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Stochastic Analysis of Land Degradation on Edo State Agricultural System

Edo state, like many other states in Niger-Delta and Nigeria as a nation has resultant land and water degradation problems such as persistent oil spillage, erosion of arable land, sedimentation of dam and reservoirs. This research study investigates the effects of land degradation in all the local government areas in Edo state. The results of the findings indicated that 28% corresponding to 634,416.3 ha of arable land had totally been affected by soil erosion. Highest erodibility index of 0.75 was obtained at Estako west (Auchi), while least value of 0.1 was found at Akoko-Edo local government area respectively. Between 1976 and 1997, 1,820,410.50 barrels of crude oil spilled with maximum spill value 600,511.02 barrels in 1984 and minimum spill of 5,956 barrels in 1989. Reduction of cassava production was estimated and analyzed. The result showed that the reduction is highly significant at 95% confidence interval. Etasko -west had the highest reduction from 7.26 MT/HA in 1993 to 1.1 MT/HA in 2002. In addition, analysis of erosion and land degradation control expenditures showed that little attention has been paid to controlling land degradation in the state. Erosion control expenditure was increased from 4.1% in 1990 to 10% in 2002. This increase is not significant at 0.01 and 0.05 levels of significance. All these constraints affect agricultural production, human well-being, social and economic growth of the people in Edo state.

Keywords: *degradation, land, erosion, spillage, index, state, hectare, expenditure*

1. Introduction

Edo state is in the comparatively enviable position of having a large percentage of its land arable, and much of that not yet under cultivation. Approximately 75 percent of the state's land is relatively fertile and receives sufficient rainfall for rainfed cropping or pasture. Only around 30 percent of the

arable land is currently under cultivation (Pake et al,. 1999). The agricultural population is relatively concentrated in Eastern, Southern and Western Region, and zones within those areas have less relative population densities. In several regions, important signs of soil degradation trends are apparent including declining yields and a switch to crops that demand fewer nutrients. Indeed, food production has not kept up with the state's population growth despite an expansion of area under crops. Per capita food production hit a low in 1990, and even with recent increases it has not reached the levels of the 1970's (NEMA, 2001). Land degradation is a universal problem. We must not be misled into thinking it is restricted to agricultural land or agricultural livelihoods, although it is in these areas that the effects of land degradation are immediately apparent and most dramatic. In the developing world, land degradation is a symptom of under-development. It results from a combination of social and economic factors, such as poverty and inequitable distribution of the land resources, inappropriate land use systems and farming methods. In the dry areas, these factors are exacerbated by climate and the fragility of ecosystems (UNEP, 1986). Because agriculture in the poorer countries is the principal employer of labour and generator of income, the effects of land degradation are often disastrous and lead to famine and political turmoil (UNEP, 1986).

As land is cleared for development, agriculture, and livestock grazing, unprotected areas are eroded, soil nutrients are depleted, and stalinization looms. Destroyed forests and degrade water resources imperil biodiversity, induce climate change, and disturb the hydrologic cycle. The livelihoods of more than 900 million people in some 100 countries are now directly and adversely affected by land degradation (UNDP, 1994). Unless the current rate of land degradation is slowed and reversed, the food security of humanity will be threatened and the ability of poor nations to increase their wealth through improved productivity will be impeded. Land degradation can be observed in all agro-climatic regions on all continents. Although climatic condition, such as drought and floods, contribute to degradation, the main causes are human activities. Destroyed forests and degrade water resources imperil biodiversity, induce climate change, and disturb the hydrologic cycle. The livelihoods of more than 900 million people in some 100 countries are now directly and adversely affected by land degradation (UNDP, 1994).

The most significant **landscape function** affected by land degradation is the hydrologic balance of catchments. Unfavorable soil-surface characteristics of degraded lands and a lack of adequate plan cover lead to reduced surface retention and infiltration, and to higher surface runoff. This results not only in reduced soil moisture content in the soil profile, but also increased rate of soil erosion (Chan, 1998).

Land degradation takes different forms and manifestations in different regions and land-use systems. It is the result of complex causes and processes, and oversimplification of the environment, climate and land-use factors involved

can mislead to the conclusion that rehabilitation of degraded land is easy and simple. Typical forms of degradation, predominant under certain conditions, can be identified as follows:

i. In the more humid areas, rainfall can occur in erosive showers. Especially in the sloping areas of the tropics and subtropics, these may cause serious soil erosion by runoff. High rainfall can also lead to high rates of nutrient leaching and to soil acidification in many tropical regions.
ii. In the environments, vegetation cover is sparse on large areas of land. In these areas, strong seasonal winds can cause serious wind erosion, especially where the terrain is flat and the lack of standing plants or residues-due to overgrazing-leaves the soil vulnerable to wind.
iii. In irrigated agriculture, inappropriate soil and water management practices, irrigation and drainage methods, and the use of marginal quality waters without proper management lead to the accumulation of salts in the soil. Plant growth is affected by this soil stalinizations, which has disastrous effects on the productivity of the land in areas where irrigation is essential for crop production.

