Assessment of The Effects of Hot-Mixed Asphalt Production on Surface Water in Owerri, Imo State, Nigeria.

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***Abstract*- The need for infrastructural development carries with it the concomitant problem of pollution. Water is ranked as second only to oxygen as essential for all life, while water quality management contributes to achieving all the millennium development goals (MDGS) (UNEP GEMS, 2007). Owerri Capital territory is bordered on the east by the Otamiri river and on the south by the nworie river. These two rivers are the source of water supply for people. Little attention has been given to validating the quality of these surface water within Owerri.**

This study evaluated the effect of Hot-Mix asphalt production on the surface water quality of Owerri. Purposive sampling was used to select two Asphalt factories out of eight (8) factories within the study area. Samples were collected during the rainy and dry seasons. Findings revealed high level of contamination in the study area Owerri in both the new factory and old factory environment in both seasons.

The following water parameters, hardness, NO_3, PO_4, and SO_4, were high. The research recommends amongst others that Asphalt production factories be sited at least 1 kilometer away from the nearest surface water (River) and the use of brand-new Asphalt production equipment.

***Indexed Terms*- Hot-Mix Asphalt, Environmental impact, Assessment**

I. INTRODUCTION

Environmental problems have become a global issue and have been generating ripples and waves all over the world. In 1984 the United nations established the world commission on Environmental development, charged with the responsibilities amongst others, to re-examine the critical issues of Environment and Development and to formulate innovative, concrete and realistic proposals to deal with them, (WCED,2987). The commission generated a report on the concept of Sustainable Development, defined as " Development which meets the needs of the present, without compromising the ability of future generations to meet their own needs, Okoh (2009), the focal point of the entire programme, is the reduction or elimination of environmental squalor by addressing the issue of inadequate potable water supply, poor liquid and solid waste disposal facilities, water and air pollution etc.

An Environmental Impact Assessment (EIA) is an assessment of the possible positive negative impact, that a proposed project may have on the environment. The purpose of the assessment is to ensure that decision makers consider the accompanying environmental impact when deciding whether to proceed with a project (Mustapha, 2011).

Asphalt manufacturing plants, mix gravel and sand with crude oil derivatives to produce asphalt used to pave roads, highway and parking lots (US, EPA, 2011). These asphalt plants release millions of pounds of chemicals to the air during production, including many toxic pollutants.

Owerri as the capital of Imo state Nigeria, is the political, socio-economic and financial hub of the state, Owerri showcases all the developmental efforts of both public and private sector. With a population of 1,401,873 as of 2016 and approximately 100 square kilometers in area. Owerri consist of three local government areas including Owerri municipal, Owerri North and Owerri West. Owerri is bothered by the Otamiri River to the east and Nworie River to the south.

There are eight (8) active asphalt production factories in the last thirty-four (34) years in asphalt production and Hot-mix asphalt laying process in the area may have affected air quality, contaminated soil and streams. Obiekezie,(2005) observations at HMA facilities reveals the emission of thick black smoke during the production process, there are also soots deposits inside dwellings and roof tops. The National Environmental Standard and Regulations Enforcement Agency (NESREA) states “Asphalt processing and asphalt manufacturing facilities are major source of hazardous air pollutants.

These pollutants are dangerous because they tends to bio-accumulate (Montgomery, 2007). There is also the problem of discharge of untreated effluent into water niches and wet lands (El-kady, 2011). The impacts of these depositions, the multiplier effects and accompanying environmental degradation is yet to be given due attention in Owerri, the study area.

The study evaluated the physiochemical parameters of surface water in the study area Owerri. The emission loads were assessed and the effect of the emissions on the water quality analyzed.

This study seeks to evaluate the effect of Hot-Mix asphalt production on the surface water quality of Owerri, in order to develop an acceptable framework for the establishment of Hot-Mix asphalt production factories within the Owerri environment.

This work examined the emission load from asphalt production factories and analyzed the effects on the surface water quality of the study area.

II. RESEARCH METHODOLOGY

This study is essentially Ex-post facto.

This is a quasi-experimental study examining how an independent variable present prior to the study of the participant effects a dependent variable.

