Assessment of Substantive Causes of Soil Degradation on Farmlands in Yola South LGA, Adamawa State, Nigeria

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Abstract- Soil degradation remains a major serious threat agenda receiving a global attention on the pragmatic causes and its effects on food availability for the growing population. Yola South LGA, of Adamawa State is among the soil degraded region most especially in the tropics as a result of different causative agents. Therefore, this study aimed to assess the substantive causes of soil degradation on farmlands in Yola South LGA, of Adamawa State. Parameters related to soil degradation such as anthropogenic, cultural, edaphic and climatic factors were surveyed and assessed. Data collected from180 sampled farmers using administered questionnaires were statistical y analyzed using descriptive simple percentage method. The result indicated that land use/ rapid urbanization (23 %), continuous cropping (26 %), soil erosion (24 %) and high amount of rainfall (25 %) were the major factors in the parameters that led to soil degradation on farmlands in the study area. To curtail the existing menace of soil degradation in the area, extension workers should intensively engaged in training and educating farmers on soil sustainability and conservation techniques. Similarly, agricultural land should be provided by the government at all levels and make available to the small scale farmers in the area.

Index Terms- Assessment, Soil, Degradation, Causes, Yola South LGA and Farmlands.

I. Introduction

The United Nations and a number of global and regional institutions/entities have throughout the years recognized that growing soil degradation is not only a major threat to humanity, in that it compromises the continued tenure of food availability for a growing global population. (United Nations and Globalization on Soil Degradation Threats, 2018). Fertility status of a soil is a natural inherent gift bestowed within the layers of soil which are regulated under various physico-chemicals, geo-microbial, hydro-climatic and anthropogenic processes eventually subjecting the soil in to stage of depletion from its inherent nature (Sadiq, 2018). Soil degradation is the loss of actual or potential productivity and utility, and soil degradation implies a decline in the soil's inherent capacity to produce economic goods and perform environmental regulatory functions (Lal, 1997). Similarly, Soil degradation, refers to a broad spectrum of changes in soil characteristics because of natural or anthropogenic factors that alter their structure and quality, including deforestation and the removal of natural vegetation, agricultural activities, overgrazing, overexploitation of vegetation for domestic use, and industrial activities (Lal, 1997; FAO, 2015; DeLong, Cruse, and Wieneret 2015; . Karlen and Rice , 2015 and Lal, 2015). Soil degradation is causing a decline in crop productivity and huge economic loss, putting the food security and livelihood of farmers at risk (Bhattacharyya, Ghosh, Mishra, Mandal, Rao, Sarkar, Das, et al., 2015). In sub-Saharan Africa (SSA), soil degradation (nutrient depletion is the primary form of soil degradation in SSA), is leading to a decline in crop productivity, and has been linked to hunger and poverty (Tully, Sullivan, Weil, and Sanchez, 2015.).

II. Causes of Soil Degradation

Historically, soil degradation caused by agricultural intensification started to receive research interest from the 1940s onwards (e.g. Jacks and Whyte, 1939; Howard, 1940; Osborn, 1948) but it took until the 1970s before it received serious international attention (Hartemink, 2003).Thus, Soil degradation is not a new problem and many of the ancient cultures broke down and disintegrated because of soil degradation problems such as erosion and salinization (Hillel, 1991). The causes that lead to soil degradation are complex and can be of a different nature: biophysical (i.e., land use, cropping system, farming practices, deforestation), socioeconomic (i.e., institutions, markets, poverty), and political (i.e., policies, political instability, conflicts) (Blaikie and Brookfield, 1987; Young, 1998; Lal, 1997; FAO, 2015; DeLong, Cruse and Wieneret, 2015; Lal and Stewart, 2013; Oldeman, Hakkeling, and Sombroek, 1991; Lambin, Turner, Geist, Agbola, Angelsen, *et al*.2001; Barrett and Bevis, 2015). Similarly, Roy *et al*, (2007), stated the basic factors causing soil nutrient losses are: soil erosion, crop removal, human activities, leaching and losses in gaseous forms. The major pathways of soil fertility declines on farmlands include the loss of nutrients through erosion, leaching, volatilization, crop uptake, poor management and harvests without proportionate replenishments. Many soils have been changed in their chemical, physical or biological properties through the agricultural activities of man, including cultivation, tillage, weeding, terracing, subsoiling, deep ploughing, manure

