

Application of time-series analysis in predictive modelling of forest revenue sources in Akwa Ibom State, Nigeria

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Abstract

This study assessed revenues generated from various forestry related sources and their trend between 2001 and 2015 using secondary data to develop a predictive model as a means of forecasting future generated revenues for Akwa Ibom State, Nigeria. Data were analyzed using bar chart, percentages and least square regression with SPSS. The results obtained indicated that revenue from general licensing of forest activities generated the highest forest revenue accounting for 56.41% (₦48,122,578.70) of the total forest revenue generated in the state for the period. All forest revenue sources except unspecified sources followed an increasing trend with a coefficient of determination (R^2) ranging between 0.177 and 0.331. The predictive model showed that all the independent variables (revenue sources) had a positive and significant effect ($p < 0.05$) on revenue year except for unspecified sources which had a negative and significant effect ($p < 0.05$). The predictive model R was highly significant ($p < 0.01$) as all the regressors accounted for more than 91% of the variations in the revenue year. The study recommends government commitment to sustainable forest utilization as it explores all revenue opportunities in the State.

Keywords: Forest revenue sources, Time-series analysis, Predictive models, Akwa Ibom State, Nigeria

INTRODUCTION

Forest contributes to the socio-economic development of many economies through the revenue from the sale of forest products such as timber and non-timber forest products (e.g. fruits, firewood, mushroom, etc). According to Binkley (1995), the forest provides the world's most important source of energy and industrial raw materials. Many people also earn income from the collection of and trade of forest produce such as timber, fuelwood, poles, leaves, fruits, seeds, and mushrooms among others. Raw materials such as timber and pulpwood are obtained from the forest by Forest-based firms. In Akwa Ibom State, like other parts of Nigeria, no forest produce is to be taken out of the forest area without a forestry permit (license) (Udo, 1999). The permits are necessary for the

control of forest resources exploitation and revenue generation for the government since the permittee must pay for the forest product to be harvested (Nelson, 2018; Udo, 1999).

In the early 1900s, forest charges were introduced in Nigeria by the colonial regime who also passed the first forest law in the country. The law prescribed various penalties in the form of fees to discourage forest destruction and promote conservation (Etukudo et al., 1994). Until recently, these fees are continued to be charged by the government as a means of generating revenue for development (FAO, 2001). However, forest charges have remained because of the revenue they generate for the government. Also, there is a global acceptance of it as a means of managing the forest (Gray, 1983).

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Forest revenue is an instrument used by the government to achieve its various goals and objectives in forest management (Kolade et al., 2020; Nelson, 2018; Olaseni et al., 2004; FAO, 2001). To maximize forest revenue collection, forest charges must closely reflect the stumpage values of the timber cut and minor forest products fees their respective values (Gray, 1983). Forest revenue charges are often misconstrued as taxes designed to generate government revenue from the timber being exploited rather than as a substitute for the stumpage value of the timber being cut (Nelson, 2018; FAO, 2001). In the instance where the charges imposed do not fully reflect the stumpage value of the timber being cut, part of the revenue is lost to those who harvest or process the timber (Gray, 1983). On the contrary, if the charges are too high, surpassing the stumpage value of the timber, the trees may not be exploited, and the timber values will be lost as a result of it being under-utilized. In either case, the forest revenues obtained will be less than the maximum output expected to be generated (FAO, 2001).

In Nigeria, the authority responsible for formulating the model for forest charges is the state government and each of them has the legal and administrative freedom to manage its forests in any way it wishes (Kolade et al., 2020; FAO, 2001). However, the structure of the forest revenue system in most of the states contains common elements such as; the authority to regulate and collect forest revenues using various approaches or channels (Nelson, 2018; FAO, 2001). The state government does not rely on a single forest revenue source but instead depends on a combination of several forest charges such as area fees, royalties, silvicultural charges, stumpage prices, processed product royalties, log export taxes, among others. These forest charges in combination may be designed to complement each other in their cumulative impact and incentive effects on forest management and utilization. There exists variation in sources of forest revenue in Nigeria in the two broad ecological zones of the forested south and the savanna-dominated north. The savanna dominated north

derives a significant proportion of its forest revenues from charges on fuelwood, poles, gum arabic, honey, locust beans, and game hunting, while the southern states such as Akwa Ibom State rely on charges on timber harvesting and processing for their forest revenues (Olaseni et al., 2004; FAO, 2001). Thus, despite the limited forest resource base in the state, a substantial amount of revenue is realized annually from these forests in addition to monetary benefits that accrue to the society (Udo, 1992; Udo and King, 1997). This study, therefore, becomes pertinent to provide the needed information on the various forest revenue sources available in the state, its trend, and also to develop a model that can be used to predict future revenue to be generated from these revenue sources in the state.

