Vol.2(1); pp.86-110, Aug. 2021.
Article Number: AJ23421020186110
ISSN: 0794–1668

Website: www.josedet.org

Journal of Science, Engineering Development, Environment & Technology (JOSEDET)

GEOSPATIAL EVALUATION OF THE IMPACT OF IYIEKE AND EHUOMA WETLAND ECOSYSTEM RESOURCES FOR HOUSEHOLD FOOD SECURITY IN AFIKPO NORTH L.G.A OF EBONYI STATE SOUTH EASTERN NIGERIA.

(ENGINEERING AND FOOD SECURITY)

***Otunta-Mayanga Gyspyson Alexius[1], Ngozi Emeka Ekuma[2], Akombo Godwin[3]**

[1, 2, 3]Urban and Regional Planning Department

Akanu Federal Polytechnic Unwana, Ebonyi State

otuntamaiyanga@yahoo.com[1], ladybgc7@gmail.com[2], akombogodwin@yahoo.com[3]

Corresponding author: Otunta-Mayanga Gyspyson (otuntamaiyanga@yahoo.com)

Received: 23rd July, 2021; Accepted: 27th August, 2021

Abstract

This research was carried out in order to evaluate the impacts of Iyieke and Ehuoma wetland ecosystem resources on household food supply in Afikpo north L.G.A of Ebonyi state due to the problems of the effects of climate change, herdsmen/farmers clash on Iyieke and Ehuoma wetlands ecosystem resources while the objectives include:1. To determine the status of Iyieke and Ehuoma wetlands ecosystem resources from 1986 to 2018 for household food security. 2. To report on the Iyike and Ehuoma wetlands resources for household food security. Data was collected through satellite imageries, secondary and questionnaire means. Image processing was done using the ENVI CLASSIC 5.0 and IDRISI SELVA software (Clark Labs, Worcester, MA, USA).Landsat 5TM, Landsat 8 OLI/TIRS and ETM+ were imported into ENVI CLASSIC 5.0 environment for radiometric corrections while model prediction was performed in IDRISI SELVA 17.0. Image composites was performed using near-infrared band 4, red-band 3 and green band 2 for both Landsat 5TM and ETM+ while Landsat 8 OLI/TIRS composite was performed using bands 5 ,4,3 of the imagery. This information in combination with obvious spectral signatures was used to identify 15 places where land category persists over time. These places were used to generate ground reference information to perform accuracy assessment for the classified maps. The maximum Likelihood classification algorithm was performed for the image classification of the study area. The 1987 Landsat 5TM, 2002 ETM+ and 2017 Landsat 8 OLI/TIRS imageries were classified into five (5) categories: wetland, cultivation, settlement, water and forest. The overall accuracy assessment (OA) and Kappa Coefficient (K) was determined in GIS environment. Cluster random sampling technique was used in the study. A sample size of 60 households was chosen in each cluster. This gives us a total sample size of 360 household. Change detection and CA-Markov analysis was used to determine the status of Iyieke and Ehuoma wetlands ecosystem resources for household food security. The land use change detection was divided into three conditions; past, current and future time. Past and current conditions were analyzed by using supervised classification and image differencing methods. Meanwhile, the future condition was analyzed by using a Markov chain method based on past and current land uses. Descriptive statistics and Excel for windows software were used including frequencies and percentages respectively. The results thereof indicate that Iyieke and Ehuoma wetland ecosystem is very dynamic in nature. The trend of change in 2037 proper indicates that a general growth performance of all the land use land cover classes as against their trend in 2017-2037. It is highly predicted that wetland class category will increase by 38% against its reduction in 2017-2037 by -0.04%,cultivation class category by 23% against its reduction in 2017-2037 by 0.49%, settlement class category by 16% against its increase in 2017-2037 by1.52%,water class category by 3% against its increase in 2017-2037 by 0.25% and forest class category by 20% against its reduction rate in 2017-2037 by -1.72%.Socio-Economic characteristic of all respondents in the sampled villages showed a positive impact trends in aid to household food security in Afikpo north L.G.A of Ebonyi State. Above all, the response of all the respondents in the sampled villages of Ndibe/Enohia Nkalu,Ugwuagu, Unwana, Akpoha,Ohaisu and Ibii/Ozziza respectively, on the impact of Iyieke and Ehuoma wetland ecosystem resources to household food security was highly positive.

Keywords: Ecosystem, Supervised Classification, CA-Markov Chain, Kappa Coefficient (K), Accuracy Assessment.

1.0 Introduction

An introduction to the convention on wetlands, Ramsar Convention Secretariat,(2016) article 1 states that “wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres”.

Wetlands are key components of freshwater ecosystems and these include a variety of highly productive habitat types from flooded forests and floodplains to shallow lakes and marshes, but also saltwater ecosystems.

It is estimated that wetlands cover about 0.6% of the earth surface (Economics for the Environment Consultancy, 2005). The total wetland area in Africa amounts to about 5.6 million km^2 (i.e. about 16% of the total area of the continent). Nigeria is richly endowed with abundant productive wetlands ecosystem, the majority of which are found in the Niger, Benue and Chad basins. Wetlands represent 2.6% of the country’s area of about 923,768km^2. The Niger Delta is one of the most important wetlands in Nigeria, the largest in Africa and third largest area in the world.

Oyebande, et al., (2003) and Asibor, (2009), identified fourteen (14) major wetland belts in Nigeria. These includes: Sokoto-Rima, Komadugu-Yobe, Lake Chad, Upper Niger and Kainji Lake, Middle Niger – Lokoja - Jebba – Lower Kaduna, Lower Benue – Makurdi, Cross River, Lower Niger, Niger Delta, Benin – Owena and Okomu, Lagos Lagoon and Lekki Peninsula, Lower Ogun River, Ologe Lagoon, Badagry and Yewa Creeks and the trans-boundary wetlands of the Upper Benue.

Hydrologically, Afikpo north L.G.A wetland belongs to a group and class of wetlands called Freshwater and Lacustrine wetland respectively. Lacustrine ecosystems are permanent freshwater lakes and greater than 8 ha in area, as well as the seasonal lakes smaller than 8 ha, including floodplain lakes and ponds; It is enriched by Cross River, a major tributary of Benue River, which led to the development of river tributaries like Ubeyi, Uroro, Iyioka, Wowo which inundate or saturate Iyieke and Ehuomma wetlands with water permanently.

From time immemorial, wetlands have been considered as a human life form resource on earth which has provided important resources and offer shelter and food for human being and other life forms (Ramsar Convention Bureau,

 otuntamaiyanga@yahoo.com

2002).Against this back drop, one may ask,What is the status of Iyieke and Ehuoma wetlands ecosystem resources for household food security in Afikpo north L.G.A of Ebonyi state in South Eastern Nigeria?

1.2 Statement of the problem

Climate changes affect Iyieke and Ehuoma wetlands ecosystem mostly due to changes in temperature and rainfall patterns. Generally, there has been temperature increase for the whole year round affecting crops and animals in the study area. However, rainfall amounts and distribution regimes has be so erratic and dynamic causing delay in crops planting and difficulty in animal grazing due to lack of fodder which portends danger to household food supply and urban planning in the study area.

Another problem of the study area is that of rising clash between herdsmen and the farmers in Iyieke and Ehuoma wetland ecosystem. The effects of climate change and desertification in the North combined with the activities of Boko Haram in the North Eastern region has made cattle grazing difficult, and has driven herders to migrate south. This has given rise to the prevalence violent clashes and by Afikpo north L.G.A people. There are also ethno-religious interpretations of the conflict as well. While the cattle herders are predominantly nomadic Fulani Muslims, the sedentary smallholder farmers are from other ethnic groups and are predominantly Christians or of other religions. The culminations of these factors have led people to believe that the conflict is another Jihad by the invading Fulani ethnic group, and an attempt at land grabbing. And/or a struggle over land resources.

The herdsmen sees Iyieke and Ehuoma wetland ecosystem resources as having great potential (fodder and availability of water) for livestock grazing against its utilization as a pure arable agricultural crop farmland by the rural community. The grazing of livestock on the wetland by the herdsmen led to the destruction of crops and pollution of water bodies by the livestock thus endangering the source of household food security of the rural community and of their income generation too.

1.4 Aim

The aim of the study was to evaluate the impact of Iyike and Ehuoma wetlands on household food security in Afikpo North L.G.A of Ebonyi state,South-East of Nigeria and the specific objectives were to **(**1. to determine the status of Iyieke and Ehuoma wetlands ecosystem resources from 1986 to 2018 for household food security.**(**2.to report on the Iyike and Ehuoma wetlands resources for household food security.

1.5 Research Questions

What is the status of Iyieke and Ehuoma wetlands ecosystem resources from 1986 to 2018 and its resources for household food security?

1.6 The Study Area

Location

Afikpo north L.G.A is located on latitude 5^0 45’ 39”N and 6^0 54’39”N and longitude 7^0 54’ 15” and 8^0 54’15”E. It has boundaries in the north with Enugu State; on the east with Cross River State, on the south with Abia State and on the west with Enugu State.Figure1 below shows the map of the study area. The important communities of the study area are also shown in table 2 below with their various coordinate systems.

otuntamaiyanga@yahoo.com

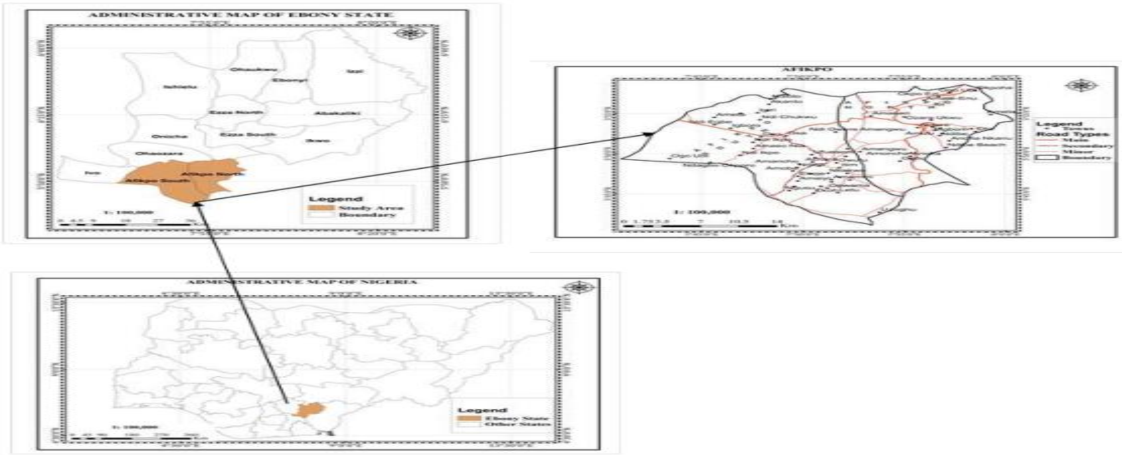


Figure1: Map of the study area.

