



Ecological Evaluation of Natural Resources: A Baseline Study of Sustainable Livelihood Capital in Parts of Ilaje Riparian Community, Ondo State, Nigeria

O. O. Gbayisemore^a, N. L. Edwin-Wosu^{b*} and L. C. Osuji^c

^a Knowledge Centre, Diamond Plaza, Opposite Elimbu Primary School, Tank–Eneka Road, Port Harcourt, Nigeria.

^b Department of Plant Science and Biotechnology, Faculty of Science, University of Port Harcourt, Choba, P.M.B. 5323, Rivers State, Nigeria.

^c Institute of Natural Resources, Environment & Sustainable Development (INRES), Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Authors OOG and NLEW designed the study, wrote the protocol and went to the field for sampling. Author OOG wrote the first draft of the manuscript. Authors NLEW and LCO managed the analyses of the study as well as managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJEE/2022/v19i4420

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/93825>

Original Research Article

Received: 25/09/2022

Accepted: 28/11/2022

Published: 03/12/2022

ABSTRACT

Aim: This study was aimed at evaluating the Ilaje coastal biodiversity scenarios and sustainable livelihood opportunities.

Study Design: A Participatory Rapid Appraisal and purposive random sampling technique were adapted.

*Corresponding author: E-mail: nsirim.edwin-wosu@uniport.edu.ng;

Place and Duration of Study: Field sampling: Parts of Ilaje littoral community in Ondo State, Nigeria, between September 2020 and October 2021.

Methodology: Data analyses by descriptive analytical tools and Likert-Type scale 7 point and 5 point levels of agreements.

Result: Result of the natural resources biodiversity has recorded 20 representative flora diversity under 12 families across sampled communities, diverse representative fauna in Odonla (28), Ikorigho (14), Molutehin (10), Odun-Igo (8) and Awoye (3). The biodiversity composition has indicated Fishes as the highest resource among others particularly in Awoye with the highest percentage, while the highest mangrove livelihood of 50% for housing in Molutehin which also recorded with Awoye a highest (44%) alternative income source in trading among other communities.

Conclusion: this study was significant while providing a better understanding of the biodiversity scenarios and sustainable livelihoods associated with the Ilaje riparian community and their ecosystem interaction.

Keywords: Biodiversity; flora; fauna; income; assets.

1. INTRODUCTION

Ondo State is among the well-endowed resourceful ecological zones housing the Ilaje community in part of the littoral zones in Nigeria at the lower gulf of Guinea. Livelihood in the Ilaje coastal ecosystem is not so much different from other coastal area. Several school of taught both at the local and international community have made efforts in conceptualizing this terminology with all having similar focus to a common goal of achieving a sustainable social development. A livelihood entails capabilities, assets and activities required for a means of living. In other words livelihood comprises the capabilities, assets (natural, physical, human, financial and social capital) the activities and the access to these that jointly determine the living gained by the individual or rural household" [1,2]. It can also be viewed to involve the capacities, goods such as capital and social, and the activities needed to live [3]. A livelihood by Krantz [4] constitute adequate stocks and flows of food and cash to meet basic needs of life and it comprises people, their capabilities (stores, resources, claims and access) and activities required for a means of living including income and assets which can be tangible (physical resources) or intangible (claims and access) assets.

"Livelihood is sustainable when it is resilience, recover from and cope with any form of stress and shocks while maintaining or enhancing its capabilities and assets without compromising the future, if it can provide opportunities for the next generation, which contributes net benefits to other livelihood at the local as well as global levels in the short and long term and not undermining the natural resource base" [3-6]. "A

livelihood can be classified as sustainable, if it is independent from external support, if it is able to maintain the long-term productivity of natural resources and if it does not undermine the livelihood options of others" [7]. "Other assertions have divergence bases of what constitute livelihood sustainability: A livelihood is environmentally sustainable when it contributes to the stability of environmental assets and has a sustainable positive net benefit effects on other livelihoods sources" [8]. It has also been explained that livelihood is sustainable when it has the capacity to meet the immediate needs of the people while its ability to meet future needs is not jeopardized [9]. In determining the level of household livelihood sustainability, several factors considered as the principal assets, pillars or capital have been grouped into five categories, viz: natural resources, human, financial, physical and social capitals [10]. These assets contribute or enhance the situation of a family by responding to shocks and stresses as they adjust to overcome them and stay sustainable over a period of time. The natural resource capital consists of resource stocks of biotic and abiotic nature (soil, water, air, genetic resources) used to support livelihood activities of household.

"Sustainable livelihood in relation to coastal environment can be their sustainable utilization of natural resources biodiversity for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem." It can also be defined as: "human use of a wetland so that it may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations" [11]. Several studies have been reported on coastal

ecosystem and its biodiversity scenarios in the light of its' conservation priorities and sustainable livelihood in parts of Niger Delta. This include the; sustainable livelihoods assessment of project in the Nigeria's Niger Delta Communities [12]; delineation of selected site of mangrove and *Nypa* for biodiversity conservation in Rivers State [13,14]; the development of sustainable livelihoods and biodiversity project (SLBP) communities' operational plans in the Niger Delta, Nigeria [15]; assessment and valuation of wetland ecosystem services in the Niger Delta, Nigeria [16] and assessment of wetland degradation and loss of ecosystem services in the Niger Delta, Nigeria [17]. "Others include sustainable livelihoods and biodiversity project (SLBP) in Nigeria's Niger Delta, ecological and socio-economic baseline studies" [18].

The main occupation of Ilaje community is predominantly aquaculture and fishing. However, the inhabitants have other alternative source of income for wages to give them a sustainable livelihood. However, the entire livelihoods in the study location are not sustainable, shocks, trend and seasonality are more or less in every activity. Due to this, their economic condition is at messy. The rationale for this research corroborates part of agreements on the goals of the United Nation Conference on Environment and Development (UNCED) that sustainable livelihoods serve as an integrating factor between the politics of resource management and poverty reduction among sustainable practices for environmental improvement and the pursuit of economic development [19]. To understand the livelihood of this community (study location), DFID framework is being used to explain all the livelihood activity.

This study was aimed at evaluating the Ilaje Coastal biodiversity scenarios and sustainable livelihood opportunities; with the objectives of: i) establishing through ecological field studies and ground truting appropriate data on the existing status of all identifiable and associated livelihood components of the study location and ii) assessing the Ilaje biodiversity ecosystem of the various study sites (Odonla, Ikorigho, Molutehin, Odun-Igo, and Awoye) in Ondo State. The study is significant hence it is expected to provide a better understanding of the biodiversity potential of the Ilaje people in Ondo State, provide data information that can be a baseline for impact prediction and judgment in environmental assessment of any envisaged ecological disaster in the area, widen the knowledge on biodiversity

scenarios, sustainable livelihood and ecological scenarios associated with the interaction between the inhabitant of the area and capital assets of the environment.

2. MATERIALS AND METHODS

2.1 Study Area, Location and Site

The study area is Ondo State with its' capital in Akure; situated between longitudes 4°30" and 6° East of the Greenwich Meridian, 5°45" and 8° 15" North of the Equator (Fig. 1). The state lies entirely in the tropics, bounded in the North by Ekiti, Kwara, and Kogi States; in the East by Edo State; in the West by Oyo, Ogun and Osun States; and in the South by Delta and the Bight of Benin of the Atlantic Ocean. The State among others in Nigeria is characterized by two distinct environmental condition (rainy season, April - November and dry season, December - March) of a tropical climate, associated with an annual maximum temperature range (21°C to 29°C), high relative humidity due to proximity to the high sea, and maximum rainfall range of 2000mm in the southern part to 1150mm in the northern area and decreases in amount and distribution from the coast to the hinterland. The area is characterized by luxuriant with both heterogeneous and homogenous discrete structural formation, composition and stratification of a high forest zone consisting of the mangrove-swamp forest near the Bight of Benin, tropical rain forest in the centre part, and sub- savannah forest comprising the woodland savanna on the gentle slopes of the Yoruba Hills in the northern fringes.

