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Diffrentials in Forcast Modeling of Target and Generated Forest Revenue in Akwa Ibom State, Nigeria

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ABSTRACT

Sales of forest produces is the most important roles various state forestry departments in Nigeria concentrate efforts to maximize their revenue generation. Forest revenue generation therefore represent an important factor that have an impact on sustainable forest management. This study examined forest revenue generation trend between 1996 and 2015 using secondary data on target revenues, generated revenues, including government expenditure to develop a model as a means of forecasting future targets and generated revenues in Akwa Ibom State, Nigeria. Data were analyzed using descriptive and inferential statistics including simple linear and second polynomial regression. The results indicated that Oron Forestry Division had the highest forest revenue (₦14,573,570/ USD 40,482.14), while ₦93,150,018.00 (USD 258,750.05) was generated forest revenue for the state. Generated forest revenue followed an increasing trend with a strong positive relation between revenue year (R^2 = 0.76) and target revenue (R^2 = 0.74). Simple linear model, X_{e1} = 5002298 + 473409.7t and non-linear models X_{e2} = 5429022 + 460185t - 12871.7_{t2} were developed for generated revenue forecast for the state respectively. However, both models were not significantly different (p>0.05) from each other, while the model Y_{et} = 1251043.39+1.03*X_{t-1} was developed for target revenue. Also, annual forestry expenditure compared to agriculture was very low as it ranged between 38.23% and 0.0%. The study recommends sustainable forest revenue opportunities in the State and financial investment in forest regeneration and protection for the continuous supply of forest resources in the State.

Keywords: Forest Revenue Generation; Sustainable Development; Revenue Models; Expenditure; Akwa Ibom State

Introduction

A model is a simplified representation of reality (Knuuttila, et al. [1]). Models are tools with which one can experiment and learn about a specific problem situation. However, translating a problem situation into a problem structure well-suited for analysis is the most challenging step in the modelling process. This translation is often as much an art as a science. Firstly, it requires consideration of data availability issues. It is also essential to balance the need for simplicity and practicality with the need to adequately describe the complexities of the situation. Assumptions made in this translation impinge on the utility and applicability of the resulting model (Cizek, et al. [2]). A model also encompasses mathematical equations, numerical values, logic necessary to link the equations in a meaningful way, and the computer code required to implement the model on a computer (Ben-Ari, et al. [3]). There are extensive studies on various models for solving forest management options (Segura, et al. [4]). Notable among them include the compilation of arithmetic growth formulae, biological-based growth formulae, Bertalanffy and Computer-based individual tree models. However, much of these studies have addressed modeling growth of plantation stands of the temperate forests and many avoided the complexities of tropical moist forest (Blanco, et al. [5]). Although critical solutions have been proffered by authors such as (Vanclay, et al. [6]) and (Alder, et al. [7]), there is need for further study on modeling forest resources.

Time series modeling is a dynamic research area which has attracted attentions of many researchers over the last few decades. The main aim of time series modeling is to carefully collect and rigorously study the past observations of a time series to develop an appropriate model which describes the inherent structure of the series (Adhikari, et al. [8]). This model is then used to generate future values for the series, i.e. to make forecasts. Time series forecasting thus can be termed as the act of predicting the future by understanding the past (Orang, et al. [9]). Due to its indispensable importance, it is applied in numerous practical fields such as business, economics, finance, science and engineering, etc. (Chatfield, et al. [10]) In practice a suitable model is fitted to a given time series and the corresponding parameters are estimated using the known data values. The procedure of fitting a time series to a proper model is termed as Time Series Analysis (Adhikari, et al. [8]). It comprises methods that attempt to understand the nature of the series and is often useful for future forecasting and simulation. In time series forecasting, past observations are collected and analyzed to develop a suitable mathematical model which captures the underlying data generating process for the series (Gershenfield, et al. [11]). The future events are then predicted using the model. This approach is particularly useful when there is not much knowledge about the statistical pattern followed by the successive observations or when there is a lack of a satisfactory explanatory model.