Afikpo population, according to 1991 population census, is put at 107,633, in 2006, is put at 156,633 and finally projected to 207,300 in 2016 respectively. It has a density of 863.8km² (2016) and a change rate of +2.84% per a year (2006 → 2016). The most densely populated areas of the study area include: Afikpo main town, Unwana, Amasiri, Akpoha, Enohia, Itim and Ozizza communities.

In terms of relief, the study area has been one of the centres of deposition following the Santonian folding in South -Eastern Nigeria (Figure 2). There are tectonic elements which characterize the onshore Nigeria, during this sedimentation. They are southern Benue Trough to the northeast, Abakaliki high anticlinorium to the east, Onitsha high to the southwest, Ankpa Low in the northwest separated by Nsukka High, Calabar Flank of the Oban Massif and the Afikpo Low to the southeast. The thickness of the sediments in the area ranges from gravity measurements of 3 to 4.5 km. According to Odigi (2007), in the Afikpo Syncline three main Cretaceous litho-strati-graphic units were recognized, the Asu River Group, the Eze Aku Group and the post-Santonian proto Niger Delta succession. The area consists of some parallel low and high anticlines and synclinal structures that show outcrops. The base of sediments of Asu River Group Late Albian to Early Cenomanian is about 3000 m. The Eze Aku Group overlies the Asu River Group unconformably with a thickness of about 2000m Late Cenomanian to Early Santonian sediments (Figure 2). The Eze Aku Group is unconformably overlain by post Santonian sediments of pro-Niger Delta (Odigi and Amajor, 2009; Odigi, 2010).

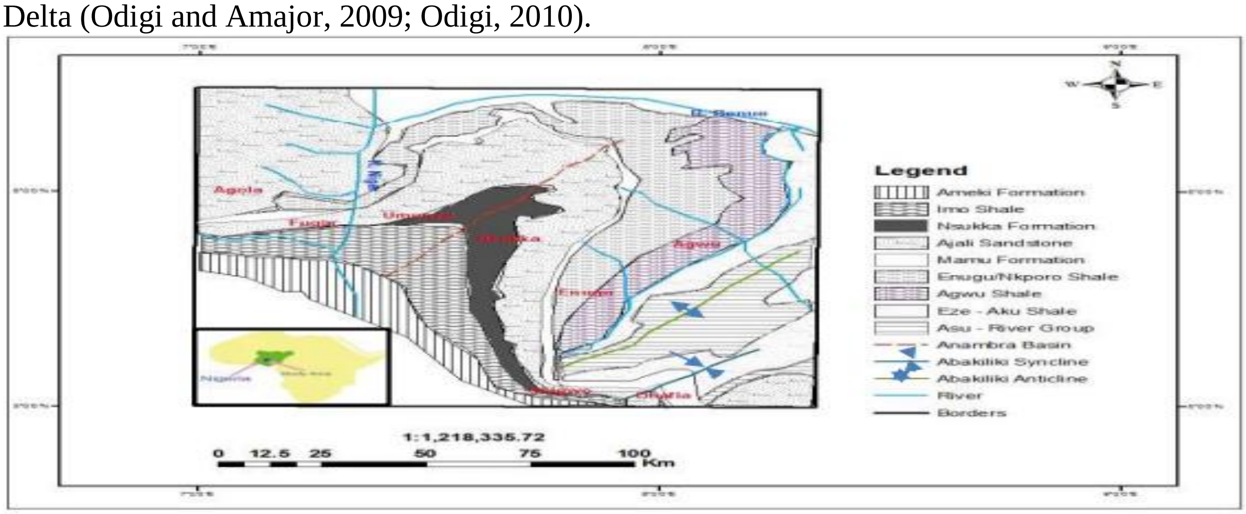


Fig. 2. Geological map of parts of southeastern Nigeria showing the study area (Egesi, 2017)

otuntamaiyanga@yahoo.com

Digital Elevation Model (DEM) offers visual perspective capability of terrain features. It is used for structural, slope, drainage pattern, locating geologic boundaries and fault. The DEM data derived from remote sensing data were used in determining characteristics of terrain, slope and aspect. The green areas represent relatively flat areas. From the slope map, steep slope is seen at the Afikpo area and is interpreted as a sandstone ridge while the low lying and gentle slope is at Amasiri area.

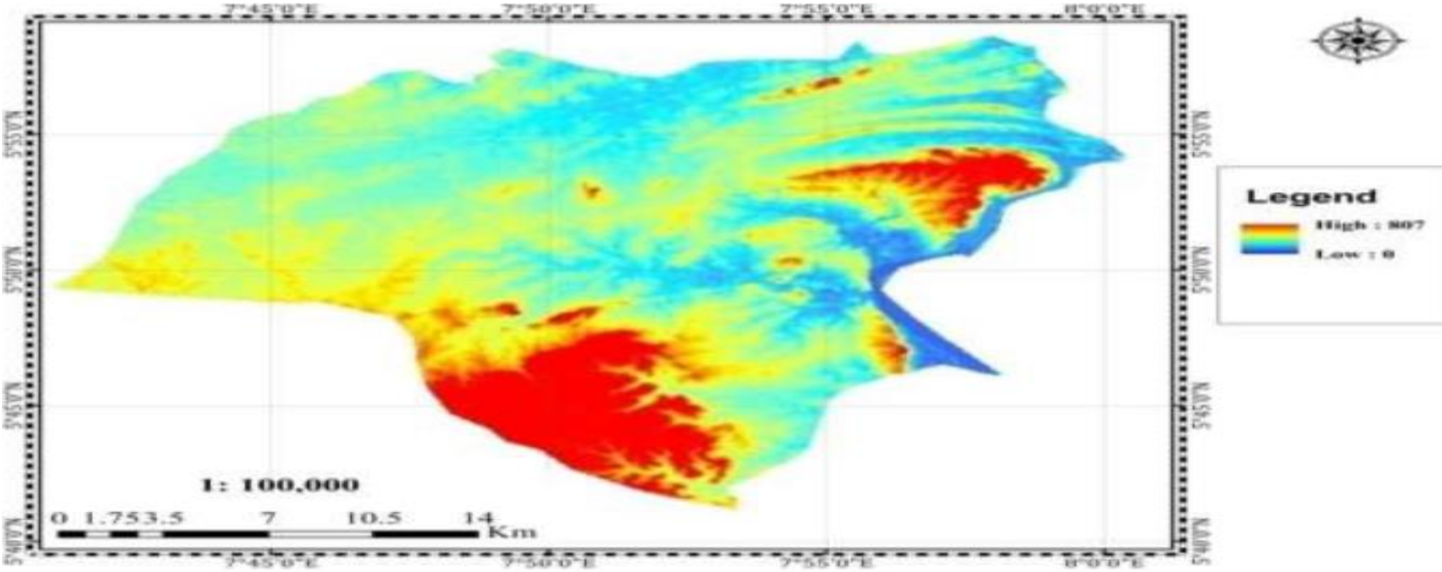


Fig. 3:.Digital Elevation Model of Afikpo North LGA

The slope of the ridge is identified as representing a sudden change in topography. The slope is characterized by numerous streams, gullies, and rivers. The high topographic relief area is indicated by sandstones and the low areas are characterized by mixture of shale, mudstones and sandstones.

The drainage pattern reflects a marked structural control of drainage by faults. The major drainage, the Cross River channel has many tributaries aiding wetland ecosystem –agriculture interaction which run along the channel. The DEM consists of six classes of surface elevation and shows the highest elevation value as red (76 to 281m) and the least elevation as blue (6 -31m) as shown in the colour and slope map (Figures 1 and 11). The drainage pattern reflects the nature of the subsurface formations. The stream network flow directions always explore the conduit path of weak zones, joint and fracture portions of the subsurface formations. The dendritic pattern as expressed by the drainage map aided the wetland ecosystem agriculture for household food security in the study area.

otuntamaiyanga@yahoo.com

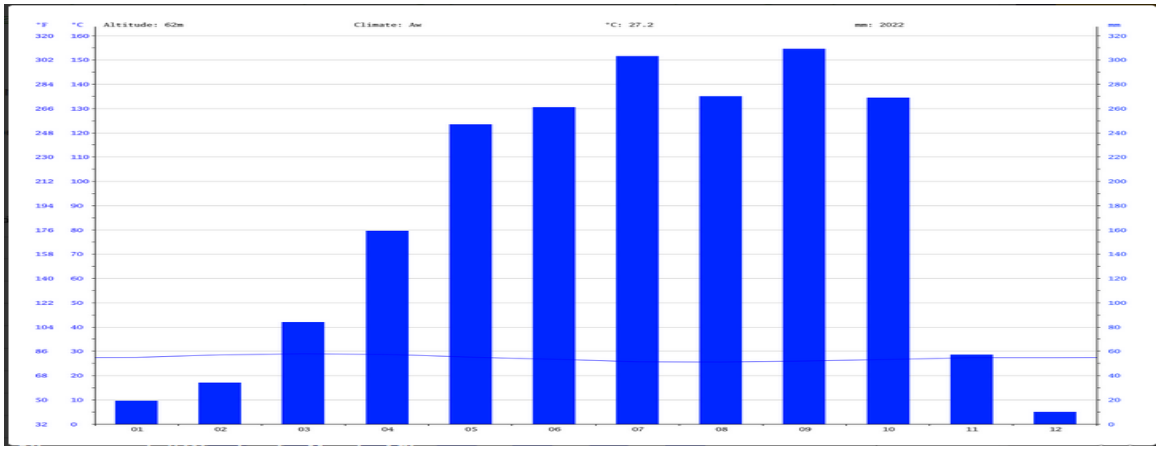


Fig. 4: Afikpo North L.G.A Climate graph and Weather by Month

The driest month is December, with 10 mm of rain. In September, the precipitation reaches its peak, with an average of 309 mm.

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	27.5	28.5	29	28.7	27.6	26.7	25.7	25.6	26	26.6	27.4	27.4
Min. Temperature (°C)	22.5	23.2	24.2	24	23.3	22.6	22.2	22.7	22.2	22.4	22.8	22.3
Max. Temperature (°C)	32.6	33.8	33.8	33.4	32	30.8	29.3	28.6	29.9	30.8	32.1	32.6
Avg. Temperature (°F)	81.5	83.3	84.2	83.7	81.7	80.1	78.3	78.1	78.8	79.9	81.3	81.3
Min. Temperature (°F)	72.5	73.8	75.6	75.2	73.9	72.7	72.0	72.9	72.0	72.3	73.0	72.1
Max. Temperature (°F)	90.7	92.8	92.8	92.1	89.6	87.4	84.7	83.5	85.8	87.4	89.8	90.7
Precipitation / Rainfall (mm)	19	34	84	159	247	261	303	270	309	269	57	10

Fig. 5: Showing Afikpo Weather by month and weather averages

There is a difference of 299 mm of precipitation between the driest and wettest months. The variation in annual temperature is around 3.4 °C.