MATERIALS AND METHOD

Study Area

Akwa Ibom State is located in the southern part of Nigeria and lies between latitudes 4°32' and 5° 53' North and longitudes 7° 25' and 8° 25' East (Figure 1). It is located within the tropical rainforest zone with a landmass of 8,412km² (AKSG, 1989). Akwa Ibom State has a projected population of 5,671,223 persons for 2017 at a growth rate of 3.46% per year (Nelson et al., 2020; NPC, 2007). The state has 31 Local Government Areas and has common borders with Cross River State to the East, Abia State to the North, Rivers State to the West, and the Atlantic Ocean to the South (Akwa Ibom Agricultural Development Programme - AKADEP, 2006). The climate of the state is characterized by two seasons-the rainy or wet season, which lasts for about 8 months (mid-March -November), and the dry season (December-March). The total annual average rainfall is about 2500mm (Udoh and Tom, 2011; Ekanem, 2010). Temperatures are uniformly high throughout the year with slight variation between 26°C and 28°C. A high range of relative humidity (75% - 95.6%) is common across the length and breadth of the State (Nelson et al., 2018a; AKSG, 1989).

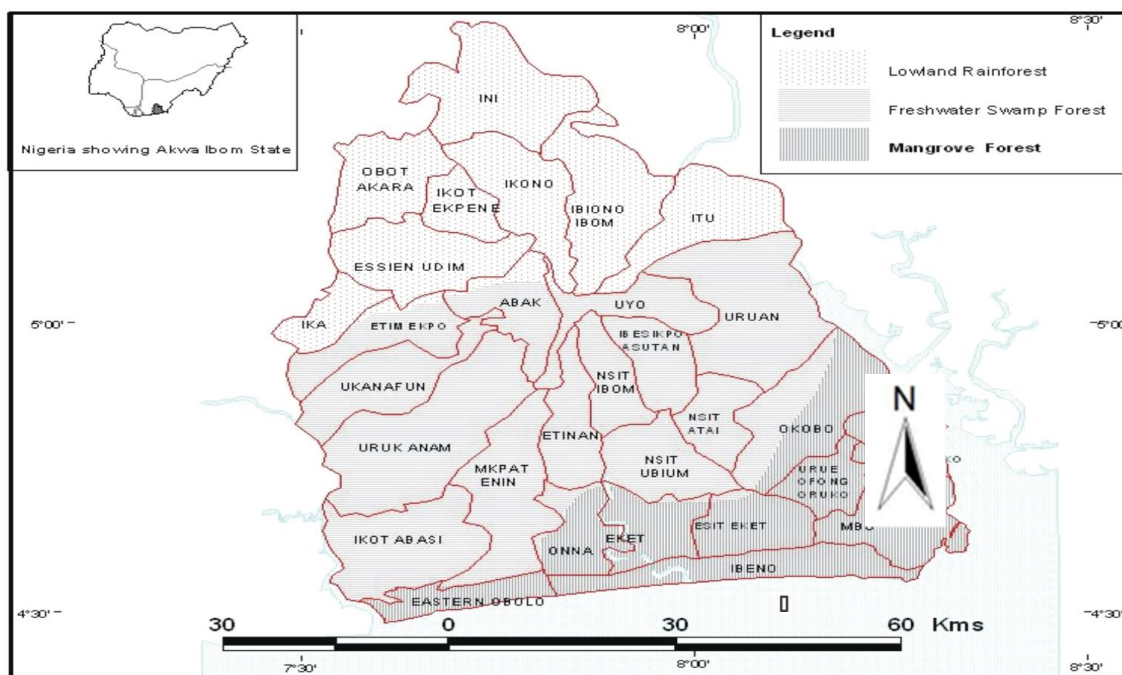


Figure 1. Administrative and vegetative map of Akwa Ibom State, Nigeria
Source: Nelson (2018)

Data Collection

Data used in the study were secondary data on forest revenue generation (targeted and actual revenue generated), and Government expenditure in forestry development from 1996 - 2015 was obtained from all the 31 divisions and the Directorate of Forestry in the state through documentary review of reports, journals, and periodicals.

Data Analysis

Descriptive statistics and inferential statistics such as least square regression and correlation were used for data analyses using SPSS version 13.0. Descriptive statistics involved the use of tables, bar chart, percentages, etc, while correlation analysis was used to ascertain the level of relationship between the revenue sources and the revenue year. Least square regression as used by Jacob et al. (2019; 2018) was used to model the relationship between the revenue sources and the revenue year. The sources of forest revenue in the state were categorized into five major groups through the guidance of the state Forestry Directorate. These categories were as follow;

i. Forestry fines and fees (Hammering fees, transit fees, timber market fees, farming fees, residing fees, permit fees)

- ii. Forestry general licensing (Registration and renewal of machinery)
- iii. Forest product: Timber (Sales of timber exploited)
- iv. Forest product: Firewood and ornamental (Sales of firewood and ornamental plants)
- v. Other unspecified sources (revenue gotten from forest resources exploited by the government for the public good e.g. revenue paid by the government to the sector for clearance of trees along the right of way, road construction, etc.)