and fertilizer addition, liming, draining and irrigation (Bridges and de Bakker, 1997).Thus, soil in Yola South LGA is not exceptional in degradation process. However, agricultural land has become one of the largest terrestrial biomes on the planet, occupying an estimated 40% of the land surface (Tilman, Cassman, Matson, Naylor and Polasky, 2002, Tilman, Fargione, Wolff, D'Antonio, Dobson, Howarth, and Schindler, D. 2001, and Foley, Defries, Asner, Barford, Bonan, Carpenter et al., 2005). But unfortunately, people have been building and expanding their cities on the most fertile soils, thereby squandering such a valuable resource (Hillel, 1991; Montgomery 2007; Nizeyimana, Petersen, Imhoff, Sinclair, Waltman, Reed-Margetan, Levine, and Russo, 2001). Thus, in Yola South LGA of Adamawa state soil degradation prompted farmers to look for new land due to rapid urbanization on the fertile agricultural land. Similarly, intensification of agriculture has also led to the degradation and exhaustion of soil and land (Gomiero, 2016). The factors that determine the kind of degradation are as follows: soil inherent properties (i.e., physical, chemical), climate (i.e., precipitation, temperature), the characteristics of the terrain (i.e., slope, drainage) and the vegetation (i.e., biomass, biodiversity) (Lal, 1997 ;Lal, 2015).

III. GUIDELINES FOR ASSESSING SOIL DEGRADATION PROCESS

According to Lal (1997), soil degradation happens when soil cannot perform one or several of the following principal functions:

1. Sustain biomass production and biodiversity including preservation and enhancement of gene pool.
2. Regulate water and air quality by filtering, buffering, detoxification, and regulating geochemical cycles.
3. Preserve archaeological, geological and astronomical records.
4. Support socio-economic structure, cultural and aesthetic values and provide engineering foundation.

Similarly, Hartemink, (2003).further explains the two main guidelines that can be of help in assessing soil degradation:

1. Clear signs of soil degradation that can be observed in the field. These could be erosion features, sealing or slaking of the soil surface, salt accumulation at the surface, or compacted and dense soil layers. These features may be accompanied by poor crop growth but that may also be caused by other, less visible, symptoms, such as drought or the outbreak of pests and diseases.
2. Trends in crop yield. This is probably the best indicator of soil degradation although a number of confounding factors exist, such as a build-up of pests and diseases over time, increased weed infestation, or weather fluctuations.

Globally, the first approximation to assess and map soil degradation at a global scale was made by Oldeman *et al.* (1991). The Global Assessment of Soil Degradation (GLASOD) recognizes five different types of human intervention that have caused soil to degrade to its present status: deforestation, overgrazing, agricultural practices, overexploitation of the vegetative cover, and bio-industrial and industrial activities. (Hartemink, 2003). GLASOD indicated that almost 40% of the agricultural land in the world has been affected by human-induced soil degradation, and that more than 6% is degraded to such a degree that rehabilitation is only possible through large capital investments. The loss of nutrients (i.e. soil fertility decline) was severe in Africa and South America, but less of a problem in the upland soils of Asia (Oldeman *et al.*, 1991).

Generally, in Yola South LGA of Adamawa state, soil degradation is quite glaring and felt through on-field observation conducted by the authors these factors includes development of erosions on farmlands (sheet to gully), deforestation practices which gradually manifest to desert encroachment, overgrazing effects on soil structure, industrialization and urbanization of buildings on fertile agricultural lands due to increase in population rate. The evident of such factors are depicted on plates 1 A-D below. In addition, reduction in crop yield had significantly experienced through poor crop growth as a result of soil nutrient depletion. Thus, it is timely and highly imperative to properly understanding and assesses the factors that caused soil degradation on their farmlands in the study area. Therefore, this study saddled to assess the soil degradation causes in Yola South LGA Adamawa State, with the specific objectives of assessing the major causes from anthropogenic, cultural, physical and climatic factors of soil degradation in the area.

A.Gradual development of desertification

B. grazing animals trampling on farmlands

C. Destruction of soil structure caused by overgrazing E. Urbanization on fertile agricultural land

Plates 1 A-E Shows some factors of soil degradation in Yola South LGA, of Adamawa State.