The study area falls under rainforest vegetation type. The vegetation consists of thick forest at the southern part with patches of some thick forest around some of the rivers and stream parts of the study area. The low lying lands, especially the uplands are full of shrubs intermix with elephant grasses while wetland are made of grasses which are simply cut down for agricultural purposes.

There is high rate of deforestation in this vegetation area orchestrated by aggressive individual and government agricultural policies. Agriculture, being the main stay and back bone of the state and local government economies, employs over 70% of labor force. As a rainforest region,tubers such as yam, cocoyam, cassava, and related crops

otuntamaiyanga@yahoo.com

like palm tree, coconut etc, are commonly grown. Rice, the major staple food second to cassava is widely and intensively cultivated in the wetlands areas of the study area.

Plate 1.1: Vegetation of Afikpo North L.G.A

2.0 Conceptual Framework and Literature Review

2.1 Food Security

Almost 240 million people, or better put, one out of every four persons in the sub-Saharan Africa, lack access to adequate food. Hike in prices of food items and the effects of climate change are forcing the population into hunger and starvation. The population of the world has now crossed the 7 billion mark, but how many will there be to feed? (Bremner, 2012).

The term "food security" first emerged in the mid-1970s, at the World Food Conference (1974). During the conference, food security was defined in terms of supply of food—"assuring the availability and price stability of basic foodstuffs at the international and national level" (FAO,2006). The World Food Summit, 1996, finally agreed that food security "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2008).

From this definition, four components of food security are identifiable: availability, access, utilization and stability of food. Based on the practical guide of Food Security Information for Action, all four components must be satisfied simultaneously to meet the objectives of food security. Based on FAO, (2008) and Simon,(2012) the four components are as follows:

Availability:
There has to be physical, social and economic access to sufficient and nutritious food by all people and at all times. Such food must satisfy the dietary needs and preference of the people. It is the amount of food physically available in a region or place. To a great extent, food availability depends on the level of local production, imports, stock levels and net trade in food items.

In the study area, Iyieke and Ehuoma wetlands ecosystem made food available for the rural communities through its provisioning services such as rice, cassava, plantain, potatoes, yam, water yam, cocoyam, beans, vegetable, tomatoes, water duck, snail, grass cutter, oyster , prawns, fish, shellfish, tortoise, crab, etc. Due to physical, social and economic access to sufficient and nutritious food by all the people in the study area and at all time, satisfying their dietary needs and their preference thereof, they export excess to the other states. For example, the study area is well known for its rice and fish production as shown below.

Plate 2.1:Rice processing made available from Iyieke and Ehuoma wetland Ecosystem farmland.

3.0 Research methodology

3.1 Data collection and source

Data were collected through satellite imageries, secondary and questionnaire sources. Image processing was done using the ENVI CLASSIC 5.0 and IDRISI SELVA soft .Landsat 5TM, Landsat 8 OLI/TIRS and ETM+ were imported into ENVI CLASSIC 5.0 environment for radiometric corrections while model prediction was performed in IDRISI SELVA 17.0. Image composites was performed using near-infrared band 4, red-band 3 and green band 2 for both Landsat 5TM and ETM+ while Landsat 8 OLI/TIRS composite was performed using bands 5 ,4,3 of the imagery. This information in combination with obvious spectral signatures was used to identify 15 places where land category persists over time. These places were used to generate ground reference information to perform accuracy assessment for the classified maps. The maximum Likelihood classification algorithm was performed for the image classification of the study area. The 1987 Landsat 5TM, 2002 ETM+ and 2017 Landsat 8 OLI/TIRS imageries were classified into five (5) categories: wetland, cultivation, settlement, water and forest. The overall accuracy assessment (OA) and Kappa Coefficient (K) was determined in GIS environment.

otuntamaiyanga@yahoo.com

Table3.1: Landsat data and sources

Data Source	Acquisition Date	Path/Row	Resolution	Band Combination	Purpose
Landsat 5 TM USGS	21/02/1987	188/056	30M	4,3,2	Image Classification
Landsat ETM+ USGS	06/02/2002	188/056	30M	4,3,2	Image Classification
Landsat 8 OLI/TIRS USGS	07/02/2017	188/056	30M	5,4,3	Image Classification
SRTM USGS	11/02/2017	188/056	1-ARC	-------------	Study Area Delineation

3.2 Sampling technique

Cluster random sampling technique was used in the study. A sample size of 60 households was chosen in each cluster. This gives us a total sample size of 360 household.

3.3 Data analysis

3.3.1 Change detection and CA-Markov analysis

Change detection and CA-Markov analysis was used to determine the status of Iyieke and Ehuoma wetlands ecosystem resources for household food security. The land use change detection was divided into three conditions; past, current and future time. Past and current conditions were analyzed by using supervised classification and image differencing methods. Meanwhile, the future condition was analyzed by using a Markov chain method based on past and current land uses.

otuntamaiyanga@yahoo.com

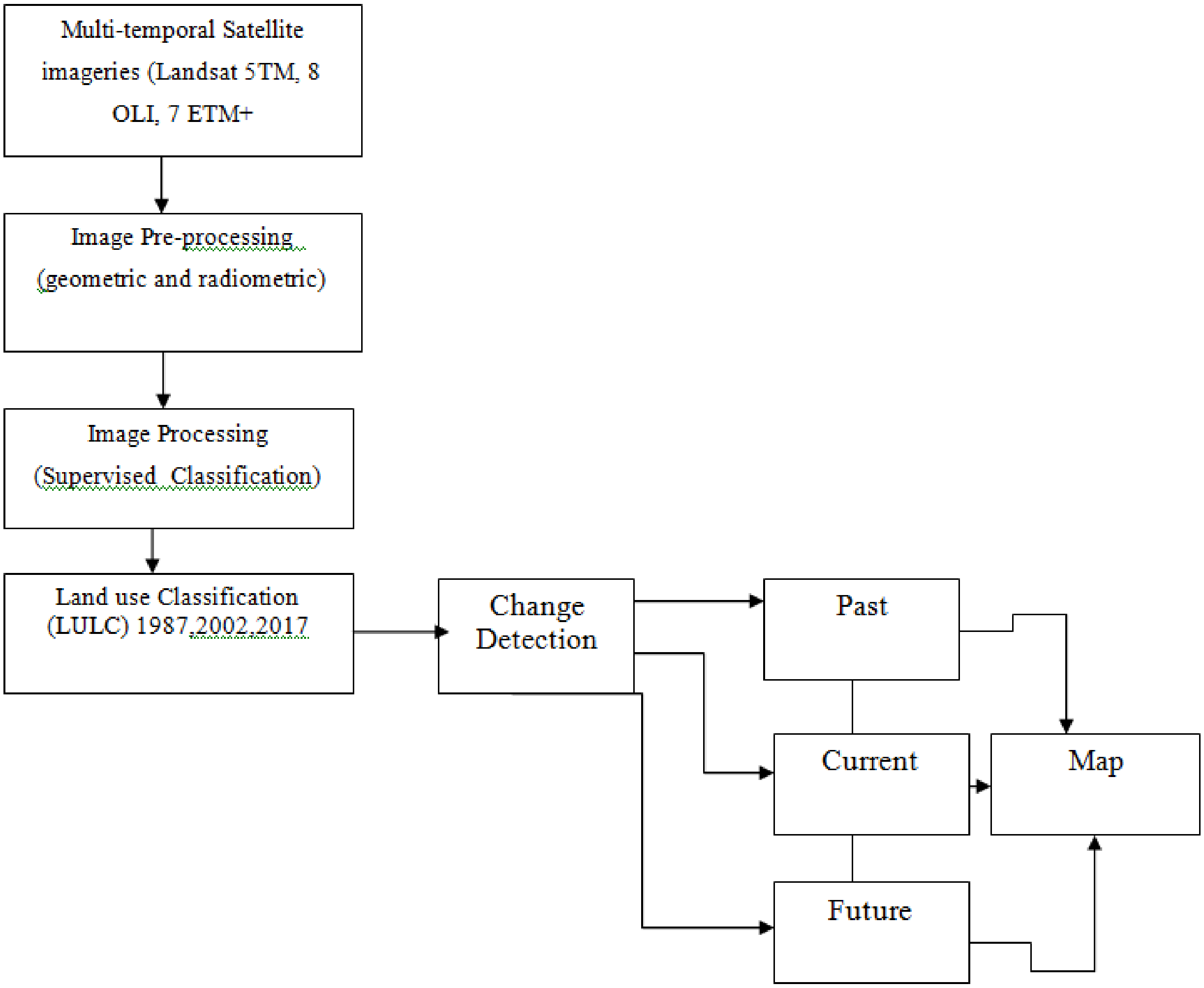


Fig. 3.1: Methodology flow chart of the study

3.3.2 Descriptive statistics and Excel

Descriptive statistics and Excel for windows software were used including frequencies and percentages respectively to analyze data generated from research questionnaire.

4.0 Results

4.1 The Status of Iyieke and Ehuoma Wetland Ecosystem Resource For Household Food Security

4.1.1 Accuracy Assessment

Table 4.1 Overall Accuracy Assessments and Kappa Coefficient of the Study Area Image Classification

Image Names	Overall Accuracy(OA)	Kappa Coefficient (K)
1987 Landsat 5 TM	80.07%	0.74
2002 ETM+	66.78%	0.58
2017 8 OLI/TIRS	98.04%	0.97

 otuntamaiyanga@yahoo.com

From the above Table 4.1 the overall accuracy (OA) assessment of land use and land cover classification of Iyieke and Ehuoma wetlands ecosystem resources for household food supply and urban planning in Afikpo north LGA of Ebony state in South East Nigeria in 1987 is 80.07% and Kappa Coefficient of 0.74, in 2002 it is 66.78% and Kappa coefficient of 0.58 while in 2017 it is 98.04% with Kappa coefficient of 0.98 respectively. This shows that the classification was done successfully and it is reliable tool to evaluate the impacts of Iyieke and Ehuoma wetlands ecosystem resources for households food supply and urban planning in Afikpo north L.G.A of Ebonyi state. The classified map of the study area is shown in Figure. 4.2 below:

4.2 Land Use Land Cover Category Changes in the Study Area

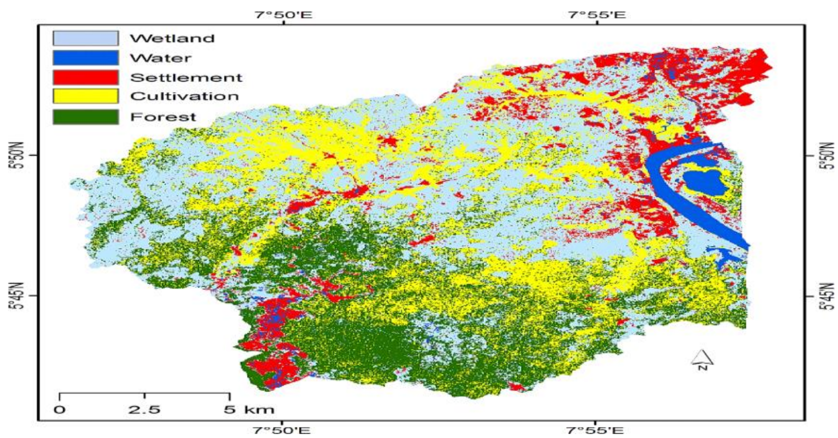


Fig..4.3 : Classified Map of Afikpo 2002.