Model Specification for The Forest Revenue Sources

To develop a predictive model that is capable of predicting the contribution of the various forest revenue sources for the forest revenue year for the state by way of its contribution over time, all the revenue sources determined were considered. The sources of revenue considered were; fees and fines (X₁), general licensing (X₂), sales of timber (X₃), sales of non-timber products (X₄), and other unspecified sources (X₅). Thus, Revenue year (R) was assumed to be influenced by the above-listed factors. This was expressed as a model in an equation form as follows:

$$R = f (X_1, X_2, X_3, X_4, X_5) \quad (1)$$

The variables were treated independently and jointly

$$\text{Therefore } R = a + b_1X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5X_5 + e \quad (2)$$

Where a = intercept and b₁ - - - b₅ are coefficients and e is error term

RESULTS

Sources of forest revenue and contribution to total forestry revenue in Akwa Ibom State

The results in Figure 2 indicates that revenue generated from general licensing of forest equipment, industries, and markets accounted for 56.41% (₦48,122,578.70) of the total forest revenue generated in the state for the period (2000 - 2015), followed by revenue from the sales of timber (20.75%,

₦17,705,683), fees and fines (20.63%, ₦17,604,571) and sales of non-timber forest products (2.03%, ₦1,729,626) respectively, while revenue from other unspecified sources such as revenue gotten from forest resources exploited by the government for the public good e.g. payment for clearance of trees along right of way, road construction, etc.) accounted for the remaining 0.19% (₦154,490.00).

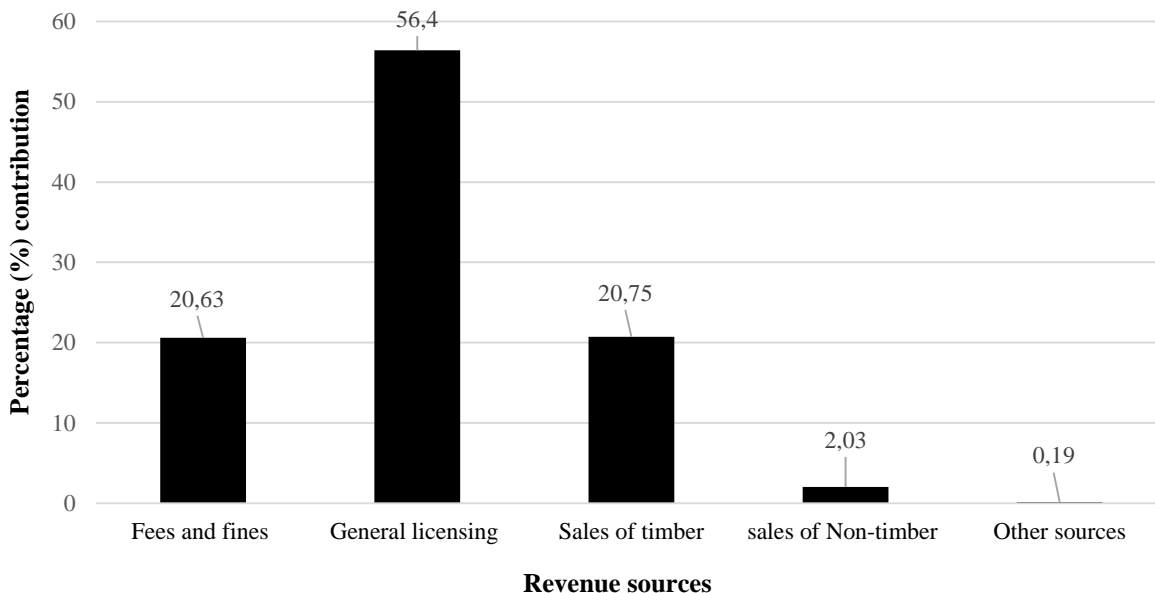


Figure 2. Contribution of various revenue sources in Akwa Ibom State (2000-2015)

Revenue From Forestry Fees and Fines

Figures 3 shows the line and least square composite graphs of forest revenue generated from fees and fines on forest products and services. Trend analysis of the revenue source indicates that revenue generation followed a `wavy pattern

where it rises gradually and falls after a period. Between the years 2000 and 2008, the revenue gradually increased from ₦254795, peaked at ₦2275450 in 2003 before decreasing gradually to ₦232300 in 2008. Also between 2008 and 2015, the revenue rises twice and peaked in 2011 (₦1837900) and

2014 (₦3857450) before decreasing again with a mean annual revenue of ₦1100286 ± 928874.20. The variation in annual revenue trend for forest fees and fines is statistically defined by the function $y = 401838 + 82170x + e$ ($p > 0.05$) with a coefficient of determination (R^2) of 0.1774 or 17.74%. (Figure 3). Also, there existed a weak correlation between the forest revenue generated from fines and fees in the state and years (r

= 0.4212). This is an indication that forestry revenues generated from fines and fees in the state were not directly influenced by the revenue year but by other external factors such as the efficiency of forestry personnel in revenue collection, arrest and prosecution of offenders, and motivation of staff.

