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The Impact of Coastal Forest Succession and the Healthcare Challenges in Eastern Obolo Local Government Area of Akwa Ibom State, Nigeria

Ettemfon Silas Udom[1*], Iniodu George Ukpong[2] and Anietie Udom[3]

[1]Community Comprehensive Secondary School, Four Towns, Uyo, Akwa Ibom State, Nigeria.
[2]Department of Animal and Environmental Biology, Cross River State University, Calabar, Cross River State, Nigeria.
[3]Community Secondary School, Aka Offot, Uyo, Akwa Ibom State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author ESU designed the study, collected and analyzed data, carried out the statistical analysis, wrote the initial draft. Author IGU supervised, corrected the work/manuscript, help in plot design, while author AU managed the literature searches most appropriately and data collection. All the three authors read and approved the final manuscript.

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ABSTRACT

The impact of coastal forest succession and the healthcare challenges was conduct in some selected oil communities in Eastern Obolo. The area was abandoned after severe environment devastation by Oil Company. The major objective of the study was to determine how successions by exotic plants, impacted on the healthcare need of the people. Questionnaires, structured group – discussion and field survey were used to obtained primary data from the field, while internet and library provided the secondary data. Three 25 x 25 cm plots with replicates were designed for recording of plants of 1.0 m in height. ANOVA was employed to determine the relationship between coastal succession and healthcare challenges of the people. From the result, it was observed that succession by *Nypa fruticans* and the extinction of the original plants were evidence.

**Corresponding author: E-mail: ettemfonudom@gmail.com;*

The soil analysis shows that the nutrients were relatively normal for mangrove ecosystem. Tidal actions, deforestation, pollution, channelization, rise in sea level and flooding were factors that facilitates succession (Xs). Loss of medicinal plants, loss of herbs, low income, proximity to healthcare centres and drugs availability/affordability were healthcare challenges indices (Y). The regression of the Xs and Y variables were significant at 0.05% probability test. It was concluded that loss of medicinal plants, herbs, inaccessibility of health facilities and low income due to succession by exotic *Nypa fruticans* constituted a serious health problems to the coastal people.

Keywords: Mangrove ecosystem; forest succession; extinction; deforestation; healthcare challenges and plant regeneration.

1. INTRODUCTION

The coastal communities in Eastern Obolo as oil bearing communities experienced severe ecological disruption due to years of environmental pollution and other forms of devastation. Abandoned as they were the communities' coast- line was experiencing severe succession by exotic species and extinction of the original plants the people relied on for food, income, shelter and medicines. The people are extremely poor because the new successive plants do not provide shelter for fish and other aquatic animal for reproduction [1,2].

The benefit of the mangrove forest include: provision of medicine, herbs, food, fuel-wood for domestic and commercial purposes and added nutrient to the soil [3]. These services were provided by mangrove ecosystem for the communities until Oil Companies started oil exploration/exploitation in the area. Creating channels, building of wells and oil platforms in the process causes the removal original mangrove plants in the creeks, allowing other plant species to filled in the gap created by the deforestation and pollution. It is evidently clear that some mangrove plants can cope with polluted environment (water), for instance, *Nypa fruticans* and *Eichhornia crassipes* (Water hyacinth) are good examples of such plants [4, 5].

Some exotic plants like *Nypa fruticans* and *Eichhornia crassipes* apart from surviving polluted environment (water) reproduced and spread easily along the river flow. *Nypa fruticans* germinate while floating on water. These was lacking in most native mangrove plants, making extinction possible and competition with exotic plants difficult. However, the root network of some native plant such as *Rhizophora* family, provided habitat, food, and anchor for fish eggs and these enhance reproduction. Their extinction leads to the decline in fish and other aquatic animal reproduction [5].

Healthcare accessibility and affordability is a function of money, availability of medicinal plants, herbs and availability of healthcare facilities. The studies investigate to determine the extent to which succession impacted on the healthcare needs of the people. With the dominant of alien species, it is believed that the socio-economic life (especially health) of the locals would be adversely influenced. The low catch in the area leads to low income and loss medicinal plant/herbs, call for investigation on how these impacted on the healthcare status of the people.

