PLANTATION FORESTRY AND ASSOCIATED ECOSYSTEM SERVICE BENEFITS AT LANDSCAPE SCALE

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Abstract
With little information on the ecosystem services of planted forests across Nigeria, especially in south eastern Nigeria, this study sought to understand the ecosystem service potentials of the ecosystem and its prospects for handling natural hazards across the region. This was conducted at a landscape scale by using Ideani community in Anambra state where an extensive forest cover of *Anacardium occidentale* plantation exists. Questionnaire which focused on understanding the reasons for establishing the plantation, ecosystem services it provides, challenges it encountered and ongoing forest dynamics of the ecosystem, were used to elicit information from respondents across the study area. Using simple random sampling technique, thirty responses were elicited for each of the four villages and this gave a total of 120 responses. Principal component analysis, correlation analysis and descriptive statistics: frequency and simple percentages were employed for the analysis. The study revealed that the forest was useful for ecosystem services namely: provisioning, regulating and supporting services. Provisioning services constituted the bulk of the services derived from the ecosystem and were to a large extent responsible for much of the forest dynamics and cover changes experienced over the years. The ecosystem was equally seen to provide regulatory functions through erosion control and sparingly benefited the zone in supportive roles through soil fertility augmentation. Generally, the dynamics of the ecosystem showed that there were decline in the forest cover and extent and this was attributed to lumbering, bush burning and pest/disease attacks on the plantation. On the whole, the ecosystem was seen to benefit the community and suitable for mitigating natural hazard (erosion) and climate change concerns. Efforts to ensure that the landscape is protected from further losses and consequent reduction in the ecosystem services it provides were advocated across the zone.

Introduction

Forest landscapes are threatened at increasing scales across the globe and this affects the services they provide and their role in biogeochemical cycling. This is much pronounced in the tropics where vast numbers of households depend on it for sustenance and livelihood (Lewis, 2006; Igu and Marchant, 2017). With population growing at increasing proportions in the region, more forest lands are converted to arable lands in order to meet the teeming demands of the populace and with this, more forests are either degraded or deforested. Such scenarios make the region to be much vulnerable to the impending impacts of climate change and natural hazards since the resilience forest cover provides have been much reduced. Addressing the concerns of forest loss over the past decades emphasized the use of protected areas and gazetting of forest reserves across tropical landscapes. In response to that, vast lands were reserved for this purpose across Africa and other parts of the tropics (Ezebilo, 2013). However, as good as this initiative seems, the aim of establishing them are not being realized in many zones as they are equally prone to losses and human encroachment (Laurance, Useche, Rendeiro, Kalka, Bradshaw, Sloan, Laurance, Campbell et al. 2012; Igu, Nzoiwu and Anyaeze, 2017). This is very glaring in many forest reserves across Nigeria where much of the land have been taken over by host communities

for farmlands and in some other cases, urbanization have equally crept in, leaving much of the forest area to be bare land with very minimal vegetal cover.

Other forest holdings found in parcels of land belonging to communities and individuals seems to be another channel of actualizing the aim of biodiversity conservation and promotion of ecosystem services across tropical landscapes, and are yet to be maximized across many landscapes. This exists in different forms from region to region in terms of ownership, use and management as well as the capacity to which they provide ecosystem services (Igu, 2017). Some of these forest landscapes exist as plantations that were established for different purposes such as to check desertification, erosion or for agricultural purposes. They occupy vast areas of land and serve similar functions as seen in natural forests, even though they are mostly not accounted for and so are not maximized and managed as required. Plantation forestry has progressed from being a traditional practice with great potential to the point where development experts agree that it provides an important science-based pathway for achieving important objectives in natural resource management and poverty alleviation (Adedapo, 2014).