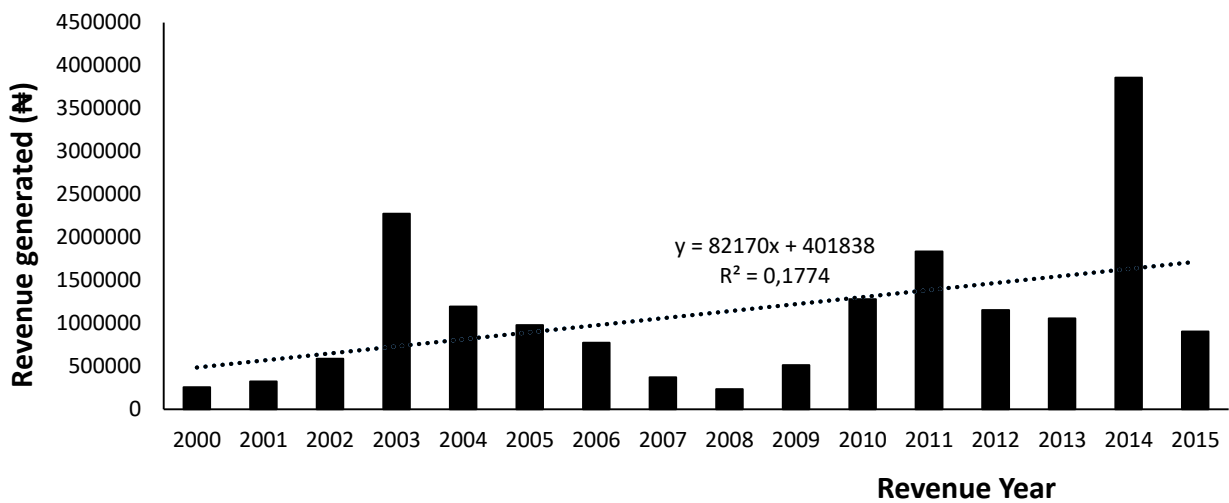


Figure 3. Trend analysis of forestry revenue from forestry fees and fines

Revenue From General Licensing of Forestry Equipment and Operators

The trend in forest revenue from general licensing of forestry equipment and operators did not follow any definite pattern but increased and decreased over the period assessed. The highest forest revenue generated from this source was in 2006 (₦7795880), followed by 2013, 2012 and 2015 with ₦5474400, ₦5441400 and ₦4716800 respectively, while the least forest revenue generated was ₦660050 in 2003 with a

mean annual revenue of ₦2083825.43 ± 2310280.80. The variation of forest revenue from general licensing was defined by the equation $y = 864820 + 252099x$ with a coefficient of determination of 0.3317 (Figure 4). The correlation between revenue source and year showed a positively strong 0.5760 relationship. This implies that forest revenue generated from the licensing of forest equipment and operators was influenced by the revenue year.

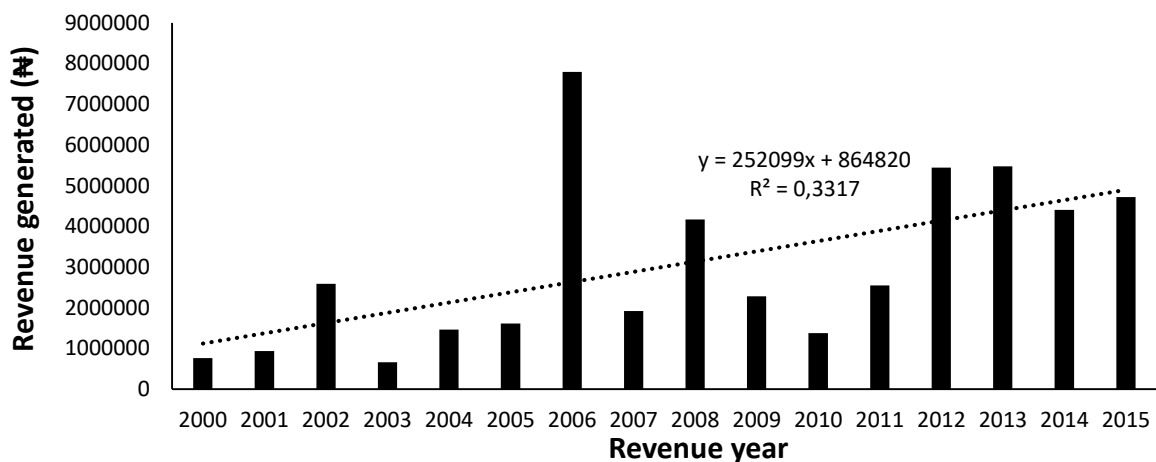


Figure 4. Trend analysis of forest revenue from forestry general licensing

Revenue from Sales of Timber

The result in Figure 5 shows an upward trend line for revenue generated from the sale of timber in the study area despite the annual increase and decrease in revenue collected. As indicated in figure 3, the highest annual revenue generated from the sale of timber was ₦2625600 in 2013, followed by ₦2365300, ₦2060000, ₦1937000 and ₦1736600 in 2010, 2008, 2009, and 2011 respectively, while ₦70257 was the least revenue collected from the sale of timber in the year 2000 with a mean annual revenue of ₦1106605 ± 824696.60. The

correlation between the revenue generated from the sale of timber products and revenue year showed there existed a positive relationship with them ($r = 0.5362$). Also, the variation in annual revenue generated from the sale of timber is defined by the function $y = 317092 + 92884x + e$ ($p > 0.05$) with a coefficient of determination (R^2) of 0.2875 or 28.75%. (Figure 5). This implies that 28.75% of the variation in revenues generated from timber in the state was directly influenced by the revenue year, while the remaining 71.25% were caused by other factors.