The State is endowed with both human and natural resources involving well blessed resourceful, industrious and hospitable people, who are predominantly Yoruba and Ijaw speaking tribes (the Akoko, Akure, Apoi, Idanre, Ijaw, Ikale, Ilaje, Ondo and the Owo) that cut across 18 local council areas. Beside the prowess as the most educationally advanced State in Nigeria the people are mostly subsistence farmers, fishermen and traders. Their livelihood represents an embodiment of culture, ranging from the local foodstuff to the mode of dressing, dancing, wood crafts, such as carved house post and decorated doors. Natural resources include timber and non-timber forest products and non-forest resources Traditional industries include pottery making, cloth weaving, tailoring, carpentry, and blacksmithing as well as diverse mineral deposits.

“The state with its’ land mass area of 14,788.723 square kilometers comprises 18 local council areas, viz: Akoko north east, Akoko north west, Akoko south east, Akoko south west, Akure north, Akure south, Ese odo, Idanre, Ifedore, Ile-oluji / Okeigbo, Irele, Odigbo, Okitipupa, Ondo east, Ondo west, Ose, Owo and Ilaje - study location (Fig. 2) located in the south western zone of Nigeria. The study location -Ilaje (Fig. 2) with headquarter at Igbokoda occupies the entire southern part of Ondo State, Nigeria. It is bordered in the south by the Atlantic ocean, in the west by Ogun state, east by Ese-odo local council area and delta state and in the north by Okitipupa local council area. Its coastline covers a distance of 82 kilometres making it the local government area with the longest coastline in Nigeria. Ilaje land has an area not less than 1,318 square kilometres, with associated climatic conditions of maximum rainfall and relative humidity due to proximity to the coastal ecology. Edaphic condition is sandy silt and sandy loam soil complex. The area is characterised by riparian vegetation of fresh and marine ecosystem heterogeneous in nature. The study

location is known for its major five kingdoms: Ugbo, Mahin, Etikan, Aheri and Igbotu consisting of over 100 communities including such sampled sites (Fig. 3) as: Odonla, Ikorigho, Molutehin, Odun-Igo and Awoye” [20].

2.2 Field Sampling and Analysis

The field sampling of response by the littoral community and their interaction with the natural resources involved descriptive and explorative approach based on Participatory Rapid Appraisal (PRA) by the use of well-structured questionnaires and personal interviews / discussions, focused group discussions, and key informant interviews to obtain such data as environmental and socioeconomic details of respondents and benefits due to ecosystem services [21,22]. A purposive and random sampling technique was used to determine sampling size for respondents of selected sampled sites (Odonla, Ikorigho, Molutehin, Odun-Igo and Awoye) (Figs. 4 to 8) to administer the questionnaire.

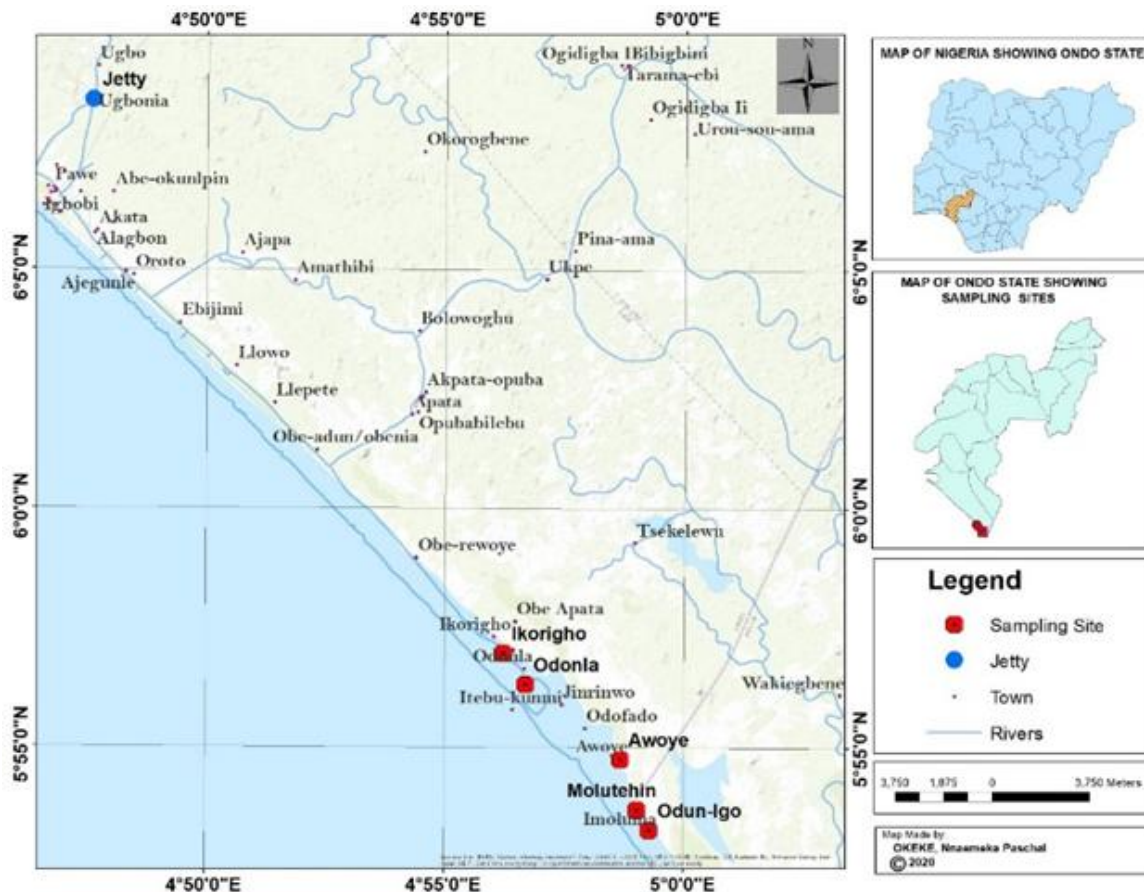


Fig. 1. Nigeria indicating Ondo State (the study areas) [20]

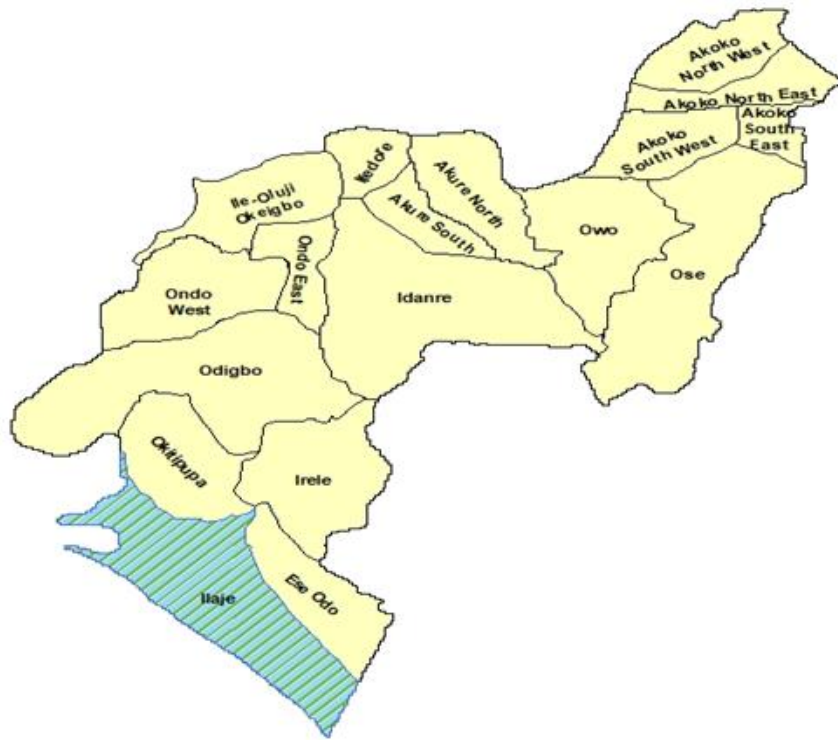


Fig. 2. Ondo State indicating Ilaje – study location [20]