Plantation forestry offer practical ways of deploying and utilizing trees to create integrated and sustainable rural land use systems. It is increasingly seen to be providing ecosystem services, suitable environmental interactions and economic benefits at landscape scales. They have both protective and social-economic benefits (Aloa and Shuaibu, 2013) and equally provide direct agricultural benefit for local communities. Furthermore, they could be relied on for an ever increasing demand for wood products especially as forest degradation increases in natural ecosystems across the globe. Plantation forestry have significant potentials for mitigating land degradation (Stanturf, Palik, Dumroese, 2014) and could be relied on in restoring degraded or deforested landscapes. As seen in other forest landscapes, ecosystem service provided by planted forests can also be categorized as provisioning, regulatory, supporting or habitat and cultural services (MEA, 2005; De groot, Alkemade, Braat, Hein and Willemen, 2010). While the role of planted forests as ecosystem service providers have attracted increasing attention especially in recent times (Yao, Scarpa, Turner, Barnard, Rose, Palma and Harrison, 2014) not much is known about it across some landscapes such as south east Nigeria. Understanding how local communities view it and exploring its potential for maximum ecosystem provision is important for addressing natural hazards and impending climate change concerns of the region. This study was conducted to verify the possible ecosystem services derived from plantation forestry at the landscape scale and furthermore underscore its potential for addressing natural hazards in the region.

Study area

The study was conducted in Ideani, Idemili North local government area of Anambra state (Fig 1 and 2). Ideani is bordered by Uke in the West, Alor in the South and Abatete in the North and East. It lies between latitudes 6^0 07'N and 6^0 12'N and longitudes 6^0 49'E and 7^0 0'E.The climate of the zone is hot equatorial with average maximum temperature of 29^0C and minimum temperature of 24^0C. Depending on the season, it could rise up to 35^0C as seen in dry seasons around the month of March. Annual rainfall ranges from 1300mm-2800mm. Rainy season ranges from March to October with its peak in July and September, and a short break in August. The dry season ranges from November to February with the influence of harmattan felt between the months of December and January. The relative humidity is high in the area, an average of about 75%. Idemili North predominantly experiences south-westerly winds all year round and is found within the humid tropical rainforest belt of Nigeria. The dominant vegetation is high forest but guinea savannah which is a derivation of the high forest through human activities can be seen in many parts of the study area. The vegetation of the area encourages the practice agroforestry. Major crops cultivated include, cassava, yam, cocoyam, vegetables and oil palm, while major livestock reared are poultry, goat, sheep and cattle.

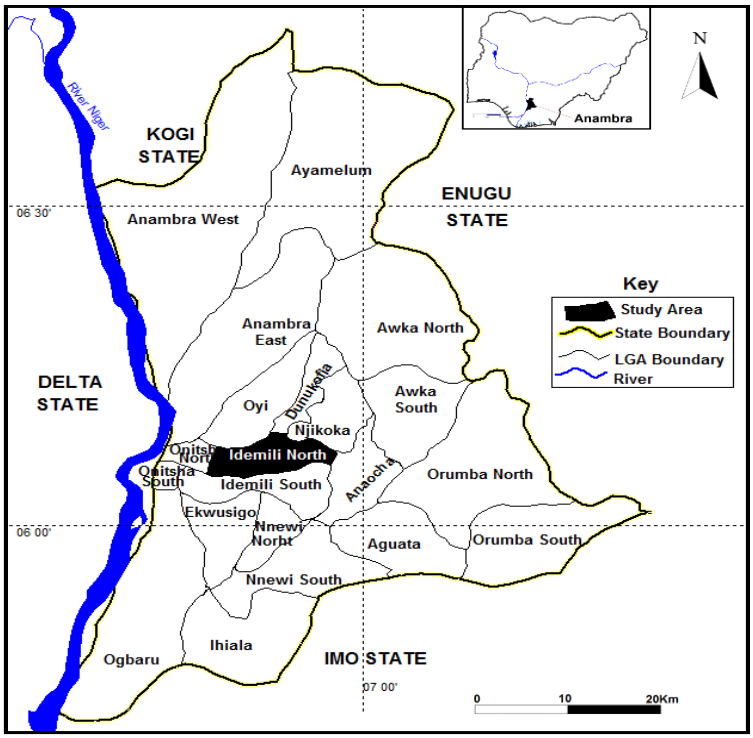


Fig. 1 Map of Anambra state showing the Idemili North LGA and map of Nigeria inset