Land degradation will remain an important global issue for the 21st century because of its adverse impact on agronomic productivity, the environment and its effect on food security and the quality of life. Productivity impacts of land degradation are due to a decline in land quality on site where degradation occurs (e.g. erosion) and off site where sediments are deposited. However, the on-site impacts of land degradation on productivity are easily masked due to use of additional inputs and adoption if improved technology.

2. Materials and methods

2.1. The study area

Edo State was created on August 27th, 1991. Edo State was one of the two states carved out of the defunct Bendel state of Nigeria. There are at present Eighteen (18) local Government Areas in Edo state as shown in Table1. Edo state has approximately between latitude 05^{o} 44'N and 07^{o} 34'N of the Equator and between latitude 06^{o} o4^{o}'E and 06^{o} 43^{o}'E. It is bounded in the south by delta state in the West by Ondo state in the North and North East by kogi state and in the East by Anambra state (Segynola, 1993). Edo State covers an area of 19,744km^{2} and has a total population of 2,159,848 and population density of 109 (based on the 1991 census figure). The major relief regions in the State include the swamps/Creeks, the Esan plateau, the valley and the dissected uplands of AKoko-Edo local Government area which ranges from183 to 305 meters above sea level. The soil type in the state is generally the reddish yellow land which varies from one to area in the state. The vegetative also vary from rain forest type in Benin low land to Savanna in the Akoko-Edo upland (Segynola, 1993). The two distinct

seasons are the wet and dry seasons. Map 1 shows the map that indicates every local government areas in Edo State.

Map of Edo-State, 2008

The data for this research came from both secondary and primary sources. The secondary sources include literature materials from the government ministries, agencies and previous research studies conducted by different authors. While the primary data sources were from questionnaires and structured interviews carried out in the field during the study. A total of 300 questionnaires were randomly distributed to some respondents across all the local government areas in the state. Out of the number that was distributed, 255 completed questionnaires were returned (representing 85 percent). Structured questionnaires were distributed to capture the following information:

(i) The rate of oil spillage;
(ii) Degree of Agricultural soil lost to erosion;
(iii) Soil and yield loss in arable land in all the local government areas in Edo State; and
(iv) Quantities of waste generated in all the local government areas in Edo State. The data were sourced from the field study, ministries and some journals.

2.2 . Data analysis

Obtained data were subjected to statistical analysis using tools such as ANOVA, T-test, SSPS and correlation regression models

3. Results and discussion

3.1 Reduction in cassava production

1993 to 2002. The yield per hectare is 8.21mt/hectare and decreased to 3.21 mt/ha in the year 2002. The province of Etsako-West reflected the highest decrease from 7.26 mt/ha in 1993 and 1994 to 1.10 mt/ha in 2002.The results of the T-test carried out on the yield of cassava in Table 2 and 3 showed that the reduction in the yield of cassava is significant at 95% confidence interval in all the selected local government areas in Edo State. The computed T value of 9.077 is greater than the critical t- values of 4.0730 and 6.7770 respectively. The reason for this sharp reduction of cassava yield is due to the effect of land degradation of arable soil. From the elementary statistics at 0.05 level of significance, it showed that arable land/agricultural soil in the selected areas had been lost to soil erosion. In addition, the agricultural soil of the remaining arable soil has been eroded, thus leaves the soil infertile.

Table 1. Average yield per hectare of cassava (MT/HA) in Edo-State

S/N	Year	Akoko Edo	Esan North East	Etsako West	Ovia North East	Owan East	Owan West
1	1993	8.21	10.10	7.26	8.10	6.87	6.25
2	1994	8.01	8.19	6.10	7.30	6.04	6.00
3	1995	7.03	7.22	5.11	6.90	5.77	5.77
4	1996	6.51	6.82	4.20	6.01	5.09	5.01
5	1997	5.20	6.01	3.94	5.89	4.87	4.66
6	1998	4.87	5.50	3.02	5.00	4.10	4.00
7	1999	4.01	4.81	2.98	4.78	3.90	3.61
8	2000	3.72	3.84	2.05	3.86	3.01	3.28
9	2001	3.48	3.02	1.82	3.01	2.81	2.70
10	2002	3.21	2.50	1.10	2.60	2.40	2.39