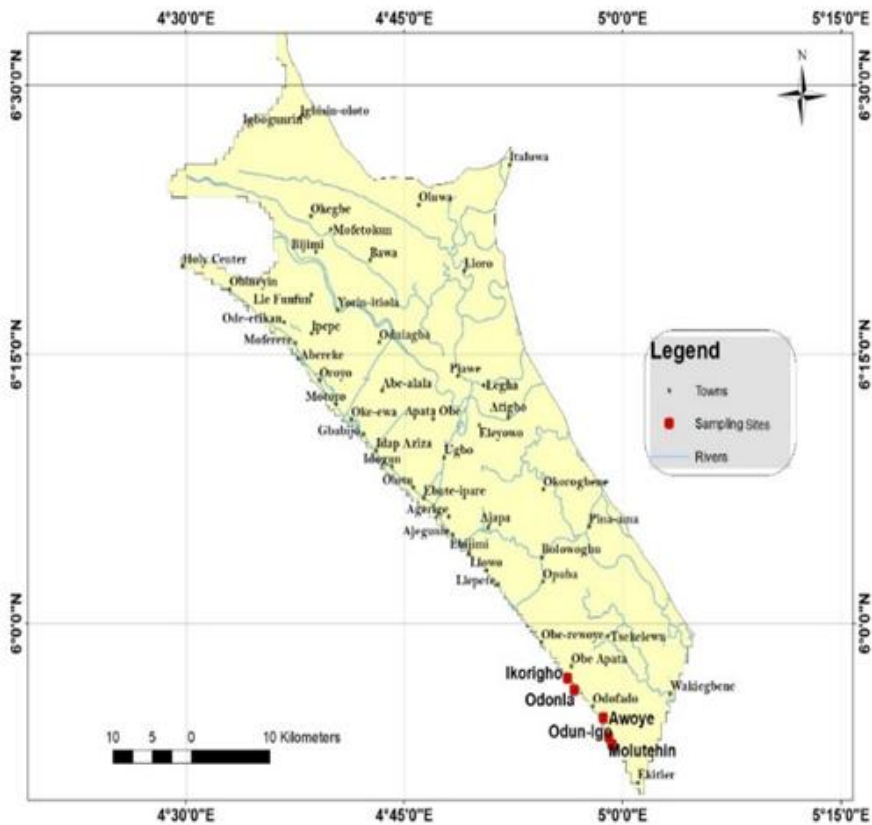


Fig. 3. Ilaje –study location indicating sampled sites [20]

A direct observational and ground-truthing to acquire information on the livelihood natural resource capital assets was adopted to validate the 25 random points (Table 1) of the sampled site using a hand-held Garmin Geographic Positioning System (GPS - *Garmin Dakota 10 mode*) for georeferencing of exact sampled point and imagery production of the sampled sites (Odonla, Ikorigho, Molutehin, Odun-Igo and Awoye) as exemplified in Figs. 4 to 8. The data generated were subjected to descriptive analytical tools such as: frequency count, percentages and charts as adopted in Edet et al. [21] to ascertain the natural resources capital assets of the respondents of the coastal environment at study area.

3. RESULTS

The results of the study on natural resources sustainable livelihood in parts of Ilaje coastal ecosystem are exemplified in Figs. 9-11. The result interpretation of study observations in quantitative presentation of frequency and

percentage composition of natural capital assets has revealed various trends of sustainable livelihood of the ecosystem services of the coastal environment with regards to the economic and biodiversity environmental data of respondent in parts of Ilaje coastal communities.

The natural resources biodiversity has recorded 20 representative flora diversity under 12 families across sampled communities, diverse representative fauna in Odonla (28), Ikorigho (14), Molutehin (10), Odun-Igo (8) and Awoye (3). The frequency composition of biodiversity natural resources of sustainable livelihood across the community has indicated fishes as the highest resource among other resources with 84% status in Odonla, Molutehin and Odun-Igo respectively; 88% in Ikorigho and 92% in Awoye. The least natural resources include: pig, mudskipper, and tortoise respectively with 4% status in Odonla, 4% for snail in Molutehin, and 8% for cray fish and periwinkle respectively in Odun-Igo and Awoye being recorded in Fig. 9.

Table 1. Coordinates of sampled site in parts of Ilaje coastal ecosystem, Ondo State [20]

S/N	Lat. (N)	Long. (E)	Alt.	Community / Sampled site
Igbokoda				
1	06°08.543'	004°47.618'	17ft	Jetty
Odonla				
2	05°56.407'	004°56.768'	9	Jetty
3	05°56.391'	004°56.743'	28	Sampled site
4	05°56.387'	004°56.737'	21	Sampled site
Ikorigho				
5	05°57.042'	004°56.241'	27	Sampled site
6	05°57.035'	004°56.222'	43	Sampled site
Molutehin				
7	05°53.816'	004°59.048'	30	Jetty
8	05°53.802'	004°59.025'	15	Jetty
9	05°53.782'	004°59.034'	15	Jetty
10	05°53.817'	004°59.054'	10	Sampled site
11	05°53.743'	004°59.021'	4	Sampled site
12	05°53.743'	004°59.017'	7	Sampled site
13	05°53.774'	004°59.046'	-15	Sampled site
Odun-Igo				
14	05°53.433'	004°59.231'	7	Jetty
15	05°53.427'	004°59.226'	13	Jetty
16	05°53.404'	004°59.237'	14	Jetty
17	05°53.446'	004°59.250'	14	Jetty
18	05°53.297'	004°59.287'	-1	Sampled site
19	05°53.300'	004°59.287'	4	Sampled site
20	05°53.324'	004°59.288'	15	Sampled site
21	05°53.299'	004°53.302'	24	Sampled site
22	05°53.444'	004°53.189'	59	Sampled site
Awoye				
23	05°54.838'	004°58.766'	9	Sampled site
24	05°54.901'	004°58.737'	4	Sampled site
25	05°54.904'	004°58.693'	12	Sampled site

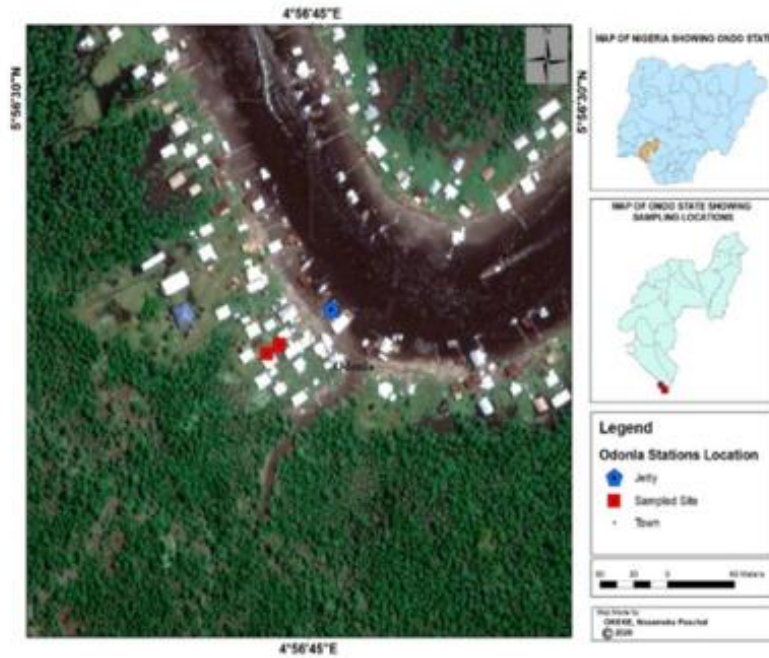


Fig. 4. Imagery of Odonla sampled site at Ilaje study location [20]

