Analysis of Weather On Haulage Operations: A Case Study of Road Connecting South-West to Northern Nigeria

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DOI: 10.29322/IJSRP.9.02.2019.p8643
http://dx.doi.org/10.29322/IJSRP.9.02.2019.p8643

Abstract- Road transport infrastructures are naturally exposed to several degradation factors. Traffic load (weight) and weather conditions represent two major causes of degradation which in turns result to demurrage an aftermath of delay. Asphalt rutting, bridge cracking, potholes, drainage system obstruction are all examples of weather induced degradation. Asphalt rutting for instance is induced by high temperature, but the effect is enhanced under high truck traffic axle load. Weather-related events such as (rainfall, blizzards, flood, sheet, snow and ice) are significant disruptors of travel time and other transport related operations. Heavy rainfall reduces visibilities, speeds and cause significant increase in crashes and when this occurs, delay in evacuating the vehicles involved over hours perhaps days. This results to partial blockage of the roads. Damages of extreme weather on infrastructure are grouped into two main types namely: “rainfall and flood” including “harmattan and wind”. Rainfalls (Partly including flooding) and harmattan (dusty winds) are the most relevant problem in highway transport operations in Nigeria. In weather, the category “heavy rainfall” induces floods which emanated from the rivers and over flow the bridges in low areasresulting to landslides.

This study covered two states (Oyo and kwara, States) with an intensive focus on the Oyo-Ogbomoso (Oyo State), Kanbi, Oloru-Bode Saadu-Jebbaroads in Kwara State. 120 Motorists were randomly selected for their knowledge on climate related problems encountered during trips. A simple random sampling technique was adopted. Weather induced crack and collapsed infrastructures (bridges, route and roadmarks) were directly observed.

Multiple Regression Model was used to analysis the data collected. Where the predictors (r^2) is0.669, F=199.541, $p<0.5^{**}$ $p<0.10$ which shows that weather has greatly affected haulage operations since the regression indicators were negative for sensitive variables.

This study revealed that, weather conditions have negative impact on haulage operations most especially in the study area with significant level of crashes on the route, traffic delay, wear and tear among other factors causinglots of damage to goods on this route. Based on the findings, since weather conditions are inevitable it is recommended that, relevant authorities responsible for road construction and maintenance (government and general public) take cognizance of these inevitable conditions for the durability of highway infrastructures and constant supervisions and maintenance to minimize high loss goods and elongate the life span of these roads.

Index Terms- Weather, Rainfall, Flood, Bridge Cracking, Haulage Operation

I. Introduction

Transport would be mostly affected through rise in weather conditions variance and also weather extremes, for instance very warm days; extreme precipitation incidents;drought; and also increasing ocean levels, together with breeze surges, landslides and also weather change. The effect differs from place to place with mode of transportation applied. Planning,design,construction, operation and maintenance of transport structures emerge as elementary challenges in haulage operations. In 2014, Ibadan North local government suffered flood calamity that proclaimed a lot of lives and also ruined properties quantified in tens of millions. The wrecked was so prominent simply because, it occurred in the municipal of Nigeria. Flooding of highways, transit systems and also water drainage systems could be a significant challenge of haulage operations. This was not understated due to global increasing of ocean levels, together with extreme rainfall, breeze surges are prominent in southern regions of Nigeria. The Atlantic and Gulf Coasts are particularly exposed since they have actually suffered increased levels of erosion, extreme rainfall especially in 2010 (NIMET , 2018) .

Some relative excessively varying weather conditions (e .g. severe precipitations and also rigorous temperatures) which on their turn can lead to extreme result for the physical environment (e .g. floods , landslides) fig. 1and 2 signify damages of transport infrastructures. Construction designs and thus routine maintenance of transport infrastructures are crucial to sustain their durability and also services ability (l .Gardiner et al, 2009).