Time series forecasting has important applications in forest revenue generation. The general tendency of a time series to increase, decrease or stagnate over a period of time is termed as Secular Trend or simply Trend (Adhikari, et al. [8]). Thus, it can be said that trend is a long term movement in a time series. For example, in series relating to forest revenue growth, increased revenue collection showed upward trend, whereas downward trend can be observed in decreased revenue collection, etc. Forest revenue system is a policy instrument that is effectively used to ensure that a nation obtains maximum benefits from the management of its forest resources (Nelson, et al. [12]). It is a strong instrument for stimulating appropriate forest industrial development and efficient wood utilization. Generation of revenue appears to be the most important primary role of the various state forestry departments in Nigeria whereby constituted authorities only concentrate efforts on how to maximize revenue from the sale of forest produce by granting large tracks of land for harvesting to the total neglect of forest regeneration and management (Jacob, et al. [13]) (Nelson, et al. [14]). In Akwa Ibom State, the exploitation of the forest resources for revenue generation plays a significant role in the state administration. Therefore, this study examines and model forest revenue generation in the state in a bid to ascertain the trend in forest revenue generation from 1996-2015.

Methodology

Study Area

Akwa Ibom State is located in the southern part of Nigeria. It 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 (Nelson, et al. [15,16]). 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. [17]). The state has 31 Local Government Areas with three gazetted forest reserves namely; Stubbs Creek, Ogu Itu and Obot Ndom Forest Reserves and other protected forests in each local Government Area. Akwa Ibom State 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 (Nelson, et al. et al. [15]). With an ocean front which spans a distance of 129 kilometres from Ikot Abasi in the west to Oron in the east, Akwa Ibom presents a picture of captivating coastal, mangrove forest and beautiful sandy beach resorts (Nelson, et al. [15]). The climate of the state is characterized by two seasons – 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. Temperatures are uniformly high throughout the year with slight variation between 26 °C and 28°C. High range of relative humidity (75% - 95.6%) is common across the length and breadth of the State (Nelson, et al. [15]).

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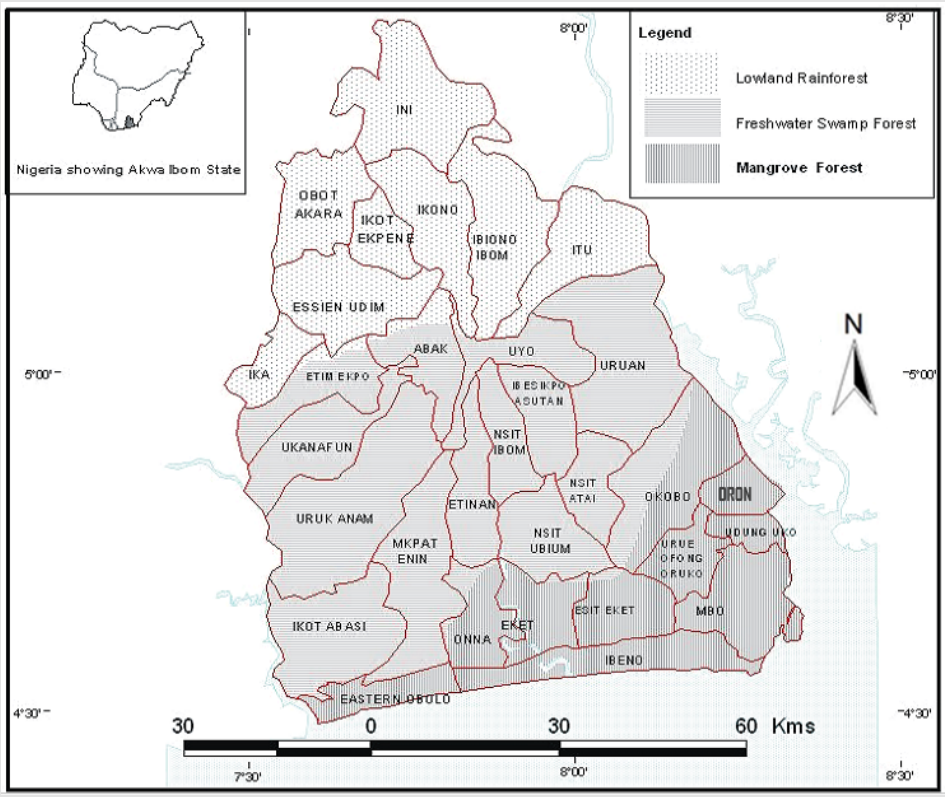

Note: Source: Nelson, et al. [15].

Figure 1: Administrative and vegetative map of Akwa Ibom State, Nigeria.