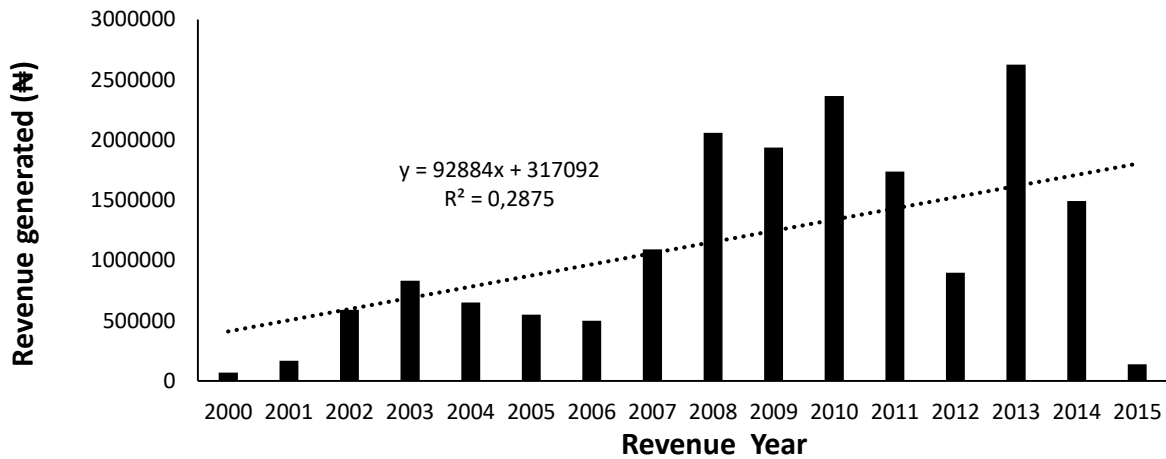


Figure 5. Trend analysis of forest revenue generated from the sales of timber products

Revenue from the sales of Non-timber forest products

Trend analysis of the sales of non-timber forest products as a forest revenue source in Akwa Ibom State indicates (Figures 6) indicates that the revenue generation also followed a wavy pattern where it rises gradually and falls after a period. Between the years 2000 and 2009, the revenue gradually increased from ₦12140.60, peaked at ₦176100 in 2006 before decreasing gradually to ₦26300 in 2009. The trend pattern

continued between 2010 and 2014 while peaking at ₦137100 (2011) and finally at ₦741100 in 2015. This variation in annual revenue trend from sales of non-timber forest products is defined by the function $y = 33663 + 16678x + e$ ($p > 0.05$) with a coefficient of determination (R^2) of 0.2057, thus following an upward trend line. The relationship between revenue year and revenue source showed a weak positive correlation ($r = 0.4536$). between them.

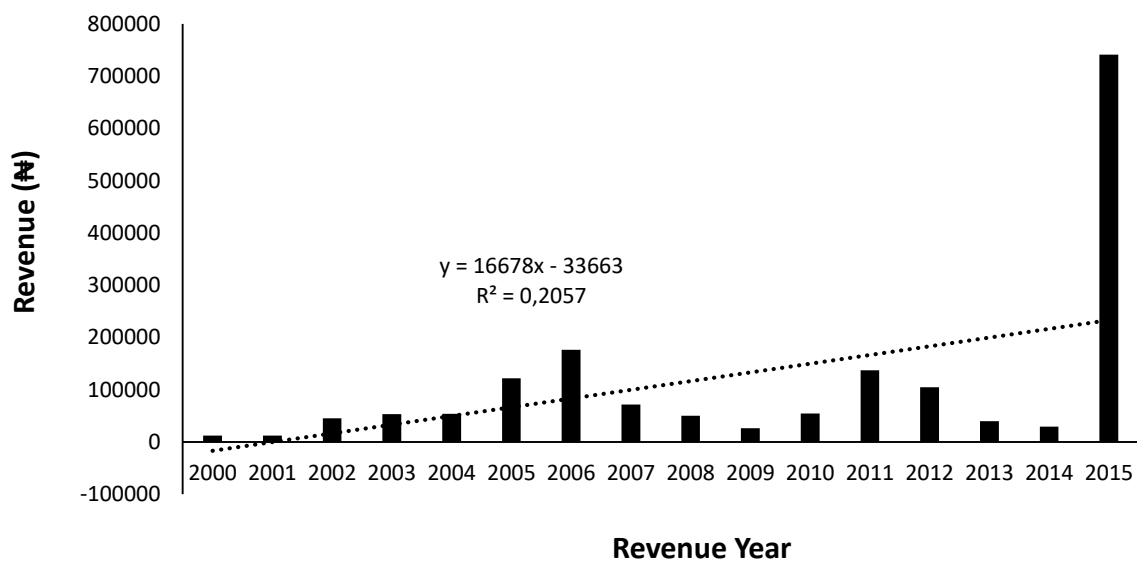


Figure 6. Trend line analysis of forest revenue from the sales of non-timber forest products

Revenue from unspecified sources

As the name implies, revenue generated under this source did not have a specified revenue subhead in the Forestry Directorate in the state. However, to ensure that there was accountability for all the revenues generated in the sector, they were grouped under the subhead unspecified revenue sources. This includes revenue gotten from forest resources exploited by the government for the public good e.g. revenue paid by the government to the sector for clearance of trees along the right of way, road construction, etc. As indicated in figure 7, the

trend of revenue was very irregular with some of the revenue years (2000, 2001, 2007, 2008 – 2011, 2014, and 2015) no revenue generated from the subhead. The highest revenue generated was ₦73900 in 2002, followed by ₦39900 and ₦16090 in 2003 and 2006 respectively, while the least was ₦1000 in 2012. The revenue source had a downward trend line and was defined by $y = 26179 - 1943.9x$, a coefficient of multiple determination (R^2) of 0.2111, and there existed a weak negative correlation ($r = -0.4595$) between the revenue generated and the revenue year.