2. MATERIALS AND METHODOLOGY

2.1 The Study Area

Eastern Obolo is located in the mouth of the Atlantic Ocean. It lies between latitudes 4º28ˡ and 4º53ˡ and longitude 7º50ˡ and 55ˡ East. It is bounded in the north by Mkpat Enin, Onna in the North East and Ikot Abasi in the South East all in Akwa Ibom State. It has a population of 60542, which was projected to 2018. Using geometric growth rate formula, given as Po = P1 + (1 t r) ^ Where Po ending point of computing the rate of change; r = the rate of growth (in this case 2.3), ^ = rate of change (10 yrs rate of change) P1 = population of the area [6].

Hence,

$$Po = P1 + (1\ t\ r)\ \hat{}$$
$$= 60542\ (1 + 2.3)^{1.2}$$
$$= 60542\ (3.3)^{1.2}$$

Projected popu. (2006 - 2018) = 60542 (4.1900260964) = 253672.6 Equation 1.

2.2 Sample Size of the Population of the Study Area

Finite population for sampling using Yamana Taro Formula: $n = N \div I + [N\,(e)2]$ as shown below [7].

Where: n = current population. N = finite population. e = the level of significant (0.05%)

$n = N \div I + [N\,(e)2]$
= 253673/1+ [253672(0.05)^2]
= 253672 /1 + 253672 (0.0025)
= 253672 /1+ 634.18 = 253672/ 635.2
= 399.5 = 400 Equation 2

2.3 Experimental Design

Research and development survey was adopted to identify and investigate the problem in Eastern Obolo in an attempt to provide possible solution. Three random 25 cm x 25 cm plots (A, B, and C) were designed with 3 replicates in Iko, Obianga and Edowick swamps as Disturbed plot, Control plot (none deforested area) and completely alter plot respectively. The 25 cm X 25 cm plots were further segmented into 5 cm in row and column to record plants of up to 1 m. The identification and enumeration started in January 2016 to December 2018.

2.3.1 Soil sample collection

Soil samples were taken from depths 0 cm – 15 cm to 15 cm – 30 cm from five locations to determine the required soil parameters (pH, Ec, Org. mat, TN, Av.P, Ca, Mg, Na, K, EA, ECEC, Sand, Silt, and Clay). Samples collected were put in labeled paper bags from the three plots and were later mixed and the composite soil was analyzed using standard procedures. Soil extracts preparation was done by rotating upside down 100 g of the soil in 25 ml of decolonized water for 30 min: followed by centrifuging at 600 g for 10 min. [8]. The pH of the soil was measured with Beakman pH metre. The organic carbon from the extract was determined by the Walkley Black method, phrosphorus by Barry P – 1 method and total nitrogen by Microkjeldahl method [2]. The exchangeable base were extracted with 1m ammonium acetate, while potassium and sodium determined via flame photometry, calcium and magnesium were determined by EDTA filtration method Black et al (1965). The determination of exchangeable acidity was by INKCL titration method with phenol phithalem as indicator [9].

2.3.2 Collection of healthcare indices and ecosystem disturbances (succession aiding/facilitating factors)

Various healthcare parameters were obtained from the field via questionnaires and structured groups' discussion. Health challenges were water related, air born, food poisoning and low income. These were seen and regarded as healthcare indices in the analysis. Collection of data on succession aiding factors was also done via same means.

2.4 Method of Statistical Analysis of Dependent and Independent Variable

Multiple regression analysis techniques were used in the analysis. Due to the large volume of data extracted, Factor analysis was first employed to reduce the data to a meaningful size while ANOVA was employed to determine the relationship between succession factors (deforestation, channelization, coastal flooding, pollution, soil nutrients, rise in sea level and tidal actions) Xs (independent variables) and healthcare factors (the number of health centres, herbal houses, water sources, occupation/income, numbers of pharmacies, medicinal stores, hospitals and medicinal plants) Y (dependent variable). These statistical tools has been used by many in analyzing/determining the relationship between variables X and Y [10, 2]. 400 of 410 questionnaires that were retrieved and sorted were used in the data analysis.