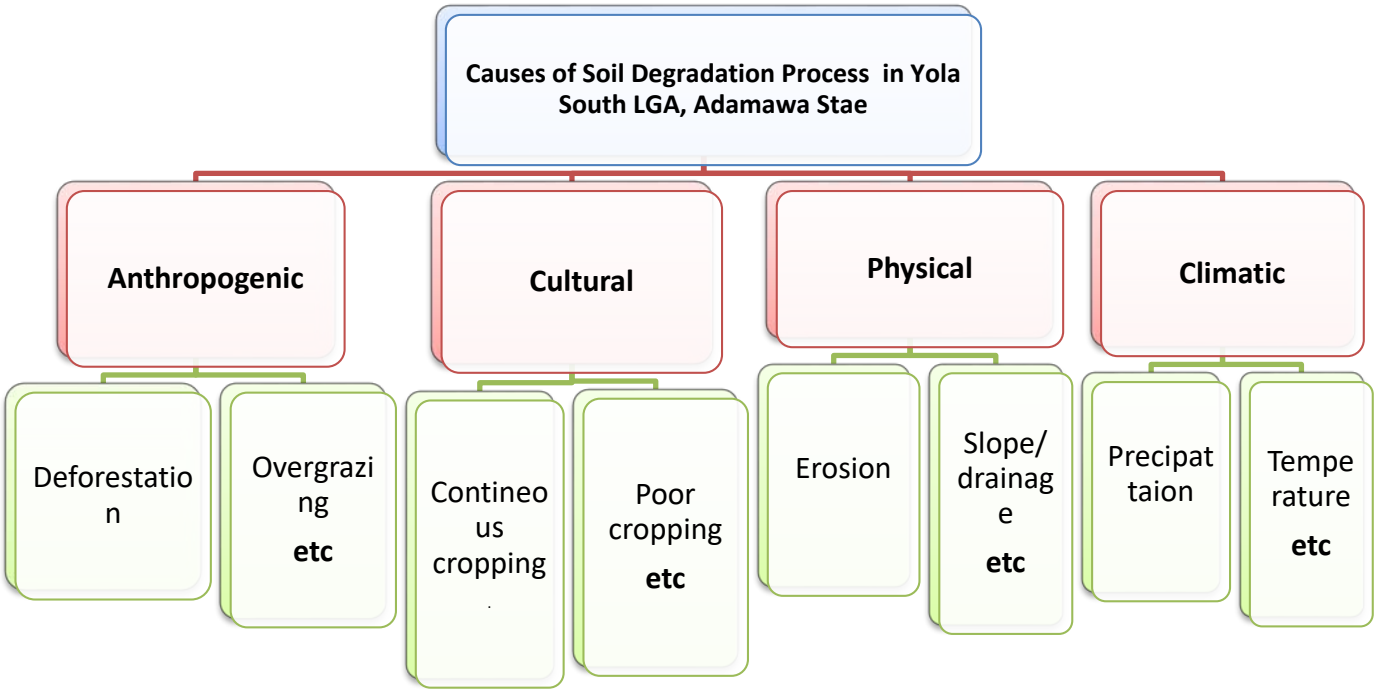

Fig.1. Shows the overview of some factors that cause soil degradation in Yola South LGA, Adamawa State. (Adopted by the authors; field observation. , 2019)

IV. STUDY AREA

The study was conducted in Yola South LGA of Adamawa State which lies on latitude 09^0 14'N and 09^0 20'N of the equator and longitude 12^0 25'E and 12^0 28'E of the Greenwich meridian, it has total population of 336, 648 persons as of 2010 (Census, 2006; National Bureau of Statistics, 2006). The average annual rainfall in the study area ranges between 850mm-1000mm with over 41% of rain falling in August and September. Temperature also has a significant temporal variation in the study area; with an average maximum temperature of 42^0C with an average relative humidity of about 29%. (Upper Benue River Basin Development Authority, 'UBRBDA' 2018).

