

TERESTRIAL BIODIVERSITY STUDY REPORT

FOR

MM PORT PROJECT FZE ESIA

EXECUTIVE SUMMARY

As a part of ESIA, wet season field data gathering exercise, this study was conducted between 4 to 7th July 2023 and covers biodiversity/ecological component (vegetation and wildlife) study within and around the Project Site, and the nearby communities i.e., Owo-Ogono and Ele-Ogu.

Vegetation Characteristics: The study area contains secondary forests and bush-fallow in the Owo-Ogono and Ele-Ogu communities, and modified vegetation (patches of riparian and grasses/sedges) within the proposed project site. A total of 85 species belonging to 75 genera, and 33 families were identified in the study area and comprised of trees, shrubs, and herbs. The herbs were the predominant group of the species identified. The proposed project site contains mainly of grasses and sedges with few species of mangrove at the bank of the river. Some of the plant species identified useful to the residents of the study area as food, medicine, construction, and general environmental sustainability however these important species are dominant in the Owo-Ogono and Ele-Ogu communities which are about 3.0km away from the proposed project site. The vegetation health in the area could be described as good. None of the IUCN endangered (EN), vulnerable (VU), and Near Threatened (NT) plants species identified in the study area. Also, there is no conserved area within the project site and its environs. There are no known biodiversity hotspot or Important Bird Area (IBA), neither any flora of conservation concern within the study area.

Wildlife Characteristics: The birds constituted more than 75% of the fauna species physically observed during the fieldwork while the records of the other fauna were based on interviews with the hunters and workers in the adjoining facilities. Among the fauna groups (mammalian, reptilian, avian, and mollusks), the avian constituted 38 species (40%), mammalian 30 species (31%), and the reptilian 25 species (26%). The avian are more frequently seen and reported by the locals. This could be attributed to the fact that they are not easily restricted by barriers. Also, during fieldwork, we observed majority of the bird species in the open areas of the proposed project site. There is no known biodiversity hotspot or Important Bird Area (IBA), neither is there any flora of conservation concern within the study area and the IUCN status of all the avian species identified in the study area Least concern (LC) except *Rhyticeros cassisix* which is on the vulnerable (VU) status. The IUCN status of the mammalian species indicated that *Cephalophus* spp and *Phataginus tetradactyla* are vulnerable (VU), *Cercopithecus nictitans* is endangered (EN) while other mammals identified are on the least concern category. Among the reptiles, *Amblyrhynchus cristatus* and *Bitis arietans* are on the the vulnerable (VU) list while *Python Regius* is on the Near threatened (NT) list. Other reptile species are on the Least concern (LC) list. These particular mammalian, reptilian, and avian species were not sited within the proposed project site but were only reported by the hunters as one the fauna seen in the secondary forests which are more than 2.0km away from the proposed site. This however asert that the proposed project area is not inhabited by these species and the birds sited during the fieldwork are not resident in the proposed project site since there is no nest or breeding sited observed within the proposed site.

ECOSYSTEM SERVICES

The ecosystem services associated with the study area include provisioning (timber, genetic resource, firewoods, wild food, bush meat, fisheries, medicinal plants, and water supply), supporting (habitat for fishes, nursery ground for mangrove and nypa species, and primary production), and regulating (nutrient cycle, and erosion control). Wildlife studies was out mainly through interviews with relevant people of nearby communities. The local markets were also surveyed to identify wildlife species that are on sale and obtain information on their occurrence in the area. Field activities includes inspection and observation of wildlife spoors, feeding and nesting ground, feathers nets, holes, etc.

VEGETATION AND WILDLIFE STUDY

Background information

Indorama operates a Petrochemical and Fertilizer manufacturing facilities within the Indorama Complex in Eleme, Port Harcourt, Rivers State, Nigeria having manufacturing capacity of 2.8 MMTA of Urea & 400 KTA of Polymers (Polyethylene & Polypropylene) utilizing Natural Gas & Natural Gas Liquids as feedstock. The Petrochemical manufacturing facilities comprising of the Cracker, Polyethylene and Polypropylene plants have been in operation since 2006. The Fertilizer manufacturing facilities consists of two trains of 2,300 TPD & 4000 TPD each of Ammonia and Urea, respectively. While the first line of Fertilizer was commissioned in 2016, the second line was commissioned in May 2021.