3. RESULTS AND DISCUSSION

3.1 Plant Identified and Enumerated

The plant composition in the study area had few mangrove species family dominating the coastline while other plants were spotted upland. It is natural to see fewer species of plant growing in the mangrove swamp. This is not far from the physiological adaptation requirement needed for plant to grow in such saline mud-field. Hence, in the three plots only the plants listed in Table 1 below were identified and enumerated.

3.2 Physical and Chemical Property of the Soil

The Table 2 low presented the physiochemical property of the soil as obtained from the field. The value was compared with that obtained by Udofia and Udom in 2011 (Table 3) in the same area. However this was just for base-line observation.

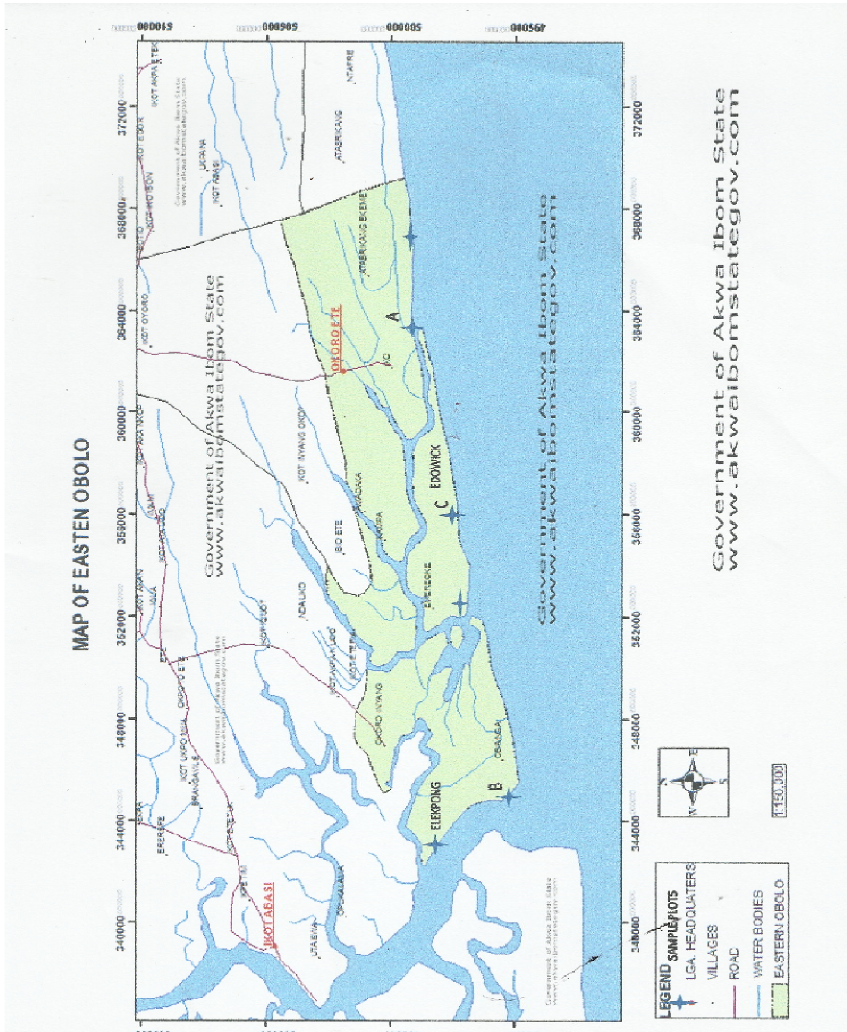

Fig. 1. Hydrological map of the study area

Table 1. Summary of relative abundance and frequency occurrence of species

Botanical names	**Plot**			**Total**	**Relative abundance**	**Relative frequency of occurance**
	A	**B**	**C**			
Costus afer	0	1	3	04	0.794	66.7
Conocarpus erectus	7	4	4	15	2.796	100
Acrostichum danaeifolium	1	0	3	04	0.794	66.7
Bambusa vulgaris	2	3	0	05	0.992	66.7
Raphia hookeri	3	1	5	09	1.786	100
Avicennia germinans	6	21	3	30	5.952	100
Laguncualaria racemosa	2	9	1	12	2.381	100
Myrianthus grandifolia	1	2	0	03	0.595	66.7
Elaeis guinensis	3	2	0	05	0.992	66.7
Nypa fruticans	88	44	132	264	52.381	100
Rhrizophora spp.	54	84	14	153	30.357	100
Total	167	171	165	504	100%	

