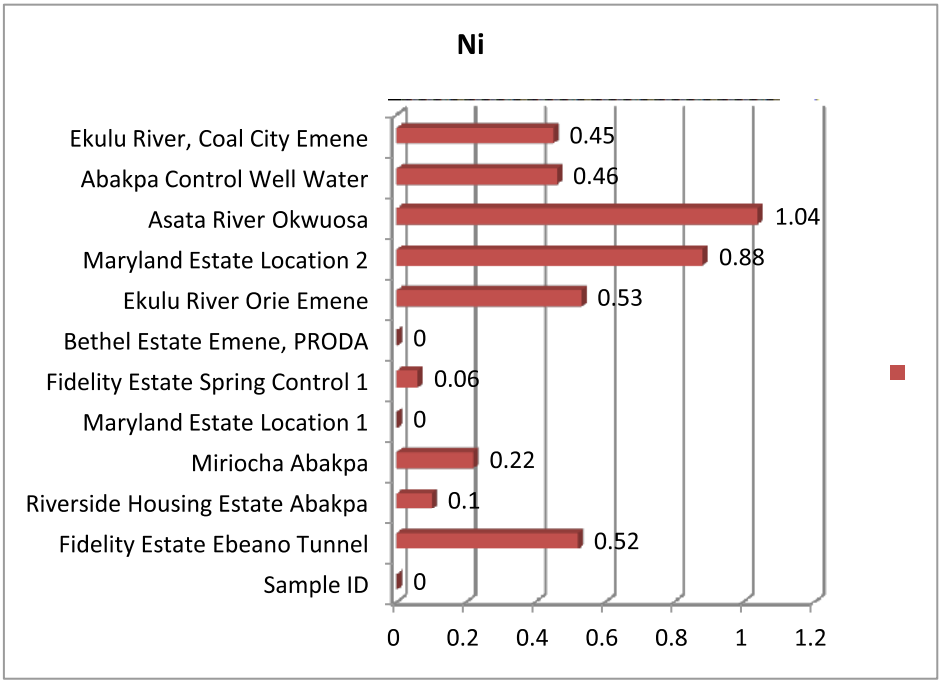

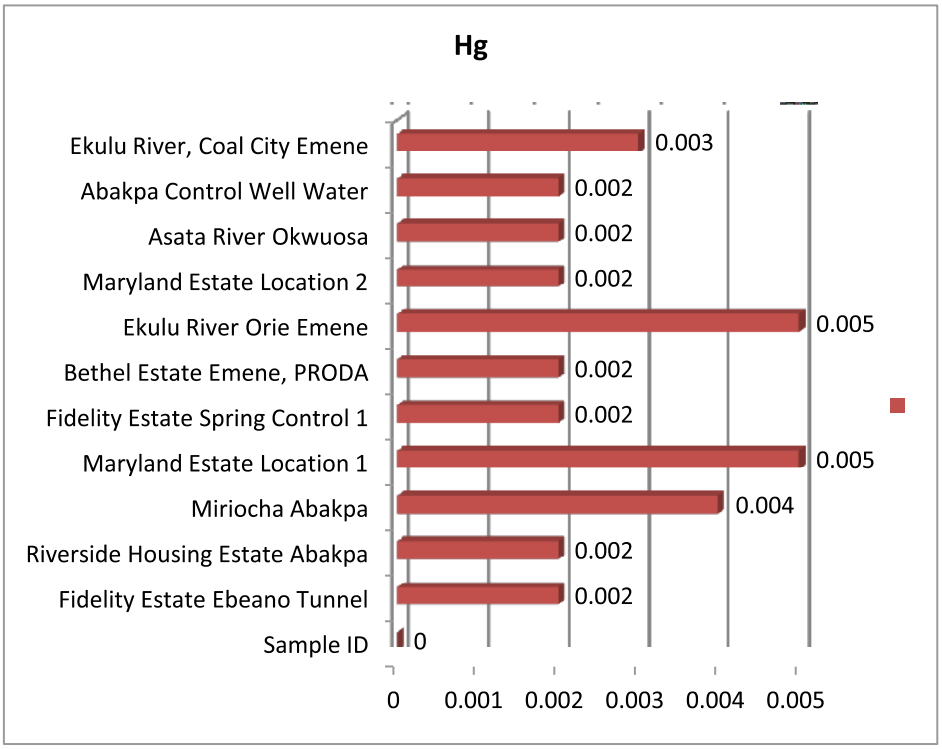

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Impact of Housing Development on Soil Quality

Experimental Results

The results obtained from the laboratory analysis of relevant physico-chemical parameters are shown in Table 4 and Figures 8 and 9. It is clear from the table that soil pH in the vicinity of Okwuosa, Ekulu, Maryland and Riverside rivers are very acidic and thus is indicative that living organisms may not exist in such soils.