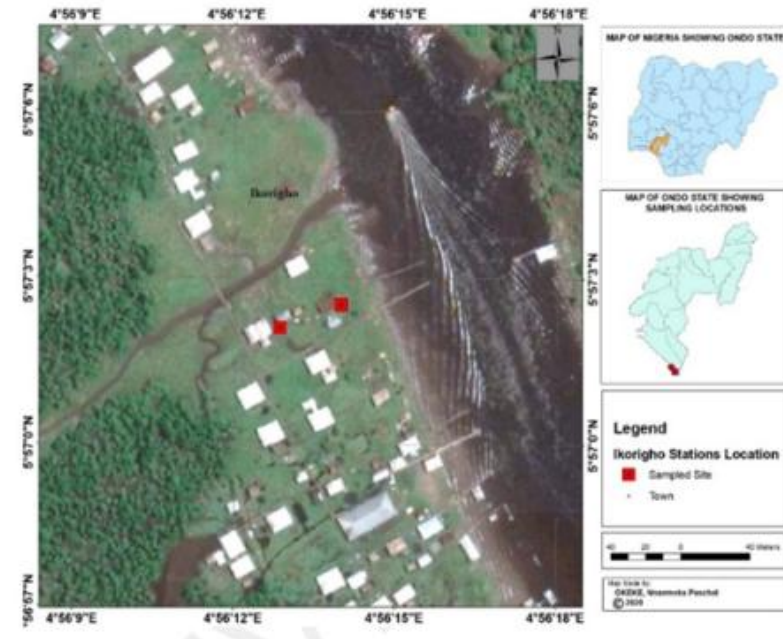


Fig. 5. Imagery of Ikorigho sampled site at Ilaje study [20]

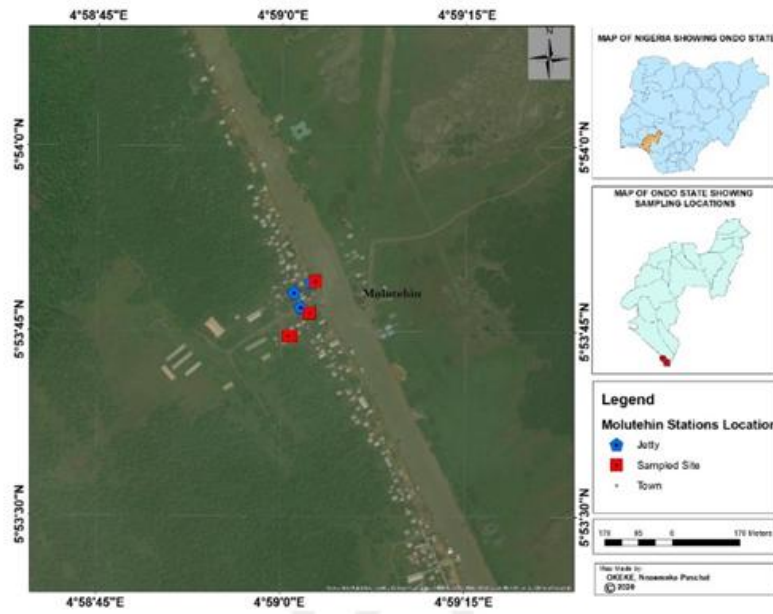


Fig. 6. Imagery of Molutehin sampled site at Ilaje study location [20]

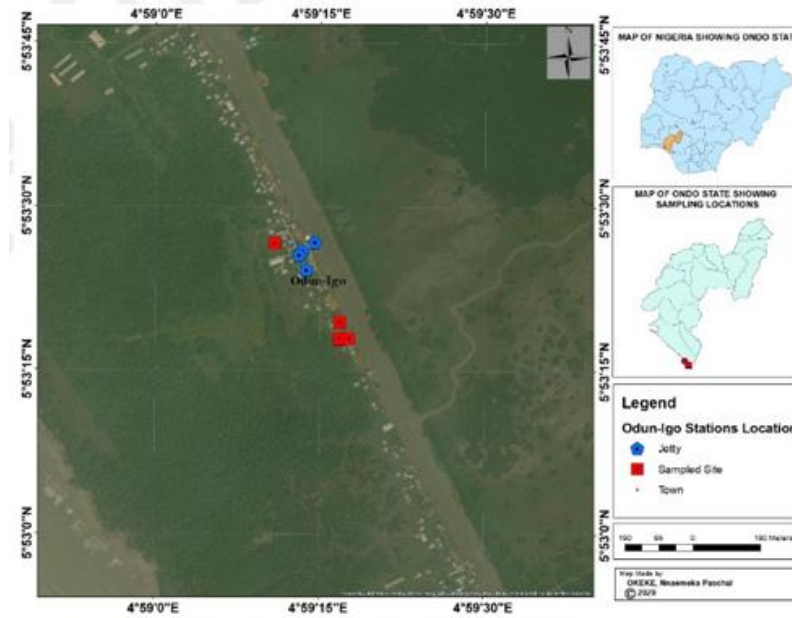


Fig. 7. Imagery of Odun-Igo sampled site at Ilaje study location [20]