Note: Relative abundance = $n \div N \times 100$ *Relative frequency occurrence = no. of times obser./ N of observation*

Table 2. Physiochemical property of the soil

Exchangeable cations **particle size analysis**

Villages	**Depths**	**pH**	**EC**	**Org**	**Total**	**Av. P**	**Ca**	**Mg**	**Na**	**K**	**EA**	**ECEC**	**BS**	**Sand**	**Silt**	**Clay**
	cm		**ds/m**	**Mat %**	**N %**	**mg/kg**	**cmol/kg**						**%**	**%**	**%**	**%**
Iko	0-15	6	1.27	3.5	0.12	8.33	2.6	1.1	0.11	0.14	2.8	6.75	58.52	85.8	0.6	8.2
	15-30	5.7	1.077	2.8	0.08	10.13	2.2	1	0.1	0.12	2.7	6.12	55.88	83.8	8	8.2
Obia-	0-15	6.2	1.2	3.6	0.14	16.2	2.8	0.2	0.12	0.13	2.4	6.65	63.9	85.8	4	10.2
gana	15-30	6	1.013	2.99	0.09	13.66	2.57	1.01	0.12	0.14	2.8	6.64	57.83	78.8	8	18
Edo-wick	0-15	6	1.27	3.2	0.1	14.66	2.57	1.2	0.1	0.15	2.48	6.59	62.37	83.8	6	10.2
	35-30	5.9	0.131	2.26	0.07	13.33	2.4	1	0.07	0.13	2.52	6.16	58.12	83.8	8	12.2
Atabri-	0-15	5.9	0.694	2.58	0.06	21.33	2.7	1.2	0.09	2	6.05	6.05	66.41	84	5	14
kang	15-30	5.8	0.506	1.8	0.04	19.66	2.88	1.3	0.07	0.08	2.2	6.52	66.41	81	5	14

Field survey: 2016 -2018

Table 3. Physiochemical property of the soil

Exchangeable cations **particle size analysis**

Villages	**Depths**	**pH**	**EC**	**Org**	**Total**	**Av. P**	**Ca**	**Mg**	**Na**	**K**	**EA**	**ECEC**	**BS**	**Sand**	**Silt**	**Clay**
	cm		**ds/m**	**mat%**	**N %**	**mg/kg**	**cmol/kg**						**%**	**%**	**%**	**%**
Irung	0-15	4.08	0.118	1.42	0.04	8.3	1.4	0.6	0.03	0.04	1.44	3.55	59.4	19.7	2.2	7.1
	15-30	4.23	0.116	1.22	0.03	9.6	1.2	0.5	0.03	0.06	2.5	4.33	41.8	89.1	2.8	7.1
Iko	0-15	6.29	1.9	5.82	0.12	2.7	10.4	3.4	0.24	0.04	4.2	18.64	77.6	76.4	12	11.6
	15-30	5.1	2.2	5.37	0.11	4.7	29.7	8.1	0.2	0.5	7.1	45.2	84.29	72.4	23.7	3.6
Obia-	0-15	5.2	2.4	6.85	0.13	5.7	7.2	2.8	0.28	0.6	7.8	18.68	58.24	73.2	7.2	11.6
gana	15-30	4.7	0.065	1.75	0.04	7.8	1.68	0.42	0.04	0.05	2.76	4.95	44.24	19.1	7.1	18
Edo-	0-15	4.8	0.088	2.4	0.06	8.88	1.99	0.4	0.06	0.08	1.04	3.38	69.23	80.4	8.24	11.36
wick	35-30	4.33	0.099	2.1	0.05	8.23	2	0.8	0.05	0.08	2.6	5.53	52.98	82.46	8	9.54
Atabri-	0-15	5.5	0.186	2.55	0.1	9.66	2.43	0.7	0.06	0.08	1.43	4.7	69.57	80.46	8	11.54
kang	15-30	5.22	0.126	2.09	0.07	7.34	2.4	0.6	0.06	0.07	1.69	4.81	64.86	80.46	8	11.54

