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Impacts of Flooding on Road Transport Infrastructure In Enugu Metropolitan City, Nigeria.

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ABSTRACT
An assessment of the impact of flooding on the road transport infrastructure in Enugu Metropolis was carried out using survey research method. Thirty impact indicators were rated by the respondents against six impact dimensions of *population, vulnerability of activities, frequency, intensity, extent and risk.* Three null hypotheses were postulated and tested. One sample t-test was used for testing hypothesis one which stated that damages to the road transport infrastructure resulting from flooding are not significant to warrant mitigation.Since the p-value =0.000($p<0.05$), the null hypothesis is rejected.Structural Equation Modelling (SEM) was used for testing hypotheses two and three. A statisticallysignificant impact was recorded in hypothesis two since the calculated p–value (0.000) was less than 0.05, ($p < 0.05$), indicating high impact of flooding on the socio-economic activities in Enugu urban.Furthermore a statistically significant impact was equally recorded in hypothesis three since thecalculated p–value (0.000)was less than 0.05, ($p < 0.05$). The implication was that damages to road transport infrastructure due to flooding have significant impact on the environmental sustainability of the study area. The model generated hadGoodness of Fit Index (GFI) = 0.974; Adjusted Goodness of Fit Index (AGFI) = 0.951; Comparative Fit Index (CFI)= 0.949 and Incremental Fit Index (IFI) = 0.950; while the Root Mean Square Error of Approximation (RMSEA) = 0.059. The paper therefore recommendedproper infrastructural design and planning, good governance, population control and appropriate weather monitoring as some measures that could be adopted to mitigate the impact of flooding on the road transport infrastructure in Enugu Urban.
Key words: Flooding, Infrastructure, Impact,Mitigation.

I. Introduction

Flood is a natural process which occurs when water inundates land that is ordinarily dry. When rain falls on an area of land (catchment), some of the water percolate into the soil while the left-over flows downhill as runoff and the amount of this runoff depends largely on the nature of the catchment. Floods therefore occur when the amount of water from the catchment far exceeds the capacity of the drain channels available. The intensity of *rainfall*, the*catchment* and the *drains* are therefore major contributory factors to flooding. Flooding is a major environmental phenomenon creating severe impacts on the socio-economic and environmental aspects of human endeavour. It is prominent in highly built-up and low-lying areas especially where little or no attention was paid to proper planning in the development of infrastructures. These infrastructures, therefore are highly vulnerable and are the first to receive the impacts of this event, prominent among which is the road transport infrastructure which attracts very high budgetary provision in the overall development process. Nemry and Demirel (2012), stated that for road infrastructures, weather stresses represent from 30% to 50% of current road maintenance costs in Europe (8 to 13 billion € /year) and that 10% of these costs (0.9 billion € /year) are associated with extreme weather events alone, in which extreme heavy rainfall and flood events represent the first contributors. They further opined that construction, design and maintenance of transport infrastructures are essential to maintain their integrity and serviceability. The cost implication of flooding was highlighted as Aliyu (2014), copiously quoting NEMA (2013), stated that Nigeria, in 2012, experienced an unprecedented flood disaster that affected half of the 36 states with 21 million people displaced; 597,476 houses destroyed or damaged; over 363 people killed and an estimated loss of USD 19.6 billion. However, conspicuously absent in this report was the damage to road transport infrastructure.

High incidence of flooding could be attributed to climate change, reduction in percolation, poor environmental and infrastructure planning, poor governance, population explosion as well as rapid urbanization. The persistent migration of people from deprived areas, coupled with poor governance have put unprecedented pressure on cities' resources and infrastructure (Odufuwa, Adedeji, Oladesu and Bongwa, 2012).Flood is a natural disaster and its occurrence is exacerbated by various human activities' interface with the environment.The impacts and effects of flooding have alsobeen noted to range from submerging of roads, obstruction of traffic, coastal erosion, disruption of economic activities, displacement of people, loss of property, to loss of lives,Akukwe and Ogbodo(2015) quotingEtuonovbe (2011). These impacts can be viewed from both short term, medium and long term perspectives. The immediate impacts include: destruction of roads, bridges and culverts and disruption of road transport systems, traffic jams, long travel time, loss in man-hour, stress, fatigue as well as other stress related issues. In the medium and long term, impacts include: cost of rehabilitation of damaged infrastructures, cost of reconstruction of existing ones to cope with futureoccurrences, restoration of lost assets.