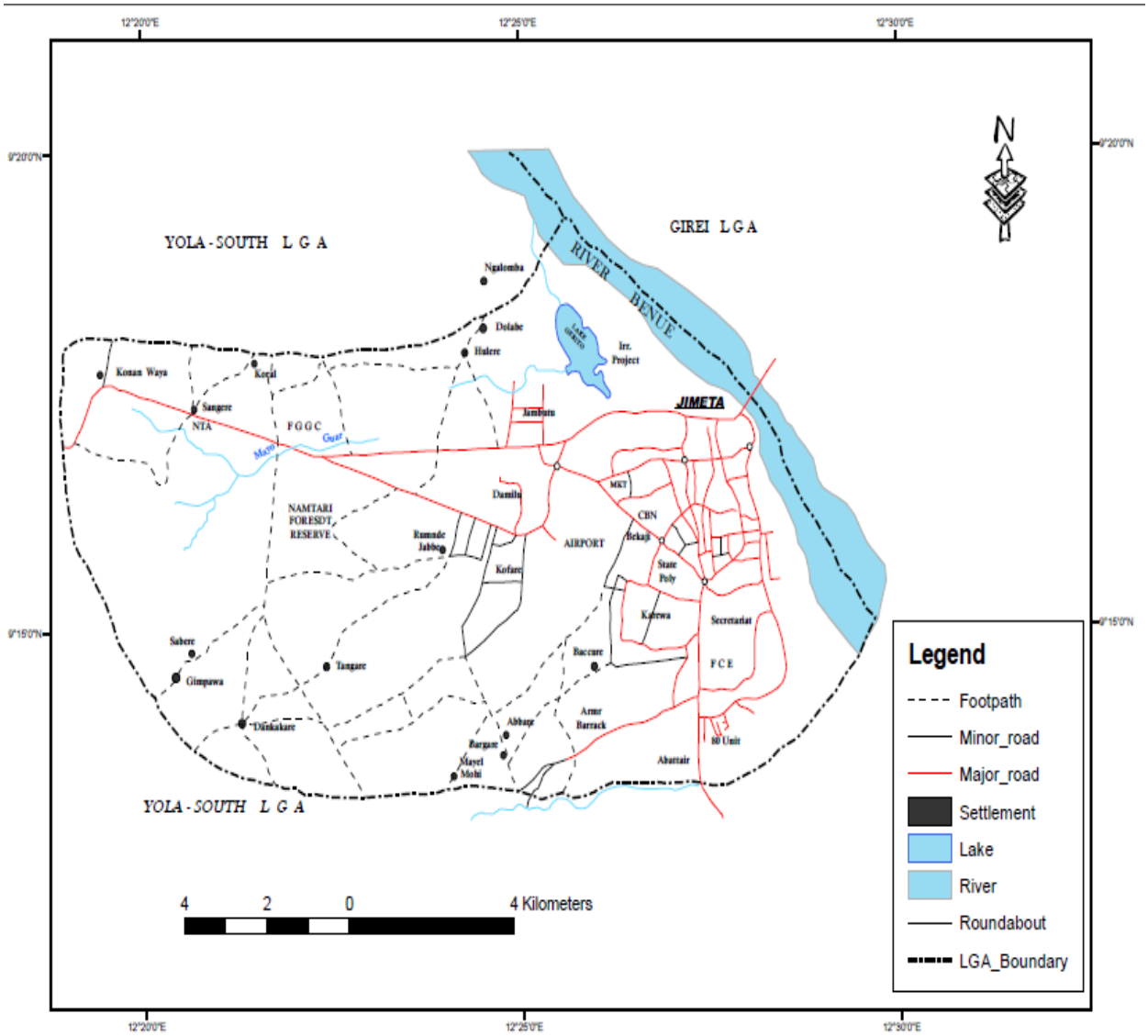

Fig 2. Shows the map of the Study Area (Adopted from Festus, 2016)

V. SAMPLING TECHNIQUES AND DATA COLLECTION.

This study was quantitative in nature which largely based on both primary and secondary data, where total number of 180 sampled farmers were randomly selected as respondents and administered to them a well design and structured field assessment questionnaires (FAQ) with on-field oral interviews respectively. While Secondary sources were obtained from relevant agencies/institutions and other related scientific literatures were also overviewed from Journals, textbooks, from e-library, institutions, internet and unpublished thesis as well.

VI. DATA ANALYSIS

The data collected were subjected to descriptive statistical analysis where simple percentages, frequency distribution and charts were obtained.

VII. RESULTS AND DISCUSSIONS

Table 1. Assessment of Anthropogenic Causes of Soil Degradation.

VARIABLES	Frequency	Percentage (100 %)
Bush Burning	27	15

Overgrazing	34	19
Deforestation	38	21
Removal of Crop Residues	40	22
Land Use/Urbanizations	41	23
TOTAL	**180**	**100 %**

Source; Authors' Field Survey Assessment (2019)