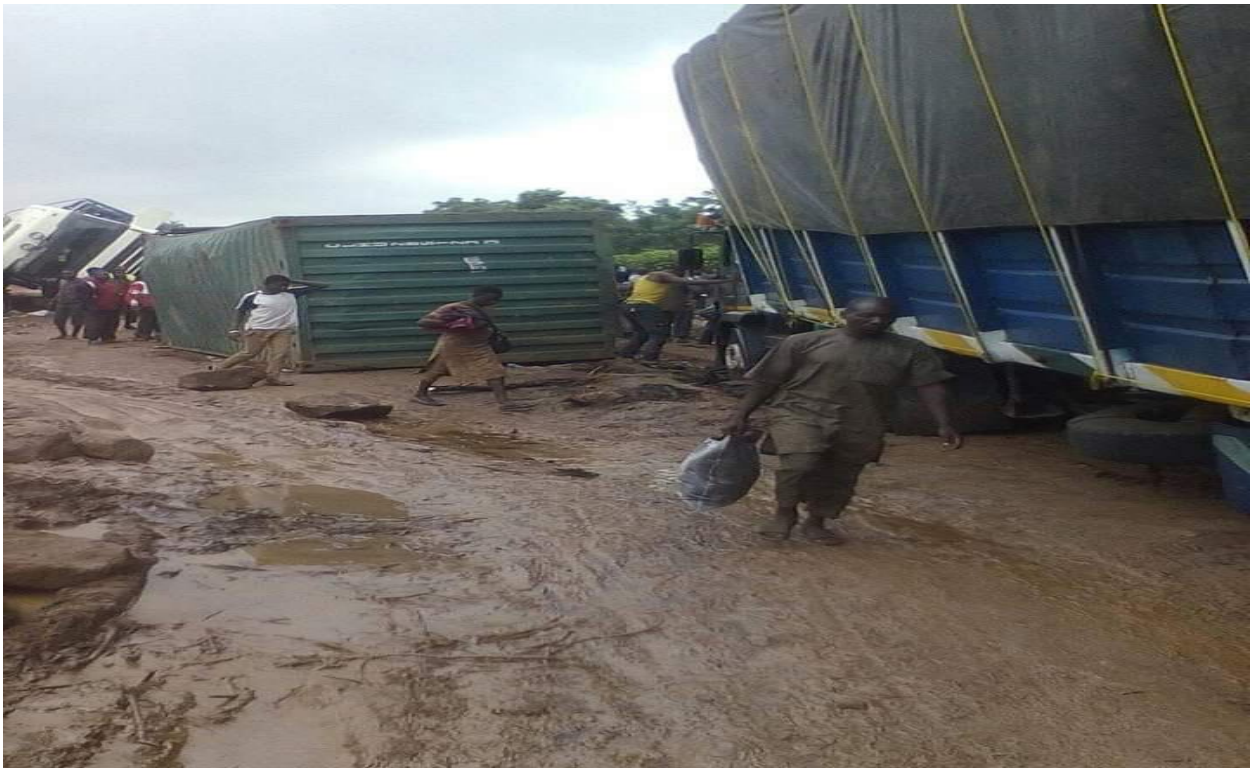

Fig 1: Failed portion of road resulting to delay in travel time

The interstate net-work is gradually overcrowded in Nigeria, it is because a multi-modal or even inter modal transport method is partly or perhaps not employed. With improving dimensions of importation the matching need for haulage operations gets very important. Considerably outdistancing accessible highway potential , major waiting times are routine and also congestion is growing over further places and even over increased numbers of times (Mark koetse , 2008). Congestion-related delay in the biggest urban centers was projected to be particularly excessive and price of routine maintenance raises. Much of this delay caused mainly because of over reliant on roadstransport system. However , today's high-volume of roads traffic makes degree of service more in danger of disruption from various mishaps, for instance , failed road segments and also security-related challenges (Onifade et al ,2014) . Interstate service disturbances have become more numerous and also lengthy traffic congestions frequently come with even affordable incidents. Moreover, these situations are the main contributor to the insufficient predictability and also reliability of haulage operations in Nigeria. Certain instances also have harmful influences to life safety as well as loss of vital cargos (fig3).