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 were 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 least square regression were used for data analysis. Least square regression was used to calculate the trend in target and generated revenue in the study area. In determining the revenue trend, the following models as used by (Udo, et al. [18]) were used;

Model 1 – Simple linear model of the form,

$$y_1 = a + bt + e \quad (1)$$

Model 2 – Non-linear (second polynomial) model of the form,

$$y_2 = a + bt + ct^2 + e \quad (2)$$

Where; y = f(t) with 2005 = 0; (1996, 1997, ... 2015 = -10,...., 9)

The trend lines were fitted with 2001 as the base year using the least square method. To examine the predictive abilities of the two models, their respective model-predicted values were compared statistically using their r2 and standard error (SE).

Results and Discussion

Forest Revenue Generation among Forestry Divisions in Akwa Ibom State

The result in Figure 2 indicates the sums of forest revenue generation from each of the Forestry Divisions in Akwa Ibom State from 2004 to 2015. Due to insufficient data for some months across various divisions, revenue estimates from 1996 to 2003 were not included in the analyses to ensure uniformity of the revenue estimates for each of the forestry divisions. Yearly breakdown of the revenue for all the forestry divisions in the state from 2004 to 2015 indicates that Oron Forestry Division had the highest revenue estimate (₦14,573,570) followed by Uruan, Itu, Forestry Headquarter, Mbo and Esit Eket Forestry Divisions with ₦13,342,880, ₦12,514,680, ₦6,122,210, ₦6,112,200 and ₦4,423,600 respectively. Urue Offong Oruko and Ika Forestry Divisions had the least revenue with ₦272,750 and ₦234,400 respectively. The first six forestry divisions in terms of revenue generation

(i.e. Oron, Uruan, Itu, Headquarter, Mbo and Esit Eket Forestry Divisions) accounted for more than 72% of the total revenue generated in the state for the period under review (2004 – 2015). Thus, not all the divisions in the state were able to generate forest revenue as there exist variations in their revenue collection potentials which could be attributed to either staff-oriented factors such as gender, education, marital status, motivation and insincerity of staff or divisional factors in the form of shortage of staff and resource base (Nelson, et al. [12-14,19]).

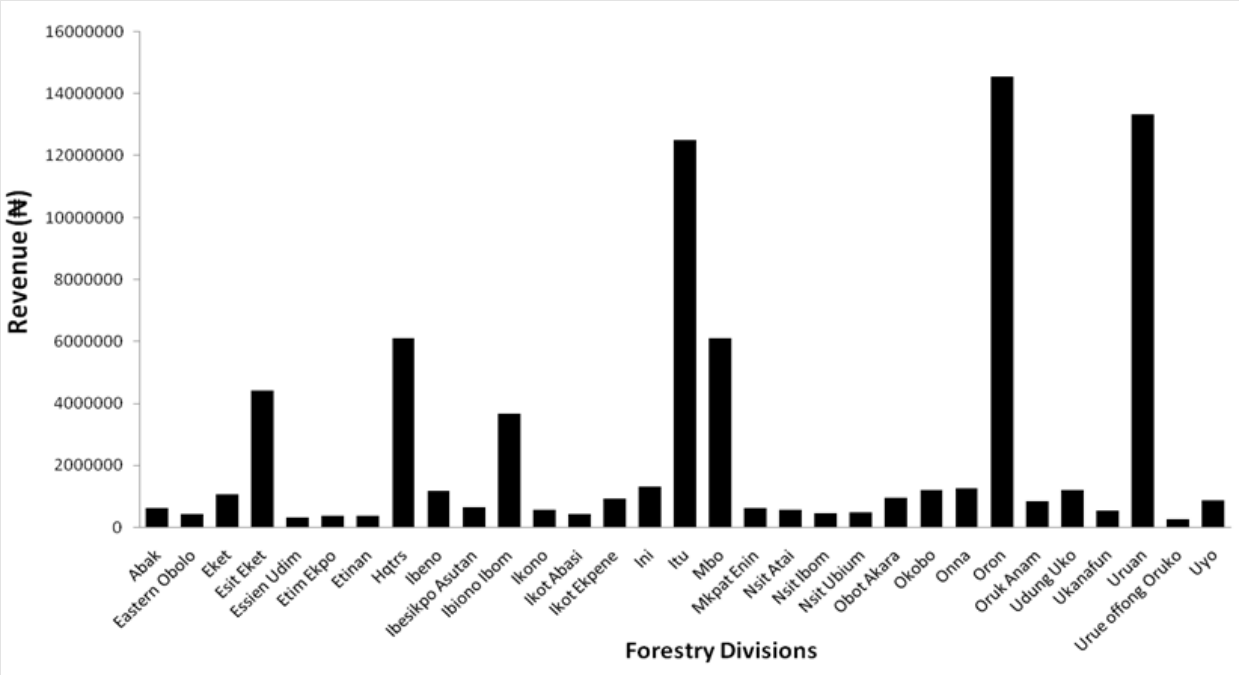

Figure 2: Total revenue generation in Akwa Ibom State according to Forestry Divisions in the state, 2004-2015.