Anthropogenic causes of soil degradation process entails direct and indirect human activities associated with soil nutrients depletion. From the above table 1, it was revealed that land use and or urbanization was the utmost factor that caused devastating soil degradation in the study area with 23 % of the respondents. This might be largely due to increase in population density which prompted inhabitants in the area to occupy the fertile agricultural land under cropping to building of houses and industries. This finding agreed with the report of Montagomery, (2007) who explained that people have been building and expanding their cities on the most fertile soils, thereby squandering such a valuable. Similarly, 22 % of the respondents agreed that removal of crop residues on the farmland caused the soil degraded; likely crop residues are removed in the study area as animal forage rather than incorporating them in to the soil to improve the soil nutrients. This finding is in conformity with the report of Sadiq and Tekwa (2018) explained that, in Mubi region, most farmers usually gather crop residues on their farms and sale them to pastoralists as a source of income without minding its negative implications or even understand the need to recycle such crop residues as sources of soil fertility enrichment on their farmlands and more than 50% of crop residues are utilized for animal feeds and other economic purposes. While other respondents (21%) assessed deforestation as the main factor of soil degradation in the area, where trees (leaves, litters which decomposed in purification process of organic matter in nitrogen cycle are indiscriminately cut down as fuel wood for cooking and economic purposes subsequently subjecting the area in to desert encroachment zone .Thus, In Nigeria desertification is fast becoming a threat in the northern parts especially the states in the sahel and sudan svannna areas (Uchegbu, 2002). Overgrazing by the animals was perceived by 19 % of the respondents to had caused soil degradation in the study area. Perhaps might be due to their traction effects on the soil physical properties such as structures, texture, porosity and compaction. Overgrazing affects soil structure, compaction rates, porosity, and top soil depletion which have led to soil erosion and reduced soil fertility. (Sadiq, Abdullahi and Ardo, 2019a). Lastly, bush burning had received fewer respondents (15 %) in the area to have cause soil degradation respectively. Hence, in an oral interview conducted with the respondents revealed that bush burning practices was not heavily engaged by the inhabitants in the study area due to the sanctions attached to it by the traditional rulers.

Table 2. Assessment of Cultural Causes of Soil Degradation.

VARIABLES	FREQUENCY	PERCENTAGES (100%)
Continuous Cropping	47	26
Excessive and Deep Tillage	32	18
Poor Soil Management	38	21
Nutrient imbalance	29	16
Excess use of Chemicals	34	19
TOTAL	**180**	**100 %**

Source; Authors' Field Survey Assessment (2019)

Among the cultural causes which has to do with the farming practices and farmer's perception that leads to soil degradation in Yola south LGA, were depicted on table 2 above. Continuous cropping revealed to be an ultimate factor that caused degradation of soil resources with 26 % of the respondents. It might be probably due to unavailability of farmland and tenure system as a result of high increase in population. In an on-farm oral interview conducted with some farmers revealed that they cultivated over than 20 years on the same piece of land as they inherited the farmlands from their parents without effective management practices. This result had agreed with the report of Sadiq, (2018) who explained that that unavailability of fertile agricultural lands has made most farmers to engaged in continuous cropping systems and without involving proper management techniques. Similarly, farmers in Mubi area cultivated a piece of land for over 15 years without minding the recommended soil nutrient management rules. (Sadiq and Tekwa, 2018). Thus, this farmers' behavior have degraded the inherent resources of soil in Yola South LGA, and thereby causing lower crop yields over time. In addition, 21 % of the respondents conceived that poor soil management by the respondents caused degradation of soil resources. Perhaps this might due to lack of adequate skills and technical know-how and less or no adoption of effective conservation techniques. Akintola, Odu and Baiyegunhi (2013) explained that intensive cultivation and cropping, coupled with less or no adoption of conservation techniques concerned the farmlands' nutrient status and eventually put most of their (farmers) production less economical. Similarly, other respondents (19 %) agreed that excessive use of chemicals while 18 % of them attached it to deep tillage practices were among the cultural causative factors of soil degradation in the study area respectively.

Table 3. Assessment of Physico-Edaphic Causes of Soil Degradation.

VARIABLES	FREQUENCY	PERCENTAGES (100 %)
Soil Erosion/ Erodibility	43	24
Poor Drainage system	38	21
Soil Compaction	30	17
Nature of the Slope	40	22
Soil Creeping/ Solifluction	29	16
TOTAL	**180**	**100 %**

Source; Authors' Field Survey Assessment (2019)

Among the physico-Edaphic causes of soil degradation process in the study area as shown on table 3 above, soil erosion and erodibility was revealed by the most of the respondents (24 %) to had triggered dilapidation of soil nutrients. Yola south LGA is experiencing rapid development of extended gully erosion from its all farmland axis which carries organic soil from the top soil and sediment on farmlands. Thus, Soil erosion by water or wind agents selectively damages the soil by removing organic matter, soil particles, plant nutrients, pedon thickness, and reducing soil chemical capacity to retain added nutrients (Sadiq, *et al*.,2019a). Hence, erosion removes soil particles that are necessary for water storage and denies root exploration for plant nutrients (Sadiq and Tekwa, 2018). In Nigeria, it has been reported that over 25 million tons of valuable top soils are lost annually to erosion (Ezedinma, 1982). Moreover, 22 % of the respondents conceded that nature of the slope in the area causes the soil to degraded, because some farmlands in the study area is suited in steeply sloping (20-22 %) ground most especially those along Benue riverine areas. The sloppy nature of the farmland increases the rate of erosion and is the most serious soil loss agent devastating the area. It was reported by Serageldin, (1987) in West Africa, soil erosion gulps about 10-21 tons of top soils per ha on nearly gentle slopes of 0.4 - 0.8% and up to 30 - 35 tons on 1-2% slopes. Poor drainage system considered to have caused soil resources depletion with 21 % of the respondents in the area which led to seasonal flooding affecting hundred hectares of valuable farmlands and consequently reducing the yield per unit area. Others among the respondents 17 % and 16 % conceived that soil compaction and soil creeping were among the causative agents of soil degradation respectively.