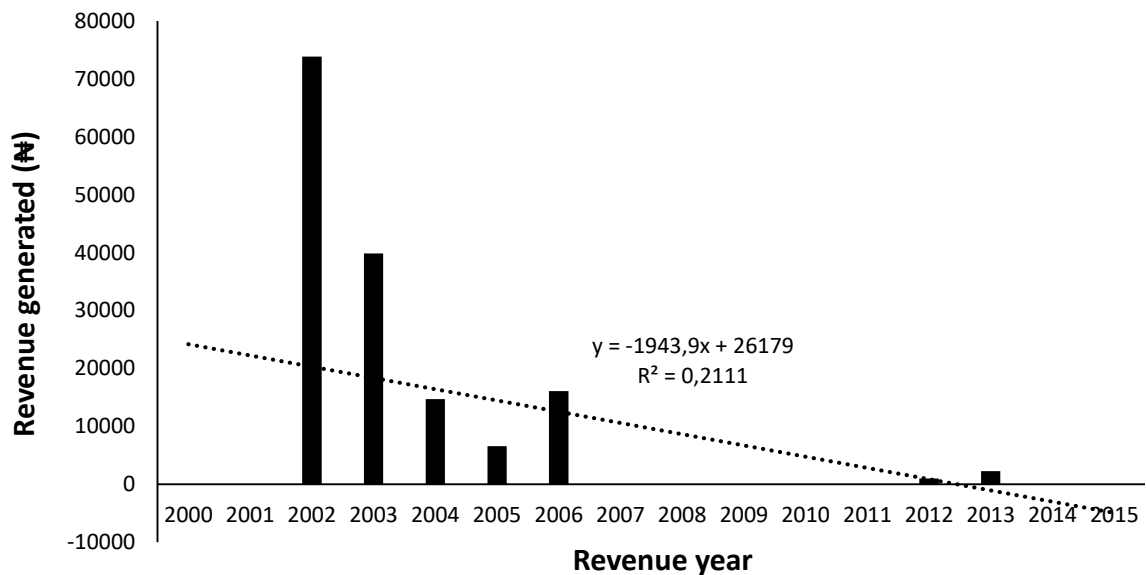


Figure 7. Trend line analysis of forest revenue from unspecified sources in Akwa Ibom State

A Predictive Model for the Contribution of Various Forest Revenue Sources in Akwa Ibom State

The result of the analysis of factors to ascertain their contribution and effect in revenue years in Akwa Ibom State using SPSS is indicated in Table 1. The regression result indicates the coefficient of multiple determination (R^2) value to be 0.9163, implying that all the regressors included in the predictive model explained about 91.63% of the variations in the revenue years in the study area. The correlation (r) value of 0.9572 implied that there existed a very strong and positive relationship between the factors and the revenue year. The F-Statistic of 21.896 was highly significant at $p < 0.01$ and indicated that the regressors included in the model had a positive and significant impact on the revenue year in the study area. Coefficients of fees and fines ($1.61E-06$), timber forest

product ($3.15E-07$), and non-timber forest products ($1.44E-06$) were significant at $p < 0.01$, while general licensing ($5.89E-07$) and other unspecified revenue sources ($-5.3E-05$) were significant at $p < 0.05$. This result implies that any increase in a single unit of revenue from any of the positive factors (forest fees and fines, general licensing, timber products, and non-timber products) while the others remain constant will result in a corresponding increase in the revenue year except for revenue from other unspecified sources. The negative coefficient of the revenue from other unspecified sources implies that a unit increase in it while every other variable remaining constant will result in a decrease in the revenue year. The mathematical expression of the predictive model for revenue sources in Akwa Ibom State can be expressed as follows;

$$R = 1999.432 + 1.61E-06X_1 + 5.89E-07X_2 + 3.15E-06X_3 + 1.44E-05X_4 - 5.3E-05X_5 + e \quad (3)$$

Table 1. Regression analysis of factors affecting revenue year in Akwa Ibom State

Variables	Coefficients	Standard Error	Significant level
Intercept	1999.432	1.119666	***
Fees and fines	1.61E-06	4.81E-07	***
General licensing	5.89E-07	2.33E-07	**
Timber forest products	3.15E-06	6.29E-07	***
Non-timber forest products	1.44E-05	2.97E-06	***
Other unspecified revenue	-5.3E-05	2.31E-05	**
r	0.957238		
R Square	0.916305		
Adjusted R Square	0.874457		
F-Stat	21.89629***		

*** = significant at $p < 0.01$, ** = significant at $p < 0.05$, * = significant at $p < 0.1$

The Trend in Forest Revenue Generation in Akwa Ibom State

The trend in yearly forest revenue generation in Akwa Ibom State indicates that revenue generation also followed a wavy pattern of its revenue sources. The highest generated

revenue between 2000 and 2015 was ₦9778850 (2014), while the least was ₦1095872.28 (2000). The increasing and decreasing pattern of the revenue peaked in 2002 (₦3880960), 2006 (₦6512180), and 2014 (₦9778850) respectively with an annual mean of ₦5332309±2524544. The annual variation in

forest revenue is defined by the function $y = 2000000 + 441887x + e$ ($p > 0.05$) with a coefficient of determination (R^2) of 0.6126, thus following an upward trend line. This implies that the model was significant and explained 61.26% of the

variation in annual revenue. Also, the relationship between the revenue year and revenue showed a weak positive correlation ($r = 0.4535$) indicating that revenue generated was weakly influenced by the year of revenue.