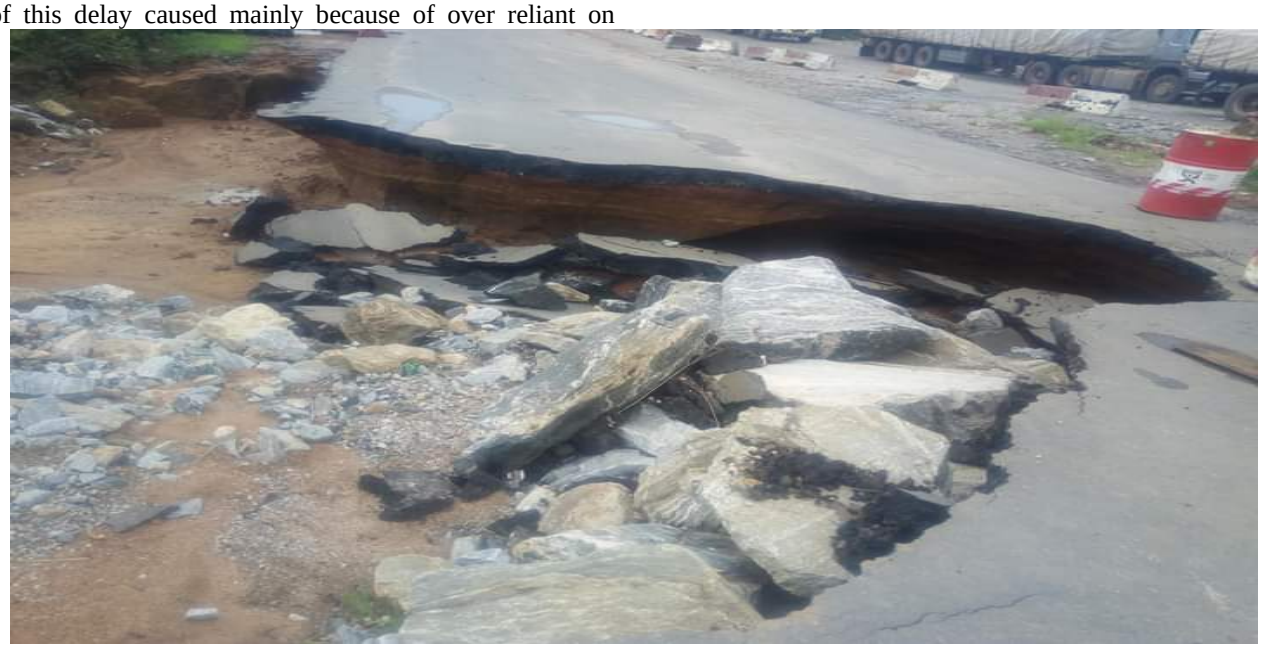

Fig 2: A failed portion of road under study

Landslides are the implications of multi-factors, such as soil dampness – as determined by severe rainfall, soil different types and also slopes (fig 2). Just like the instance of dazzle floods, severe precipitations (e .g.precipitations above 150-200 mm/24h) can simply be used as a quite difficult proxy sensor to detect potency hazards, with regards to mountainous locations. The Nigerian Meteorological Agency (NIMET, 2012) forecasted that there may be extremely severe rains and also flooding in lots of states in Nigeria in 2012. In Oyo State, Ibadan is particularly stated as an urban area to encounter flooding (NIMET, 2012). Flood may be referred to as an over-flow of water that submerges every physical materials e .g. structures, water drainage systems and also human population (Bradshaw, 2007). The European Union (EU) Floods Directive defines flood as a covering up of land by massive quantity of water (Henry, 2006). Flooding can occur as an over-flow of water from water body, for instance a river or lake, by which the water overtops and even splits its borders leading to some of that water getting out of its normal borders. Likewise, it might happen due to abuildup of rainwater overtime on saturated ground in a region (Bradshaw, 2007). This natural event takes place when water runoff from the land surface and surpasses the potential of the stream channel (Ajayi et al, 2012).