In Enugu urban, significant improvement on the road transport infrastructure has been made over the past eight years but these roads are fast deteriorating in spite of evident quality of the design and construction. The severe damage inflicted on these roads, bridges, culverts and public rights of way is becoming alarming and a source of serious concern especially when one considers the enormous resources ploughed into the design and construction process. The ultimate factor of damage is not the quantity of water but how high water is above normal restraints or embankments as stated inAdedeji and Salami (2008). Some of the major roads within the metropolis have started showing signs of severe structural failure. They are inundated when it rains while the drainage systems have been overwhelmed, apparently converting these roads to drainage line probably as a result of blockage and silting of the designed drains.

It has become a nightmare for city dwellers in Enugu urban each time there was a downpour. Commuting takes considerably longer time thus compounding the already bad traffic situation. The very few diversionary routes which lack the capacity to take the diverted traffic are helplessly overwhelmed and do not seem to offer any significant response to the chaotic traffic congestion. Kofo (2012) stated that flood destroys farmlands, property, industrial installations, roads, railways, residence and it carries people away. The consequences of flooding are more severe at the rural areas where costs are more significant and funds less available. Productivity, security, welfare, economic viability, social stability and environmental sustainability are facilitated by efficient road network and so whereroad alignment is wrong and road inefficient, flooding is precipitated causing infrastructural breakdown, thus hindering the availability of urban facilities.

Authors such as Odufuwa*et al*, 2012; Watson, 1993; Neal and Curtis, 2008; Tibaijuka, 2008;have argued that cities are the focal points that enhance economic and social activities of people in the society at large.Kazmierczak and Kenny (2011), further posited that various types of infrastructure, including water and energy supply, communications, transport, but also emergency services (e.g. hospitals) and social infrastructure (e.g. schools) allow the modern society to function and the importance of infrastructure in our lives is emphasised when it is damaged, or when its function is hindered,

Furthermore, experts have copiously written on flooding but there is dearth of literature on its impact on city transportationresulting in the uncertainty about the potential impacts. For instance, Tunstall et al, (2006); Tapsell et al (2002); Adger et al (2005); Brouwer and Remco (2004), all wrote on the social impact of flooding, while Green et al (1991); Few (2003); Akukwe and Ogbodo (2015) concentrated on risk and vulnerability to flooding.

There are emerging signs of dilapidation on the urban roads in Enugu city that could be linked to flooding.In this paper, therefore an assessment of the impact of flooding on the road transport infrastructure is most imperative so as to alert the policy makers to devise a lasting strategy to cub the menace on the city roads.

Three null hypotheses were postulated and they include:

Ho: Damages to the road transport infrastructure resulting from flooding are not significant to warrant mitigation;

Ho: Damages to road transport infrastructure due to flooding has no significant impacts on the socio-economic activities of Enugu urban.

Ho:Damages to road transport infrastructure due to flooding has no significant impact on the environmental sustainability of Enugu urban road transport infrastructure. This study is anchored on these three hypotheses.

II. Materials and Methods

2.1 Study Area

Enugu is the capital of Enugu State, a mainland state in South-easternNigeria. The state shares borders with Ebonyi State to the east, Kogi and Benue States to the northwest and northeast respectively, Anambra State to the west, Abia and Imo States to the south. The major cities in close proximity to Enugu are Port Harcourt in Rivers State, Aba in Abia State, Onitsha in Anambra State and Abakiliki in Ebonyi State, all within one to three hours' drive, the furthest being Port Harcourt.

Enugu is blessed with good soil, interesting landscape and excellent climatic conditions.

Enugu is located in a tropical rain forest zone with a derived savannah (Sani, 2007; Reinfsnyder, 1989)). It has a humid climate typical of the tropical savanna, with its highest between March and

November(Reinfsnyder, 1989). For the whole of Enugu State the mean daily temperature is 26.7 °C (80.1 °F (Sani, 2007).The average annual rainfall in Enugu is around 2,000 millimetres (79 in), which arrives intermittently and becomes very heavy during the rainy seasonEgboka, (1985).