Based on the design capacities of Ammonia and Urea plant, Post IEFCL-Train3 Project commissioning, there will be a surplus ammonia of 375 MTPD over and above the requirement of Urea plants. Indorama is planning to export this surplus liquid ammonia and 1.4 million tons of Urea produced by IEFCL-Train3 project, through MM Port Terminal.

In compliance with FMEnv guidelines and procedure decided to conduct ESIA for the proposed MM Port FZE.

SCOPE OF WORK

The vegetation and wildlife aspects of the environmental and social impact assessment covered vegetation and wildlife study within and around the proposed project site. The main points of vegetation and wildlife study of the environmental component are emphasized below.

- Vegetation (Flora): This included trees, shrubs and herbaceous species composition and family composition of plant species in the area.
- Wildlife (Fauna): This included reptiles, primates, and mammals.
- Plants diseases and elemental analysis
- Ethnobotanical value/uses of flora species and ecological status of wildlife species.
- To establish existing flora, fauna species and their habitat within and around the proposed project site
- Brief impact assessment and mitigation measures

LOCATION

The proposed MM Port FZE Facility at Federal Ocean Terminal (FOT), Onne Port Complex, Onne, Eleme LGA, Rivers State for the storage and export of Urea and Ammonia. The proposed project site is already sand-filled, and grasses/herbs could be found colonizing the reclaimed area.

SAMPLING METHODOLOGY

Characterizations of the vegetation and wildlife species in the project area were carried out initially by a general surveillance to determine the natural stratification of the plant community. The vegetation distribution, composition, abundance, and diversity were determined.

2.1 Sampling Method (Flora)

The study technique adopted the quadrants methods. In each six quadrats were marked at about 25m intervals for easy field estimate. Random quadrants of varying dimensions of 10m x 10m (for tree enumeration), 5m x 5m (for shrubs enumeration), and 1m x 1m (for herbs enumeration) were enumerated in each quadrat (**Fig. 1**) and plant identification were carried out ((Brower and Zar 1984, Nambu 2001), and counted according to Mueller-Dombois and Ellenberg (1974), Kershaw (1975), and Nambu (2001). All plant species as far as possible were identified with unknown species collected, labeled, pressed, and taken to University of Port Harcourt Herbarium for identification. Further plant identification was based on Hutchinson and Dalziel (1954), Keay (1989) Okezie and Agyaakwa (1989) and Okezie et al. (2016) and ethno-botanical uses of the plants were derived from the local interviews.

The Shannon evenness index, abbreviated as SEI, of the plant species were calculated as

$$SEI = 1 / \sum p_i^2.$$

Where P_i = The proportional representation of each habitat (p_i). ...

Also, the diversity of the plant species was calculated using Shannon index as follows:

$$H = \sum_{i=1}^s - (P_i * \ln P_i)$$

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$$H = - \sum_{i=1}^s (P_i * \ln P_i)$$

where p = the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), \ln is the natural log, \sum is the sum of the calculations, and s is the number of species.