Source: Extract from Udofia and Udom (2011)

3.3 Healthcare Challenges and Environmental Disturbances

It was observed that the following were various healthcare challenges: loss of medicinal plants, extinction of herbal plant, absence of hospital, high cost of drugs and low income due to low catch in the river making procurement of drugs difficult. Others include inadequate medicinal stores and high cost of drugs in areas were medicinal stores were sighted. It was observed also that the common sicknesses/ diseases in the area were: Bronchitis, rheumatic, measles, polio, eye problem, yellow fever, tuberculosis, malaria, cholera and diarrhea. It was also observed that the following factors contributed to the ecosystem disruption and as well contributed immensely to the succession that took place in the area. These factors were: channelization, pollution, coastal flooding, soil nutrient, and rise in sea level. Other were soil nutrients and deforestation.

3.4 Multiple Analysis of Dependent and Independent Variables

The Table 4 below shows the total variance explained in the Factor Analysis. The factor analysis produces six significant eigenvalues which loaded high (have value that is not less than 1) and accounted for 74% variation in the data set. Five factors were extracted and named as: F1 income factor, F2 medicinal plant factor, F3 herbal plant factor, F4 affordable drugs factor and F5 hospital proximity factor. Multiple Analysis of the Dependent Variable - Healthcare (Y) and independent variables – Succession (X_1 ... X_n) via ANOVA was employed to test the null hypothesis (Ho) – there is no significant relationship between succession and the healthcare challenges of coastal people in Eastern Obolo Local Government Area of Akwa Ibom State.

Table 5 below presented the R Square Statistics for the analysis (Multiple Analysis of the Dependent Variable - healthcare (Y) and Independent Variables – Succession). Table 6 indicated a strong relationship between the healthcare of the people in the coastal riverine area of Eastern Obolo and succession in the area. F – Test value of 609.767 and significant value of .000, rejected the null hypothesis of no significant relationship between succession and healthcare needs of the people, and accepted the alternative hypotheses of significant relationship between them. The T – test value of individual significant parameters shows that tidal action, pollution, rise in sea level and coastal flooding were more significant in the regression (Table 7).

3.5 Discussion of Findings

It is evidently clear that from plant composition in the area (Table 1), *Nypa fruticans* - an exotic species constituted more than 52% of the plants in the area, leaving less than 48% for all other plants believed to be native to the area. Some fresh water plants spotted in the plots could not survived for long because they lack the adaptive mechanism to survive in mangrove swamp.

Table 4. Total variance explained in the factor analysis

Component	Initial eigenvalues			Extraction sum of square		
	Total	% of variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.708	19.339	19.339	2.708	19.339	19.339
2	1.859	13.278	32.618	1.859	13.278	32.618
3	1,817	12.981	45.599	1.817	12.981	45.599
4	1.534	10.961	56.559	1.534	10,961	56.599
5	1.300	9.288	65.847	1.300	9.288	65.847
6	1.085	7.748	73.596	1.085	7.748	73.596
7	.945	6.748	80.343			
8	.880	6.283	86.626			
9	.842	6.017	92.643			
10	.766	5.470	98.112			
11	.213	1.525	99.637			
12	.045	.325	99.962			
13	.044	.026	99.987			
14	.002	.013	100.000			

Extraction Method: Principal Component Analysis

Table 5. Model summary[b] of Y and X_s

					Change statistics				
Model	R	R. square	Adjusted square	Std. Err. est	R square change	F change	df1	df2	Sig, Fc.
1	.957[a]	.916	.914	.29260140	.916	609.767	7	392	.000

a. Predictors: (Constant), Pollution, Deforestation, Rise in sea level, Soil nutrients, Tidal actions, coastal flooding, Channelization b. Dependent Variable: Healthcare