Also, the variations in revenue generation among the forestry divisions could be attributed to the differences in forest resources base of the various divisions and presence of beaches in some divisions (Jacob, et al. [13]); (Nelson, et al. [19]). These beaches served as landing sites for floating logs exploited from outside the state and brought in for trade especially from Cross River State and Cameroon. According to (Sedell, et al. [20]) these logs are transported in loose aggregations in water and the natural or flushed streamflow supply the power for moving these logs to their desired destination. However, in Mbo Division, most of its forest revenue within the period was attributed to the royalties paid by Septa Energy for trees destroyed during its oil exploration activities in the area.

Trend in Forest Revenue Generation in Akwa Ibom State

The trend in yearly forest revenue generation in Akwa Ibom State from 1996 to 2015 is presented in Figure 3. The trend analysis made use of omitted 1996 to 2003 revenue data as total forest revenues for the State was available for these years, except for the year 2000. The results indicated that forest revenue generation followed an increasing pattern from 1996 to 2003 before decreasing downward to 2005. Between 2006 and 2015, the revenue followed an upward trend except for 2007, 2010 and 2015 which it steeped downward again. Statistically, there existed a strong positive relation ($R^2 = 0.76$) between the revenue year and the generated revenue in the state. In other words, forest revenue, on the average, tended to be increasing yearly. This increase in revenue generation could be attributed to annual increase in target which are arbitrarily fixed. This agreed with the observation by (Nelson, et al. [11]) who reported that the preceding year's revenue performance was usually used as determinant in setting subsequent year's revenue target. Also, despite the low forest resource base in the study area, there was still an average increase in yearly revenue generation which adversely affected the available forest resources. This agreed with the observation by (Akpan-Ebe, et al. [21]), who reported that in an attempt to increase these annual revenues from the forest resources, the limited forest resource base in the state was overstretched as inadequate attention was given to the regeneration of harvested stock to sustain the revenue drive of the state.

