Journal of Forests
2021 Vol. 8, No. 1, pp. 37-44.
ISSN(e): 2409-3807
ISSN(p): 2413-8398
DOI: 10.18488/journal.101.2021.81.37.44

EVALUATION OF SOCIO-ECONOMIC IMPACTS OF DEFORESTATION IN EDO STATE, NIGERIA

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Article History
Received: 18 January 2021
Revised: 5 February 2021
Accepted: 26 February 2021
Published: 15 March 2021

Keywords
Environmental
Deforestation
CO2
Emission
Concentration
Radiation.

ABSTRACT

Deforestation creates imbalances in weather patterns, making the weather drier and hotter, consequently leading to increased drought and desertification, coastal flooding, crop failures, and dislodging major vegetation regimes. The study evaluates the socio-economic impacts of deforestation in Edo State. The study utilized ArcGis digitizing tool to determine the tree population and downscale the spatial datasets using defined boundary conditions. Signal 2.0 was used to establish the relationship of linearity between the forest and economic loss over the region using R-square. Results revealed that as the rate of deforestation in Edo state rose from 4100ha in the year 1990 to 14100ha in 2016, there was also a gradual increase in economic loss from 0.7 to 10.9 billion nairas in 2016. It was also observed that the relationship of linearity between deforestation and economic loss in Edo State shows a strong relationship at an R-square of 0.97. Therefore, there is an urgent need to take action towards ameliorating new Climate Change CC problems by exploring and protecting the local values of forests in order to improve livelihood sustainability. Lowering CO2 emissions is a central global focus through the International Climate Change Policy. About a 5th of emissions globally are caused primarily by deforestation. Reducing CO2 emissions is highly dependent on the reduction of forest loss which can also contribute significantly to the low-cost mitigation portfolio.

Contribution/Originality: This study contributes to the existing literature on the global impacts of deforestation with particular focus on the socio economic impacts of deforestation in Edo State, Nigeria.

1. INTRODUCTION

Deforestation connotes the loss or decline in forest land and/or the permanent conversion of forest areas to other land uses like grazing, agriculture, and residential uses due to urban development [1]. There has been a gross loss in vegetal cover over the last century. Irrefutably, this is associated with the hike in global population and the consequent transformation of lands covered by forests to residential, agricultural, and other related uses [2]. Estimated, there is an annual depletion of forests up to 13.7 million hectares globally, if this decline is

consistent, the world will be rid of all forest land in the next 100 years [2]. Deforestation is recognized as a major global problem. Regardless, tropical regions are of particularly higher deforestation rates. The issue of deforestation is a case of a local problem that drives global concerns. African countries are found at the top of the ladder of countries that have the highest deforestation rates [3].

Forest loss is a significant type of environmental degradation fostering a host of other environmental challenges which include but not limited to climate change, soil erosion, permanent species loss, flooding, and urban heat. The benefits and ecosystem services provided by forests are limitless. In fact, the safety of humanity is greatly dependent on the world's forests [4]. Between the years 1985 and 1990, there was a hike in the poverty rate from 184 million to 216 million people within Sub Saharan Africa SSA. Projections put this number at 300 million in 10 additional years (the year 2000). Also, the only region of the world where poverty is projected to rise is the SSA [1]. This is due to their high reliance on subsistence agriculture as a means of livelihood. Forest lands are often cleared for the expansion of their farmlands in order to provide food for their growing families.

In time past, the case of deforestation was a thing of the sub-tropical and temperate regions; however, forest loss is no longer a thing of concern in temperate developed countries as many countries in this region are already recording an increase in forest lands [5]. These developed countries are mostly found within the temperate domains while developing countries are often located in the tropical domains. The majority of deforestation activities in recent times is experienced by the tropical rainforest, of which up to 60% of the deforestation that took place between 1990 – 2010 within the tropical rainforest was in dry and moist deciduous forests [6]. The highest net loss of forest area annually was recorded among five countries which include Uganda (-2.6%), Mauritania (-2.7%), Nigeria (-3.7%), Togo (-5.1%), and Comoros bearing the greatest net loss at -9.3%. Furthermore, there was a decline in global woodland in other areas of about 3.1 million hectares annually between 1990 -2000, however, this declined to 1.9 million hectares annually over the previous decade [7].