Source: Field study, 2010

Table 2. One-sample statistics

	N	Mean	Std. Deviation	Std. Error Mean
Year	10	1997.5000	3.02765	.95743
Akoko-Edo	10	5.4250	1.89000	.59767
Esan N/E	10	5.8010	2.37658	.75154
Etsako West	10	3.7580	1.96337	.62087
Ovia N/E	10	5.3450	1.83182	.57927
Owan East	10	4.4860	1.49409	.47247
Owan West	10	4.3670	1.38471	.43788

Source: Field study, 2010

Table 3. One-sample test

	Test Value = 0					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
	Lower	Upper	Lower	Upper	Lower	Upper
Year	2086.321	9	.000	1997.50000	1995.3341	1999.6659
Akoko-Edo	9.077	9	.000	5.42500	4.0730	6.7770
Esan N/E	7.719	9	.000	5.80100	4.1009	7.5011
Etsako West	6.053	9	.000	3.75800	2.3535	5.1625
Ovia N/E	9.227	9	.000	5.34500	4.0346	6.6554
Owan East	9.495	9	.000	4.48600	3.4172	5.5548
Owan West	9.973	9	.000	4.36700	3.3764	5.3576

Source: Field study, 2010

3.2. Soil loss and land degradation

Table 4 shows the effect of soil erosion of arable land in all the local government areas in Edo State. Highest arable land loss of 75% corresponded to 30,384.8ha was estimated to have been affected by soil erosion at Etsako-West. However, Akoko Edo recorded the least value of 10% land degradation corresponded to 9,324.6ha. Fig 1 shows the total arable land affected by land degradation in Edo –State. In Etsako –West, the main reasons for land degradation are as follows: steep slope, deforestation, poor farming and vulnerable soil. This situation has generally reduced the nutrient in agricultural soil and thereby, leads to food shortage. Degraded land has numerous bad ripple effects to the environment. Plant and animals die due to poor or little nutrient and food supply. Thus, there is loss of biodiversity, people (Farmer) fail to produce enough to eat, people become prone to various diseases, rivers and dams dry up due to siltation. This, results in the death of aquatic life and disruption of food chain. In the long run, the whole ecological processes in terms of water cycle, mineral cycle, plant succession and energy flow is disrupted with the subsequent occurrence of floods, droughts, pest and diseases outbreaks and complete breakdown of human social fabric. This has a negative impact on the state Gross Domestic Product (GDP).

Table 4. Soil and yield loss of arable in all the local government areas in Edo-State

S/N	Agricultural development Areas	Population	Total Areas (HA)	Arable Land (HA)	Indicator of soil loss (%)	Arable land loss to soil erosion (HA)
1	Akoko Edo	124,366	126,025	93,246	10	9,324.6
2	Esan Central	66,169	22,500	16,132	25	4,033
3	Igueben	62,342	21,085	15,340	23	3,528.2
4	Esan North East	88,358	34,4240.5	18,100	30	5,430.0
5	Esan South East	89,486	137,048	100,131	30	30,039.3
6	Esan West	91,748	64,999.5	31,109	30	9,332.7
7	Etsako East	143,903	141,827.6	111,062	30	33,318.6
8	Etsako Central	143,263	35,980.1	20,603	65	13,391.0
9	Etsako West	87,663	99,982.4	40,513	75	30,384.8
10	Oredo	305,230	121,521.2	41,234	40	16,493.6
11	Egor	212,485	121,521.2	110,141	40	44,056.4
12	Ikpoba Okha	263,261	121,521.2	87,531	40	35,012.4
13	Ovia North East	122,107	184,986.0	125,271	30	37,581.3

14	Ovia South West	81,020	337,909.7	301,052	30	90,315.6
15	Owan East	78,136	122,990.5	75,421	30	22,626.3
16	Owan West	72,963	81,567.4	59,441	30	17,832.3
17	Orhionmwon	118,054	238,896.1	200,162	40	80,064.8
18	Uhunmwode	109,294	206,97.7	169,325	40	67,730
	Total			1,615,814		634,416.3