In designing this experiment, two groups were set up, an experimental group and a control group.

The only different between the two groups is the variable. The variable tested is the emissions.

The population of the study comprises eight (8) asphalt plants in Owerri, see table

S/N	NAMES	LOCATION
1	MACOL	OWERRI-ABA ROAD
2	JALINGO	OWERRI-ABA ROAD (GPS $5^0,27^1,43.44^{11}$ N, 7^0 02 34.3E)
3	ROYAL ROCK	ONITSHA ROAD INDUSTRIAL LAYOUT
4	MACON	ONITSHA ROAD INDUSTRIAL LAYOUT
5	RUDO	ONITSHA ROAD INDUSTRIAL LAYOUT
6	FRANK & G	ONITSHA ROAD INDUSTRIAL LAYOUT
7	NEW IDEA	ONITSHA ROAD INDUSTRIAL LAYOUT
8	RHAS	ONITSHA ROAD INDUSTRIAL LAYOUT (GPS $5^030^147.3^{11}$N,$6^034^147.9^{11}$ E

Purposive sampling was employed in selecting two asphalt factories namely Jalingo asphalt factory at Naze kilometer 2, owerri-aba highway and Rhas Asphalt factory at Irete, along Owerri-onitsha federal highway. The criteria for choosing both asphalt factories, as their location and number of years in operation., Jalingo asphat factory is located on owerri-aba highway and has been in operation for seven (7) years, while Rhas asphalt factory is on owerri-onitsha road and has been in operation for twenty-two (22) years

The Jalingo Asphalt factory is bordered on the west by the otamiri River, while the Rhas Asphalt factory is bordered in the south by the Nworie River Primary data was collected from the two asphalt factories through observation and recording with requisite instruments. Secondary data was sourced through libraries, professional journals and magazines.

III. WATER SAMPLING

Water samples were collected in 2 liters plastic containers from the subsurface (15-20cm) deep. The samples were collected along the banks the surface water at four location

Close ------ 100 meters from edge of asphalt factory
DS 1 -------100 meters from DS1

DS 2 -------- 100 meters from DS 2
CONTROL ..... 1 kilometer from DS 1

Samples collected were transferred into clean Storage container. All samples collected were properly packed in ice containers and transferred to laboratory for analysis. The samples were analysed within twenty-four (24) hours, Nwaugo et al(2012).

Water samples taken were analysed for PH, total dissolved solids, temperature conductivity and water hardness.

The temperature, PH and conductivity were determined in the field using portable battery operated conductivity meter (model DC ten-way, USA). The measurement was done insitu by dipping the probe into the water Samples and reading off the values directly. The readings were taken two times in the day (morning and evening) Nwaugo et al (2012).

Nitrate was determined colorimetically using UNICAM UV Visible Spectrometer Model 939. One ml of the sample was analysed directly using brucine sulphate as a complexing agent in the presence of sulphuric acid and measured at a wavelength of 090758475900km.

Phosphate was determined in accordance with CAEM/ALPHA 4500-P-D, also a barometric method but based on a blue complex induced by the addition of stan-nova chloride analysed at a wavelength of 080391746090km.

Sulphate in water was determined using the turgid metric method based on chemical analysis of ecological matter (second edition) and ALPHA 4500S042

Water hardness was determined titrametically using ethyl diamitetracine acid. Water samples ($50cm^3$) were placed in an Ertenmeyer flask and 1-2 drops of dilute H_2SO_4 was added. Standard EDTA titrant was added slowly from a burette with continuous stirring until the last reddish tinge disappeared from the solution giving a blueish end point.

The PH was determined insitu, electrometrically by using PH/Temperature meter (HANNA INSTRUMENTS, HI 2210). The meter was calibrated with PH buffers of 4,7 and 10 to correspond with the expected PH range of the sample by adjusting slope calibration controls. the PH value and temperature were displayed on the LCD of the meter using mode control.