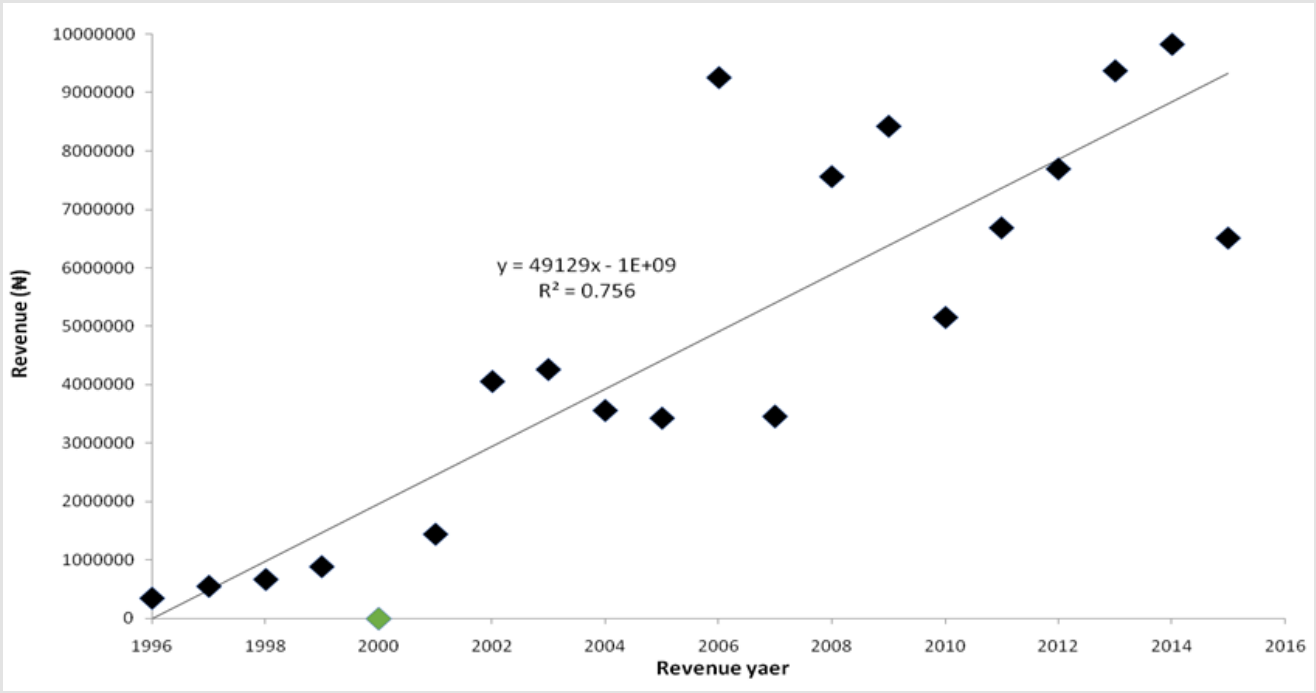

Figure 3: Revenue trend in Akwa Ibom State (1996 – 2015).

Estimated Model for Target Forest Revenue in Akwa Ibom State, Nigeria

The results in Table 1 show the actual target revenue and the estimated revenue targets using a simple linear model Y_{et} = 1251043.39+1.03*Xt-1 with a coefficient of determination (R^2) = 0.3 and standard error (SE) of 3936692.80 developed from past revenue targets in the state. The low coefficient of determination (30%) indicated that there existed some uncontrollable and unknown factors influencing revenue targets in the study area that are not included in the model. According to (Bujang, et al. [22]), value of R square ranging from about 0.4 to 0.6 and above is acceptable in all cases of model estimation either it is through simple linear regression or multiple linear regressions. Also, there was a positive linear relationship (r = 0.54; p = 0.05) between the two variables (target and generated revenues) although not as high as 0.91 and 0.98 recorded by (Olaseni, et al. [23]) and (Udo, et al. [18]) for Ondo State and Akwa Ibom State respectively. This implied that the preceding year's revenue performance was the major determinant of the subsequent year's revenue target (Nelson, et al. [11]). Thus, if target revenue was met in the previous year, the subsequent year target revenue would be increased and vice versa (Nelson, Jacob, et al. [15]). The results in Table 1 also shows that the estimated model overestimated the revenue target from 2002 to 2005 and in 2007 between the range of ₦913,166.94 and ₦5,081,284.49. However, it underestimated the target revenue in 2006 and 2008 – 2015 between the range of ₦930,042.71 and ₦5,375,433.81.

Table 1: Estimated annual target revenues using simple linear and non-linear model.

Year	Target Revenue (TR) ₦	Estimated Target Revenue (ETR)₦	Variation in Revenue (ETR - TR) ₦
1996	1800000	-	-
1997	-	1607373.95	-
1998	-	1820633.39	-
1999	-	1943203.39	-
2000	-	2167743.39	-
2001	1110000	-	-
2002	1755000	2731628.22	976628.22
2003	4450500	5428043.59	977543.59
2004	4000850	5639574.69	1638724.69
2005	4000850	4914016.94	913166.94
2006	5710000	4779957.29	-930042.71
2007	5710000	10791284.5	5081284.49
2008	8216000	4804821.49	-3411178.51
2009	11400000	9036947.29	-2363052.71
2010	11400000	9936219.69	-1463780.31
2011	11940000	6564566.19	-5375433.81
2012	12400000	8134739.39	-4265260.61
2013	12400000	9180755.89	-3219244.11
2014	14700000	10910692.4	-3789307.61
2015	14700000	11369299.9	-3330700.11
Total	125693200	111761502	-18560652.6
Mean ± SD	7855825±	6208972.31±	-1325760.90±
	4808626.6	3412487.76	2905864.43