Table 4: Results of Physico-Chemical Analysis of Collected Soil Samples

Sample ID	Total Organic Carbon (%)	Ph	Organic Matter (%)	Fixed Carbon
Okwuosa	1.40	3.65	4.15	17.55
Ekulu Coal City, Emene	0.92	4.16	2.73	11.55
Maryland	1.14	4.23	3.38	14.30
Miricha Abakpa	0.93	6.10	2.76	11.68
Ebeano Tunnel	0.89	7.07	2.64	11.17
Riverside Abakpa	1.07	4.20	3.17	13.41
W.H.O.	6.5ug/I	No limit listed	2.9	17.9

Source: *Researcher's field work 2020*

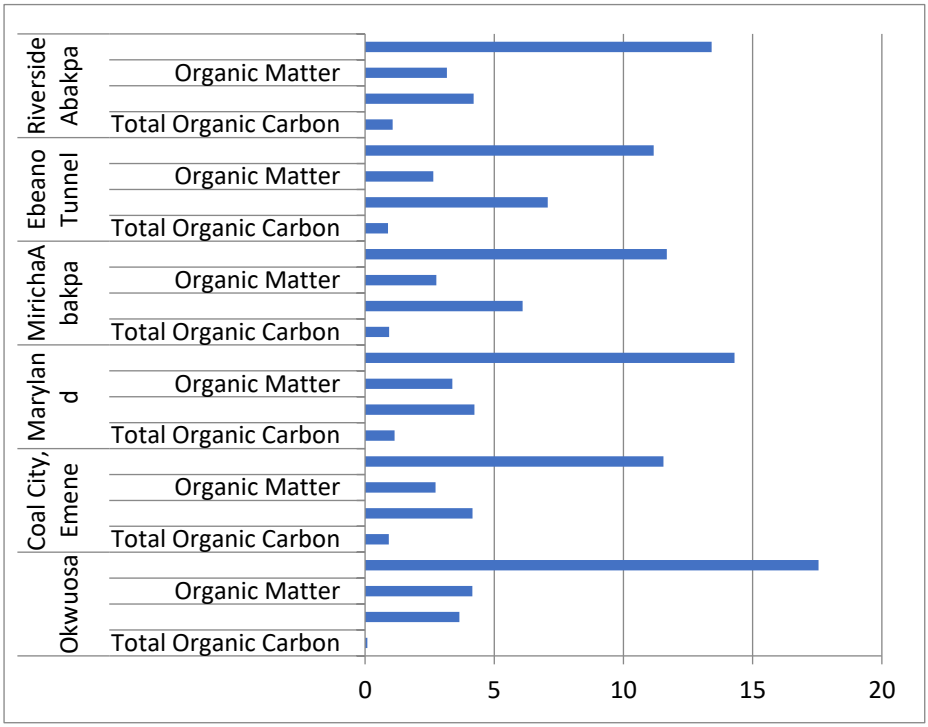

Figure 3 : Graphical Representation of Result of Physico-Chemical Parameters

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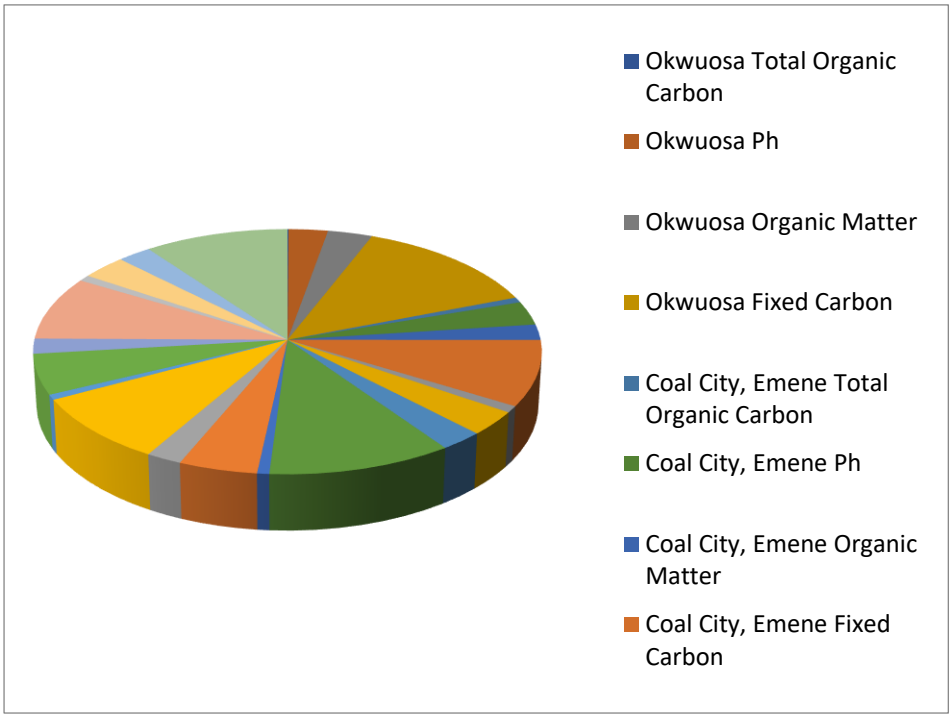

Figure 4: Graphical Representation of Other Physico-Chemical Parameters

It can be clearly seen from Table 4 that Okwuosa has the highest percentage of Total Carbon at the Magnitude of 1.40%, which was followed closely by Maryland which yielded 1.14%. The table further shows that Riverside Abakpa yielded a Total Organic Carbon of 1.07%, Ebeano Tunnel yielded 0.89%, Miricha Abakpa yielded 0.93% and Coal City, Emene yielded 0.92%.

From the dimension of pH which is another physico-chemical characteristic, Ebeano Tunnel yielded the highest outcome at the magnitude of 7.07%, followed closely by Miricha Abakpa (6.10%), Okwuosa yielded 3.65%, Coal City (4.16%), Maryland (4.23%) and Riverside Abakpa yielded a value of 4.20%.
From the dimension of Organic Matter which was recorded in relative percentage, Table 5.5 yielded 4.15%; for Okwuosa, the table further reveals that Coal City, Emene yielded 2.73%, Maryland yielded 3.38% which is the second highest to Okwuosa, Miricha Abakpa yielded 2.76%, Ebeano Tunnel yielded 2.64% and