Source: Field study, 2010

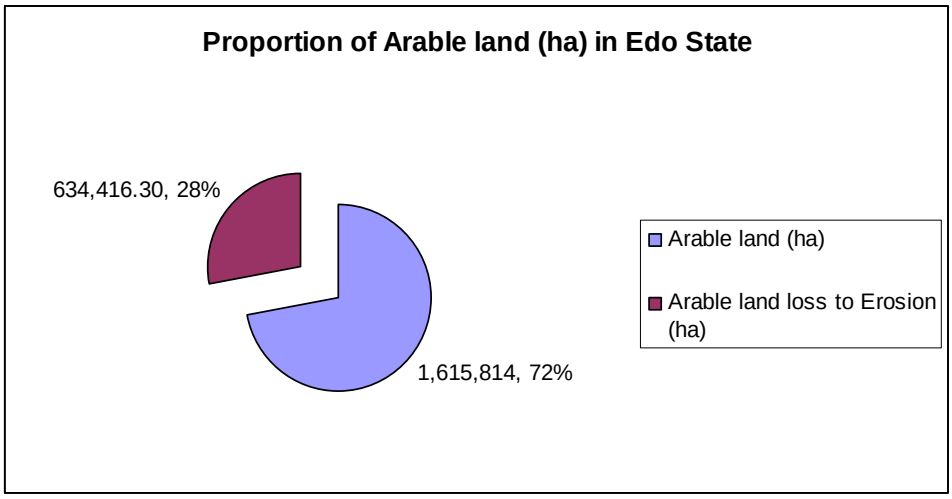

Figure 1. Proportion of Arable land (ha) in Edo State
Source: Field study, 2010

3.3 . Oil spillage and food production

Between 1976 and 1997, 4,647 cases of oil spillage were recorded, which sum up to total net loss of 1,820,410.50 barrels of crude oil as shown in Table 5, Fig 2 shows oil spillage curve which is indicated that maximum spillage of 600, 511.02 barrels of crude oil was spilled in 1984 and least spillage of 5,956 barrels in 1989. This trend continued and it has resulted to adverse effect on agricultural production in Edo and other Niger-Delta States. It is estimated that the second main cause of land degradation to soil erosion is oil spillage (Olotu et al., 2005). From the elementary statistics at 0.05 (5%) level of significance, it showed that about 30% of arable land in Niger-Delta region has been degraded by the action of oil spillage (Olotu et al., 2005). This has resulted to a sharp drop in food production. More than 45% of nutrient in the soil has been lost to chemical decomposition. Millions of fishes and fingerlings have been killed and made the

environment highly unfavourable for the production of economic aquatic life (fishes) etc. This development contributed to significant reduction in food production and increase in poverty level in Edo and other Niger-Delta States

Table 5. Oil Spills in Nigeria (1976 – 1996)

Year	Number of Spills	Quantity Spilled (barrels)	Quantity Re-covered (barrels)	Net loss to the Environment (barrels)
1976	128	26157.00	7135.00	19021.50
1977	104	32879.25	1703.01	31176.75
1978	154	489294.75	391445.00	97849.75
1979	157	64117.13	63481.20	630635.95
1980	241	600511.02	42416.83	558094.19
1981	238	42722.50	5470.20	37252.30
1982	257	42841.00	2171.40	40669.60
1983	173	48351.30	6355.90	41995.40
1984	151	40.209.00	1644.80	38564.20
1985	187	11876.60	1719.30	10157.30
1986	155	12905.00	552.00	12358.00
1987	129	31866.00	6109.00	25358.00
1988	108	9172.00	1955.00	7207.00
1989	118	5956.00	2153.00	3830.00
1990	166	14150.35	2092.55	12057.80
1991	258	108367.01	2785.96	105912.05
1992	378	51187.90	1476.70	49711.20
1993	453	8105.32	2937.08	6632.11
1994	495	35123.71	2335.93	32787.78
1995	417	63677.17	3110.02	60568.15
1996	158	399036.67	11838.07	387198.60
Total	4,647	2,369,470.04	549,060.38	1,820,410.50

Source: Department of Petroleum Resources, 1997.