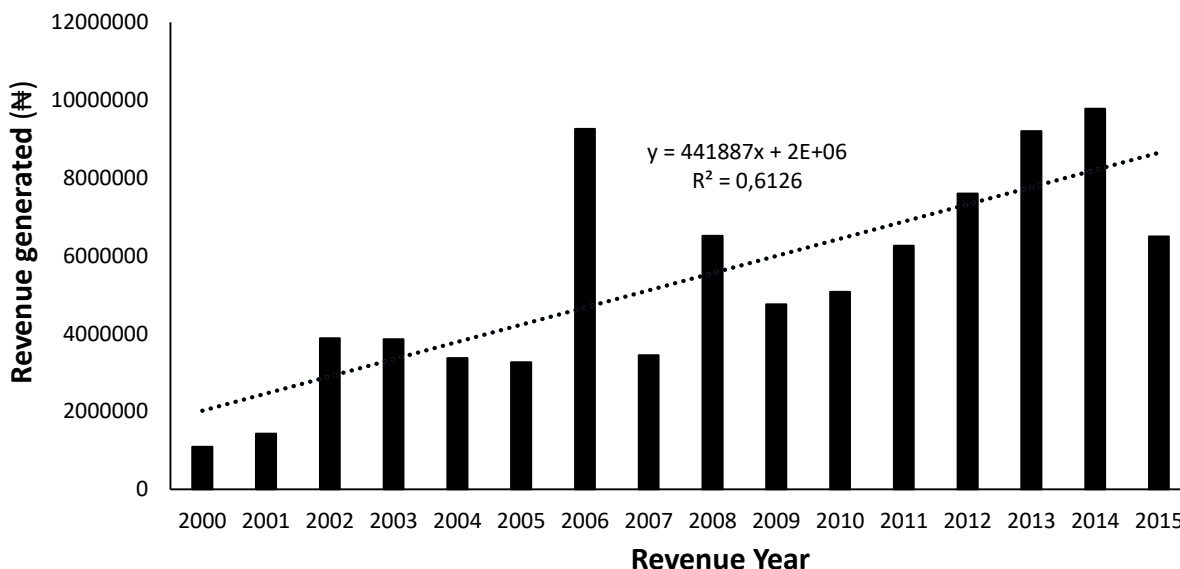


Figure 7. Trend analysis of generated forest revenue in Akwa Ibom State

DISCUSSION

The sources of forest revenue in Akwa Ibom State include timber production fees, non-timber, and minor forest product fees, and general licensing fees that encompasses industry and enterprise fees and penalty fees. The timber production fees were collected for the removal of timber products exploited in the state. Non-timber and minor forest product fees included fees for the collection of leaves, tapping palm, and making raffia wine, chewing sticks, ropes, and fruits. The revenue from general licensing included registration fees for timber contractors, holders of property hammers, industry license renewal fees, and registration fees for forest machinery, while revenue from fees and fines were charges obtained from hunting and recreational forest land-use fees (hunting permit and farming fees) and from penalties for breaking the law such as fines and sale of confiscated forest products (Forestry Department, 2013). According to Udo, (1997), in Akwa Ibom State, on the average, 90 forest offenses were committed annually between 1988 and 1998, and on the average ₦17,994 was realized annually as compounding fees.

The contribution of the various revenue sources to the total forest revenue of the state indicated that revenue obtained from general licensing was the major source of forest revenue for the state as it contributed more than half (56%) of the total revenue for the state. The above result is in contrast with the observation of FAO (2001) who reported timber as the main source of revenue in the rainforest states such as Ondo, Ogun, Osun, Edo, and Ekiti State and that southern states rely on charges on timber harvesting and processing for between 70 - 80 % of their forest revenues. The contrasting scenario of timber not being the major source of revenue in the state could also be attributed to the revenue sources grouping or categorization in the study and rate of illegal timber exploitation in the state. In other studies, such as Olaseni *et al.* (2004) and FAO (2001), revenue from registration/renewal of sawmills, resaw benches, property hammers, and chainsaws were considered among revenue generated from timber charges such as stumpage and out-turn-volume (OTV) which

increased the amount of revenue generated from timber exploitation which is the reverse in the study.

The amount of illegal exploitation of timber products was another factor that had a major impact on forest revenue generation from timber (Nelson *et al.*, 2020). Generally, many people indulge in illegal forest acts due to ignorance, lack of alternative sources of livelihood, and the seemingly lucrative nature of the illegal acts as a result of the profits made on illegally obtained forest produce without adverse consequences, low ethical standards in the society, and inadequate penalties on offenders (Adeyoju, 2005; Udo, 1997). Forest offenses contribute to forest degradation and destruction as well as revenue losses to the government and so are at variance with the aims of sustained yield management of forests (Jacob *et al.*, 2019; Nelson *et al.*, 2019; Nelson *et al.*, 2018b). According to Udo (1997), forest revenue is primarily associated with preventing the misuse of the forest and protecting the rights of individuals and the general public in matters of access, hence it should also serve as an agent for development and as an incentive for good forest management.