Table 4. Assessment of Hydro-climatic Causes of Soil Degradation.

VARIABLES	FREQUENCY	PERCENTAGES (100 %)
Humidity	29	16
Temperature Level	36	20
Evaporation Rate	30	17
High amount of Rainfall	45	25
Flooding	40	22
TOTAL	**180**	**100 %**

Source; Authors' Field Survey Assessment (2019)

From table 4 presented above, it was revealed that high amount of rainfall experienced in the area was found to be major factor of soil degradation among the hydro-climatic parameters. This is because the flood frequency and magnitude, rate of run-off, erosion and soil loss depends directly on the amount of rainfall recorded. Similar finding was made by Sadiq, *et al* (2019b) who reported that 28.5% of the respondents believed that high amount and prolong duration of rainfall was responsible for flooding in the area which hampered hundred hectares of land. This finding is in conformity with the verdict reported by Oyegun, 2001 and. Angillieri, (2007) that flood may be induced by a variety of factors, most notably heavy precipitation (intensity, duration, amount, or snow) . Similarly, Knapp (1997) looked time to time heavy rainfall resulted in flood occurrence. Despite the climatic region of Yola South with relatively low amount of annual rainfall, the area however from the last decade (2008-2018) was experienced an increase in total amount of rainfall of more than 800 mm with more than 60 days number of rainy days as shown in the figure 3 and 4 below respectively. Thus, the high amount of rainfall experienced in the year 2018 had led to excessive run-off which subsequently resulted to river flooding in the study area which aids in degrading soil nutrients. Changes in precipitation events will affect flow rates and timing (Constantine, 2009)

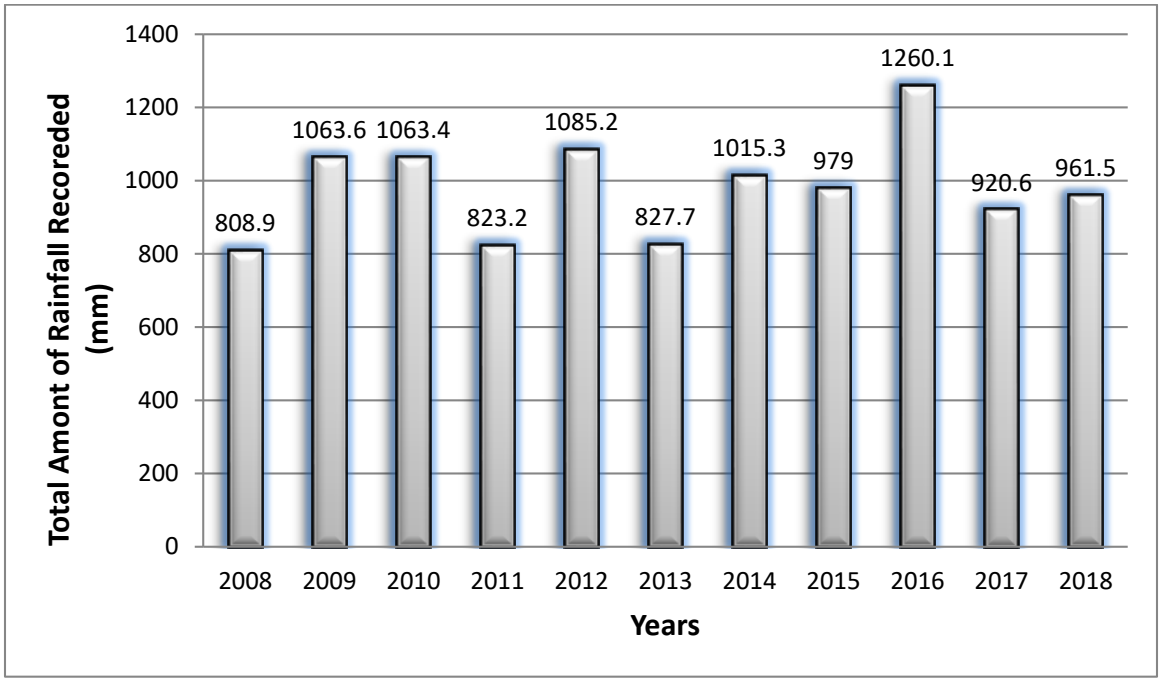

Fig 3. Shows the total amount of rainfall for a recent decade (from 2008-2018) of Yola South