Table 6. ANOVA[b] of Y and Xs

Model		Sum of square	df.	Mean square	f	Sig.
1	Regression	365.439	7	52,205	609.767	.000[a]
	Residual	33.561	392	.057		
	Total	399.000	399			

a. Predictors: (Constant), Pollution, Deforestation, Rise in sea level, Soil nutrients, Tidal actions, coastal flooding, Channelization b. Dependent Variable: Healthcare

Table 7. Coefficients[a] of Y and X_s

Model	Unstd. coefficients		Std. Coeff.			Collinearity statistics	
	B	Std. Err	Beta	t	Sig.	Tolerance	VIF
1 (Constant)	.194	.121		1.596	.111		
Channelization	-.126	.102	-.062	-1.235	.217	.086	11.593
Coastal flooding	.736	.028	.402	26.252	.000	.913	1.095
Soil nutrients	.036	.018	.029	1.964	.005	.991	1.009
Tidal actions	1.1722	.032	.543	36.484	.000	.970	1.031
Rise in sea level	-1.722	.033	-.776	-52.093	.000	.967	1.034
Deforestation	.062	.020	.045	3.061	.002	.994	1.006
pollution	.277	.099	.140	2.787	.000	.085	11.790

a. Dependent variable: Health care

Again, from group discussion, it was observed that *Nypa fruticans* was the only alien plant in the area.

Table 2 and Table 3, presented the nutrients level of the area and from the contrast, it was observed that there is a little significant variation in nutrient composition. But the variation has little or no influence on the current level of plant composition. The swamp forest was rich with nutrients deposit from ruin off to nutrient deposited by ocean wave as sediment [11]. Both the dominant exotic plant (*Nypa fruticans*) and the local native plants had same chances of nutrients intake, hence, succession by *Nypa fuiticans* was not a functions of nutrient. However, there was a synergy between nutrients and other determining factors as shown in the analysis.

In Table 7 the negative relationship of channelization and rise in sea level against healthcare indicated that increase in channelization process and unavoidable raise in sea level in the coast leads to lower returns from fishing engagement of the coastal dwellers as well as lowering chances of survival of the native plants. The channelization processes; the removal of the threatening native mangroves plants creates room for competition among the original plants of the area and *Nypa fruticans* whose introduction was accelerated by tidal actions. The native plants lacked the capacity to cope with the disturbances, give way to the highly competitive exotic *Nypa fruticans*. Whereas, the positive relationships of other independent factors with healthcare shows that as deforestation, pollution, tidal actions, soil nutrients and coastal flooding increased in the coastal area, the more *Nypa fruticans* spread causing decline in native plant species composition, fish population and impoverishing conditions of the local fishermen.

4. CONCLUSION

The locals mostly depended on natural ecosystem for the treatment of illness. The original ecosystem provided them with herbal plants, food, shelter and water, whereas the succeeding plant lack the capacity to provide the people with these services. The loss of medicinal plants and herbs previously provided by the original plants worsened the poor health condition of the coastal people who cannot afford hospital bills. Affordable healthcare is a function of one's income. The coastal people derived their revenue from sales of fish and other marine products, hence, the decline in fish catch due to succession of the coast land by exotic *Nypa fruticans* constituted a serious consequence to the healthcare status of the people. They are faced with low income and cannot afford adequate healthcare services.

In sum, the array of destruction of the native ecosystem that encouraged succession by exotic species and the subsequent alteration of the ecosystem functions adversely affected the resources base of the people. When native plants give way to exotic successive plants there was an adverse effect on the ecosystem. This is because not all biological interactions are profitable to the ecosystem. Organisms operate for their own survival with their own species or tolerate their members or individuals of other species for survival and reproduction [12,13]. *Nypa fruticans* spread and completely dominate the coastline living no space for other mangrove species. It presence contributed little or nothing to the new ecosystem or its components, thereby worsening the healthcare and wellbeing of the locals.

5. RECOMMENDATION

Good silvicultural practices should be encouraged for the reproductions and reestablishment of the native mangrove species, effort should be made to eradicate *Nypa fruticans.* Provision of adequate healthcare system at affordable rate should be put in place by governmental and non-government/concern organizations. There should be proper enlightenment of the riverine people about the need to protect their environment. Laws/guidelines on sustainable harvesting of native mangrove plants be put in place.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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