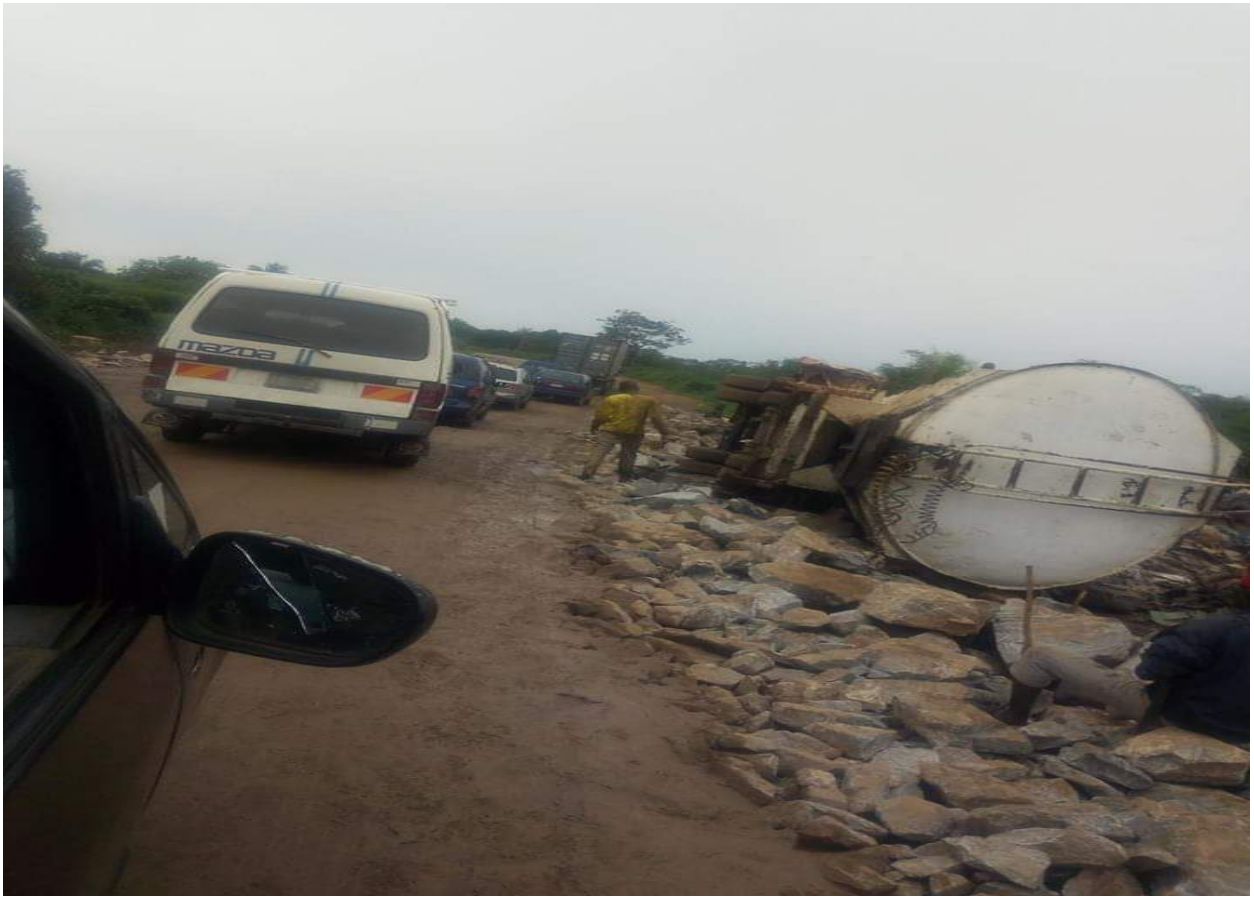

Fig 3: Overturned truck as a result of failed spots on the road

Transport system is designed and placed to be resistant to natural weather hazards in highly developed countries around the world. While it is worldwide recognized that weather changes may have influence road transport infrastructures. A precondition for flooding of particular regions is associated with riverbeds, guttering or other drainage facility not cleaned up from waste and also vegetation (Ajayi et al, 2012). Given the presence of many huge dams in the nation, there is certainly a threat of flooding as a result of the unchecked discharge of huge water due to severe rainfalls. The most common calamity in Oyo state is flooding due to severe rainfall and also over-flow of river beds. The effects of weather change on transport operations are an enduring phenomenon and will be experienced slowly over many years. This was projected that, flooding of urban regions has caused substantial harm to private property, such as residences and also businesses (Kingsford, 2000).