Enugu acquired a township status in 1917 and was of strategic importance to the British colonial masters because of its beautiful landscape, serene environment, perfect scenic beauty, and high potentials for commerce as a result of the abundant natural resources of coal, natural gas, limestone, bauxite and very rich agricultural potentials. It thus became the capital of the Southern province and later the regional capital of the then Eastern Region of Nigeria. The current state government has taken bold steps to harness these potentials through its various development programmes thus turning the city into a very attractive rendezvous for people from all works of life, encouraging, as it were, commerce, education, agricultural activities, tourism, and so on. With its beautiful rolling green hills and well planned environment, Enugu became a centre of attraction in terms of improved standard of living. This places, on environmental stakeholders, the compulsive responsibility of ensuring the sustained development of this great city.

2.2 Methodology

This is an empirical study based on qualitative primary data. Survey research method was, therefore, adopted using well-structured and extensively detailed questionnaire administered on respondents selected from the residents of Enugu metropolis, to elicit information on the subject matter. The questionnaire sort information on relevant personal characteristics of the respondents and on the magnitude of damage and degree of impact of flooding on the road transport infrastructure. This was captured by listing some key impact indicators and relevant impact dimensions (Appendix). The Likert-type scale was used to rate the respondents' perception with which impact evaluation was carried out. Thirty (30) impact indicators were carefully selected and rated against six (6) impact dimensions which include: *Vulnerability of activities, Population, Frequency, Intensity, Extent and Risk.* The questionnaires were administered on six hundred and twenty five (625) respondents representing the sample size drawn from a projected population of nine hundred and one thousand, one hundred and sixty two (901,162) residents of Enugu urban, (National Bureau of Statistics, 2006).Three hypotheses were formulated. One sample t-test was used to test hypothesis one while hypotheses two and three were tested using Structural Equation Modelling (SEM).The oval shaped constructs (variables) in the (SEM) shown in figure 1 are the latent constructs, the rectangular shaped ones are the observed. The construct DRI stands for Damages to the road transport infrastructure. The indicator variables for DRI are DR1, DR2and DR3, which were got from the questionnaire items. The construct, ESU represents Environmental Sustainability. Attached to it are the indicator variables ES1 and ES2 while the construct SEA means Socio Economic Activities with SE1, SE2, SE3, SE4, respectively, as the observed variables. Also each indicator variable has error term on it. The 30 questionnaire items were compressed into the observed variables in the model according to their relevance to the indicator variables. This was achieved by combining similar variables into a composite measure for the indicator variables. Hair *et al* (2010) opined that summated scale provides two benefits; first it provides a means of overcoming to some extent, the measurement error inherent in all measured variables; secondly, summated scale has the ability to represent the multiple aspects of a concept in a single measure. All the thirty items in the questionnaire, measuring Assessment of Socio-Economic and Environmental Impacts of Flooding on Road Transport Infrastructure in Enugu Metropolis were measured using metric scales. Also, for the purpose of performing the inferential statistics, the summated scale for the six impact dimensions for each impact indicator item were computed and the average scores determined .On the basis of five point scale, the rating of each of the items for the impact indicator/ dimensions were as follows;: Very high (5); High (4); Moderate (3); Low (2); Very low (1)

III. Results and Discussion

3.1Results

Out of six hundred and twenty five respondents, 330 (52.8%) were of the male gender while 295(47.2%) were female. The data revealed fairness in the gender distribution. Furthermore, the age distribution revealed that 395 (63.2%) of the respondents were not more than 50 years of age while 230 (36.8%) of the respondents were above age 50.This appears to be a moderate distribution of age. The level of education of the valid respondents showed that 425 (68%) of the respondents had acquired tertiary education while 200(32%) had attained other levels of education; thus, the degree of education of the respondents seems to have consolidated the dependability of the data got from them bythe researchers.

3.1.1 Rating of Impact Indicators/Dimensions by the Respondents

Table 1 shows that in terms of **Vulnerability** dimension, the highest impact of flooding as perceived by the respondents is traced to population displacement (mean=4.36) followed by loss of lives (mean=4.32) while loss of property is third in ranking with (mean=4.30). For **Population** dimension, the first in rank from table 2 is frequent failure of tarred roads (mean=4.82) while social unrest (mean=4.82) is of equal degree with respect to ranking of population dimension. The third in order of priority is loss of environmental aesthetics (mean=4.78). Table 3 which shows **Frequency** dimension of the impact indicators reveals that population displacement ranks first (mean=4.43) followed by destruction of water line (mean=4.42) while the third in rank is threat to peace (mean=4.08). **Intensity** dimension of table 4 reveals that loss of lives emerged first in ranking (mean=3.82) followed by population displacement (mean=3.79) and the third in rank is destruction of power line (mean=3.73). **Extent** dimension of table 5 indicates that loss of confidence in government (mean=4.07) ranks first followed by disruption in business activities(mean=3.99), while third in rank is threat to peace(mean=3.98). Table 6 of **Risk** dimension shows loss of lives as first in rank(mean=4.40) followed by loss of confidence in government(mean=4.25) while the third in rank is high cost of goods and services (mean=4.22).