Data generated was tested for homoscedasticity. It was necessary to determine if the data share a common covariance. One way ANOVA with post-hoc Turkey test was employed to generate the statistical difference between the parameters analyzed in the study using SPSS

IV. DATA PRESENTATION AND ANALYSIS

Table 1. Comparison of mean values for surface water for newer plant and older plant, dry season

NEWER			OLDER		
ELEMENT	RANGE	MEAN	RANGE	MEAN	WHO/FME
TEMPERATURE	28-28.4	28.2	28.4-29.3	28.9	25
PH	6.1-6.6	6.35	5.8-6.6	6.2	6.5
EC	78.4-36.5	57.45	30.6-98	64.3	100
HARDNESS	10.2-26.4	18.30	11.4-18.2	14.80	50
TURBIDITY	2.5-6.4	4.45	3.0-6.3	4.65	
TDS	11.20-16.70	13.95	11.3-87.4	49.35	25
TSS	16.40-70.00	43.20	10.6-20.7	15.65	
SO_4	1.6-7.8	4.70	3.0-8.2	5.60	25
PO_4	0.4-2.10	1.25	0.9-10.4	5.63	1.0
NO_3	0.5-1.9	1.20	0.8-2.00	1.4	20

Table 1 above compared the values of parameters recorded at the newer plant and older plant in the dry season with WHO standard. The mean values were derived from appendices 1 and 2. All the values obtained for all the parameters were lower than standards of the same, except for TDS which recorded a higher value of 49.6163mg/L.

Table 2. Comparison of mean values for surface water for newer plant and older plant, rainy season.

NEWER			OLDER		
ELEMENT	RANGE	MEAN	RANGE	MEAN	WHO/FME
TEMPETURE	27.00-27.5	27.25	28.00-28.8	28.4	25
PH	6.3-6.4	6.35	5.3-6.4	5.85	6.5
EC	35.4-54.5	44.95	36.3-59.4	47.85	100
HARDNESS	12.1-18.3	15.20	10.6-25.3	17.95	50
TURBIDITY	6.0-8.2	7.1	6.1-8.8	7.45	50
TDS	9.2-18.4	13.80	10.5-16.4	13.45	25
TSS	92.2-141.4	116.8	10.5-16.1	13.30	25
SO_4	1.4-6.7	4.05	2.4-9.7	6.05	25
PO_4	0.6-3.6	2.10	1.1-4.4	2.75	1.0
NO_3	0.70-1.80	1.25	0.80-2.95	1.88	2.0

From table 2 above, all the mean values for the parameter recorded higher values than standard. The mean values were derived from appendices 3 and 4. The trend was same for both newer plant and older plant locations. For all the physicochemical properties tested, highest values were obtained nearest the facility. The values decreased as you move down stream.

V. DISCUSSION OF FINDINGS

Analysis of the surface water showed high level of contamination in the study area in both the new and old asphalt factory areas. Observations in the physiochemical properties in the new asphalt, showed highest values nearest the plant and limited to 100m of the plant. The parameters showed high seasonal effects as some of the values were significantly increased during the rainy season above those of the dry season.

Temperature, acidity EC and hardness decreased considerably during the rainy season. This could be attributed to the cooling effect of water and its consequent dilution. This solution decreased the metallic ions concentration and hence lowered Electrical Conductivity, increased acidity (high PH values) and hardness. On the other hand, a lot of other particulate matter with mineral attachment and contents were washed into the surface water body. This increased the mineral nutrient content of NO_3, PO_4, and SO_4.

The increased substances further caused the observed increase in turbidity as a result of increased TSS and TDS following storm water runoffs during the wet season rains (Nwaugo et al 2006) (Pelczar, Chan and Noel, 2020).

Macginlly (2011) observed that water became more turgid with increase in particulate matter, TSS and TDS. This could be so, as rain water might have washed the carbonates, nitrate, sulphate and phosphates deposited on the soil into the surrounding river. Okeke, Ndu, Nwachinemere, Nawfal, Abada and Onwasigwe (2018), Nwaugo et al (2007, 2008) and Iwegbue et al (2006) reported that the highest concentration of pollutants is at the source of the pollution. This explains why the highest impact of the environmental alterations were observed nearest the asphalt factories, observations of the result also showed higher values were reported at the older asphalt factory location. The effect of the older plant extended up to DS 2 (200m) away from the factory. This shows that the effect has been long and gradually extended to areas initially considered to be out of reach. This observation indicates that, if left unchecked, time will come when the effect will extend further to areas presently unaffected.