The high standard error in the estimated model could be attributed to the wide difference between the high revenue target for 2014 (₦14,700,000.00) and 2001 (₦1,110,000.00) as it tended to exaggerate the model error and accounted for the over estimations and underestimations of the estimated revenue targets by the models (Udo, et al. [18]).The significant difference ($p = 0.05$, $t_{cal} = 1.6939 > t_{tab} = 1.1616$ at 32df) between the means of the actual target revenue (₦7855825±4808626.62) and the estimated revenue target (₦6208972.31±3412487.76) in the study could be attributed to the use of the previous years generated revenue in estimating the target revenue unlike the actual target revenue which was arbitrary set. This implies that the estimated model ($Y_{et} = 1251043.39+1.03*X_{t-1}$) could be used to forecast future revenue targets for the state based on the relationship between the preceding year's target despite its low coefficient of determination (Bujang, et al.[22]).A cross examination of the developed model for the year 2001 to 2015 and that of (Udo, et al. [18]) developed for the year 1988 to 1996 showed that there was no significant difference ($p = 0.05$, $t_{cal} = 0.969 < t_{tab} = 2.920$ at 2 df) between the two models using their predictive abilities (coefficient of determination (r^2) and standard error (SE)).

Estimated Model for Generated Forest Revenue in Akwa Ibom State, Nigeria

The trend in actual generated revenue for Akwa Ibom State from 1996 to 2015 was modeled into a simple linear and a non-linear (second degree polynomial) model expressed as $X_{e1} = 5002298 + 473409.7t$ with $r^2 = 0.74$ and SE = 1670091, and $X_{e2} = 5429022 + 460185t - 12871.7t^2$ with $r^2 = 0.76$ and SE = 1667885 respectively. Judging from their coefficient of determination and standard errors, it could be assumed that the second-degree polynomial model had a better fit than the simple linear model because of its higher coefficient of determination and lower standard error than the later. This is in line with (Udo, et al. [18]) who also adjudged the second-degree polynomial model to be better than the simple linear model based on

the above stated criteria. However, there was no significant difference ($p = 0.05$, $t_{cal} = 0.001 < t_{tab} = 2.919986$ at 2 df) between the two models using their predictive abilities (r^2 and SE) as estimators of the revenue trend from 1996 to 2015. Both models (Table 2) underestimated the 1996, 2002, 2003, 2006, 2008 to 2009 and 2013 to 2014 revenues, but overestimated the 1998 to 1999, 2001, 2004 to 2005, 2007, 2010 to 2012 and 2015 revenue figures. Difference in estimates in terms of either overestimated or underestimated was observed in 1997. Statistically, there was no significant difference ($p>0.05$) between the actual generated revenue and the two estimated revenues. The lack of difference between the two estimated revenue models and the actual generated revenue in the study implied that either of the two estimated models could be used to forecast the revenue generation potential of the study area.

Table 2: Estimated annual generated revenues using developed model.

Year	Generated Revenue (₦)			Variation from Generated revenue (₦)	
	Revenue	Model 1	Model 2	Model 1	Model 2
1996	345952	268201	-459998	-77751	-805950
1997	553000	741611	244749	188611	-308251
1998	672000	1215020	923753	543020	251753
1999	890000	1688430	1577014	798430	687014
2000	-	-	-	-	-
2001	1437461	2635250	2806305	1197789	1368844
2002	4055340	3108659	3382335	-946681	-673005
2003	4260710	3582069	3932622	-678641	-328088
2004	3556285	4055479	4457165	499194	900880
2005	3426130	4528888	4955965	1102758	1529835
2006	9262370	5002298	5429022	-4E+06	-4E+06
2007	3450270	5475708	5876335	2025438	2426065
2008	7559130	5949117	6297905	-2E+06	-1E+06
2009	8432210	6422527	6693732	-2E+06	-2E+06
2010	5158760	6895937	7063815	1737177	1905055
2011	6683200	7369347	7408155	686147	724955
2012	7698750	7842756	7726751	144006	28000.8
2013	9378300	8316166	8019604	-1E+06	-1E+06
2014	9823550	8789576	8286713	-1E+06	-2E+06
2015	6506600	9262985	8528079	2756385	2021479
Total	9.3E+07	9.3E+07	9.3E+07	5.2	2.2
Mean±SD	4902632.53± 3243093.55	4902633± 2807740.20	4902632.60± 2836355.06	0.27368421± 1623037.17	0.115789± 1572497.23

Note: 1USD = ₦360.00

This could be attributed to the fact that the revenue data being used in the model development is based on time series, hence, all the revenue variations in the models summed up to the total of the actual generated revenue of all the study period irrespective of the model being used for the revenue forecast. The variations in estimated and actual generated revenue is in accordance with (Adhikari, et al. [8]) assertion that models developed using time series data is non-deterministic in nature, i.e. it cannot predict with certainty what will occur in future as they follow more or less some regular pattern in long term. This could be the reason why the estimated models yielded results that were close to the actual revenue value.