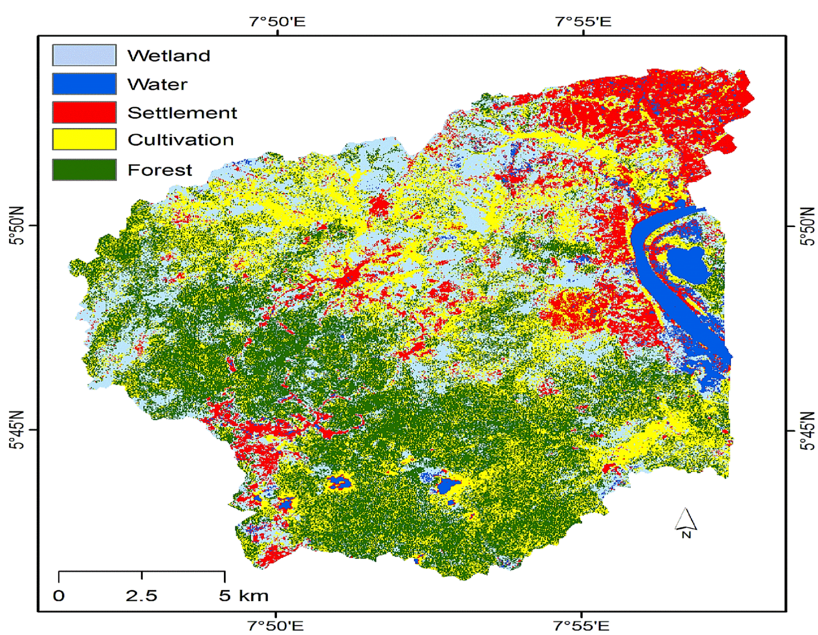


Fig.4.3 : Classified Map of Afikpo 2002.

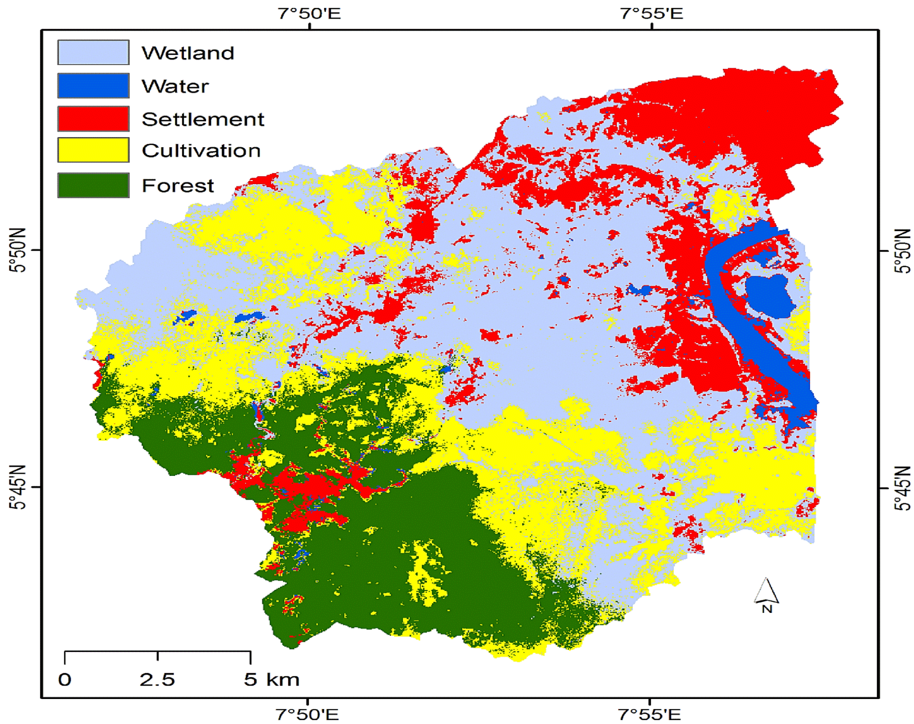


Fig.4.2.3: Classified Map of Afikpo 2017.

Table 4.1: Land Use Land Cover Category Changes in the Study Area

LULC CLASS	1987		2002		2017		CHANGE	
	Area (SqKm)	Area (%)	Area (SqKm)	Area (%)	Area (SqKm)	Area (%)	1987-2002 (%)	2002-2017 (%)
WETLAND	129.58	40	89.39	28	122.89	38	-12	10
CULTIVATION	82.44	25	84.86	26	76.68	24	1	-2
SETTLEMENT	32.54	10	39.84	12	56.06	17	2	5
WATER	11.61	4	13.46	4	10.05	3	0	-1
FOREST	69.67	21	96.29	30	59.17	18	9	-12
TOTAL	324.84	100	324.84	100	324.84	100		

otuntamaiyanga@yahoo.com

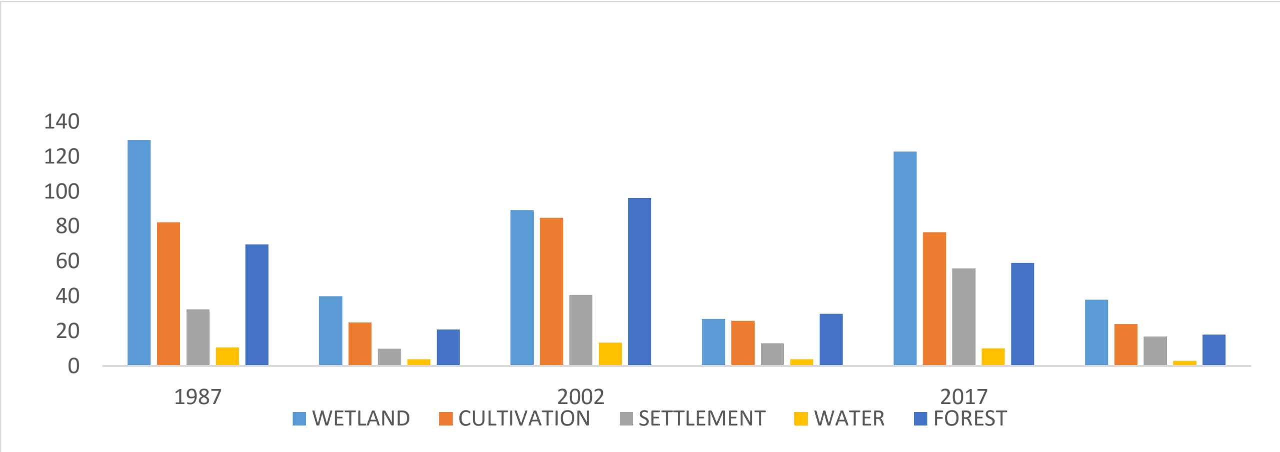


Figure 4.5: Bar Chart of Land Use Land Cover Category Changes in the Study Area

From the Table 4.2 and Figure 4.2, in 1987 wetland cover a total area of 129.58 Sq Km (40%), cultivation cover a total area of 82.44 Sq Km (25%), settlement cover a total area of 32.54 Sq Km (10%), water cover a total area of 11.61 Sq Km (4%) and forest cover a total area of 69.67 Sq Km (21%) respectively.

In 2002,wetland cover a total area of 89.39 Sq Km (28%), cultivation cover a total area of 84.86Sq Km (26%), settlement cover a total area of 39.81 Sq Km (12%), water cover a total area of13.45 Sq Km (4%) and forest cover a total area of 96.29Sq Km (30%) respectively.

In 2017,wetland cover a total area of122.89 Sq Km (38%), cultivation cover a total area of76.67 Sq Km (24%), settlement cover a total area of56.05 Sq Km (17%), water cover a total area of 10.05 Sq Km (3%) and forest cover a total area of 59.16 Sq Km (18%) respectively.

Generally, in terms of changes in land use land cover between 1987-2002, wetland had a change rate of -12% and in 2002-2017, it had a change rate of 10%, cultivation had a change rate of 1% in 1987-2002 and -2% in 2002-2017, settlement had change rate of 2% in 1987-2002 and 5% in 2002-2017, water had a total change rate of 0% in 1987-2002 and -1% change rate in 2002-2017 while forest in 1987-2002 had a total change rate of 9% and in 2002-2017 a change rate of 12% .