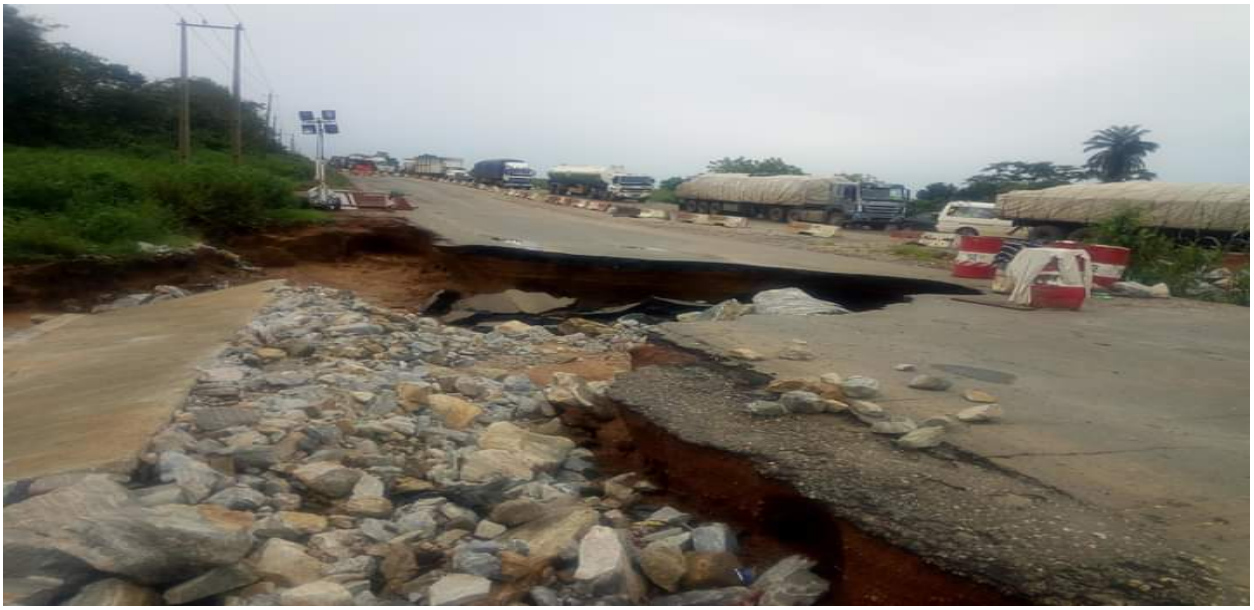

Fig 4: Oyo-Ogbomoso road

This research work observed and evaluated the effect of weather change on interstate infrastructures and it focused on the effect of flood and also landslides on haulage operations in Oyo and Kwara State high-way to put forward suggestions and adjustment measures.

II. LITERATURE REVIEW

The concern of whether or not weather change would notably increase the diverse weather challenges to transport infrastructures and transport exercises is an increasing issue in the scientific literature and also adaptation technique reviews. Imperative research works have for example already been carried out in many non-European industrialized nations (e. g. New Zealand,Australia, United States – by EPA and by the US Department of Transportation), and in European countries (e .g. UK program on Climate change). Weather is an important element affecting the useful life of infrastructure as well as transport basic safety. Routine maintenance or fixing transport infrastructures are necessary to assure their longevity along with the transport services that they can support. Dazzle floods, as related to severe rainfalls (in the event of thunderstorms for example) are likely to become more regular in various areas in Europe. Excessive precipitation (50 mm/day) can be a proxy sensor for upcoming patterns in dazzle flood event frequencies. Landslides are the results of multi-factors, including soil dampness – as driven by rainfall severeness, soil different types and also topography. Just like the event of dazzle floods, severe precipitations (e .g. precipitations more than 150-200 mm/24h) may only be used as a truly abrasive proxy sensor to determine potency risks, with regards to mountainous regions.