There is a continuous struggle towards saving the world's forests and the tropical rainforest in particular as concern for this issue continues to grow worldwide [6]. For us to effectively save forests from being degraded, there is a need to understand the drivers of their destruction. Clearly defining deforestation agents and causal factors is crucial in understanding the key determining factors of deforestation. These deforestation agents include firewood collectors, loggers, ranchers, commercial farmers, slash and burn agriculturists, infrastructure developers, and all others who clear the forest for one purpose or the other [7-9]. One major driver of deforestation in SSA today is agricultural expansion. As the population continues to grow, the need for more farmlands to cater to this growing population also increases [10, 11]. Nigeria like other third-world countries depends highly on fuelwood for heating and cooking. Expanding towns results in the dislodgement of forest lands to cater to the growing population and also for establishing various infrastructures needed to support them [9, 10]. Basic infrastructural development such as the construction of hydroelectricity dam, logging concessions, oil exploitations, road network expansions, and road construction in pristine areas depend highly on the exploitation of tropical forests [11]. Road construction, airports, railways, and bridges bring about development to an area and consequently bringing more people to occupy forested lands. New settlers in search of subsistence land often gain access to forested areas through newly created roads and logging trails with or without the support of governmental programmes. Building infrastructures and development projects are of global concern, this is because tropical deforestation is responsible for about 20% of the excess carbon released by anthropogenic activities and degrading worldwide substantial carbon sinks [12]. There's been a decline of roughly 21% of the tropical forest since the 1980s [13].

Figure-1. Deforestation in Sub-Sahara Africa (a), and deforestation in Nigeria (b).
Source: Angelsen, et al. [14].

In Nigeria, bushes and forest land are been set on fire merely for the purpose of hunting bush animals like grasscutters (Thyonomys swinderianus). Likewise, farmers see bush burning as an easy way of land clearing for farming purposes. Bush burning may be advantageous to farmers, however, it poses a lot of environmental disadvantages which include but not limited to a decline in soil moisture content, destruction of soil microbes and biodiversity, and reducing soil water absorption capacity. Regardless, fire is upheld as a key tool in clearing forests for permanent agriculture and shifting cultivation as well as the development of pastures. In Nigeria, fire is a case of a good servant with a poor master. If properly managed, a fire could be a great tool in managing forests and agricultural activities, but it could also result in mass deforestation if not properly handled.

In Edo State, there has been an upsurge of a host of environmental challenges that are collectively regarded as degradation such as soil erosion, flooding, biodiversity loss, and urban heat. These issues are all strongly linked with the loss of forest to other uses due to the hike in population and consequent deforestation. Consequently, this is followed by the loss of fertility of several farmlands due to soil aridity caused by bush burning and deforestation, thus lowering farm productivity. Despite the extant literature on deforestation, significant uncertainties still remain in our knowledge of it. Relevant research and management questions concerning the impact of deforestation on household income, employment, and government revenue among others are unknown in many parts of the world. Therefore, the study is aimed at evaluating the socio-economic effect of deforestation in Edo State, Nigeria with a view to developing mitigation strategies.