4.4 Land Use Prediction For 2037

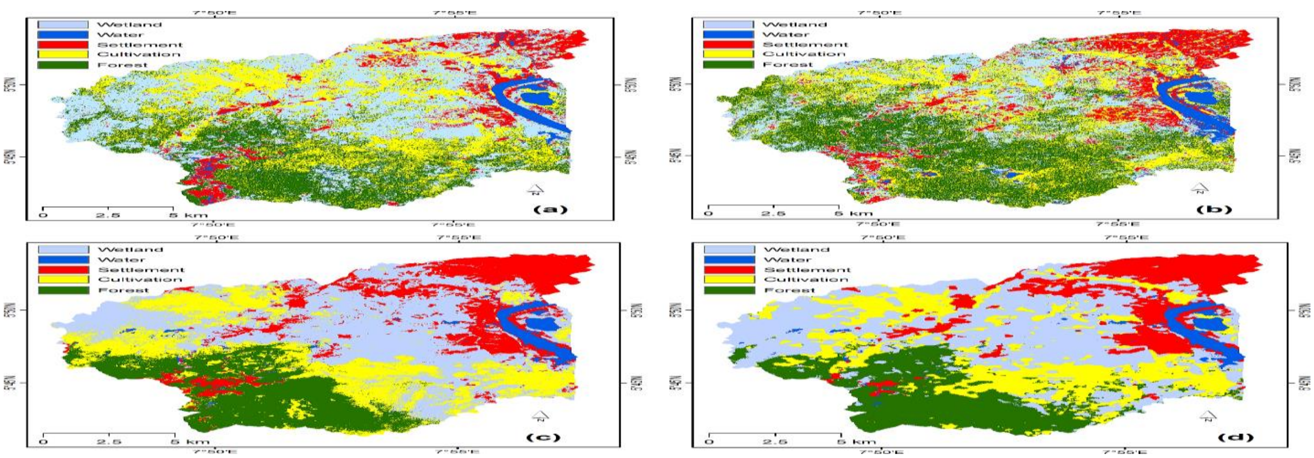
In this study the researcher when further to predict the status and trends of land use change in Iyieke and Ehuoma wetlands ecosystem resources for household food supply and urban planning in Afikpo north LGA of Ebonyi state n South East Nigeria for year 2037. The combination of Cellular automata and Markov chain was applied to produce future land use classification map of the study area (Figure.4.4.1). The result reveals that wetland and cultivation classes have the highest probability of land use change compared to other land use types in the period of 1987-2002 (Table 4.4.1) and (Figure.4.4.1). Moreover, it is predicted that settlement and water will reduce by 10%and 3% respectively during this period. Forest areas will still decrease to approximately 21% and water will increase by 3%.The trend of land use change from 1987-2037 is depicted in Figure.4.4.1 below.

otuntamaiyanga@yahoo.com

Table.4.4.1: Land Use Prediction Iyieke and Ehuoma wetlands ecosystem resources for household food supply and urban planning of Afikpo1987-2037

Land Use Land Cover Class	1987-2002		2002-2017		2017-2037		2037	
	Area Sq Km	Area (%)	Area Sq Km	Area (%)	Area Sq Km	Area (%)	Area Sq Km	Area (%)
Wetland	40.18	39.89	-33.49	-10.311	-0.13	-0.034	123.029	38
Cultivation	-2.42	28.38	8.18	2.52	1.60	0.49	75.07	23
Settlement	-8.29	10.018	-15.21	-4.68	4.923	1.52	51.13	16
Water	2.85	3.27	3.40	1.05	-0.81	-0.23	10.86	3
Forest	26.62	21.45	37.12	11.43	-5.59	-1.72	64.76	20

1987 **2002**



2017 **2037**

Fig.4.4.1: Prediction Map of Iyieke and Ehuoma wetlands ecosystem resources for household food security in Afikpo for (a)1987 (b)2002 (c) 2017 and (d)-2037

otuntamaiyanga@yahoo.com

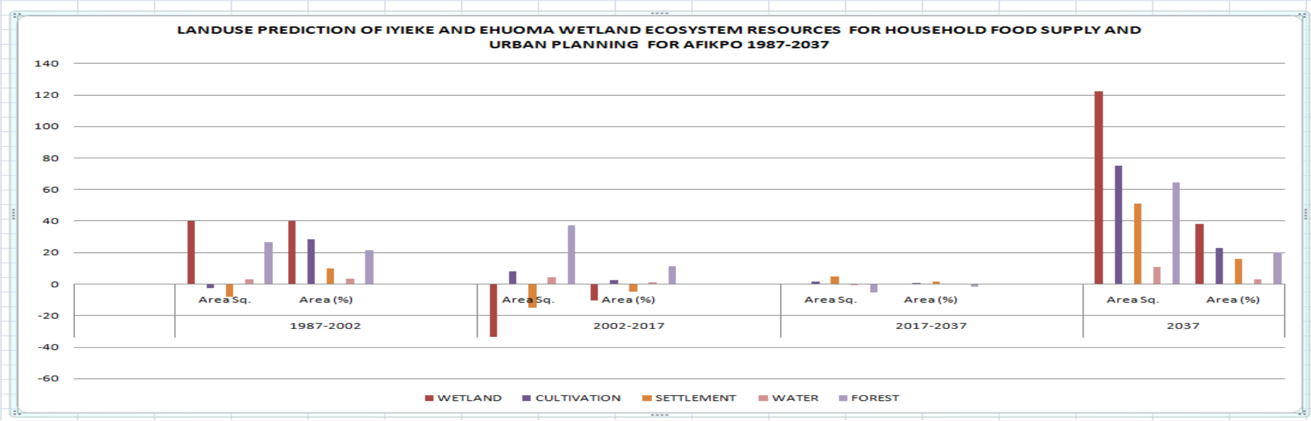


Fig.4.7: Bar Chart of the Prediction of Land Use Changes of Iyieke and Ehuoma wetlands ecosystem resources for household food security in Afikpo 1987-2017.

The trend of change in 2002-2017 indicates that wetland and settlement class categories shall drastically change by -10% and -5% respectively while forest, cultivation and water will increase by 11%, 3% and 1% respectively.

The trend of change in 2017-2037 indicates that cultivation and settlement will increase by 0.49% and 1.52% respectively while wetland, water and forest will drastically reduce by -0.04%, -0.25% and -1.72% respectively.

The trend of change in 2037 proper indicates that a general growth performance of all the land use land cover classes as against their trend in 2017-2037.It is highly predicted that wetland class category will increase by 38% against its reduction by in 2017-2037 by -0.04%,cultivation class category by 23% against its reduction in 2017-2037 by 0.49%, settlement class category by 16% against its increase in 2017-2037 by1.52%,water class category by 3% against its increase in 2017-2037 by 0.25% and forest class category by 20% against its reduction rate in 2017-2037 by -1.72%.

4.5 Analysis

The geospatial study of the impact of Iyieke and Ehuoma wetland ecosystem resources for household supply in Afikpo north LGA indicate that the LULC is so dynamic in nature suggesting further that,

.From the Table and Figure 4.2, in 1987 wetland cover a total area of 129.58 Sq Km (40%), cultivation cover a total area of 82.44 Sq Km (25%), settlement cover a total area of 32.54 Sq Km (10%), water cover a total area of 11.61 Sq Km (4%) and forest cover a total area of 69.67 Sq Km (21%) respectively.

In 2002,wetland cover a total area of 89.39 Sq Km (28%), cultivation cover a total area of 84.86Sq Km (26%), settlement cover a total area of 39.81 Sq Km (12%), water cover a total area of13.45 Sq Km (4%) and forest cover a total area of 96.29Sq Km (30%) respectively.

In 2017,wetland cover a total area of122.89 Sq Km (38%), cultivation cover a total area of76.67 Sq Km (24%), settlement cover a total area of56.05 Sq Km (17%), water cover a total area of 10.05 Sq Km (3%) and forest cover a total area of 59.16 Sq Km (18%) respectively.

Generally, in terms of changes in land use land cover between 1987-2002, wetland had a change rate of -12% and in 2002-2017, it had a change rate of 10%, cultivation had a change rate of 1% in 1987-2002 and -2% in 2002-2017, settlement had change rate of 2% in 1987-2002 and 5% in 2002-2017, water had a total change rate of 0%

in 1987-2002 and -1% change rate in 2002-2017 while forest in 1987-2002 had a total change rate of 9% and in 2002-2017 a change rate of 12% .

The status of Iyieke and Ehuoma wetland ecosystem resources for household food security is highly dynamic and performance of food productivity is highly dependent on farm inputs energizing food crops growths and yields.

4.2 Iyieke And Ehuoma Wetland Ecosystem Resources For Household Food Security In Afikpo North L.G.A Ebonyi State

4.2.1. Production of Food Crops

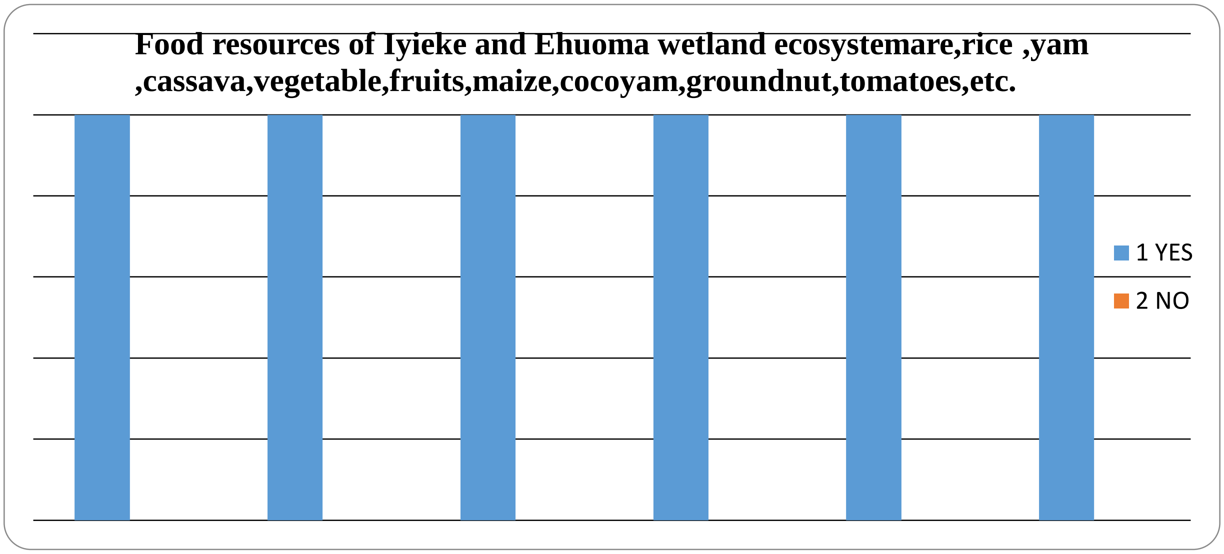


Fig.4.2.1: Column chart of respondents on the food crop resources of Iyieke and Ehuoma wetlands ecosystem for household foodsecurity.

One of the main functions of Iyieke and Ehuoma wetlands ecosystem is provisioning service which include, among other things, food production as stipulated above. Confirming this, Dries, (1989); Soerjani, (1992) and Omari,(1993),observed that wetland farming activities are major economic pursuits in and around many wetlands, where crops such as rice, maize, and various vegetables and fruit are cultivated. Seasonally, inundated floodplains are often particularly important farming resources because they frequently have fertile soils, with high clay content (which facilitates water retention in the dry season). Various methods have been developed to maximize the use of these areas throughout the seasons, both during the flood period and especially after it has receded (Adams, 1993; Meinzen-Dick and Bakker, 1999).