TABLE 1 **IMPACT DIMENSION: VULNERABILITY OF ACTIVITIES**

Descriptive Statistics

	N	Mean	Std. Deviation
Loss of lives	625	4.32	.850
Loss of property	625	4.30	.884
Destruction of water line	625	4.18	1.021
Destruction of Power line	625	4.11	.925
High cost of goods and services	625	4.12	.911
Reduction in purchasing power	625	3.94	1.192
Mental Stress	625	3.71	1.122
Fatigue	625	3.23	1.035
Loss in man-hour	625	3.19	1.027
Reduction in productivity	625	3.61	1.322
Disruption of social activities	625	3.92	1.090
Migration	625	4.29	.753
Population displacement	625	4.36	.634
Loss of livelihoods	625	4.04	.844
High cost of infrastructure maintenance	625	3.74	1.039
Slow economic growth	625	3.72	1.083
Slow pace of development	625	3.78	1.049
Public discontent	625	3.60	.881
Loss of confidence in government	625	4.10	.868
Threat to peace	625	4.08	.755
Social unrest	625	3.88	.874
Loss of environmental aesthetics	625	3.90	.914
Frequent failure of tarred roads	625	3.98	.964
High cost of vehicle maintenance	625	3.37	1.285
Enhanced structural weakness of culverts and bridges	625	3.47	1.193
Reduction in lifespan of roads	625	3.25	1.283
Increase in road mishaps	625	3.27	1.242
Poverty	625	3.92	1.358
Traffic congestion	625	3.49	1.159
Disruption in business activities	625	3.99	1.032
Valid N (listwise)	625		

TABLE 2

IMPACT DIMENSION: POPULATION

Descriptive Statistics

	N	Mean	Std. Deviation
Loss of lives	625	4.46	.952
Loss of property	625	4.46	.987
Destruction of water line	625	4.41	1.029
Destruction of Power line	625	4.42	1.026
High cost of goods and services	625	4.41	.978
Reduction in purchasing power	625	4.37	1.020
Mental Stress	625	4.33	1.061
Fatigue	625	4.31	1.081
Loss in man-hour	625	4.00	1.007
Reduction in productivity	625	3.98	1.031
Disruption of social activities	625	4.35	1.036
Migration	625	4.42	.898
Population displacement	625	4.47	.875
Loss of livelihoods	625	4.30	.920
High cost of infrastructure maintenance	625	4.12	.947
Slow economic growth	625	4.70	.701
Slow pace of development	625	4.68	.692
Public discontent	625	4.75	.704
Loss of confidence in government	625	4.56	.588
Threat to peace	625	4.54	.545
Social unrest	625	4.82	.558
Loss of environmental aesthetics	625	4.78	.687
Frequent failure of tarred roads	625	4.82	.577
High cost of vehicle maintenance	625	4.43	.857
Enhanced structural weakness of culverts and bridges	625	4.49	.665
Reduction in lifespan of roads	625	3.58	1.352
Increase in road mishaps	625	4.74	.674
Poverty	625	4.63	.934
Traffic congestion	625	4.37	.947
Disruption in business activities	625	4.36	.995
Valid N (listwise)	625		

TABLE 3

IMPACT DIMENSION: FREQUENCY

Descriptive Statistics

	N	Mean	Std. Deviation
Loss of lives	625	3.66	1.132
Loss of property	625	3.86	1.138
Destruction of water line	625	4.42	.743
Destruction of Power line	625	3.99	1.218
High cost of goods and services	625	3.96	1.203
Reduction in purchasing power	625	3.65	1.271
Mental Stress	625	3.42	1.184
Fatigue	625	3.25	1.164
Loss in man-hour	625	3.35	1.281
Reduction in productivity	625	3.88	1.218
Disruption of social activities	625	4.03	1.033
Migration	625	4.07	.973
Population displacement	622	4.43	.594
Loss of livelihoods	625	3.88	1.150
High cost of infrastructure maintenance	625	3.78	1.209
Slow economic growth	625	3.77	1.168
Slow pace of development	625	3.76	1.112
Public discontent	625	3.61	.897
Loss of confidence in government	625	3.86	1.045
Threat to peace	625	4.08	.755
Social unrest	625	3.88	.874
Loss of environmental aesthetics	625	3.90	.914
Frequent failure of tarred roads	625	3.98	.964
High cost of vehicle maintenance	625	3.37	1.285
Enhanced structural weakness of culverts and bridges	625	3.48	1.173
Reduction in lifespan of roads	625	3.27	1.244
Increase in road mishaps	625	3.42	1.212
Poverty	625	3.13	1.384
Traffic congestion	625	3.18	1.345
Disruption in business activities	625	3.55	1.367
Valid N (listwise)	622		