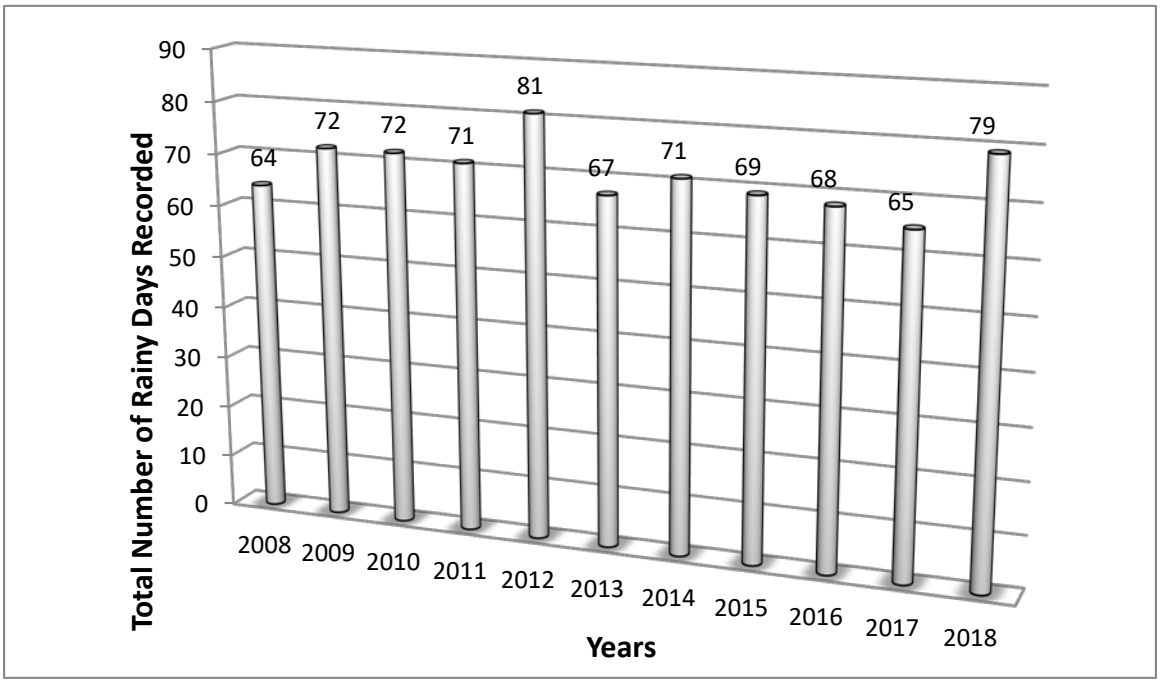

Fig 4. Shows the total number of rainy days for a recent decade (from 2008-2018) of Yola South.

Flooding also was found to be second major causes of soil degradation in the study area with 22 % of them. It was reported in the recent findings of Sadiq *et al*, (2019b) in Yola, floods have removed significant amount of topsoil on farm lands (off-site effects) while some parts of the farmlands were deposited (with some sediments; on-site effects) which damaged crops as shown in plates 2 below..

Plates 2. Shows the apparent effects of on-site erosion caused by river flooding in the study area (Adopted from Sadiq *et al*.. 2019b)

In Nigeria, flooding is the most frequent and most widespread natural hazard accounting for about one-third of all disasters arising from geophysical hazards and adversely affecting more people than any other natural hazard (Adebayo and Oruonye , 2012). According to the report of Sadiq and Hena, (2018) who explained that in Nigeria, Adamawa state is one of the most occurring flooded states over the decade with a large extent of vulnerability leading to devastating loss of lives, properties, farmlands, displacement and negatively affecting the socio-economic activities in the state. They added that in Adamawa state, Yoal South LGA, is grouped in a highly flood prone areas for the past decades consequence to its extent, proximity to river Benue and reoccurrence respectively.