finally, Riverside Abakpa an organic matter of 3.17%. Fixed Carbon as one of the physico-chemical characteristics of the collected soil sample was extracted and analyzed. Table 5.10 reveals that Okwuosa yielded a Fixed Carbon of 17.55%, Coal City Emene yielded 11.5%, Miricha Abakpa yielded 11.68%, Ebeano Tunnel yielded 11.17% and Riverside Abakpa gave an output of 13.41%. This clearly shows that Okwuosa has the highest level of soil total fixed carbon, and Ebeano Tunnel has the least level of soil total carbon.

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Table 5: Results of Heavy Metal Contaminants for Soil Samples

Values in (Mg/g)								
Sample ID	**CU**	**Pb**	**Cd**	**Cr**	**Ars**	**Co**	**Ni**	**Hg**
Okwuosa	0.09	Nil	0.004	Nil	0.30	0.01	Nil	Nil
Coal City, Emene	Nil	0.09	0.02	Nil	0.08	0.14	0.01	Nil
Maryland	Nil	Nil	0.02	Nil	0.64	0.20	Nil	Nil
Miriocha Abakpa	0.007	Nil	0.02	Nil	Nil	0.04	Nil	0.002
Ebeano Tunnel	0.003	0.08	Nil	0.02	0.01	0.11	0.003	Nil
Riverside Abakpa	0.001	0.09	0.04	0.01	0.35	0.12	0.01	0.001
W.H.O.	1.98	0.009	3.2	1.91	2.78	2.54	4.21	1.2

Source: *Researcher's field work 2020*

The soil testing for heavy metals contaminants was also carried out and analysis produced specific outcomes for specific physicochemical parameters. Table 5 is a tabular presentation of the analytical results with respective housing estates while the raw data pie chart analysis was reported in appendix I. Table 5 reveals that Okwuosa soil sample constitutes inorganic chemical hazards as it contains copper (Cu) at the magnitude of 0.09mg/g, zero lead (Ph), Cadmium (Cd) of 0.004mg/g, Chromium (Cr) of zero contents, Arsenic (Ars) of 0.30% and Co of 0.01.