2. MATERIALS AND METHODS

2.1. Study Area

Edo state is one of the six States that constitute South-South Nigeria with Benin as the capital city. It has eighteen Local Government Areas (LGAs). It lies between latitudes 05° 441N and 07° 301N of the equator and Longitudes 06° 041E and 5° 451 of the Greenwich meridian (Figure 1). Edo State is made up of three senatorial districts (Edo Central, Edo South, and Edo North). Edo Central is made up of five LGAs (Iguiben, Esan Central, Esan West, Esan Nort East, and Esan south), Edo South comprises of seven LGAs (Orhionmwon, Ikpoba Okha, Egor, Uhunmwode, Ovia North East, Ovia South West, and Oredo) while Edo North is made up of six LGAs

(Akoko Edo, Owan East, Owan West, Etsako East, Etsako Central and Etsako West);. The State has an annual rainfall of above 1,950mm, air temperature of 26.5oc, and relative humidity of above 78%. Figure 1 shows the map of Nigeria showing Edo State (the study area). The State occupies an area of about 19, 744 km2 with a population of over two million (2,159, 848). Tropical rainforests are categorized by a warm and wet climate with no substantial dry season.

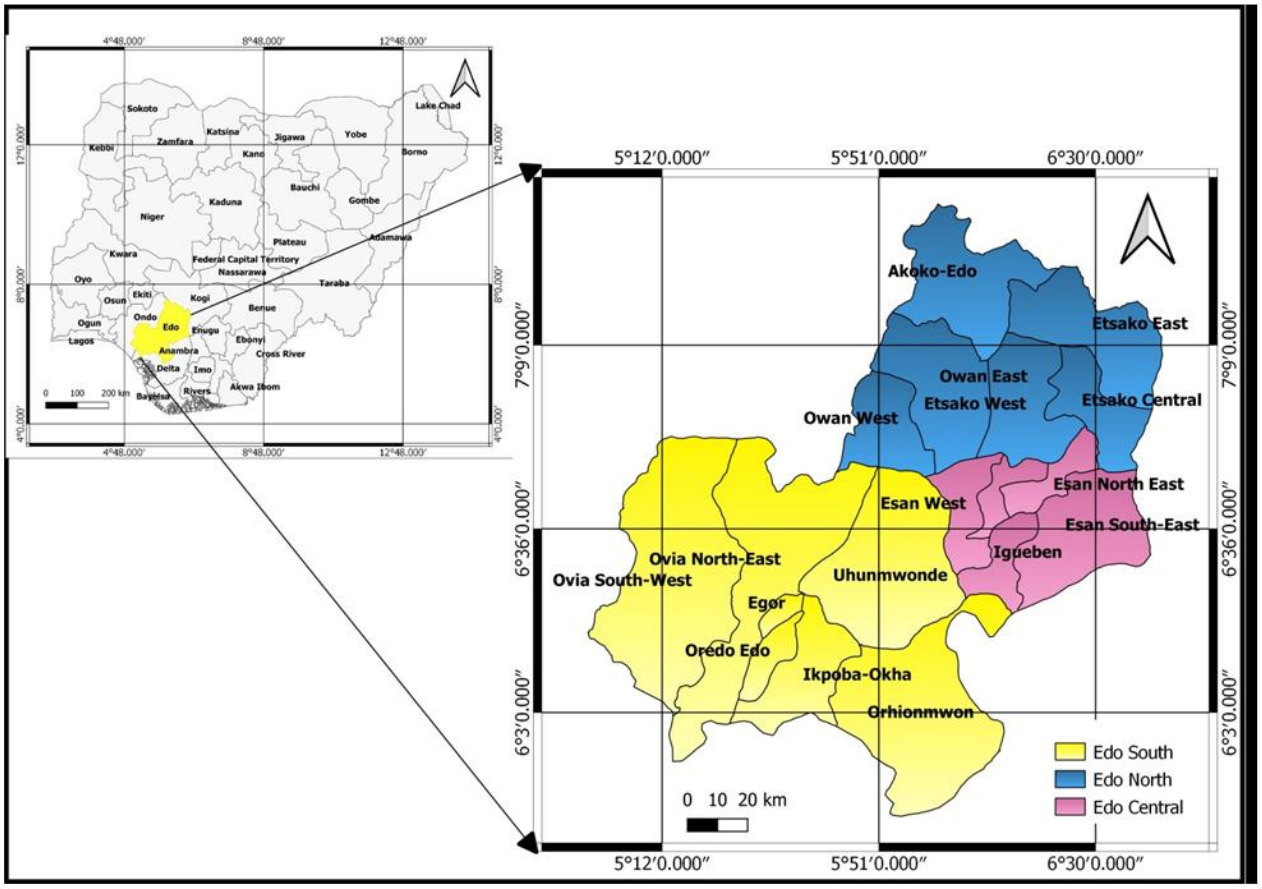

Figure-2. The map of Nigeria indicating the study area.