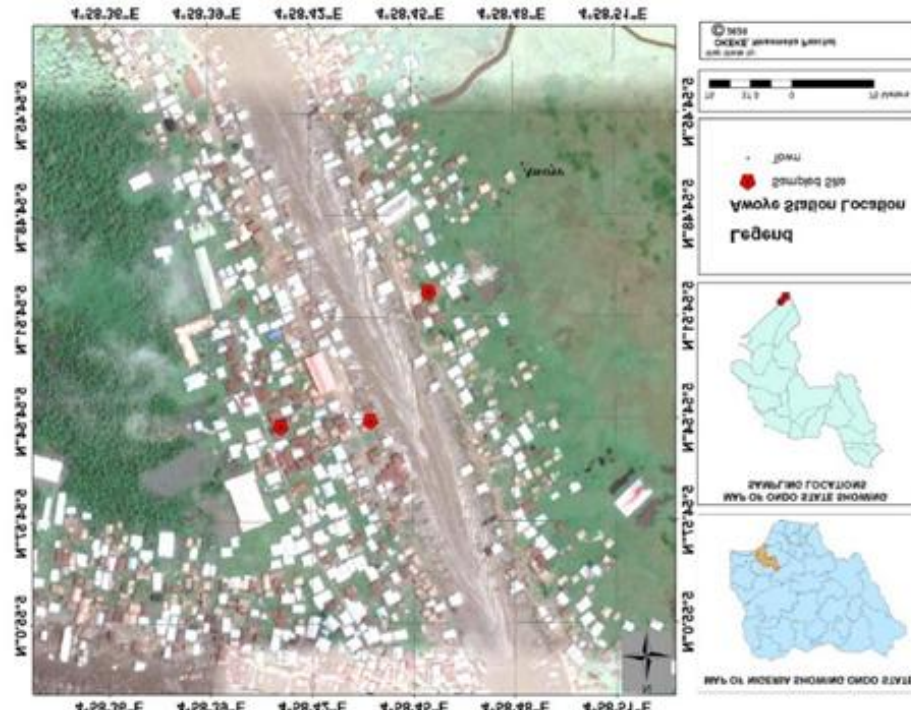


Fig. 8. Imagery of Awoye sampled site at Ilaje study

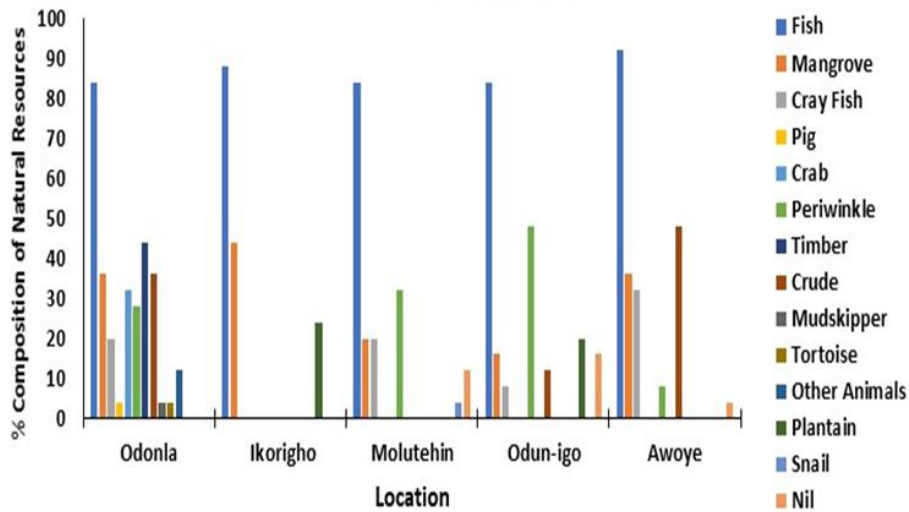


Fig. 9. Frequency composition of biodiversity natural resources in parts of the studied communities in Ilaje

The significance of the mangrove ecosystem services within and among the communities has recorded varying percentage of livelihoods with the highest livelihood of 34% for firewood in Ikorigho, and 24% as herbs in Odonla, and 46%; 50%, 26% and 28% were respectively for housing in Ikorigho, Molutehin, Odun-Igo and Awoye, which also had 30% of the mangrove used as firewood. The least livelihood of mangrove in the various communities were as follows: food and hunting (2%) in Odonla and Awoye, footbridge (8%) in Ikorigho, farming and logging (2%) respectively in Molutehin, while Odun-Igo had farming as the least (4%)

livelihood of the mangrove as exemplified in Fig.10.

A varying trend of alternative income sources of respondents within and among the respective study communities as presented in Fig. 11, has recorded high income of 20% trading in Odonla and 44% trading in Molutehin and Awoye respectively and 36% in Odun-Igo; 44%, 48% and 56% of fishing respectively in Ikorigho, Odun-Igo and Awoye which recorded the highest income from fishing across the communities among the various indices of income source.

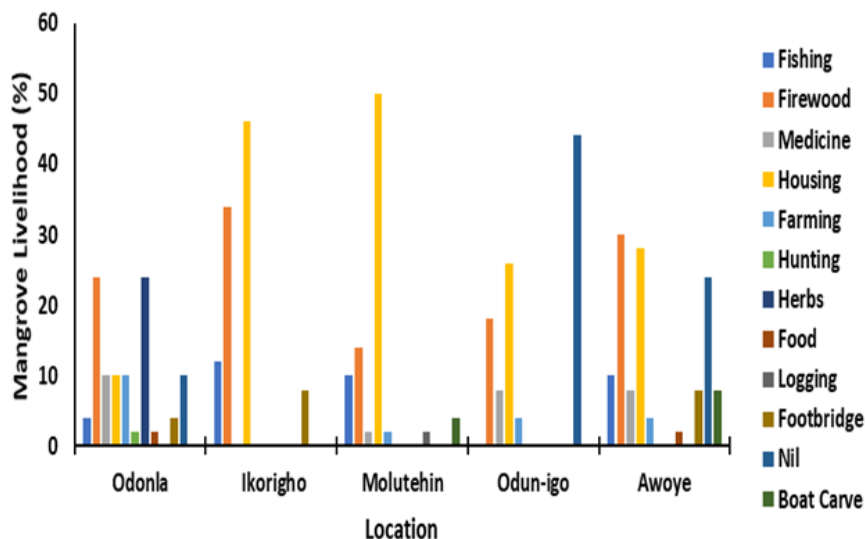


Fig. 10. Livelihoods of the mangrove in the studied communities in Ilaje

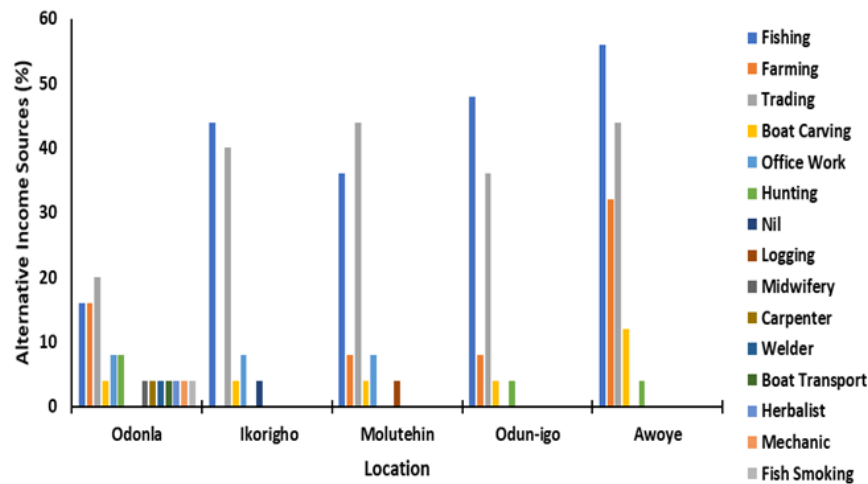


Fig. 11. Alternative sources of income in parts of the studied communities in Ilaje

4. DISCUSSION

This paper provides an example of a cutting-edge, multi-disciplinary research effort that couples natural resources biodiversity scenarios and livelihoods in light of their ecological evaluations. The research is also significant in that it has pioneered sustainable livelihood programme at Ilaje in the field of natural resources capital and management. The present study has reported the general observations and opinions of rural dwellers of Ilaje communities in Ondo State, Nigeria in light of sustainable livelihood natural resources capitals. As exemplified in the Table and Figs., there are diverse trend of natural resources capitals across the various studied communities in Ilaje littoral zone.

The study has also revealed that various natural assets (resources) accessed by the inhabitants of the studied community include: Cray fish, Pig, Crab, Periwinkle, Timber, Crude oil, Mudskipper, Tortoise, Plantain, Snail and other animals in their percentage proportion. However, the greater percentage of the accessed natural assets by the inhabitants was Fishes and Mangroves. Besides, there was greater percentage of natural resources across the various communities but this was in variance among the communities with Awoye (92%) recording the highest percentage of fishery activities, followed by Ikorigho (88%), then Odonla, Molutehin and Odun-Igo with 84% respectively, while Odonla had the highest percentage (28%) and Ikorigho (14%) of fauna. The findings imply that most of the coastal

inhabitants are rural dwellers and have access to natural assets for their sustainable livelihood. This corroborates the assertion that such natural assets can be used for productive purposes to support livelihood activities [2,23]. "This also suggests that households would survive with the help of key environmental resources and services as well as food produced from natural capital" [21]. "Related study has revealed that fisheries-related activities provide important sources of livelihoods for nearly 7 million people in India" [24]. "A large percentage of rural dwellers are involved in artisanal, small-scale fishing operations in open water bodies including the sea, rivers and creeks, as well as in fish trading, processing and related activities" [25]. "The Ninth Five-Year Plan of the Government of Orissa recognizes the crucial role that the fisheries sector has played in generating income and employment in the state, and places adequate emphasis on improving the employment potential of the sector" [26].