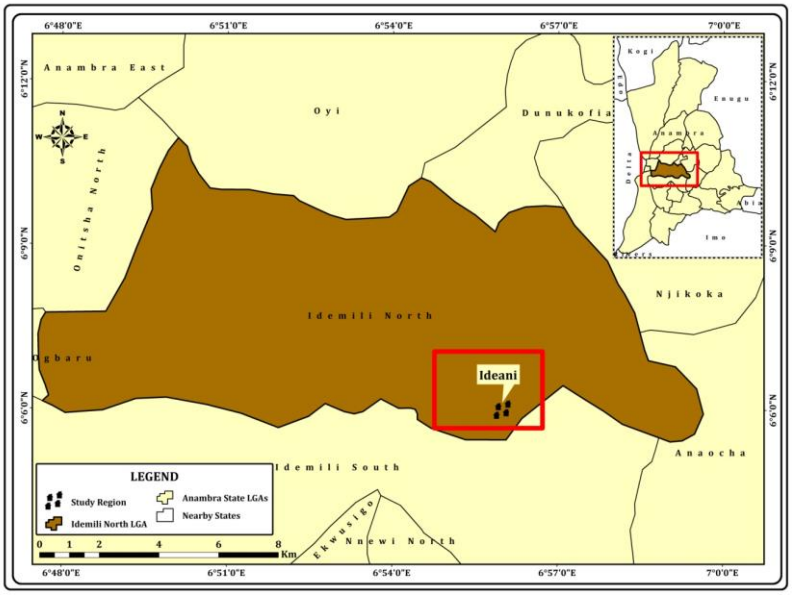


Fig. 2: Map of Idemili North showing Ideani with Anambra state inset

The study area consists dominantly of red ferrallitic soils and loose sandy sediments. Its geology is underlain by unconsolidated sedimentary rocks with bands of calcareous rocks inter-bedded with shale in some parts and lies within Awka-Orlu escarpment. The Nanka sands predominates the geologic series and a member of the Bende-Ameki Formation, but overlain by lignite- rich Ogwashi-Asaba formation, (Reyment, 1965).

The region is densely populated, partly because of the existence of major markets around the area such as Ogidi building materials market, Nkpor Motor Spare Parts, as well as the hospitality and peaceful nature of the indigenes

Methods

Data on ecosystem services provided by the plantation forest were captured from Ideani community using structured questionnaire. The design of the questionnaire followed literature review on the subject of study: ecosystem system services according to their classifications (MEA, 2005; De groot et al. 2010). It covered the characteristics and demography of the respondents, reasons for planting the forests, ecosystem services it provides, challenges it encounters and forest dynamics. This was eventually used to elicit information from the respondents in the area using household survey. The survey was conducted in Ideani which comprises of eight villages namely: Akana, Uruechem, Umuru, Urueze, Mkpazu eziama, Nsokwe, Oko and Umuoduba. Purposive non-probability sampling method was used due to the fact that the aspect of the population to be sampled was based on individuals living in the area. Thus, four villages (Oko, Akana, Urueze and Mkpazu eziama) were purposively selected because of their involvement in plantation forestry practices. Using simple random sampling technique, thirty responses were elicited for each of the four villages and this gave a total of 120 responses. Principal component analysis (PCA), correlation analysis and descriptive statistics: frequency and simple percentages were employed for the analysis.

Results

The occupations of the respondents were varied across the area of study: traders, farmers, civil/public servants, artisans and retirees (table 1). Majority of the respondents were farmers, while the other categories constituted the remaining proportion (table 1).

Table 1 Occupation of Respondents

Occupational category	**Number of respondent**	**Percentage**
Trader	33	27.5
Farmers	57	47.5
Civil/public servant	12	10
Artisanship	13	10.8
Retired	5	4.2
Total	**120**	**100**

Given the nature of the outlined occupations above, the respondents were also asked to select an economic activity for which they think is their secondary source of income. Apart from the respondents who are core salary earners, a good number of them (43%) indicated that they generate income from the sale of products from the cashew plantations (table 2). This showed that farming (directly or indirectly) was indeed the major economic activity in the area.