2.2. Tree Population

This stage involved the determination of the tree population (TP) of a forest by using satellite imagery and an ArcGIS digitizing tool. The observed TP was compared to the TP from the year 1990 to 2016. The annual total number of trees felling (TF) is expressed in Equations 1,2,3,4,5. Geographic Information System (GIS) was used to downscale the spatial datasets using a defined boundary condition. Our datasets covered deforested regions between 1990-2015. Information was extracted in each of the eighteen (18) local government areas (LGAs) that comprise the study region. The deforested field size for the year 2015 was used as a controlled and independent variable to the spatial datasets from the 1990-2014-time scale. The downside of the datasets is basically that the spatial resolution is generally small. Conversely, the map covered the entire Nigeria, but the data related to Edo State was adopted.

$$TP_{ArcGIS} - TP_{obs-1990} = FT_{1990} \quad (1)$$

$$TP_{ArcGIS} - TP_{obs-1991} = FT_{1991} \quad (2)$$

$$TP_{ArcGIS} - TP_{obs-1992} = FT_{1992} \quad (3)$$

$$TP_{ArcGIS} - TP_{obs-1993} = FT_{1993} \quad (4)$$

$$TP_{ArcGIS} - TP_{obs-1994} = FT_{1994} \quad (5)$$

2.3. Statistics Metrics

Sigmal 2.0 was used to create a scatter plot to establish the relationship of linearity between the forest and economic loss over the region using R-square. In addition, variations of forest and economic loss were checked over the period of consideration. Mixed model of Poisson regression was used to compute the economic loss using Equation 6.

$$P\left(\frac{Y}{D}\right) = \sum_{g}^{j-0} C_a . D_t \quad (6)$$

Where $\left(\frac{Y}{D}\right)$= Expected deforestation count (Y) given input conditions (D).

Dt = independent variable (Do =1 for the constant term).

Ca = variable coefficients or parameter).

3. RESULTS AND DISCUSSION

3.1. Spatial Distribution of Deforestation in Edo State

Satellite imaginary using ArcGIS digitalizing tool was used to determine the tree population and forest over the study region. The super-imposition of the digitized maps over the baseline showed that Edo South (ES) and Edo Central (EC) have higher forested land than Edo North (EN). However, there exists a progressive increase in deforestation Figure 3b. Smaller field sizes in ES and EC increased the rate of deforestation from 0.35 and 0.45 in 1990 to 0.75 and 0.84 in 2016. Following the same trend, deforestation increased from 0.21 in 1990 to 0.45 in 2016 over the Edo North district. The output of sensitivity analyses showed that the significance of the socio-economic interest of each of the local government areas (LGAs) that comprises each district determines the magnitude of the deforestation.

For instance, in Edo central where there is a high dependency for wood to make furniture, production of biochar (Charcoal) for cooking, and rapid industrial expansion, the magnitude of deforestation showed an R-square effect of 0.73. Conversely, Edo South is rated to have a large field attributed to deforestation due to the exportation of logs, timber, and other agricultural produce from this district to the neighboring countries and other parts of Nigeria. This finding agrees with the study of Anonymous [7]; Myers [8]. Also, our bootstrap analysis on agricultural practices such as burning and slashing revealed significant deforestation in both small and large field sizes. The associated relationship between the farmers' population and adopted methods of land clearing and preparation showed that most farmers in Edo State involved in bush burning and slashing with an R-square effect of 0.84. The increase in deforestation in 1990-2016 occurred due to government complete neglect with no workable enacted policies to protect the forest and promote afforestation. The primary intention of the government is the conversion of most of the forests to revenue-driven sources without considering the adverse effects of deforestation such as global warming due to high carbon emission rate, flooding, and loss of biodiversity.