The seemingly upward trend lines and a positive correlation between all the revenue sources and generated forest revenue and revenue year in the state can be attributed to the arbitrary fixing of yearly revenue target. According to Nelson and Jacob (2017) and Udo (1999), the preceding year's revenue performance was usually used as a determinant in setting the subsequent year's revenue target, without regard and consideration of the forest resource base in the study area. An average increase in the yearly revenue generation is likely to adversely affected the available forest resources without any commensurate investment to restock or regenerate the exploited forest resources in the state. This observation is following Akpan-Ebe (2015) reported that the limited forest resource base in the state was overstretched due to inadequate attention in regenerating harvested stock to sustain the revenue drive of the state.

As the state government is being confronted with mounting economic recession, external debts, the need to provide health, educational and infrastructural facilities, jobs and promote economic development in the state, it has consistently lacked revenues (Nelson, 2018), hence its priority has therefore been to maximize available revenue-generating opportunities in the state including promoting the extraction of natural resources to generate the revenue required for these programs (Udo, 2016). This priority coupled with the immense political power wielded by those in authority (head of government, politicians, commercial interests, and the bureaucrats) has caused forestry development in the state to be dictated by the revenue-generation potential of forest resources (Tee *et al.*, 2002; Udo, 2004). With this development in the state, its main objective to regulate access to the forest, timber resources, and other forest resources for conservation is relegated to the back to enable it to control extraction amidst conservation (Udo, 1999). Under the above circumstances, government policies in the forestry sector have overwhelmingly promoted the exploitation of timber products, a situation that has directly undermined its programs intended to afforestation the state (Nelson *et al.*, 2020).

Even though the series of public declarations, as well as forestry laws and regulations introduced since the creation of the state, suggest that the state government has been aware of the problem of forest destruction and its consequences, the policies, programs, and actions taken by the state government to address the problem of forestry development in the state have proven inadequate (Nelson, 2018; Nelson and Jacob, 2017). In practice, the unsustainable extractive forestry policies of the state government to generate revenue have superseded its protective regulatory policies and development. Overall, the state forestry policies, their implementation processes, and outcome have not reflected the declared intentions of forestry development in the state. The Forestry Department which is the lead agency responsible for forestry development has been plagued with many problems; hence these challenges have hindered it from achieving its set objectives (Akpan-Ebe, 2015). Foremost is the fact that the functions and performance of the state Forestry Department have been dictated by the economic priorities of the state government, the most important being the exploitation of forest resources for forest revenue and the promotion of cash crop and food crop cultivation. As the economic recession continues to mount and as the population increases and access to land and forest resources become more and more critical, the level of importance attached to forest development will continue to diminish. Thus, the major task of the Forestry Department in the administration and development of forestry in the state has become conflicting and more ill-omened over time.

This goal of forest protection and development by the directorate has become more arduous because, in essence, it has been designed to prevent the citizens from making a living from the forest by utilizing the few available income revenue avenues available to them. In contrast to high profile and prestigious agencies and departments such as Finance, Economic Planning, and Works, Forestry lacks the prestige and political power.

Consequently, it has perpetually lacked the necessary funding and resources, and implementation of development policies and programs have been actively undermined by revenue-generating activities (Udo, 2016; Akpan-Ebe, 2015). In practice, it could be said that the objectives of addressing

unsustainable exploitation of forest resources in the state to ensure effective environmental conservation purposes has not been prioritized. The pursuit of that objective which would entail controlling the rate of timber exploitation or in other words allocating sufficient resources for forest regeneration would amount to the government acting contrary to its mission of generating revenue from the forest resources. However, by this, politically powerful extractive bureaucracies have effectively contradicted the mission of the weak Department of Forestry, the agency in charge of implementing the government's protective regulatory policies. Also, the active promotion and support of government to the people in giving cash crop (e.g. cocoa) and other stable food crops production is further encouraging the clearance and destruction of the available forest lands for the development of new farms thereby diminishing the forest area in the state.

CONCLUSION

An assessment of forest revenue sources is important in the achievement of sustainable forest management. The result of the study showed that among the various revenue sources, revenue from general licensing constituted the major forest revenue source for the state followed by revenue from sales of timber products. Also, all the revenue sources were influenced by the revenue year and they all tended to follow an upward trend annually except revenue from unspecified sources. All the revenue sources had a significant effect on revenue year and could be used to predict or forecast the revenue year using a defined model.

The study recommends that government should endeavor to exercise its mandate of providing a safer environment for citizenry through its commitment to policies that will promote efficient use of natural resources on a sustainable basis while meeting its financial target to execute development programs in the state. Also, modalities that will check illegal and unsustainable resource exploitation while improving forest revenue generation should be encouraged.

assessment of forest revenue sources is important in the management of forest resources to achieve sustainable forest management. The result of the study showed that among the various revenue sources, timber hammering fees constituted the major forest revenue source for Akwa Ibom State

CONFLICT OF INTEREST

Authors declare no conflict of interest

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