Table 2 Secondary Source of Income

Source of Income	**No. of Respondents**	**Percentage**
Salary earners	34	28.4
Sale of plantation produce	43	35.8
Sale of farm produce	30	25
Others	13	10.8
Total	**120**	**100**

The number of people that benefitted from the plantation forest was seen to increase over the years (table 3).

Table 3 Number of Years of Plantation Use

Years of Dependence on Plantation Forest Use	**No. of Respondents**	**Percentage**
5-10 years	15	12.5
11-15 years	22	18.3
16-20 years	30	25
20 years and above	53	44.2
Total	**120**	**100**

Responses gathered showed that the Cashew (*Anacardium occidentale)* plantation was established mainly to control erosion. However, it has equally benefitted the community as a source of food and income (table 4).

Table 4 Reasons for Plantation establishment

Reasons for Establishment of Forest Plantations	**Yes**	**No**	**No response**	**Total**
Erosion control	116	3	1	120
Source of food	76	41	3	120
Source of income	102	12	6	120

Ecosystem services derived from the plantation were varied across the zone (table 5). Among them, the role of the forest in controlling soil erosion and protection of soil from the damaging impacts of rain (aspects of regulating services), ranked high with the former being the highest (116) than any other benefit. This was followed by its provisioning services: providing food for rural farmers, income for rural farmers, timber and firewood for the villagers and source of herbs/traditional medicine. Supporting services such as biodiversity conservation were equally seen to be useful.

Table 5 Ecosystem Services Provided by Plantation

Ecosystem services provided by the forest	**Yes**	**No**	**No response**	**Total**
Controlling soil erosion	116	3	1	120
Providing income to rural farmers	102	12	6	120
Increasing soil fertility	43	23	54	120
Protecting soil from damaging impact of rain	87	27	6	120
Lowering of surface soil temperature	7	5	108	120
Biodiversity conservation	32	10	78	120
Providing food to rural farmers	119	0	1	120
Livestock grazing	34	83	3	120
Providing raw materials for industry	21	11	88	120
Providing fuel-wood, timber and charcoal for cooking	96	12	12	120
Means of adaptation to climate change	12	11	97	120
Source of many herbal remedies and traditional medicines	44	67	9	120

On the other hand, it was observed that the plantation decreased in size over the years. This loss was mainly attributed to lumbering, bush burning and disease/pest attack (table 6).

Table 6 Forest dynamics

Response	**Has forest size reduced**	**Causes of reduction**		
		Lumbering	**Bush burning**	**Disease/pest Attack**
Yes	68	76	38	6
No	43			
No response	9			
Total	120			

Results of the correlation analysis conducted to examine the relationship between the various ecosystem services provided by the plantation forests in Ideani are presented thus.

Table 7 Coding and Labelling of the 12 Ecosystem Services Associated with Cashew (*Anacardium occidentale)* Plantation forests in Ideani, Idemili North L.G.A.

S/N	**Variable Description**	**Variable Code**
1	Controlling soil erosion	X1
2	Livestock grazing site	X2
3	Regulating soil fertility	X3
4	Protecting soil from damaging impact of rain	X4
5	Lowering of surface soil temperature	X5
6	Biodiversity conservation	X6
7	Providing food to rural farmers	X7
8	Providing income to rural farmers	X8
9	Providing raw materials for industry	X9
10	Providing fuel-wood, timber and charcoal for cooking	X10
11	Means of adaptation to climate change	X11
12	Source of many herbal remedies and traditional medicines	X12