Mangroves are a group of highly adaptive salt tolerant plant species inhabiting intertidal zones of tropical and subtropical coastlines. They possess important ecological and socio-economical livelihoods. In the various studied communities of Ilaje coastal ecosystem the mangrove resources have significant livelihoods in different dimension ranging from provisioning, habitat-support, regulating and socio-cultural services; in light of fishing, firewood, medicine, housing, farming, hunting, herbs, food, logging, foot bridge and boat carving. Though, with the highest livelihoods as firewood, herbs and housing, these livelihoods were at significant

variance among the study communities in Ilaje. The mangrove has recorded diverse ecosystem benefit which varied among the communities in the present study. The Ikorigho had the highest percentage (34%) of mangrove benefit in firewood energy source, Odonla (24%) in herbaceous benefit, and Molutehin (50%) inhousing benefit. However, there were also least benefit associated with mangrove; this include food, hunting (2%) respectively in Odonla and Awoye; footbridge (8%) in Ikorigho and farming and logging (2%) respectively in Molutehin. Related study had revealed some vital livelihoods of mangrove in many aspects of human endeavours in terms of therapeutic uses for malaria, diarrhea, ulcer, skin infections, diabetes and snake bite [27], as food, fuel and fodder and medicine for coastal communities [28-30]. "Mangroves are also potential sources of livelihood for communities through the development of policies and programmes that can help provide incentives to local people who are largely dependent on mangroves" [31]. "In some coastal areas mangrove ecosystems are converted into farm lands, resorts and aquaculture" [32-35].

Further studies have earlier recorded a regulatory / protective role of mangrove in synergy with other ecosystems with regards to increase in soil / sediment accretion and shorelines stabilization [36], nutrient and heavy metals trapping and facilitate improved water quality [37-39] and also act as a barrier against natural disasters (e.g., cyclones, typhoons or tsunamis) in coastal areas, [28,40-44]. In habitat support serve as a breeding, nesting as well as nursery ground for different types of amphibians, mammals, crabs, shrimps, mollusks, fishes, prawn, shellfishes, crustaceans and many other invertebrates [45,46], as well as a home for large numbers of mammals, birds and reptiles [47].

Analysis of the socio-economic profile of the study communities has revealed that greater percentage of the inhabitants had fishing, farming and trading as their major alternative source of income among other sources of self-employed means of livelihood survival beside the secondary occupational office work. This implies that majority of the inhabitants have alternative means of livelihood survival apart from office work. However, some level of variation have been revealed among the communities with Molutehin and Awoye having the highest (44%) percentage respectively in trading as source of income, Odun-Igo and Awoye with 56%

respectively in fishing as source of income. This is in tandem with several other studies which have however recorded farming and trading among other alternative as major livelihood activity done by rural dwellers in Nigeria [48-51]. However, it has been observed that younger people have the tendency to pursue multiple livelihood activities in rural areas of Nigeria [52-54]. The provision of alternative income-generating sources has become one of the most widely used strategies at the community level to improve local livelihoods [55] and participation in different income generating sources have effect on rural household welfare and vice-versa [56].

"Livelihood diversification is one of the most remarkable characteristics of rural livelihood strategy. It is a process of building rural households' capital by pursuing different group of activities to advance their standard of living" [57]. "It can be measured by using activities, income and assets. Households use both productive assets, mainly land and human capital, and unproductive assets such as household items and property and engage in various activities to generate income" [58], "Rural households' world-wide engage in a variety of non-farm activities to generate income" [59-61]. "In the present scenario, diversification has become the key word for better living and for being more resilient to shocks and stresses. In addition to other factors, diversification in livelihood requires better adaptability to the change and open to the market mechanism. Households that have diversified income sources have better welfare indicators in terms of food security, healthcare, and affording school fees among others" [62] "Thus, assets, activities, and income can serve as complementary indicators of diversification" [58,63].

"The contribution of non-farm income to rural income shares cannot be underestimated. In Latin America and the Caribbean, estimates of rural non-farm income shares for rural households were 22 per cent in Honduras, 59 per cent in Costa Rica and 68 per cent in Haiti" [61]. "In Africa also, various studies have shown that while most rural households are involved in agricultural activities as their main source of livelihood, they also engage in other income generating activities to augment their main source of income" [64]. "Similarly a study indicated that in Kamba *woreda* in Gamo Zone Ethiopia, nonfarm livelihood diversification activities could become good-looking alternatives to farming families' income. The study also

indicated that only focusing on agricultural production may not be enough to generate sufficient and secure livelihoods. Evidences has shown that rural people in Ethiopia are vulnerable to poverty, food insecurity, limited access to social and health services, and limited options for livelihoods diversification and security resulting to their inability and challenges in sustainable livelihood. Some Ethiopians are often unable to achieve household food security as a result of unreliable sources of income, instability in their livelihoods, and lack of diversified livelihoods” [65].

It's been discovered that as diversification increase households' income increases by 4337.24 on average income. This result has been supported by Omeotesho and Fadimula [66], Households having non and off-farm sources of income tend to easily become secured in their income than households that do not have such access. The result of this study was also supported by Nasa *et. al.* [67], indicating that “when comparing farmers on the basis of livelihood diversification in respect to income security, diversified farmers are relatively food secured than the undiversified farmers”.

5. CONCLUSION

Wetland resources contribute significantly to the household economy of people living near the coastal ecosystem. Generally the Ilaje coastal communities depend on the ecosystem for either their own consumption or the sale of such resources for money to buy food. Fuel wood, fish, periwinkle and crayfish were the major wetland resources being extracted. Using the explanatory based Participatory Rapid Appraisal (PRA) approach in the study to identify the various ecosystem services and their ranking significance to livelihood it was evident that Food, Aquaculture practices, craftsmanship, sea transport and trading are the most important livelihood benefit of biodiversity provisioning service of the ecosystem. Sustainable livelihood especially among rural dwellers is one of the prerequisites for the envisaged rural development and diversification in the country. Sustainable livelihood among coastal communities of Ilaje will help to reduce poverty, crimes; militancy, terrorism and reduce over dependency on government among others. However, sustainable livelihood itself is conditioned by the quality, quantity, accessibility and sometimes affordability of the identified natural assets. Hence, sustainability in livelihood

of Ilaje coastal community is hinged on the balance in these assets, and it degree of resilience to shock or stress.

Looking at the seriousness of the problems in conservation of the mangrove and other associated resources, the following measures can be recommended.

- i. GIS geospatial delineation and implementation of conservation priorities for coastal biodiversity in other coastal communities in Ilaje and the Niger Delta need to be largely conducted to have comprehensive and well synthesized biodiversity-specific information of the region. This shall improve on the existing record including this present research.
- ii. Various species information including the presence of threatened species is imperative for refining conservation priorities such as the designation of critical habitat, biodiversity hot spot, buffer zone, or coastal marine protected areas.
- iii. Such comprehensive and systematic biodiversity-specific data collation shall inform policies to regulate resource extraction or coastal development; a sustainable delineation of biodiversity ecotypes of Niger Delta ecological zone and the minimum viable population size.
- iv. Such data collation shall also be used to determine the probability of extinction for all known species of Niger Delta coastal biodiversity under the categories and criteria of the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species.
- v. Involvement of people for conservation of mangrove forests is the most valid approach. But selection of villages for Joint Mangrove Management (JMM) is the most important. The coastal people who are directly or indirectly getting benefit from the mangrove forest should be included. There should be the formation of rural conservationists: The Coastal Restoration and Conservation Committee (CRCC) for proper implementation of biodiversity conservation programmes and investment. It may be the case that the villagers at far distance places are exploiting the forest resources more than the nearer villages. All these villages should be incorporated with specific duties for coastal ecosystem protection according to their suitability and capacity. Conservational

approach should be integrated with the developmental approaches.