TABLE 4
IMPACT DIMENSION: INTENSITY

Descriptive Statistics

	N	Mean	Std. Deviation
Loss of lives	625	3.82	.998
Loss of property	625	3.73	1.048
Destruction of water line	625	3.63	1.128
Destruction of Power line	625	3.73	1.020
High cost of goods and services	625	3.64	1.094
Reduction in purchasing power	625	3.48	1.139
Mental Stress	625	3.54	1.014
Fatigue	625	3.29	1.159
Loss in man-hour	625	3.32	1.090
Reduction in productivity	625	3.25	1.141
Disruption of social activities	625	3.45	1.058
Migration	625	3.67	1.023
Population displacement	625	3.79	.910
Loss of livelihoods	625	3.60	.976
High cost of infrastructure maintenance	625	3.37	1.071
Slow economic growth	625	3.48	1.011
Slow pace of development	625	3.38	1.118
Public discontent	625	3.61	.994
Loss of confidence in government	625	3.67	1.030
Threat to peace	625	3.64	1.075
Social unrest	625	3.59	.997
Loss of environmental aesthetics	625	3.48	1.148
Frequent failure of tarred roads	625	3.69	.915
High cost of vehicle maintenance	625	3.24	1.185
Enhanced structural weakness of culverts and bridges	625	3.63	1.001
Reduction in lifespan of roads	625	3.64	1.055
Increase in road mishaps	625	3.62	1.105
Poverty	625	3.34	1.183
Traffic congestion	625	3.66	.977
Disruption in business activities	625	3.47	1.201
Valid N (listwise)	625		

TABLE 5

IMPACT DIMENSION: EXTENT

Descriptive

Statistics

	N	Mean	Std. Deviation
Loss of lives	625	3.82	.921
Loss of property	625	3.58	1.114
Destruction of water line	625	3.57	1.081
Destruction of Power line	625	3.60	1.053
High cost of goods and services	625	3.60	1.014
Reduction in purchasing power	625	3.39	1.081
Mental Stress	625	3.42	1.001
Fatigue	625	3.15	1.136
Loss in man-hour	625	3.21	1.044
Reduction in productivity	625	3.15	1.105
Disruption of social activities	625	3.31	1.123
Migration	625	3.62	.984
Population displacement	625	3.67	.981
Loss of livelihoods	625	3.65	.874
High cost of infrastructure maintenance	625	3.74	1.039
Slow economic growth	625	3.72	1.083
Slow pace of development	625	3.78	1.049
Public discontent	625	3.60	.881
Loss of confidence in government	625	4.07	.868
Threat to peace	625	3.98	.846
Social unrest	625	3.86	.866
Loss of environmental aesthetics	625	3.85	.934
Frequent failure of tarred roads	625	3.93	.986
High cost of vehicle maintenance	625	3.33	1.271
Enhanced structural weakness of culverts and bridges	625	3.45	1.176
Reduction in lifespan of roads	625	3.26	1.253
Increase in road mishaps	625	3.26	1.215
Poverty	625	2.97	1.284
Traffic congestion	625	3.49	1.159
Disruption in business activities	625	3.99	1.032
Valid N (listwise)	625		