Table 8 Correlation Matrix of Ecosystem Services

	X1	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**	**X10**	**X11**	**X12**
X1	1											
X2	0.957	1										
X3	0.854	0.969	1									
X4	0.616	0.767	0.844	1								
X5	0.934	0.993	0.975	0.836	1							
X6	−0.801	−0.715	−0.593	−0.672	−0.748	1						
X7	−0.471	−0.376	−0.268	−0.553	−0.440	0.906	1					
X8	0.861	0.953	0.966	0.925	0.982	−0.754	−0.504	1				
X9	−0.328	−0.563	−0.724	−0.522	−0.556	−0.118	−0.406	−0.561	1			

X10	0.904	0.988	0.993	0.844	0.995	−0.68 2	−0.36 5	−0.9 81	−0. 636	1		
X11	−0.86 6	−0.73 6	−0.57 5	−0.534	−0.74 2	0.971	0.816	−0.7 02	−0. 142	−0. 671	1	
X12	0.187	0.329	0.427	0.846	0.437	−0.54 0	−0.66 2	0.598	−0. 161	0.43 5	−0. 324	1

Table 7 revealed a high association between some variables as well as serial autocorrelation for as many of the services provided that showed strong and significant positive correlation with each other. For example, X1 was strongly and positively correlated with X_2, X_3, X_5, X_8, and X_{10}. Furthermore, X_2 was very highly correlated with X_3, X_5, X_8, and X_{10}. With the very serious autocorrelations that characterized the data, there was no other alternative than to subject the correlation results to PCA.

PCA was able to collapse the 12 variables into significant and orthogonal components that explained the variables in the observed data. When PCA was transformed, the primacy of three components manifested (Table 9)

Table 9 Varimax Rotated Component Matrix of the Variables

	Components		
Variable	I	II	III
X1 (Controlling soil erosion)	.857	.512	-.062
X2 (Livestock grazing site)	.947	.298	.118
X3(Regulating soil fertility)	.960	.094	.264
X4 (Protecting soil from damaging impact of rain)	.661	.187	.727
X5 (Lowering of surface soil temperature)	.922	.311	.232
X6(Biodiversity conservation)	-.454	-.841	-.296
X7 (Providing food to rural farmers)	-.062	-.876	-.479
X8(Providing income to rural farmers)	.865	.285	.414
X9 (Providing raw materials for industry)	-.765	.618	-.182
X10 (Providing fuel-wood)	.945	.214	.248
X11 (Means of adaptation to climate change)	-.498	-.865	-.059
X12 Source of many herbal remedies	.159	.218	.963
Eigen value	6.549	3.268	2.183
% of variance explained	54.57	27.23	18.29
Cumulative % explained	54.57	81.826	100.00

The varimax rotation however maximizes the covariance loadings on each component in order to achieve as many high and as many low loadings as possible while maintaining the orthogonality (i.e. the uncorrelation) of the original components. From table 9, it was clear that the first two components explained 81% of the variance while all the other components had eigen values greater than 1.00. The variables with the highest loadings on each of the components were picked and shown in tables 10 – 12 with their corresponding variables.

Table 10 Variables with high loadings on Component I

VARIABLE	LOADINGS	VARIABLE NAME
X1	0.857	Erosion
X2	0.947	Grazing
X3	0.960	Soil fertility
X5	0.922	Surface temperature
X8	0.865	Income to rural farmers
X9	~0.765	Provision of Raw materials
X10	0.945	Fuel wood

Table 11 Variables with high loadings on Component II

VARIABLE	LOADINGS	**VARIABLE NAME**
X6	~0.841	Biodiversity conservation
X7	0.792	Providing food
X9	0.618	Raw material for industry
X11	~0.865	Means of adaptation to climate change

Table 12 Variables with high loadings on Component III

VARIABLE	LOADINGS	**VARIABLE NAME**
X12	**0.782**	Source of many herbal remedies and traditional medicines

The forgoing, X1, X2, X3, X5, X6 and X10 loaded highly on component I; variables X7, and X9 loaded highly on component II while variable X12 loaded highly on component III. From this result, it was seen that the ecosystem provided provisioning services (X8~income to rural farmer; X10~fuel wood), regulating services (X1~ erosion control) and supporting services (X3~soil fertility). In components II and III, it was obvious that the plantation forest provided mainly provisioning services to the community: X7- Providing food to rural farmers; X9 - Providing raw materials for industry; X12 - Source of many herbal remedies and traditional medicines. With this, the ecosystem benefited the study area mainly in provisioning and regulating services.