4.2.2 Aquatic Food Resources of Iyieke And Ehuoma Wetland Ecosystem

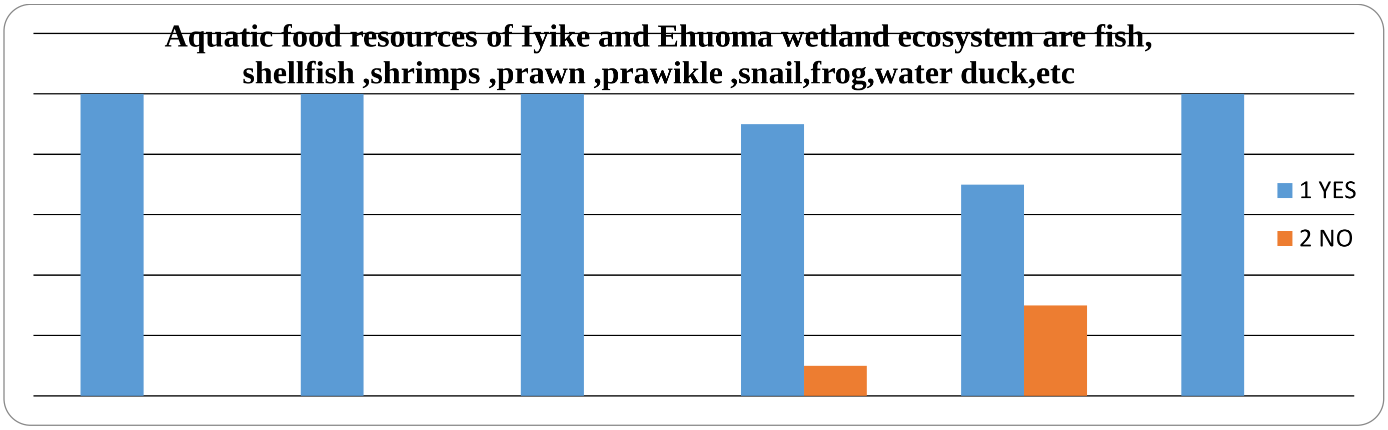


Fig 4.2.2: Column chart of respondents on the food crop resources of Iyieke and Ehuoma wetlands ecosystem for household food supply

In terms of spawning habitats for fish, Iyieke and Ehuoma wetlands ecosystem contribute immensely to economic livelihood of Afikpo north L.G.A. Iyieke and Ehuoma wetlands ecosystem do not only serve as breeding grounds for fish whose habitat is shallow waters, but were also mentioned as important spawning areas for fish that live in deep open water. During interview, field observation and focus group discussions, fish was observed as a key source of less expensive animal protein, compared to chicken, beef, and goat meat breed in the wetlands. Above all, those sampled population who disagree with the fact that Iyieke and Ehuoma wetlands ecosystem provides the above mentioned food crops may have full knowledge of resources potential of the wetlands.

4.3.4 : Iyieke and Ehuoma Wetland Ecosystem Game Food Resources

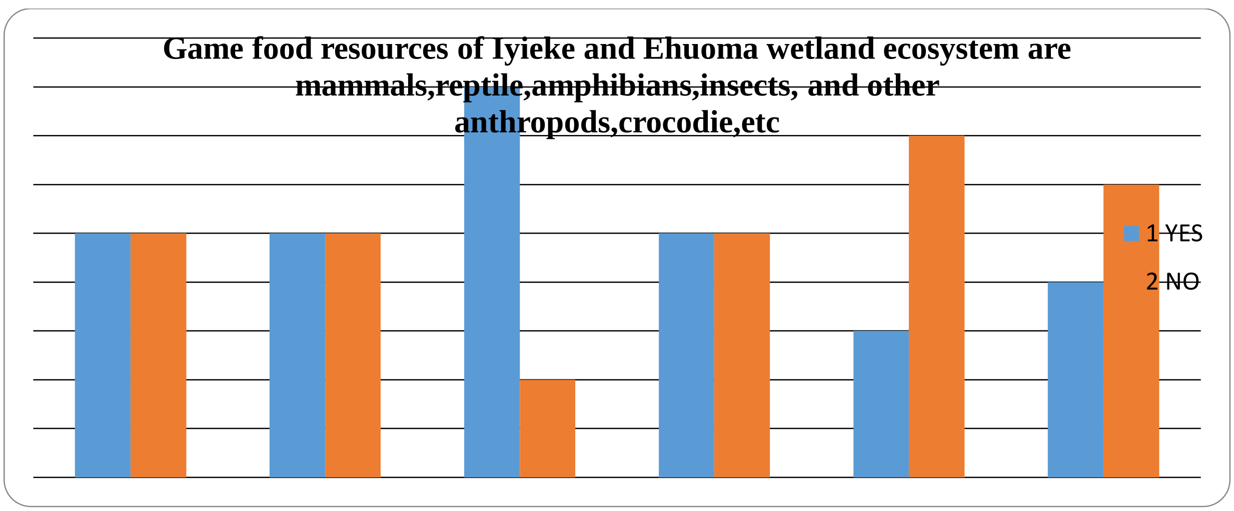


Fig 4.3.4: Column chart of respondents on the game food resources of Iyieke and Ehuoma wetlands ecosystem for household food supply

Those who disagree that lyieke and Ehuoma wetlands ecosystem have game animals available in the ecosystem may have done so as a result of lack of knowledge of what game animals are. They may also not actually be involved in wetland aquaculture and tourism. In many parts of the world, there is a growing recognition of the importance of wetlands as major wildlife habitats, which offer significant potential for household food security in the study area.

In Zimbabwe and Zambia in particular, wetland tourism is being developed as a component of a wider rural development programme in that local communities are given the responsibility of managing wetlands for their food, aesthetic and other benefits (such as game and sport fish). In return, they receive economic and social benefits from tourism (Henkens, 2007, Chabwela, 1992; Sanyanga, 1994; Barbier, Acreman and Knowler, 1997; Duim).

4.4.1 Provision of the Flow and Storage of Fresh Water for the Growth of Plants and Animals

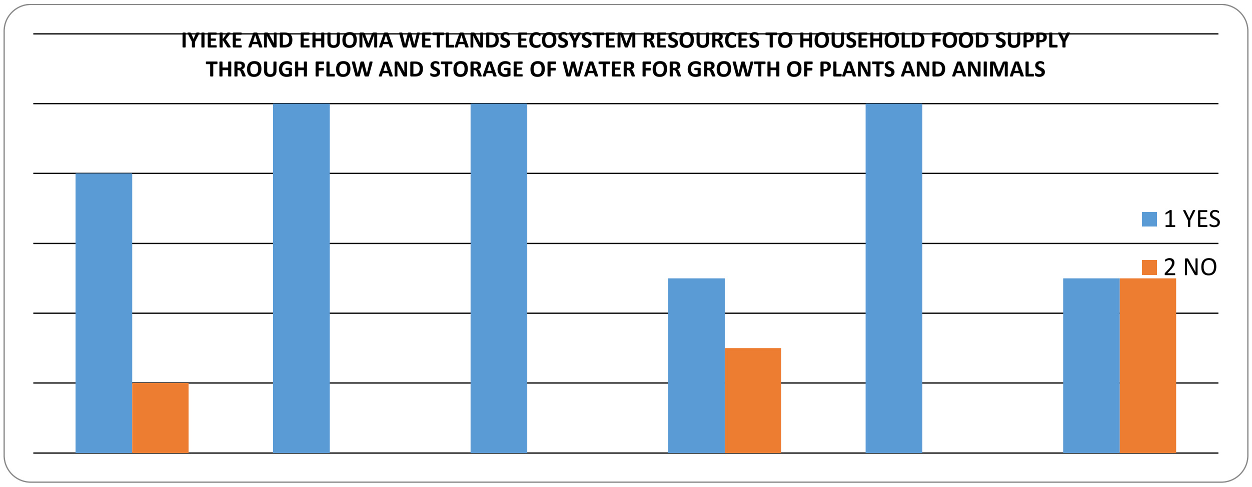


Fig.4.4.1: Columu chart of respondents to contribution to household food supply through the flow and storage of water for growth of plants and animals in Afikpo north L.G.A Ebonyi state.

Agriculturally, Iyieke and Ehuoma wetlands ecosystem resources provides a range of hydrological and ecological benefits including the recharge and discharge of aquifer water for the overall food production and security in Ebonyi state. The majority affirmation of the respondents to the contribution of the flow and storage of freshwater in Iyieke and Ehuoma wetlands ecosystem for food crop production and security is in line with the archaeological work in Central America which indicated that Mayan wetland agriculture dates back 3 000 years (Denevan, 1982). Similarly, in Southeast Asia and the Pacific, staple crops that are adapted to freshwater wetland conditions have been cultivated and consumed for thousands of years (Bayliss-Smith and Golson, 1992), while more than half of the world's population was supported by rice (CA, 2007). Wetlands of different types (from rivers to coastal lagoons) also provide important areas for various types of fishing or fish culture. Agriculture in the montane bogs of the Andes was reported to have supported food production for 25 million people prior to the arrival of Europeans (Zimmerer, 1991). In Africa, agriculture has long been practiced on the floodplains of major rivers, such as the Niger, Zambezi and Nile, and in other types of wetland such as dambos and bas-fonds or inland valley bottoms (Marie, 2000).

otuntamaiyanga@yahoo.com

4.4.2 : Creating of Buffers Against Natural Disaster Affecting Food Crop Growth and Yield

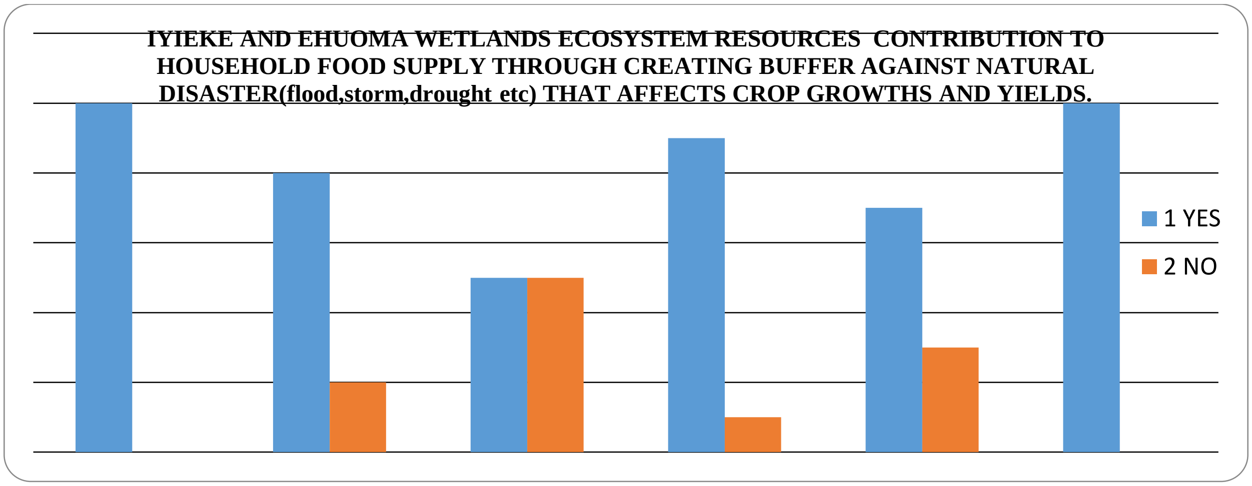


Fig.4.4.2: Columu chart of respondents to Iyieke and Ehuoma wetlands ecosystem resources contribution to household food security through the flow and storage of water for growth of plants and animals in Afikpo north L.G.A Ebonyi state.