3.2. Socioeconomic Impact of Deforestation in Edo State

Result in Table 1 and Figure 3a & b indicates that deforestation in Edo State in accompanied by Economic loss. It was observed that as the rate of deforestation in Edo State rose from 4100ha in the year 1990 to 6400ha in 1995, there was also a gradual increase in economic loss from 0.7 to 1.1 billion naira between the period of 1990 and 1995. Between the year 1995 and 2000, there was an increase in deforestation to 8450ha while economic loss also increased by about 230% (2.5 billion) in the year 2000. Deforestation increased gradually and peaked at 14100ha in the year 2016 (Figure 3b) while the estimated rate of economic loss also rose gradually to 10.9 billion naira in the year 2016 (Figure 3b). A step was taken further to establish the relationship of linearity between deforestation and

economic loss in Edo State. The result which is displayed in Figure 3c shows that an increase in deforested land was largely associated with continuous economic loss at an R-square of 0.97. This is so as there is a gradual increase in economic loss as the rate of deforestation increases. The high level of deforestation in the study area can largely be attributed to the expansion of agricultural activities, urbanization, and industrial development. The finding agrees with the study [9, 10] which showed that the causes of deforestation were industrial forest clearance and expansion of agricultural activities. It is projected that deforestation might likely increase by 19.6% in EC and 17.2% in ES, whereas a marginal increase of 5.5% is predicted over Edo North by 2035. The consequence of these predictions are grave economic loss of about USD 0.8 Billion and a high carbon emission rate of 1.08 million tone of CO2 over the study region. The finding is in line with the study of Sands [11]; Amor and Pfaff [12]; Anonymous [13] which showed that the value of annual deforestation in America is about USD 45 Billion.

Table-1. Estimated economic loss of deforestation in Edo State, Nigeria.

N/S	Year	Economic loss (N Billion)
1	1990	0.7
2	1991	0.8
3	1992	0.9
4	1993	1.0
5	1994	1.0
6	1995	1.1
7	1996	1.2
8	1997	1.2
9	1998	1.7
10	1999	2.0
11	2000	2.5
12	2001	2.6
13	2002	2.9
14	2003	3.4
15	2004	3.9
16	2005	4.2
17	2006	5.2
18	2007	6.0
19	2008	7.2
20	2009	8.0
21	2010	8.3
22	2011	8.5
23	2012	9.6
24	2013	10.2
25	2014	10.3
26	2015	10.6
27	2016	10.9

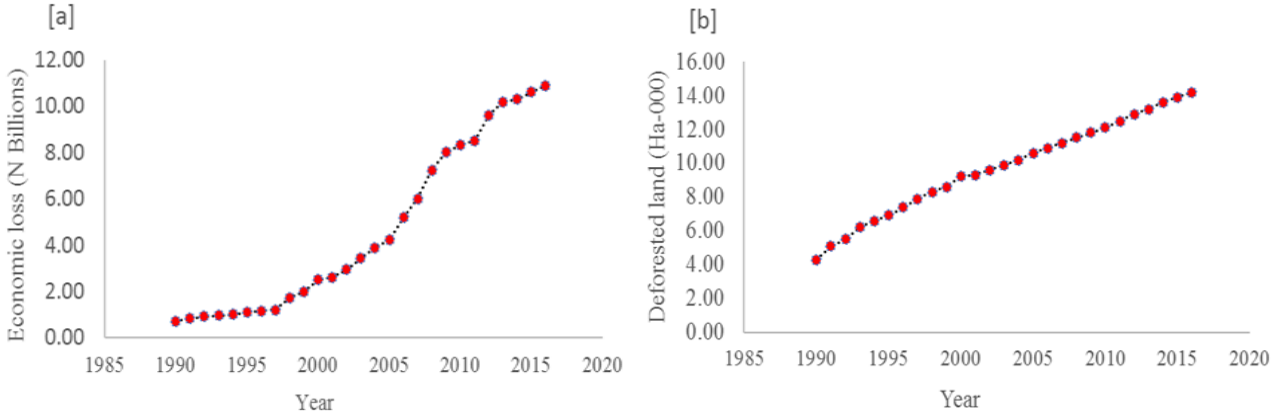

Figure-3(a). Economic loss associated with Deforestation in Edo State between 1990 and 2016. **(b)** Rate of Deforestation in Edo State between 1990 and 2016.