Discussion

Planted forests serve very important functions across the globe and to a great extent complement the forest area, functions and services that are found in natural forest ecosystems. The planted forest in the study area was seen to be very useful to the local community in various ways (Table 4-5) and provided sustenance both as primary and secondary sources of income (Table 1-2). Such landscapes are useful to local communities for nutritional purposes (such as nuts) medicinal purposes (used to treat some ailments) and are sources of fuel. These provisioning services tend to become beneficial to local communities especially when the forests are not very far from their households (Igu and Marchant, 2017). Direct benefits that people derive from forest landscapes are more known and acknowledged than other (regulatory and supportive) services that are derived from them as well. Since a vast majority of the people across the zone shared such views, they harvested the forest resources beyond its capacity; hence accelerating its degradation and loss in the zone.

Other ecosystem services derived from the plantation were mainly from the regulating services: controlling soil erosion and protection of soil from the damaging impacts of rain; which ranked high compared to others (table 5). Particularly, the role of the forest in controlling erosion was acknowledged by the people in the zone and this explained the high attestation it received. This role was seen as the major reason for establishing the plantation; being that the zone is prone to erosion. Somehow, though this was acknowledged as a key role of the plantation, it did not stop the people there from logging it for other benefits. This concern needs to be addressed by the local and regional government who should ensure that other requisite alternatives are provided and harnessed by the people. Such will go a long way to ensure that the environmental hazard (soil erosion) known to ravage the zone is no longer a challenge. Furthermore, since such hazards could be exacerbated by climate change, enforcing realistic and indigenous accommodating policies (regarding the plantations) would be a major thrust for mitigating climate change impacts.

Much of the loss of trees in the plantation was mainly as a result of anthropogenic factors (table 6). Such occurrences have underlying reasons that led to its loss (Geist and Lambin, 2002), which needs to be understood and addressed. Lumbering is being done in the area not mainly for logs of wood, since the tree involved is cashew (*Anacardium occidentale*) and the logs does not really have much commercial value while compared to tree species grown for commercial logging. Such harvested logs are mostly done for small scale consumption and suffices as fuel-wood for domestic use and source of energy for some small and medium scale industries. Loss of the plantation equally emanated from forest clearance for the purpose of agriculture and construction of home dwelling units. Generally, agricultural activity affects ecosystems both at local and regional scales and is considered a major threat to tropical forest ecosystems (Igu, 2017) as well as a primary driver of global environmental change (Foley, Ramankutty, Brauman, Cassidy, Gerber, Johnston, Mueller, O'Connel, 2011). Since agriculture is increasing in the zone, efficient policies targeted at handling associated environmental risks arising from such trends needs to be in place as well. While a good proportion of the plantation still remains in the zone, government intervention (through local participation) are needed to ensure that further decline in forest cover is discouraged and stopped. Other indices of forest cover loss arising from the need for more built up areas (more household units, village halls and amenity structures) should not be abolished but should emphasize proper land allocation, maximizing of already available spaces and reductions in the loss of existing forest areas to the barest minimum. Ensuring that the forest lands are not (or minimally) encroached into are proactive steps to ensuring that the remaining forest landscapes in the region remain preserved.

Conclusion

Plantation forest across the study area was seen to provide vital ecosystem services: provisioning and regulatory services across landscape. Their resourcefulness and over dependence by the community were the major reasons for their loss and degradation in the zone. The ecosystem was on the other hand useful for checking erosion in the zone and could be relied on for mitigating climate change associated impacts on the zone. Since their ability to continually provide vital ecosystem services are non-negotiable, the ecosystem needs to be preserved. Community inclusive participation and government support is needed and recommended to be able to fully achieve effective conservation for the ecosystem.

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