- vi. From the study, it reveals that the provision of alternative source of income may reduce the dependency of people on the mangrove ecosystem in which large scale agro forestry programmes may be promoted. Support for alternative livelihoods than fishing and aquaculture can raise the socio-economic status of the rural dwellers. In order to improve the rural livelihood of Ilaje coastal communities, opportunities to participate in alternative sources of livelihood should be created through establishment of small and medium industries, especially agro-based industries in the rural area. Besides eco-tourism can be a very good opportunity and is now a very good option to engage these people in hospitality, business and promotion of other traditional and modern craftsmanship.
- vii. Fishing activities should be conducted but in a regulated way by making federations. In this way the problems of the fishing communities can be addressed by creating a space for market by eliminating the intermediaries.
- viii. There is a need of the better scientific approach for management of mangroves. The isolated research outcome should be compiled together to correlate knowledge regarding regional and global mangrove dynamics for proper management plan. Along with the strong legislative policies special emphasis should be given on community based management of mangroves. Mass media should be involved to spread awareness among forest guards and local inhabitants. Proper and efficient information on exploitation pattern of mangrove forest products in space and over time is important and its impacts on ecosystem are vital to design suitable management plan.

This study is of high significance because It will provide additional information that would form the basis for further research, development, utilization and perpetuation of the ecological importance of the natural resources capital assets of the area. This will assist policy and decision makers, agencies, ministries and environmental scientists and conservationist in the selection of areas for conservation priorities, sustainable development planning and investment.

ACKNOWLEDGEMENTS

The Authors of this excerpt of PhD research wish to strongly appreciate the efforts of the following: Mr. Orioye Gbayisemore (Team leader and Tour guard) and his crew members (Mr. Demehin Omosuyi, Olatunji Toyin, Segun Melody and Mr. Ebijimi Tope (Boat Pilot), the community heads and their focused discussion group members for their painstaking support during the field work for this project as well as Paschal Okeke for his GIS expertise.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Elli F. The determinants of rural livelihood diversification in developing countries. *Journal of Agricultural Economics*, 2000;51(2):289-302.
2. DFID Sustainable Livelihoods Guidance Sheets. Department for International Development; 2000. Available:http://www.livelihoods.org/info/info_guidancesheets.html (accessed: 30.11.2020).
3. FAO, Medios de vida sostenibles. In: Gente. In: Social Development Dimensions. Departamento de Ordenación de Recursos Naturales y Medio Ambiente. Food and Agriculture Organization; 2009. Available:<http://www.fao.org/sd/pe4_es.htm> [02 de Julio del 2009].
4. Krantz L. The Sustainable Livelihood Approach to Poverty Reduction, An Introduction to SIDA, 2001;1-27.
5. DFID, Sustainable Livelihoods Guidance Sheets. Department for International Development; 2014.
6. Orinya S. Communal Conflict, Internal Displacement and Livelihood Security: An Analysis of the Agila Situation, *International Journal of Humanities Social Sciences and Education (IJHSSE)*, 2016;3(10):80-88.
7. Kollmair M, Gamper J. The Sustainable Livelihood Approach. Input Paper for the Integrated Training Course of NCCR North-South. Development Study Group. University of Zurich; 2002.
8. Stephen M, Nora Mc N, Moses A. Sustainable Livelihood Approach. Critical analysis of theory and practice.

- Geographical Paper No. 189, University of Readings. 2009.
9. Carney D. Sustainable rural livelihoods: what contribution can we make? Conference proceedings of the International Development's National Resources Advisers' Conference, July .1998:428.
 10. Scoones I. Sustainable rural livelihoods: A framework for analysis. IDS Working Paper No. 72. 1998.Inst.Dev. Studies, Sussex, UK.
 11. Ramsar Convention Secretariat, Wise use of wetlands: Concepts and approaches for the wise use of wetlands. Ramsar handbooks for the wise use of wetlands, 4th Edition. Ramsar Convention Secretariat, Gland, Switzerland. 2010;1.
 12. John HM, Michael U, Francis OA, Samuel OF. Ecological and Sustainable Livelihoods Assessment of the Project Communities in the Nigeria's Niger Delta, published in November; 2013.
 13. Onwuteaka JN. New Satellite Imagery for Biodiversity Conservation. 16th International HSE Biennial Conference on the Oil and Gas Industry in Nigeria. December. 2014;1-3: 88-94,.
 14. John O, Michael U, Nnaemeka O. The use of GIS techniques in delineating Mangrove sites of Conservation interest in Asarama area, Eastern part of the Niger Delta. Proceedings of NTBA/NSCB Joint Biodiversity Conference; Unilor. 2016;(350-358).
 15. Anthony C, Adeleke A. Sustainable Livelihoods and Biodiversity Report on the Development of SLBP Communities Operational Plans in Niger Delta, Nigeria. 2014,
 16. [Ajibola MO, Oni SA, Awodiran OO. Assessing Wetland Services in the Niger Delta, Nigeria. International Journal of Humanities and Social Science. 2015;5(1): 268 –277.
 17. Ayansina A, Ulrike P. Assessing wetland degradation and loss of ecosystem services in the Niger Delta, Nigeria. Marine and Freshwater Research; 2015. Available:<http://dx.doi.org/10.1071/MF15066>
 18. WIA Sustainable Livelihoods and Biodiversity Project (SLBP) in Nigeria's Niger Delta, ecological and socio-economic baseline studies. Foundation for Conservation of Nigerian Rivers. Wetland International Africa. 2015;197.
 19. Ofelia AV-R, Arturo P-V. Sustainable Livelihoods: An Analysis of the Methodology. Tropical and Subtropical Agroecosystems, 2011;14: 91–99.
 20. Gbayisemore O Oscar, Edwin-Wosu NL, Osuji LC. Biodiversity Conservation Effort and Livelihoods in Parts of Ilaje Riparian Community in Ondo State, Nigeria, Journal of Economics and Sustainable Development. 2022;13(16). ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
 21. Edet JU, Sunday BA, Edikan FU. Assessment of Sustainable Livelihood Assets of Farming Households in Akwa Ibom State, Nigeria. Journal of Sustainable Development. 2017;10(4):83 – 96.
 22. Edwin-Wosu NL, Anaele J. The floristic assessment of riparian vegetation succession in Otamiri river scape due to dredging activity at Chokocho, Etche, rivers state, Nigeria. Nigerian Journal of Botany. 2018;31(1):119-143.
 23. [Nicol A. Adapting a sustainable livelihoods approach to water projects: Implications for policy and practice (No. 133): Overseas Development Institute (ODI). 2000.
 24. Government of India India: 2003 a reference annual. New Delhi, Publications Division, Ministry of Information and Broadcasting; 2003.
 25. FAO Trends in poverty and livelihoods in coastal fishing communities of Orissa State, India. FAO Fisheries Technical Paper. No. 490. Rome. 2006;111.
 26. Government of Orissa Ninth five-year plan (1997–2002). Bhubaneswar, Planning and Coordination Department; 1997.
 27. Jeeban JM, Manas KM. Mangrove Forest and Local Livelihood: A Study in two Villages of Mahakalapada Block, Odisha. International Journal of Scientific and Research Publications, 2018;8(3):175 – 186.
 28. Guebas FD, Mathenge C, Kairo JG, Koedam N. Utilization of mangrove wood products around mida creek (Kenya) amongst subsistence and commercial users. Econ Bot. 2000; 54: 513-527.
 29. [Cornejo RH, Koedam N, Luna, AR, Troell M, Guebas FD. Remote Sensing and Ethnobotanical Assessment of the Mangrove Forest Changes in the Navachiste-San Ignacio. J Ecol Soc. 2005; 10:16.