CONCLUSION AND RECOMMENDATION

Asphalt production factories, releases substances into the surroundings during production. These emissions affect the physiochemical properties of surface water around the factory. The emission load is higher nearest to the factory location and tends to decrease as you move away downstream. Contamination of the surface water is therefore at the source of the pollutant, that is the asphalt production factory.

RECOMMENDATION

Against the backdrop of results and findings of this study, the following protocol is recommended for the establishment of Hot-mix Asphalt facility.

1. Regulatory agencies e.g. Federal Ministry of Environment, Housing and Urban Development must ensure compliance with licensing and other approval requirements before asphalt factories are set up.

2. Insist on only brand-new asphalt production equipment. Fairly used (Second hand should not be approved)

3. Carryout Environmental Audit every five years, to ensure asphalt factory locations maintain good clean environment.

4. Direct asphalt plants factory owners to use modern emission control devices like scrubbers and dust collectors.

5. site asphalt plants at least 1km away from the nearest source of surface water.

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APPENDICES

Appendix 1: Physicochemical properties of the surface water from new asphalt plant dry season

				Distance
Parameter	Close	DS_1	DS_2	US
Temp. ºC	28.4	28.1	28.0	28.0
Ph	6.1	6.4	6.6	6.6
EC-µsm^{-1}	78.4	61.8	36.1	36.5
Hardness	26.4	20.2	10.6	10.2
Turbidity	6.4	5.2	2.5	2.5
TDS mg/l	16.7	16.6	12.6	11.20
TSS mg/l	6.4	70.0	43.5	41.4
SO_4 mg/l	7.8	4.3	1.4	1.6
PO_4 mg/l	2.10	1.04	0.9	0.4
NO_3 mg/l	1.90	1.5	0.6	0.5

Appendix 2: Physicochemical properties of the surface water from old asphalt plant dry season

	Distance			
Parameter	Edge	DS1	DS2	Control (US)
Temp. ºC	29.3	29.1	29.0	28.4
pH	5.8	6.6	6.6	6.6
EC-µsm^{-1}	98.0	74.2	38.4	30.6
Hardness	18.2	16.4	13.4	11.4
Turbidity	6.3	6.1	3.4	3.0
TSS mg/l	20.7	17.3	10.6	10.8
TDS mg/l	11.3	87.4	50.3	47.5
SO_4 mg/l	8.2	6.3	3.2	3.0
PO_4 mg/l	3.6	2.5	10.4	0.9
NO_3 mg/l	2.00	1.80	1.00	0.8

Appendix 3: Physicochemical properties of the surface water new asphalt the rainy season.

		Distance		
Parameter	Edge	100m	200m	300m
Temp. ºC	27.5	27.5	27.0	27.0
pH	6.3	6.3	6.4	6.4
EC-µsm^{-1}	54.5	48.5	36.3	35.4
Hardness	21.4	18.3	12.1	12.1
Turbidity	8.2	7.4	6.0	6.0
TES mg/l	18.4	12.2	9.3	9.2
TSS mg/l	141.4	118.4	92.2	92.2
SO_4 mg/l	6.7	3.7	1.5	1.4
PO_4 mg/l	3.6	1.6	0.5	0.6
NO_3 mg/l	1.80	1.64	1.47	0.70

Appendix 4: Physicochemical properties of the surface water of old asphalt plant rainy season

	Distance			
Parameter	Close Fence	DS1 100m	DS2 200m	US 300m
Temp. ºC	28.8	28.6	28.0	28.0
pH	5.8	6.0	6.3	6.4
EC-µsm^{-1}	59.4	47.3	38.7	36.3
Hardness	25.3	18.5	11.3	10.6
Turbidity	8.8	8.0	6.4	6.1
TSS mg/l	16.1	21.3	11.7	10.5

TDS mg/l	16.4	13.6	10.4	10.1
SO_4 mg/l	9.7	6.8	2.7	2.4
PO_4 mg/l	4.4	3.0	1.0	1.1
NO_3 mg/l	2.95	2.20	0,9	0.80