Farmers in Afikpo are aware that natural disasters such as flood, storm and draught are very dangerous to crops and aquaculture productivity. In fact, no planting seasons goes without flooding, storm and drought in various parts of the country with serious damage to wetland agriculture. Naturally, wetlands act as a buffer against flooding by accumulating excess waters from rivers, lakes etc. Justifying the positive response of the sampled respondents, Maltby, (1986). States that, wetlands are able to mitigate floods by storing potential floodwaters, reducing floodwater peaks, and ensuring that the floodwaters from tributaries do not all reach the main river at the same time. During the dry season, subsurface flow from wetlands may replenish stream flow. However, there is increased evidence that wetlands vary considerably in their capacity for water storage and for dry-season flow maintenance and that these capacities are dynamic during the seasons and with rainfall conditions (Bullock and Acreman, 2003).

4.4.3: Sediments and Nutrient Depositing

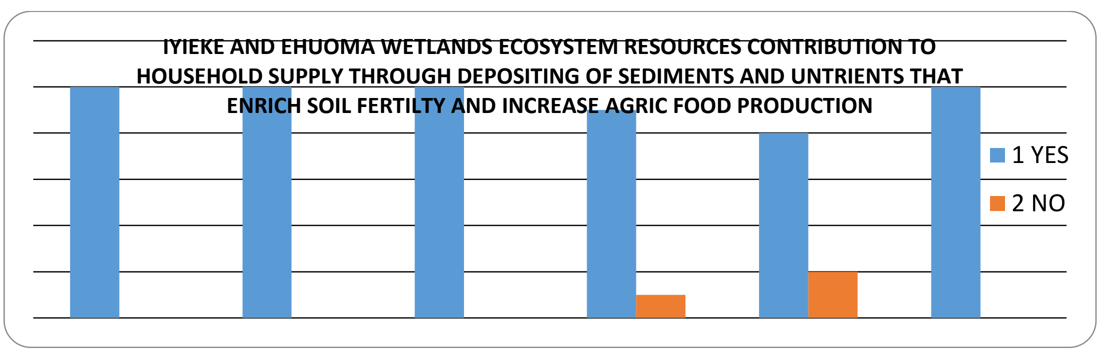


Fig. 4.2.3: Columu chart of respondents to Iyieke and Ehuoma wetlands ecosystem resources contribution to household food supply.

 otuntamaiyanga@yahoo.com

During informants interview, field observation and focus group discussion, it was observed that yields from wetland crop farming were higher, owing to the fertility replenishment of the wetland ecosystem from sediment trapping and gradual settling of silt particles and rotting of organic matter from wetland vegetation. This is an indicator that guided the use of wetland edges for crop farming which immensely contributed to livelihoods of surrounding communities and even provided incentives for their involvement in wetlands conservation.

This is in consonant with Hassan et al, (2005) comment that for many millennia, humans have been cultivating land for food production in the floodplains of Mesopotamia and which was the very cradle of human civilization 6000 years ago. From the early beginning of agricultural activities, floodplains and other riverine wetlands have been recognized as valuable land areas for food and fodder production, because they have fertile soils as a result of regular sediment deposition during flood events.

From the above comment by Hassan et al,(2005), it might be deduced that those 10%(20) and 80%(48) respondents from Akpoha and Ohaisu villages respectively, who rejected sediment deposition and nutrient cycling nature of wetland ecosystem services may not have much knowledge of such services.

4.4.4 : Acting as Mechanizes For Waste Absorption, Treatment of Inorganic Waste

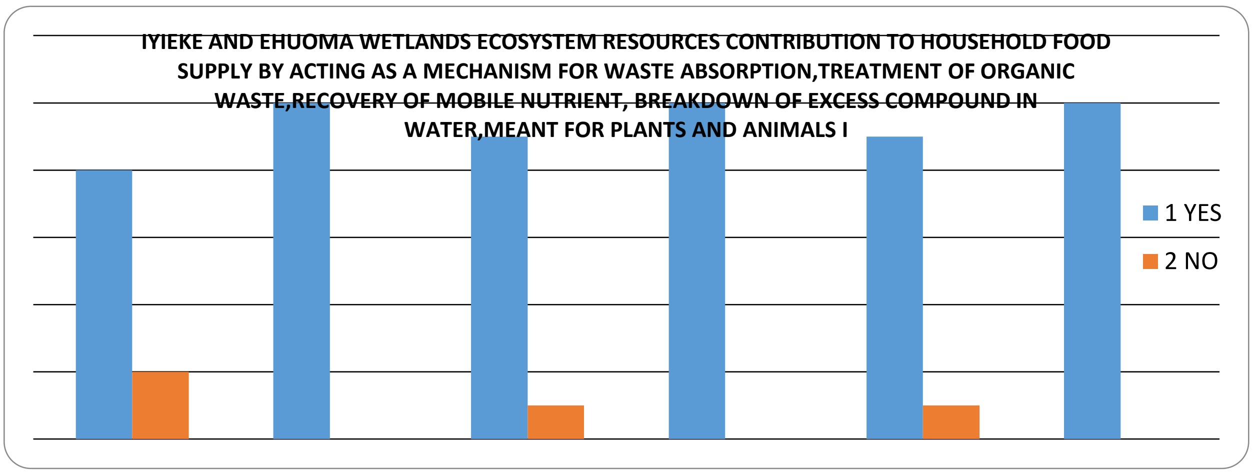


Fig.4.4.4 : Columu chart display of respondents responses to Iyieke and Ehuoma wetlands ecosystem resources contribution to household food supply.

The respondents who agreed that Iyieke and Ehuoma wetlands ecosystem resources to households food security in Afikpo north local government area of ebonyi state may have done so in line with the following reasons, the so-called 'urban heat island effect' consists of local rises in the temperature of city areas caused by greenhouse gas emission from heating and traffic in combination with heat absorption by built surfaces (Moreno García, 1994). Urban blue and green space regulates local temperatures (Hardin and Jensen, 2007). Water areas absorb heat in summer time and release it in winter (Chaparro and Terradas, 2009) and vegetation absorbs heat from the air through evapotranspiration, particularly when humidity is low (Hardin and Jensen, 2007). Urban trees moderate local temperatures by providing humidity and shade (Bolund and Hunhammar, 1999).

In the area of waste treatment, ecosystems filter out, retain and decompose nutrients and organic wastes from urban effluents through dilution, assimilation and chemical re-composition (TEEB, The Economics of Ecosystems and Biodiversity, 2011). Ponds, for example, filter wastes from human activities reducing the level of pollution in urban waste water (Karathanasis et al., 2003), and urban streams retain and fix nutrients from organic waste. Plant

otuntamaiyanga@yahoo.com

communities in urban soils can play an important role in the decomposition of many labile and recalcitrant litter types (Vauramo and Setälä, 2011).

These ecosystem services help immensely to protect agricultural crops, animals and fisheries from dangers climate change and effects water pollution on agricultural productivity.

However, 10%(6) of sampled respondents in Ohaisu may have rejected these ecosystem services of Iyieke and Ehuoma wetlands ecosystem services out the technical nature of the subject matter.

4.4.6 Through Crop Pollination

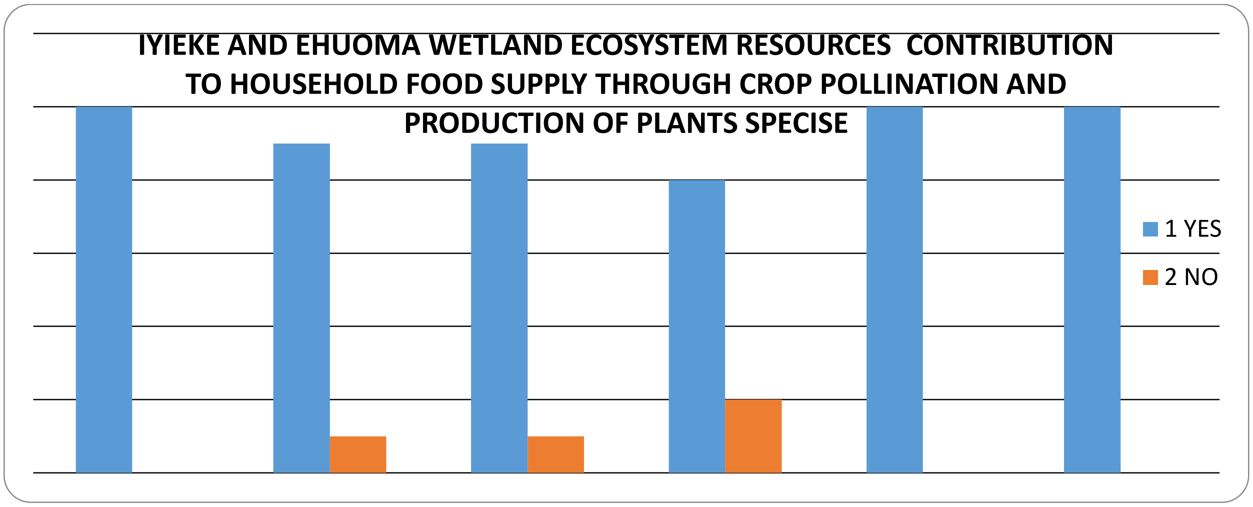


Fig.4.4.6:Column chart display of respondents responses to Iyieke and Ehuoma wetlands ecosystem resources contribution to household food security through crop pollination.

During informants' interview, field observation and focus group discussion, it was observed that Iyieke and Ehuoma wetlands ecosystem is habitat to many diverse biodiversity groups. And that both food and cash crops agriculture highly depend on crop pollination for increase in crop yield and food productivity. For example, fruits and vegetables production in the area are made possible through crop pollination.

Thus, the respondents response confirms to the observations of McKinney, (2008) and Muller et al., (2010), that urban ecosystems are heterogeneous patchy mosaics of habitats where biodiversity in specific taxonomic groups can be surprisingly high. For example, ecosystem host important populations of birds (Melles et al., 2003), and bees (Saure, 1996; Tommasi et al., 2004), thereby maintaining processes of pollination and seed dispersal. According to Andersson et al.(2007), research has shown that management practices of biodiversity in allotment gardens, cemeteries, and parks promote functional groups of insects and birds, also enhancing pollination and seed dispersal.