Dore et al (2005) have analyzed the contribution of traffic and varying weather conditions to the wear & tear of roads pavement in Canada and also investigated similar knowledge in other countries. For Canada, the share for climatic conditions caused ruins is in a 30%-80% range (high). Based on the statistical data the ruined roads infrastructure is split into national roads network and also damages in municipalities. The failures in the national economic system as a result of crisis situations occurred in 2004-2008 are associated with the damaged facilities: highways, bridges, anti-erosion structures, holding walls or fences and municipalities are included railways in urban transport in Canada. Many deficits in the national road network in 2008 and the municipalities in 2005 were as a result of the large quantity of floods

The major challenges determined by the gap evaluation in terms of weather research are the desire for: much better models for forecasting vital weather variables that could influence transport infrastructure networks, e .g. Solar emission models for identifying potentially adverse effects on transport constituents (such as ultraviolet damage or radiation heat gain) do not properly account for blur cover. In the same vein, higher decision models of useful effects to allow comprehensive analysis of spatial and also temporal distribution of weather change effects. This is really a critical input into any kind of risk analysis of transport infrastructure at the local and also regional level. Moreover, measurement of the joined effects of climatic factors subject to weather change on transport (e. g. combined effects of sea level rise, storm surge, tides and high winds for coastal areas; the combined effects of wind and rainfall on inland storm patterns), and more clear meaning of the trigger issues or even associations between key weather variables and also transport infrastructure, e. g. the relationship between environment temperature, solar emission and the level to which rails are flexible to these conditions such as optimum temperature and the quantity of antecedent very hot or cool days.

Legal guidelines and policy. The key regulation and policy issues determined by the gap analysis are the lack of: overall integration of land transportation (road, rail and coastal shipping) planning with land use planning;- unique recognition in laws and specifications to consider weather change effects as a part of transport resource and also network management obligations; - explicit recognition in strategic land transport policy and specifications to consider weather change effects as part of

transportation advantage and network management responsibilities, with a concentrate on resource managers taking action now to understand and prepare their networks better for potential risks from climate change;- clarity on appropriate planning timeframes to ensure transport-related decision making, including funding priorities, is projecting far enough into the future to take account of projected climate change effects;- definition of responsibility for dealing with climate change in terms of national and regional interests and local infrastructure providers, including the private sector's role; and - audit processes for monitoring adaptation policies and associated progress at national, regional and local levels.

III. METHODOLOGY

This study was conducted with the aid of descriptive statistics and MRA model. The study samples is comprised of selected commuters that ply Lagos to the Northern part of Nigeria via Jebba route being the sole road that connects the Southern and the Northern of Nigeria. Fig. 5 shows the road network of Nigeria.