30. Pattanaik C, Reddy CS, Dhal NK. Phytomedicinal study of coastal sand dune species of Orissa. *Ind J Traditional Knowl.* 2008;7:263-268.
31. Camacho L, Gevaña D, Carandang A, Camacho S, Combalicer E, Rebugio L, Youn Y. Tree biomass and carbon stock of a community-managed mangrove forest in Bohol, Philippines. *Forest Sci Tech.* 2011;7(4):161–167.
32. Blasco F, Aizpuru M Gers C. Depletion of the mangroves of Continental Asia. *Wetl Ecol Manag.* 2001;9:245-256.
33. [Guebas FD, Jayatissa LP, Nitto DD, Bosire JO, Seen DL. How effective were mangroves as a defence against the recent tsunami? *Curr Biol.* 2005;15:443-447.
34. Ramasubramanian R, Gnanappazham L, Ravishankar T, Navamuniyammal M, Mangroves of Godavari – analysis through remote sensing approach. *Wetl Ecol Manag.* 2006;14:29-37.
35. Duke NC, Meynecke JO, Dittmann S, Ellison AM, Anger K. World without mangroves? *Sci.*, 2007;317:41-42.
36. Satyanarayana B, Mohamad KA, Idris IF, Husain ML, Guebas FD. Assessment of mangrove vegetation based on remote sensing and ground truth measurements at Tumpat. *Int J Remote Sens.* 2011;32:1635-1650.
37. Alongi DM. The dynamics of benthic nutrient pools and fluxes in tropical mangrove forests. *J Mar Res.* 1996;54: 123-148.
38. Clark MW. Management implications of metal transfer pathways from a refuse tip to mangrove sediments. *Sci Tot Env.* 1998;222:17-34.
39. Tam NFY, Wong YS. Mangrove soils in removing pollutants from municipal wastewater of different salinities. *J Environ Qual.* 1999;28:556-564.
40. Wells S, Ravilious C, Corcoran E. In the Front Line: Shoreline Protection and other Ecosystem Services from Mangroves and Coral Reefs. UNEP/ Earth print, England, 2006.
41. [Bahuguna A, Nayak S, Roy D. Impact of the tsunami and earthquake of 26th December 2004 on the vital coastal ecosystems of the Andaman and Nicobar Islands assessed using RESOURCESAT AWiFS data, *Int J App Earth Obs Geoinf* 2008;10:229-237.
42. Harada K, Imamura F, Hiraishi T. Experimental study on the effect in reducing tsunami by the coastal permeable structures. *Final Proc. Int. Offshore Polar Eng. Conf. USA.* 2002;652–658
43. Macintosh DJ. Coastal Community Livelihoods: implication of intact ecosystem services. Paper presented at the 2010 Katoomba Meeting XVII held June. in Hanoi, Vietnam. 2010;23-24 Available:<http://www.ecosystemmarketplace.com/documents/acrobat/k17/Don%20Macintosh.pdf>.
44. Garcia KB, Pastor L, Malabrigo Jr, Dixon TG. *Philippines' Mangrove Ecosystem: Status, Threats and Conservation.* Springer New York Heidelberg Dordrecht London. 2014.
45. Nayak S, Bahuguna A. Application of remote sensing data to monitor mangroves and other coastal vegetation of India. *Ind J Mar Sci.* 2001;30:195-213.
46. Nagelkerken I, Blaber S, Bouillon S, Green P, Haywood M, Kirton LG, Meynecke JO, Pawlik J, Penrose HM, Sasekumar A, Somerfield PJ. The habitat function of mangroves for terrestrial and marina fauna: a review. *Aqu Bot.b* 2008;89(2): 155–185.
47. Ramasubramanian R, Gnanappazham L, Ravishankar T, Navamuniyammal M. Mangroves of Godavari – analysis through remote sensing approach. *Wetl Ecol Manag.* 2006;14:29-37.
48. Ekong EE, *Rural sociology.* Dove Educational Publishers. Uyo, Nigeria; 2010.
49. Nzeh EC, Eboh OR. *Technological Challenges of Climate Change Adaptation in Nigeria: Insights from Enugu State.* African Technology Policy Studies Network Working Paper. Series No 52; 2010.
50. Ifeanyi-obi CC, Asiabaka CC, Adesope OM, Issa FO. Inhabitants perception of climate change, effects and adaptation strategies in Etche local government Area of Rivers state, Nigeria. *Research India publications, Global Journal of Applied Agricultural Research.* 2011;(1).
51. Adesope OM, Ifeanyi-obi CC, Aboh CL. Socio-economic factors affecting rural household expenditure on mobile phone services. *Journal of Nature Science and Sustainable Technology.* USA. 2011;5(3).
52. Chukwuezi, B. 'Through Thick and Thin: Igbo Rural-Urban Circularity, Identity and

- Investment'. Journal of Contemporary African Studies, 2001;(1).
53. Maegher K. The Invasion of the Opportunity Snatchers: The Rural-Urban Interface in Northern Nigeria'. Journal of Contemporary African Studies. 2001;(1).
54. Bryceson DF. The Scramble in Africa: Reorienting Rural Livelihoods'. World Development, 2002; 725–739.
55. Van Vliet N. Livelihood alternatives for the unsustainable use of bush meat. Report prepared for the CBD Bush meat Liaison Group. Technical Series No. 60. Montreal, Canada: Secretariat of the Convention on Biological Diversity; 2011.
56. Shakila S, Siegfried B, Salauddin P. Impact of income diversification on rural livelihood in some selected areas of Bangladesh. Journal of Bangladesh Agricultural University.2019;17(1):73–79.
57. Ellis F. Household strategies and rural livelihood diversification. Journal of Development Studies. 1998;35(1):1–38. DOI: 10.1080/00220389808422553
58. Barrett CB, Reardon T, Webb P. Nonfarm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics, and policy implications. Food Policy. 2001;26(4): 315-331.
59. Lanjouw JO, Lanjouw P. The rural non-farm sector: Issues and evidence from developing countries. Agricultural Economics, 2001;26(1):1-23.
60. World Bank Reaching the rural poor: A renewed strategy for rural development. Washington, DC: The World Bank; 2003.
61. Umunnakwe V. Determinants of Livelihood Patterns among Rural Youth in Jabalpur District of Madhya Pradesh, India; 2015.
62. Riithi NA. Determinants of Choice of Alternative Livelihood Diversification Strategies in Solio Resettlement Scheme, Kenya. University of Nairobi; 2015.
63. Zerihun BW. Non-Farm Diversification in Ethiopia: What Determines Participation and Returns? Addis Ababa University, Ethiopia; 2017.
64. Abimbola A, Oluwakemi O. Livelihood diversification and welfare of rural households in Ondo State, Nigeria. Department of Agricultural Economics, University of Ibadan, Oyo State, Nigeria. 2013.
65. Fassil E, Elias M. Determinants of Off-farm Income Diversification and its Effect on Rural Household Poverty in Gamo Gofa Zone, Southern Ethiopia. 2016;8(10): 215-227.
66. Omotesho MOA, Fadimula KS. Department of Agricultural Economics and Farm Management, Faculty of Agriculture, University of Ilorin, Nigeria Press. Options: A Study of Two Villages in Andhra Pradesh, India 1975-2001', Working Paper (178). London: ODI; 2010.
67. Nasa'i DH, Atala TK, Akpoko JG, Kudi TM, Habib S. Analysis of Factors Influencing Livelihood Diversification among Rural Farmers in Giwa Local Government Area of Kaduna state, Nigeria. I.J.S.N. 2010;1 (2):161-165.

© 2022 Gbayisemore et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/93825>