TABLE 6

IMPACT DIMENSION: RISK
Descriptive Statistics

	N	Mean	Std. Deviation
Loss of lives	625	4.40	.630
Loss of property	625	4.10	.923
Destruction of water line	625	4.04	1.010
Destruction of Power line	625	4.13	.893
High cost of goods and services	625	4.22	.795
Reduction in purchasing power	623	3.85	1.075
Mental Stress	625	3.67	1.166
Fatigue	625	3.47	1.218
Loss in man-hour	625	3.46	1.235
Reduction in productivity	625	3.40	1.318
Disruption of social activities	625	3.65	1.149
Migration	625	4.13	.932
Population displacement	625	4.19	.856
Loss of livelihoods	625	3.93	.978
High cost of infrastructure maintenance	625	3.67	1.114
Slow economic growth	625	3.86	1.094
Slow pace of development	625	3.92	1.052
Public discontent	625	4.04	.953
Loss of confidence in government	625	4.25	.720
Threat to peace	625	4.12	.837
Social unrest	625	4.09	.875
Loss of environmental aesthetics	625	3.90	.914
Frequent failure of tarred roads	625	3.98	.964
High cost of vehicle maintenance	625	3.37	1.285
Enhanced structural weakness of culverts and bridges	625	3.47	1.193
Reduction in lifespan of roads	625	3.25	1.283
Increase in road mishaps	625	3.27	1.242
Poverty	625	3.47	1.297
Traffic congestion	625	3.71	1.132
Disruption in business activities	625	3.99	1.060
Valid N (listwise)	623		

3.1.2 Test of Hypothesis

One sample t test was used for testing hypothesis one. From table7 the sample mean is 4.06; standard deviation is 0.989, n=625while table8 shows that the calculated t-value is 26.734 with624degree of freedom; p-value= 0.000. Since the p-value =0.000($p<0.05$), the null hypothesis is rejected. The conclusion therefore is that damages to the road transport infrastructure resulting from flooding are significant to warrant mitigation.

Structural Equation Modelling (SEM) was used for testing hypotheses two and three in this study.SEM consists of statistical models that aim at explaining relationships among multiple variables. It examines the structure of interrelationships expressed in a series of equations similar to a series of multiple regression equations (Hair *et al*, 2010). AMOS software version 18 was used for the purpose of structural equation modelling.

Hypothesis two proposed that *damages to road transport infrastructure due to flooding has no significantimpact on the socio-economic activities in Enugu urban*. Table 9 shows a statistically significant impact since the calculated p–value (0.000) is less than 0.05, ($p < 0,05$). Thus, the standardized regression weights from table10, indicate that one standard deviation increase in damages to road transport infrastructure due to flooding increases impact on socio economic activities by 0.839 standard deviation.

Also, Hypothesis three proposed that *damages to road transportinfrastructure due to flooding has no significant impact on the environmental sustainability of Enugu urban road transport infrastructure.* Table 9 equally shows a statistically significant impact since thecalculated p–value (0.000)isless than 0.05, ($p < 0.05$).Thus, one standard deviation increase indamages to road transport infrastructure due to flooding increases impact on Environmental sustainability of Enugu urban by 0.934 standard deviation. Table 11 further reveals that damages toroad transport infrastructure dueto flooding accounted for 70.3% of variance in socio economicactivities. The same DRI accounted for 87.3% of variance in environmental sustainability.

Table 7.

	N	Mean	Std. Deviation	Std. Error Mean
MEAN RESPONSE	625	4.06	.989	.040

TABLE 8 **One-Sample Test**

	Test Value = 3.00					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
MEAN RESPONSE	26.734	624	.000	1.057	.98	1.14

TABLE 9**Regression Weights: (Group number 1 - Default model)**

			Estimate	S.E.	C.R.	P	Label
ESU	<---	DRI	.939	.124	7.597	***	par_7
SEA	<---	DRI	.767	.095	8.037	***	par_8
SE1	<---	SEA	1.000				
SE2	<---	SEA	1.110	.100	11.099	***	par_1
SE3	<---	SEA	1.093	.113	9.700	***	par_2
SE4	<---	SEA	.907	.119	7.635	***	par_3
DR3	<---	DRI	1.000				
DR2	<---	DRI	1.248	.143	8.727	***	par_4
DR1	<---	DRI	1.086	.127	8.527	***	par_5
ES1	<---	ESU	1.000				
ES2	<---	ESU	1.329	.154	8.603	***	par_6

TABLE 10**Standardized Regression Weights: (Group number 1 - Default model)**

			Estimate
ESU	<---	DRI	.934
SEA	<---	DRI	.839
SE1	<---	SEA	.646
SE2	<---	SEA	.617
SE3	<---	SEA	.508
SE4	<---	SEA	.380
DR3	<---	DRI	.429
DR2	<---	DRI	.684
DR1	<---	DRI	.632
ES1	<---	ESU	.523
ES2	<---	ESU	.530