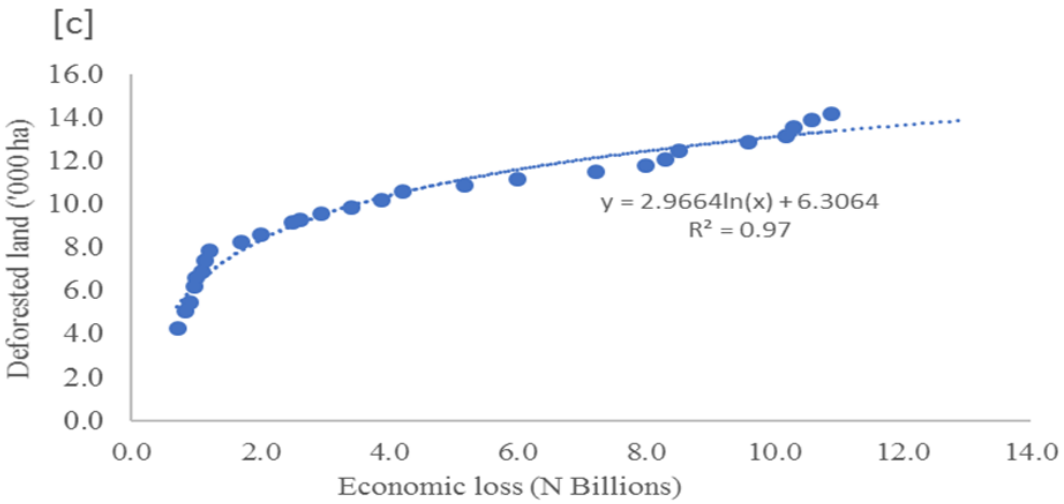

Figure-3c. Impact of Deforestation on Economic Loss in Edo State between 1990 to 2016

Regretably, deforestation control has been very difficult due to the increasing pressure on the forest for agricultural activities to address food sufficiency and security to the growing population. In an attempt to increase food production, the rate of deforestation increases. This situation contributes greatly to the hike in global warming which consequently affects crop yield. The growing population in Edo State corresponds to the increase in conversion of forested areas to agricultural land. Also, the development of industrial and residential buildings is estimated to be responsible for 5.2% of annual deforestation. However, if this trend continues unchecked, deforestation would have increased to 42.4% by 2050s. Also, the situation could lead to the risk of an increase in carbon emission by 17.8% and global warming in response to the current time slice. Conversely, deforestation can be mitigated through carbon trap, population control, and integrated afforestation.

4. CONCLUSION

Unarguably, there is a significant relationship between deforestation and socio-economic development in Edo State. This is so as the socio-economic development in the study area has exerted more pressure on the forest resources as the need for food and shelter continues to grow. Consequently, this massive rate of deforestation is accompanied with a myriad of challenges which includes economic loss and other environmental problem associated with global warming and climate change. The massive deforestation is related to an increase of 20% carbon emission. There is a need for more efficient policies that target the restoration of grossly degraded forest lands in order to mitigate the effect of deforestation. The reduction of deforestation leads to a decrease in carbon emission and; forestry could make a considerable contribution to a low-cost mitigation portfolio. It is estimated that a 10% reduction in deforestation over the study region could provide a reduction of 104.5 million tCO2 causing carbon payments totaling USD 105 million annually.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Acknowledgement: All authors contributed equally to the conception and design of the study.

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