The Temperature level in the area was agreed to have caused degradation of soil resources with about 20 % of the respondents. Temperature plays a vital role in decomposition process of organic matter and other element mineralization. High amount of temperature aids in organic matter declination and volatilization of nitrogen. Thus, organic material in the soil is essentially derived from residual plant and animal material, synthesized by microbes and decomposed under the influence of temperature, moisture and ambient soil conditions (Ajoade,2004).The temperature regime in Yola LGA is warm to hot throughout the year described as hyper-thermic soil temperate region due to high radiation which is relatively and evenly distributed throughout the year had led to loss of organic matter because of increase rate of decomposition rates most especially when there is a gradual increase in temperature from January to April with seasonal average maximum temperature of 42^0C with an average relative humidity of about 29%. (UBRBDA, 2018). Practically, flood is indirectly depended on atmospheric temperature of a given geographical area, because temperature has a direct effect on evaporation rate of water bodies on the ground surface. Hence, rising temperature will lead to an intensification of the hydrological cycle, resulting in drier dry seasons and wetter rainy seasons, and subsequently heightened risks of more extreme and frequent floods and droughts (Holmes, 2007). High temperature facilitates evaporation rate while low temperature decreases/ reduces the rate of water, moisture and vapour loss from the ground surface which may affects the availability and sustainability of soil nutrients. As the Earth's average temperature rises, the proportion of precipitation in the form of rain increases and there is also a decrease in precipitation proportion in the form of snow.(Adams and Peck, 2008). Humidity and Evaporation were among the minor climatic factor of soil degradation assessed with about 16 % and 17 % of the respondents respectively. Humidity plays a pivotal role in predicting rate of precipitation. The study area experienced moderate to high relative humidity as shown in table 6 below. This sensation might also be contributed to the unique scenario of flood and soil run-off (Solifluction effect) in the study area, because the extent of saturation depends on the quantity of water vapour present in the air which might give rise to condensation and later excessive precipitation. Thus, as the relative humidity (RH) ranges between 70-75 % there would be high possibility of intensive precipitation as was glared in the monthly mean of RH from 2007-2016 in the study area.

Table 5. Monthly Mean Relative Humidity (%) in Yola South LGA, Adamawa State.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL (%)
2007	22	21	28	47	68	70	74	82	79	72	51	26	645
2008	25	21	29	45	56	68	73	81	77	66	36	36	613
2009	27	22	26	47	62	71	75	79	80	74	46	26	635
2010	24	26	29	36	63	72	76	79	80	80	52	29	646

2011	30	36	31	38	61	66	73	77	82	72	41	31	638
2012	35	34	22	42	65	70	77	77	84	74	55	37	672
2013	30	23	38	46	60	76	77	77	78	69	50	40	664
2014	24	19	30	48	69	73	75	78	76	71	56	30	649
2015	25	23	29	28	47	65	71	77	74	71	39	27	576
2016	23	21	39	34	60	67	73	78	75	67	38	24	599

Source: UBRBDA, Agromet, Station Yola (2018).

Similarly, evaporation rate was also received a significant response (17 %) as a factor that indirectly caused soil nutrients depletion. This is because if the rate of precipitation is higher than the evaporation rate it occurs mostly in rainfall intensive months of the rainy season with low atmospheric temperature (July-September) the soil macro and micro-pores spaces will filled up with water leading to waterlogging effects and consequently rejuvenating to devastating soil degradation as it was glared in the study area. Conversely, if the rate of evaporation is higher than the precipitation the ground water surface will eventually reduce or deplete which consequently manifest to hydrological drought leading to reduction of soil moisture content at field capacity, hygroscopic water, drying of reservoirs, lakes, streams, rivers and cessation of spring flows and fall in the groundwater table thereby reducing the soil viable resourced components.

VIII. CONCLUSION

From the present research conducted in Yola south LGA, of Adamawa state, it was therefore concluded that the area is undergoing severe degradation consequence on the major identified factors such as rapid urbanization on fertile agricultural land as anthropogenic factor, continuous cropping system adopted by the farmers revealed as cultural factor, while soil erosion which regarded as physic-edaphic factor and for climatic factor heavy rainfall was assessed respectively. Therefore, technical ardent attentions are required to find out a practical workable solution as matter of emergency with the aim of realizing maximum food production per unit area of land for the growing population in the study area. Thus, optimum food production largely depends on soil productivity potentials.

IX. RECOMMENDATION.

Based on the research findings obtained. It is therefore recommends that, professional extension workers should be incorporated in the soil and water conservation agenda towards educating and training the peasant farmers cultivating on the degraded soils. Similarly, government at all levels should provide adequate agricultural land to the farmers in the area with the aim of increasing food production for the growing population in the tropics and sustaining the soil nutrients for future use as well.

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