TABLE 11**Squared Multiple Correlations: (Group number 1 - Default model)**

	Estimate
ESU	.873
SEA	.703
ES2	.281
ES1	.273
DR1	.400
DR2	.468
DR3	.184
SE4	.144
SE3	.258
SE2	.381
SE1	.417

3.1.3 MODEL FIT (SEM)

Different criteria were used for assessing the model fit. Table13 shows Goodness of Fit Index (GFI) = 0.974; and adjusted Goodness of Fit Index (AGFI) = 0.951. Table 14 shows Comparative Fit Index (CFI)=0.949 and Incremental Fit Index (IFI) = 0.950, while the Root Mean Square Error of Approximation (RMSEA) = 0.059 shown in table 15. These fit indices agree with the empirical investigation carried out by (Ahmad *et al*, 2006).

TABLE 12 Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	21	75.982	24	.000	3.166
Saturated model	45	.000	0		
Independence model	9	1057.745	36	.000	29.382

TABLE 13 RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.021	.974	.951	.520
Saturated model	.000	1.000		
Independence model	.131	.608	.509	.486

TABLE 14 Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.928	.892	.950	.924	.949
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

TABLE 15 RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.059	.044	.074	.150
Independence model	.213	.202	.224	.000

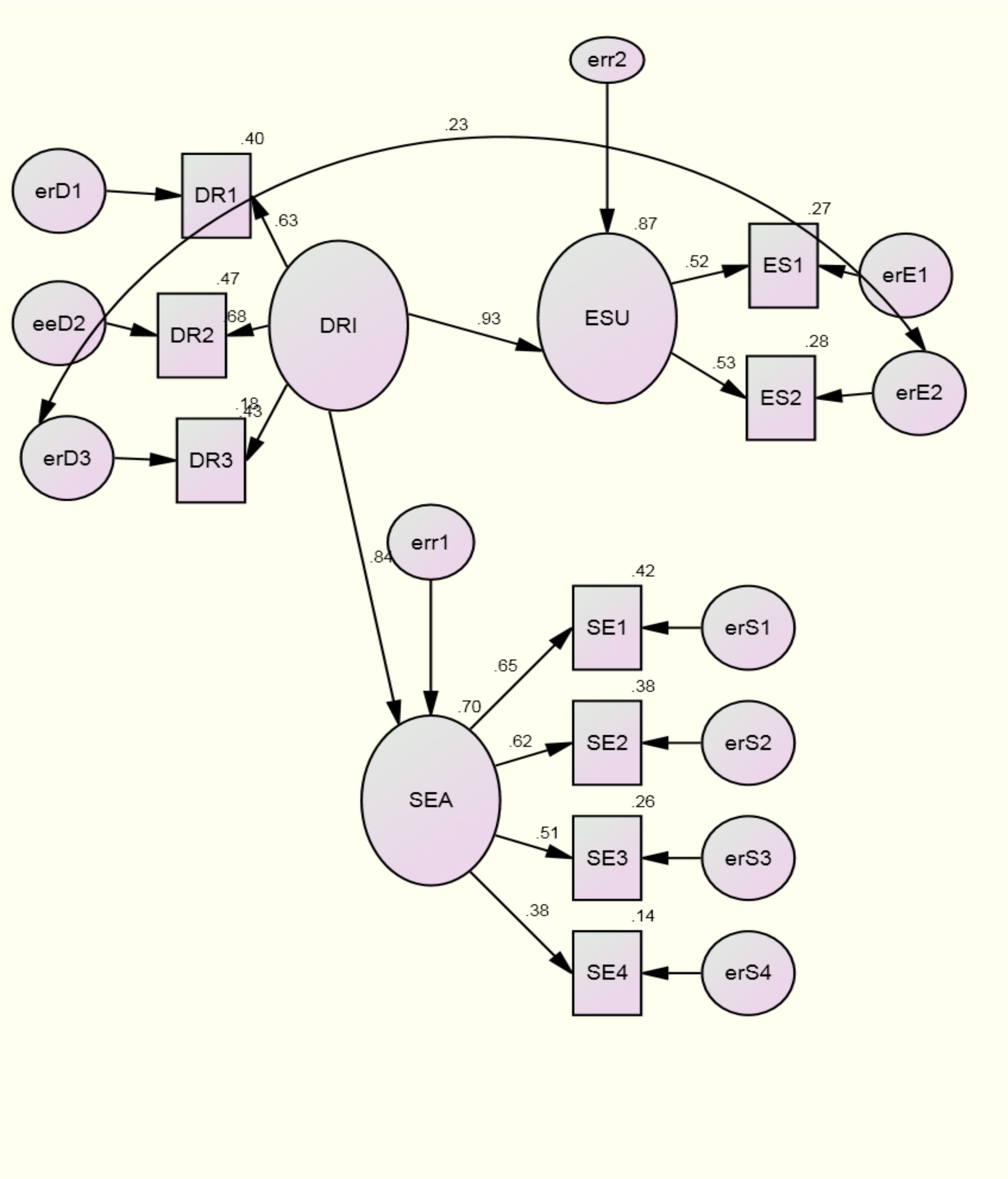

Figure 1. THE MODEL

3.2 Discussion

Frequent failure of tarred roads seems to have brought about increase in road mishaps which often lead to loss of lives, traffic congestion. These could have accounted for high cost of goods and services as a result of roads that are inaccessible for commercial activities. The cost of goods and services being high could have inevitably given rise to disruption in business activities, reduction in productivity with associated poverty. Also, the degree of poverty could bring about slow economic growth which is capable of precipitating migration when confidence must have been lost on the government. The 30 impact indicator items attained significant mean value beyond the threshold of 3.00 in the 5 point rating scale which is significant enough to warrant mitigation.

These impact indicators as shown in this study are traced to damages to road transport infrastructure resulting from flooding; thus, these multiplier effects as shown in the 30 item impact indicators have been parsimoniously segmented in the structural equation model used in this study. Thus, damages to road transport infrastructure resulting from flooding have significantly influenced socio economic activities and environmental sustainability. This is validated by the output of the descriptive statistics for the indicator items used in this study.

IV. Conclusion