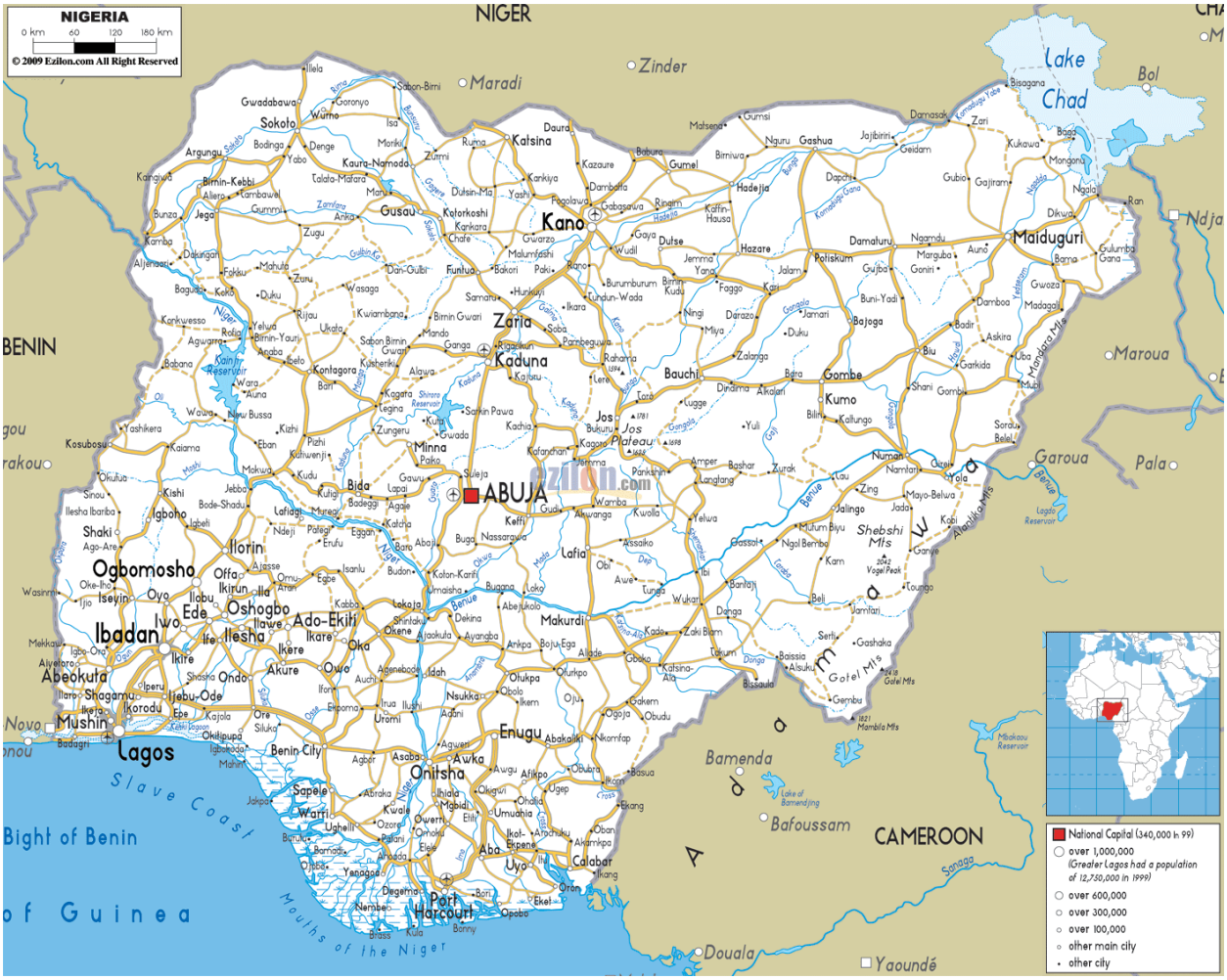

Fig 5: Nigeria roadnetwork map.
Source: http://sites.google.com/mcdagroup

The study was carried out in nine(9) local government's area of Oyo and Kwara, table 1.1.Shows the selected local governments. Oyo state coordinates are 7,^{0}19" 60" N and 4,^{0} 4"0".Current local time is 17:28; the sun rises at 09:01 and sets at 21:08 local time zone. The standard time zone is UTC/GMT+1. Oyo state is located at an elevation of 188meters above sea level and population amounts to 5.592 million(2006) with a landmass of about 27,249squqre kilometers. Oyo state weather is mostly cloudy at 25 degrees,temperature,wind speed and precipitation {mm}. The landscape consists of old hard rocks and dome shaped hills,which rise gently from about 500meters in the southern part and reaching a height of about 1,219meters above sea level in the northern part. The topography of the state is of gentle rolling lowland in the south,rising to a plateau of about 40meters. The state is well drained with rivers flowing from the upland in the north-south direction. Both Oyo and Kwara states have an equatorial climate with dry and wet seasons and relatively high humidity. The dry season lasts from November to March while the wet season lasts from April and ends in October. The vegetation

pattern of Oyo state is that of rain forest in the south and guinea savannah in the north.

Kwara state was created in 1967, when the Federal Military Government divided Nigeria into 12 new states. Kwara is one of the least densely populated regions in the Nigeria. Ilorin is the state capital while other towns like Jebba, Pategi, Offa are major locations in the state. Kwara state consists mostly of wooded savannah, but there are forested regions in the south. Almost all of its savanna area was conquered by the Fulani in the early 19th century.

A sample of 180 respondents was drawn using the simple random sampling technique. A well-structured question was used to garner data.

Table 1.1: Local government area and headquarters in the study area

S/N	Local government	Headquarters	State
1.	Akinyele	Moniya	Oyo
2.	Atiba	Offa meta	Oyo
3.	Afijio	Jobele	Oyo
4.	Oriire	Ikoyi	Oyo
5.	Ogo-oluwa	Ajaawa	Oyo
6.	Asa	Afon	Kwara
7.	Moro	Bode-Saadu	Kwara
8.	Ifelodun	Share	Kwara
9.	Ilorin East	Oke-Oyi	Kwara

Source: Authors field survey.