4.4.8: Through Provision of Fresh Water Habitat for Fishes, Shrimps, Prawn Etc.

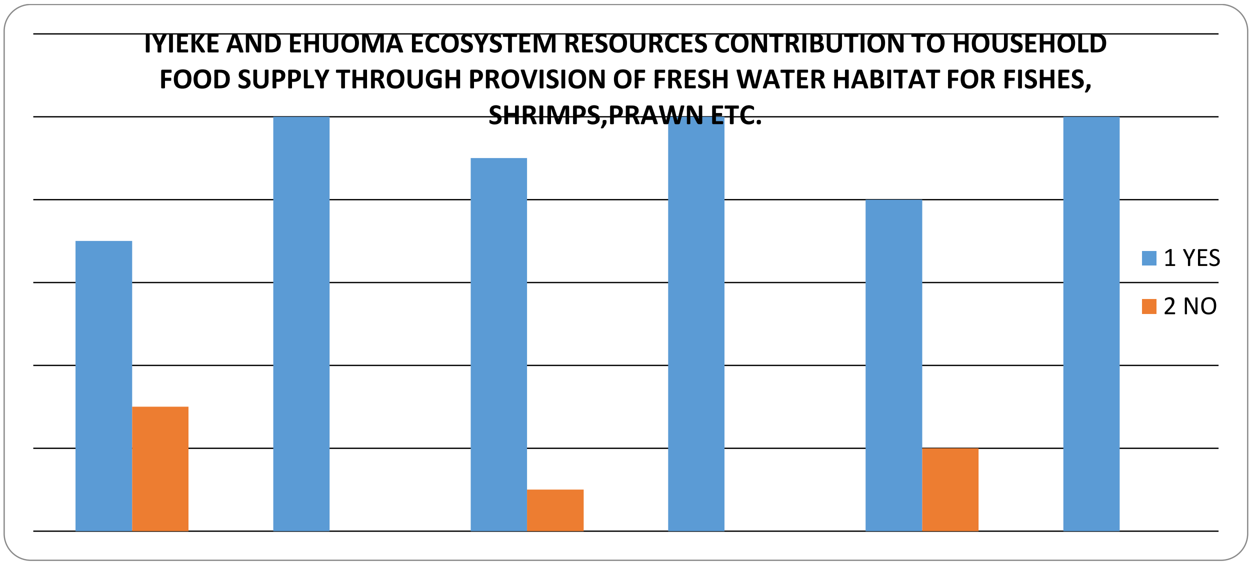


Fig.4.4.8: Columu chart respondents to household food supply through provision of fresh water habitat for fishes, shrimps, prawn etc in Afikpo north L.G.A.ebonyi state.

Affirming to the acceptance of the entire respondents above, Hassan et al (2005) state that wetland ecosystem services often provided by wetlands include storm water detention, flood protection, water quality enhancement, freshwater fisheries, food chain support, feeding grounds for juvenile marine fish, biodiversity, carbon storage and climate regulation.

4.4.9: Livestock Fodder for Animal Grazing

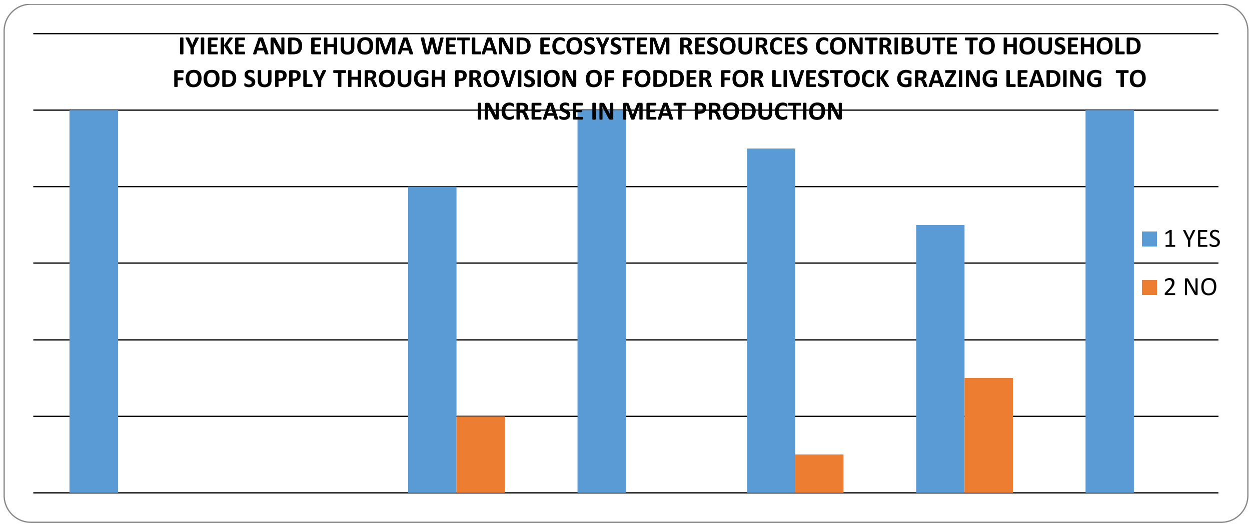


Fig.4.4.9: Columu chart display of respondents' responses to Iyieke and Ehuoma wetland resources contribution to household food security in Afikpo north L.G.A Ebonyi state**.**

During the informants' interview, field observation and focus group discussion, it was observed that Iyieke and Ehuoma wetland ecosystem were also valued for provision of fodder, especially during the dry periods, when alternative pastures were not readily available. Pastures from wetlands not only provided fodder but also enhanced milk production, thus contributing to household food supply. The importance of wetlands is also more significant due to the fact that alternative livestock feed is expensive and may not be easily affordable by most farmers in Afikpo nonyi state. L.G.A of ebonyi state. This is more significant with the current challenges of climate change and unpredicted weather conditions (Orindi et al, 2005). However, most wetlands suffer from overgrazing. Overgrazing harm wetlands through soil compaction, removal of vegetation, and river bank or lake shore destabilization (Jansen et al, 2001). These changes in turn affect wetlands' filtering capacity, flood control capabilities, water recharge, and wildlife habitat. Other studies have identified the direct effects of livestock grazing to include the consumption of

Conclusion

This study has actually demonstrated the power of geospatial tool in the evaluation of impact of Iyieke and Ehuoma wetland ecosystem resources on household food security in Afikpo north L.G.A Ebonyi state South Eastern Nigeria.With the overall Accuracy Assessment and Kappa Coefficient(K) of image classification of 1987 LandSat 5TM(80.07% and 0.74), 2002 7ETM+(66.78% and 0.58) and 2017 LandSat 8 OLI/TIRS(98.04% and 0.79) respectively, the status of Iyieke and Ehuoma wetland ecosystem resources for household food security was determined to be dynamic (Table 4.1). In keeping with the basic component of food security: availability, accessibility,Utilization and stability. Above all, from the respondents' responses, Iyieke and Ehuoma wetland ecosystem resources can contribute immensely to household food security through provisioning services.

Recommendation

Governments should introduce and train farmers in precision agriculture and the use of geospatial tools in agriculture research to ensure global food security at grassroots.

Reference

Adams, W.M. 1993. Indigenous use of wetlands and sustainable development in West Africa. Geog. J., 159(2): 209–218

Asibor, G. 2009. Wetlands: Values, Uses and Challenges. A Paper Presented to the Nigerian Environmental Society at the Petroleum Training Institute, Effurun, 21st November, 2009.Bardley J .C and Hauer F.R .2007. Effects of Hydrologic Connectivity on Water Chemistry, Soils, and Vegetation Structure and Function in an Inter-montane Deprssional Wetland Landscape.Wetlands**27**,719-738.

Bayliss-Smith, T. and Golson, J. 1992. Wetland agriculture in New Guinea highlands In B. Coles, ed.The wetland revolution in prehistory, pp. 15–27. Exeter, . The Prehistoric Society and WARP, University of Exeter,UK.

Ramsar Convention Secretariat.2007. Managing ground water: Guideline for the management of ground water to maintain wetland ecological character. Ramsar handbooks for the wise use of wetlands, 3rd edition, vol.9.Ramsar Convention Secretariat,Gland, Switzerland.

Oyebande, L.; Obot, E. O. and Bdiliya, H. H. 2003. An Inventory of Wetlands in Nigeria,Report Prepared for World Conservation Union-IUCN, West African Regional Office, Quagadougou, Burkina Faso.

Dries, I. 1989. Development of wetlands in Sierra Leone: farmers' rationality opposed to government policy. In M. Marchand & H.A. Udo, eds. The people's role in wetland management, Proceedings of the International Conference in Leiden, The Netherlands, June 5–8 1989, pp. 833–843. Leiden, Netherlands, Centre for Environmental Studies, Leiden University.

Denevan, W.M. 1982. Hydraulic agriculture in the American tropics: forms, measures and recent research. In K.V. Flannery, ed. Maya subsistence. pp. 181–204. . . . London, Academic Press.

McKinney, M.L., 2008. Effects of urbanization on species richness: a review of plants and animals. Urban Ecosystems 11, 161–176.

V. A. Orindi and S. Eriksen, 2005: Mainstreaming Adaptation to Climate Change in the Development Process in Uganda, 15, African Centre for Technology Studies (ACTS) Eco-policy, 2005.

Hassan R, Scholes R and Ash N.2005: Ecosystems and human well-being. Current state and trends Washington, DC: Island Press; 2005.

Maltby E. 1986.Waterlogged wealth. London: Earthscan; 1986.

Bremner, J. (2012) Population and Food Security: Africs's Challenges. The Population Reference Bureau, Washington DC.

Odigi MI (2010). Organic Geochemical evaluation of oil/gas generative potential of organic matter in Cretaceous strata from the Lower Benue Trough, Nigeria.Chinese Journal of Geochemistry 29(3):240- 256.

Marie, J. 2000. Delmasig: hommes, milieux, enjeux spatiaux et fonciers dan le delta interieur du Niger (Mali).Paris, HDR, Univ. Paris –X.

(MA). 2005b. Ecosystems and human well-being: wetlands and water synthesis.Washington

, DC, World Resources Institute

Zimmerer, K.S. 1991. Wetland production and smallholder persistence: agricultural change. in a highland Peruvian region. Ann. Assoc. Amer. Geog.,81(3): 443–463

Andersson, E., Barthel, S., Ahrné, K., 2007. Measuring social-ecological dynamics behind the generation of ecosystem services. Ecological Applications 17, 1267–1278

TEEB (The Economics of Ecosystems and Biodiversity), 2011. Manual for Cities: Ecosystem Services in Urban Management. UNEP and the European Commission.

TEEB (The Economics of Ecosystems and Biodiversity), 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, London

 otuntamaiyanga@yahoo.com