Flooding is a major environmental issue precipitated by inadequate or silted drains. It has immense capacity to disrupt socio-economic activities as a result of the damages to road transport infrastructure and other municipal utilities. The impact on the environment is so severe that sustainability, integrity and serviceability of urban infrastructures are interfered with giving rise to an unfriendly and unliveable city. This study has been able to statistically confirm the degree of impact of flood events on the environment and therefore recommends that appropriate mitigation strategies such as proper infrastructural design and planning, good governance, population control and appropriate weather monitoring and alert, be put in place to cope with the phenomenon.

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Appendix
Questionnaire for Prospective Respondents

Section A; Personal Characteristics
Please tick as appropriate.
1. Sex: (a) Male [ ]; (b) Female [ ]
2. Age: (a) Below 25 years [ ]; (b) 26-50 years [ ]; (c) Above 50 years [ ]
3. Marital Status: (a) Married [ ]; (b) Single [ ]; (c) Divorced [ ]; (d) Widowed [ ]
4. Level of Education: (a) Primary [ ]; (b) Secondary [ ]; (c) Tertiary [ ]; (d) Vocational [ ]; (e) Others Specify [ ]
5. Occupation: (a) Public Service [ ]; (b) Self Employed [ ]; (c) Unemployed [ ]; (d) Retired [ ]
6 Ethnic Origin: (a): Ibo [ ] (b) Hausa [ ]; (c) Yoruba [ ]; (d) Other Nigerian [ ]; (e) None of the Above [ ].

Section B: Assessment of socio-economic and environmental impacts of Flooding on Road Transport Infrastructure in Enugu Metropolis.

S/No	Impact Indicators (Key areas of impact)	Impact Dimensions					
		Vulnerability of activities	Population	Frequency	Intensity	Extent	Risk
1	Loss of lives						
2	Loss of property						
3	Destruction of water line						
4	Destruction of Power line						
5	High cost of goods and services						
6	Reduction in purchasing power						
7	Mental Stress						
8	Fatigue						
9	Disruption in business activities						
10	Loss in man-hour						
11	Reduction in productivity						
12	Disruption of social activities						
13	Migration						
14	Population displacement						
15	Loss of livelihoods						
16	High cost of						

	infrastructure maintenance						
17	Slow economic growth						
18	Slow pace of development						
19	Public discontent						
20	Loss of confidence in government						
21	Threat to peace						
22	Social unrest						
23	Loss of environmental aesthetics						
24	Frequent failure of tarred roads						
25	High cost of vehicle maintenance						
26	Enhanced structural weakness of culverts and bridges						
27	Reduction in lifespan of roads						
28	Increase in road mishaps						
29	Poverty						
30	Traffic congestion						