Coal City Emene has a lead (Pb) value of 0.09mg/g, Cadmium (Cd) of 0.02mg/g, Arsenic (Ars) of 0.08mg/g, Co of 0.14mg/g and Nickel (Ni) of 0.01mg/g.

Maryland recorded a Cadmium (Cd) value of 0.02mg/g, Arsenic (Ars) of 0.64mg/g, Co of 0.20mg/g.

Miricha Abakpa recorded a Copper (Cu) of 0.007mg/g, Cadmium (Cd) of 0.02mg/g, Co of 0.04 and Mercury (Hg) of 0.002. Furthermore,

Ebeano Tunnel yielded a Cu of 0.003mg/g, Ph of 0.08mg/g, Cr of 0.02mg/g, Ars of 0.01mg/g, Co of 0.11mg/g and 0.03mg/g. Finally, it can be deduced from Table 5.11 that the soil sample collected from Riverside Abakpa yielded a Cu of 0.001mg/g, Ph of 0.09mg/g, Cd of 0.04mg/g, Cr of 0.01mg/g, Ars of 0.35mg/g, Co of 0.12mg/g, Ni of 0.01mg/g and Hg of 0.001mg/g.

In summary, based on the physico-chemical elemental analysis, it can be concluded that the public housing estate has a significant impact on the quality of soil for the period under analysis.

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Survey Results

Table 6:~ Public Perception of Soil Quality in Enugu Metropolis

S/N	Perception	Frequency	Percentage
1	Very Significant	173	45.2
2	Significant	91	23.8
3	Average	90	23.5
4	Insignificant	21	5.5
5	Very Significant	8	2.1
Total		**383**	**100**

Source: *Researcher's field work 2022*

Table 7: Result of One-Sample Test on Public Perception on Soil Pollution

	Test Value = 0					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Soil Pollution	36.576	382	.004	1.95561	1.8505	2.0607

Source: *Researcher's field work 2022*

Table 6 clearly shows that 173 (45.2%) of the respondents agreed that the impact of housing development on soil quality is very significant. 91 (23.8%) of the respondents posited that it is significant, 90 (23.5%) said it is average, 21 (5.5%) dictated that it is insignificant and 8 (2.1%) dictated that that the impact of housing development on soil quality is very insignificant. This entails that on the average, majority of the respondents agree that the housing development has significant impact on soil quality in Enugu Urban. From the one-sample statistical analysis computed from the survey analysis, the t-test yielded 36.576 >|2|. This entails that housing development significantly affects soil quality in Enugu Urban.

SUMMARY, CONCLUSION AND RECOMMENDATION

The major findings of the study are as follows:

1. Based on the statistical analysis, it was found out that on the average, housing development contributes negatively and significantly to water quality in Enugu urban ($p = .003 < 0.05$). The experimental results revealed the physico-chemical and elemental characteristics of the water sample for the selected respective estates.

2. Based on the statistical analysis, it was also found out that on the average, housing development contributes significantly to soil quality deterioration in Enugu Urban ($p = .007 < 0.05$). The experimental dimension revealed that total organic carbon, pH, organic matter and fixed carbon yielded average values that confirmed that housing development adversely affects soil quality in Enugu Urban for the period under analysis.

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CONCLUSION

This study has been able to carry out an empirical analysis of assessment of the impact of housing development on the biophysical environment in Enugu Urban. In the course of the study, the biophysical concept was measured with two elements namely water, and soil. The study was primarily focused on estimating the biophysical impact of housing development in Enugu Urban. Based on the findings of the study, it was concluded that housing development in Enugu Urban though providing accommodation for the people and generating rent income for the landlords/house owners, has a long-run negative implication on the environment and biophysical elements. It is really alarming that with an increase in housing development, water and soil quality are at risk. This calls for urgent policy intervention.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were suggested:

1. Wastes that are pushed into waters could be turned to wealth with some research on recycling. Secondly, water pollution is not easy to solve. It is necessary that all hands must be on deck to fight it. This means that aside from controlling housing development, both government and citizens' cooperation are needed to reduce water pollution to the barest minimum. Since water contamination comes from many different sources and has many numerous effects, every aspect of water pollution needs to be addressed.

2. To sustain and improve soil quality in Enugu State, there is also a need for supported active research into waste minimization strategies, waste avoidance technologies, cleaner production processes and zero emission concepts.

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