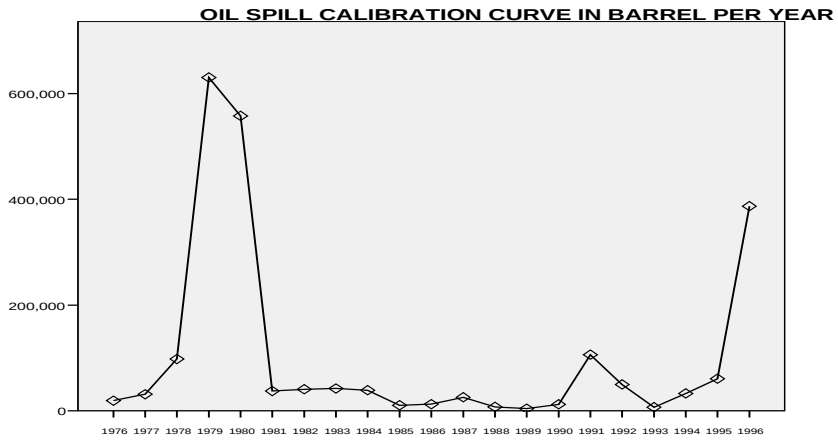

Figure 2. Spillage curve
Source: Field study, 2010

3.4. Wastes generation in Edo State

Wastes are often dumped at the edge of most towns in Edo state. This causes pollution of the soil surface and ground water .Table 4 shows the solid waste generated in Edo state between 1990-2002. It is observed from the result that the volume of water increased annually. The situation with respect to waste disposal is very serious because of its direct effect on the quality of the environment is tremendous.

The main sources of hazardous waste includes: heavy metal, oxides of nitrogen sulphur, and petroleum hydrocarbons as reflected in Table 3. Most of these come from the chemical industries, although, other industries such as primary and fabricated metal and petroleum industries produce significant quantities of hazardous substances. Effluents are discharged into rivers, lakes, or estuaries, some of which are sources of drinking and irrigation water, also they are dumped with ordinary domestic garbage and thus cause soil and ground water contamination. This development has seriously affected agricultural production and brings about health complication in the state.

Table 6. Quantity of solid waste generated in Edo- State

S/N	Year	Quantity (tons)
1	1990	149,633
2	1991	176,752
3	1992	205,689
4	1993	267,273

5	1994	288,468
6	1995	301,629
7	1996	324,327
8	1997	357,296
9	1998	401,752
10	1999	421,279
11	2000	428,526
12	2001	465,652
13	2002	482,629

Source: Edo State Ministry of Environment, 2009

4. Expenditure on erosion and land degradation

Soil loss and erosion control in Edo State is being handled by the Ministry of Environment. Table 7 shows the financial expenditure of the State Government in combating the menace of land degradation and soil erosion in the State between 1990 to 2002. In 1990, the financial allocation for the ministry was 4.1%, while in 2002 the allocation rose to 10%. The allocation to the Ministry continued to increase annually, but the increase is not significant because more land continued to be affected by soil erosion as presented in Table 2. In order to drastically reduced the impact of soil erosion, the state Government is expected to jack up the allocation for the ministry so that they can increase the state of their ecological programmes by electing the a good number of hydrological structures such as drainage, culverts e.t.c.

Table 7. Erosion and land degradation control expenditure in Edo-State

S/N	Year	Expenditure (Millions ₦)	% of Expenditure
1	1990	206,673	4.1
2	1991	256,852	5.1
3	1992	287,779	5.7
4	1993	309,873	6.1
5	1994	357,469	7.0
6	1995	401,729	7.9
7	1996	423,827	8.3
8	1997	429,196	8.4
9	1998	455,852	9.0
10	1999	469,479	9.2
11	2000	484,026	9.5
12	2001	499,652	9.8
13	2002	508,629	10.0

Source: Field study, 2009

4. Conclusion

Despite the fact that Edo State has a large percentage of arable land, soil degradation is a substantial problem in the State. Generally, it is calculated that 3 to 17 percent of Gross Domestic Product in the State is lost to the effect of land degradation from the environmental degradation, 61% of these, from soil erosion; nutrient lost and changes in crop. The worst affected areas are: Etsako West, Etsako central, Orhionmwon, Uhunwode, Ikpoba–Okha, Egor, and Oredo respectively. There has been little national scale analysis of the cause of land degradation to national economy, but the extent of the problem is well established in this research study which shows clearly on agriculture land, reduction of agriculture yield or production, sedimentation of hydraulic structure such as dams and reservoir causing acute shortage for domestic water supply and irrigation. In addition, oil spillage causes high level of degradation to soil and water in Edo State and other Niger Delta States.

The results of the investigation reveal that little attention is given to the menace and danger of land degradation to the health, economy, and physical development of Edo State.

Recommendations

Based on the result of the research study, the following recommendations are drawn:

(1) The State and the Local Government should take a serious measure to contain the problem of land degradation by investigating in construction and maintenance of soil conservation structures across the State;

(2) Environmental protection laws must be enacted so that an average person in the State plant tree and cover crops in his premises; and

(3) Farmers should be well trained on the new methodology of farming, which will discourage soil erosion/land degradation caused by poor farming system.

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