The study variable is haulage operations (dependent) and flood, extreme temperature, landslide andextreme precipitation (independent). Information collected is on socio-economic characteristics,transport infrastructural decay,weather condition and haulage operations.

Descriptive Statistical Analysis
Mean and frequency table

Regression Analysis Model
$Y = ao + b_1 x_1 + b_2 x_2 + \ldots b_n x_n + e$
Ao = constant best fit
B_1- b_n = regression coefficient
$X_1 - x_n$ = independent variables
E = residual error
Otherwise
y = haulage operation
X_1 = flood
X_2 = extreme temperature
X_3 = landslide
X_4 = extreme precipitation (above 50mm)

IV. RESULTS AND DISCUSSION

Table 1.2: Descriptive Statistics showing social variables of respondents

	N	Range	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Age	180	3.00	2.4750	.07097	.77744	.604
Occupation	180	1.00	1.3277	.04321	.47137	.222
Sex	180	2.00	1.1750	.03679	.40298	.162
level of education	180	3.00	3.7250	.05913	.64772	.420
Valid N (listwise)	180					

Source: Authors Computation, 2018.

The table 1.2 above indicates that, there is no distance between variable age and level of education. Two variable(age and level of education) range the same value which others are lower. All the value of the variables is positive which means that, the distribution is statistically balanced

Table 1.3: Model Summary of regression analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.818[a]	.669	.665	.520

Source: Authors Computation, 2018.

Table 1.3 above shows the coefficient of determinant (R^2 = 0.669) implied that 66.9 percent of the variation in dependent variable “haulage operation” was accounted for by all the independent variables “flood, extreme temperature, landslideand extreme precipitation. In other words flood, extreme temperature, landslideand extreme precipitationcontributed 66.9 percent of the explanation of haulage operation. The multiple correlation coefficient (R = 0.818) measured the strength of the association between the dependent variable “haulage operation” and the combination of all the independent variables “flood, extreme temperature, landslideand extreme precipitation”. This implied that the extent to which all the independent variables “flood,

extreme temperature, landslideand extreme precipitation" taken together provided explanation in the dependent variable haulage operation was 0.818. This however meant that, there was a very strong correlation between the dependent variable and the independent variables.

Table 1.4: ANOVA[a]result of effect of weather on haulage operation

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	215.502	4	53.876	199.541	.001[b]
	Residual	14.190	395	.271		
	Total	322.240	399			

Source: Authors Computation, 2018.

The table 1.4 above shows F-value to be far greater than 1. It shows that,there is strong relationship between flood and haulage operation and that; there is relationship between climatic change and haulage operation.

Table 1.5: Coefficients of weather on haulage operation

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.308	.150		2.061	.040
	Whatare the effects of flood on haulage operation?	.148	.025	.171	5.814	.001
	Does weather affect haulageoperation?	.595	.030	.591	19.566	.001
	Whatare the effects of weather on haulage operation?	.181	.040	.183	4.573	.001
	weather problems	.401	.037	.411	10.972	.001

Source: Authors Computation, 2018.

Table 1.5 above shows that, weather induced problems, and there effects had t-values greater than the critical p-values for all the cases, indicating that, extreme weather conditions are responsible for the decay of highway transport facilities and has greatly affected haulage operations.

V. CONCLUSION AND RECOMMENDATIONS

The study revealed that, weather variation had significant impact on highway transport infrastructural decay and had contributed negatively to haulage operations. It was therefore recommended as follows:

1. Government should endeavor to construct highly reliable highway system that can stand the test of time.
2. Transport agencies, therefore, must continuously improve their capabilities to maintain service, minimize the impact of any disruptions – such as those related to weather and to provide road – based emergency services.
3. Flood disaster could be prevented and controlled through, improved drainage efficiency, construction of structures.
4. Transport agencies, should work on indiscriminate dumping of refuse inside the stream, river channels, inside the surface drains, along the road side and dumping of municipal wastes on the flood plain.

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