Relationship between Generated and Target Forest Revenue in Akwa Ibom State

The relationship between the target revenues and the generated revenues from the state between 1996 and 2015 Figure 4 showed a trend line of $y = 1E+06 + 0.5365x$ with a positive relationship ($R^2 = 0.74$) although lower than 0.91 reported by (Olaseni, et al. [23]) for

Ondo State. This simply means that the revenues generated from forestry were highly dependent on the targeted revenues as it followed an upward trend. This could be attributed to the fact that the state government often uses incremental budgeting to fix revenue targets in relation to achievement in the preceding years. Though fixing of forest revenue targets was a common revenue collection strategy and administrative yardstick to assess performance, it was however, unsuitable for dealing with forest production which differed from agricultural production due to its diverse geographical and ecological conditions and variability in maturity or readiness for harvesting (Olaseni, et al. [23]).

Expenditure on Agriculture and Forestry in Akwa Ibom State, Nigeria

The result in Table 3 shows government expenditure in the agricultural and forestry sector. The data was limited to 2000 to 2012 due to non-availability of data for some periods. From the results, about ₦6.113 billion was spent on developing the agricultural sector in the state while ₦143.26 million was expended in forestry development. For agriculture, the highest expenditure was in 2009 (₦1.9951 billion), followed by 2010 (₦1.0769 billion), 2012 (₦992.88 million) and 2008 (₦800.57 million) while the least was in 2004 (₦28 million). For forestry, the highest expenditure was in 2001 followed by 2000 and 2002 with ₦56.78 million (24.70%), ₦38.09 million (20.92%) and ₦14.72 million (38.23%) respectively, while there were no expenditures in 2007, 2009, 2011 and 2012, because no money was released for forestry projects in those years. In general, yearly variations in agricultural and forestry sector expenditures showed that the Percentage of forestry to agriculture was highest in 2002, followed by 2001 and 2000 with 38.23%, 24.70% and 20.92% respectively, while the least (0%) was in 2007, 2009 and 2012, with a yearly mean of 2.34%. This figure is in line with the observation of (FAO, et al. [24]) that funding for forestry development in the country is usually poor ranging between 1% and 8% of the total budget allocated for agriculture (excluding provisions for fertilizer). This implies that government expenditure in the forestry sector is not adequately execute and implement planned programmes in the forestry sector. Hence, this situation has a detrimental impact on the sustainable management of the state forest estate.

Table 3: Yearly expenditure of government in agricultural and forestry sectors, 2000-2012.

Year	Agriculture (₦0,000,000)	Forestry (₦0,000,000)	Yearly Percentage (%)
2000	182.04	38.08	20.92
2001	229.85	56.77	24.7
2002	38.51	14.72	38.23
2003	28.9	3.24	11.24
2004	266.17	5.14	1.93
2005	n.a.	3.88	-
2006	357.35	12.86	3.6
2007	144.24	0	0
2008	800.57	0.48	0.06
2009	1995.1	0	0
2010	1076.92	8.07	0.75
2011	n.a.	0	-
2012	992.98	0	0
Total	6112.68	143.26	2.34

Note: n.a. = Not Available

Conclusion and Recommendation

The economic potential of forest is to provide the basis for revenue and income generation through efficient forest revenue system. In Akwa Ibom State, about ₦93,150,018.00 (USD 258,750.05) was generated as forest revenue with only few forestry divisions namely; Oron, Uruan, Itu, Forestry Headquarter, Mbo and Esit Eket Forestry Divisions generating more than 70% of the total revenue for the state. The forest revenue followed an increasing trend with a strong positive relationship (>70%) between revenue year and target revenue. However, government expenditure in the forestry sector was very low. Also, considering the fact that the tariff rates for forest produce and products were arbitrarily fixed and target revenues were based on the previous year performance there is need for them to be technical and economically reasonable, hence the recommendation that the model (second degree polynomial model with a lower level of varia-

tion) developed in the study could be used in estimating targeted and generated revenue for the state. The study also recommends that the state forest revenue system should be revised to improve the state's revenue base through increased financial investment in forest regeneration and protection for the continuous supply of forest resources in the State [23,24].

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