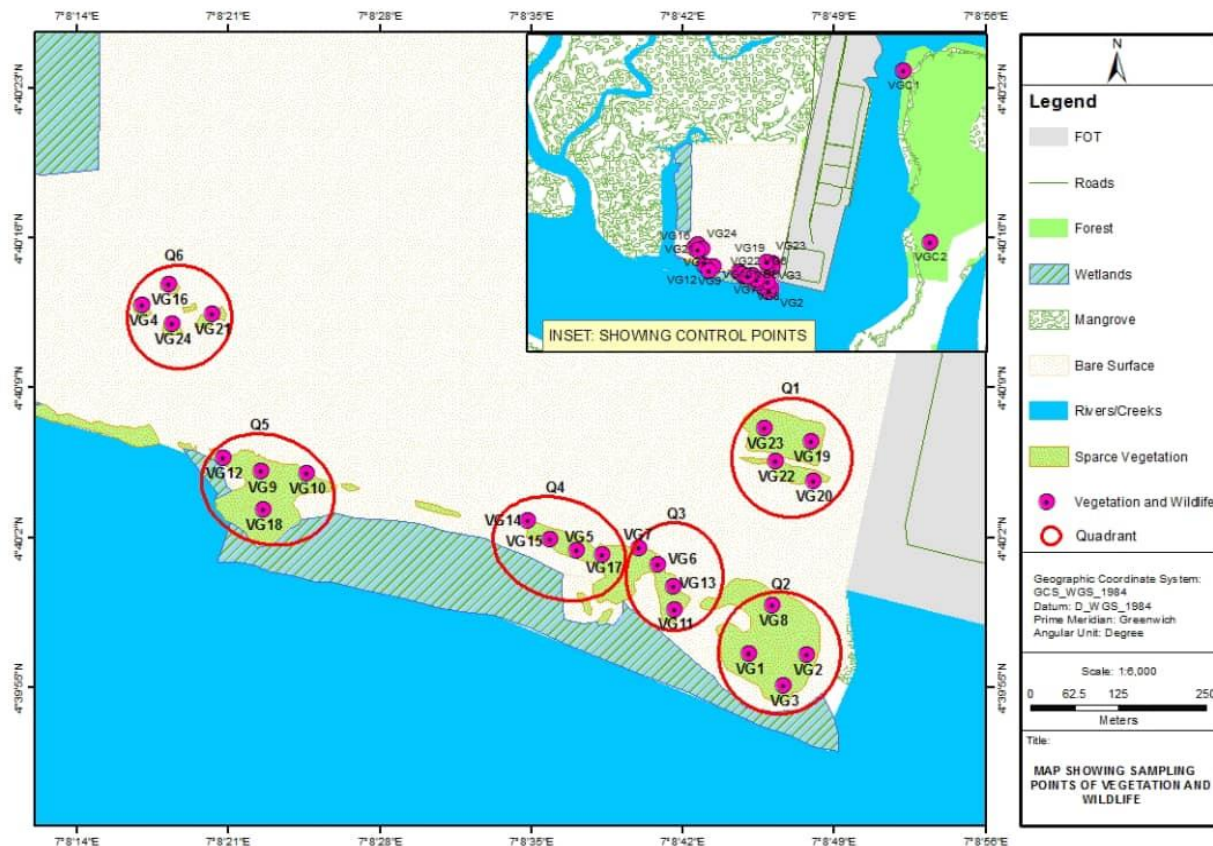


Figure 1: Layout of the location and quadrats

Coordinates

SAMPLING LOCATION	EASTING	NORTHING
VG1	7° 8' 45.15" E	4° 39' 56.60" N
VG2	7° 8' 47.80" E	4° 39' 56.52" N
VG3	7° 8' 46.71" E	4° 39' 55.09" N
VG4	7° 8' 17.10" E	4° 40' 12.86" N
VG5	7° 8' 37.15" E	4° 40' 01.41" N
VG6	7° 8' 40.95" E	4° 40' 00.74" N
VG7	7° 8' 40.06" E	4° 40' 01.51" N
VG8	7° 8' 46.23" E	4° 39' 58.85" N
VG9	7° 8' 22.60" E	4° 40' 05.09" N
VG10	7° 8' 24.71" E	4° 40' 05.02" N
VG11	7° 8' 41.68" E	4° 39' 58.64" N
VG12	7° 8' 20.84" E	4° 40' 05.76" N
VG13	7° 8' 41.64" E	4° 39' 59.74" N
VG14	7° 8' 34.92" E	4° 40' 02.81" N
VG15	7° 8' 35.96" E	4° 40' 01.92" N
VG16	7° 8' 18.33" E	4° 40' 13.85" N
VG17	7° 8' 38.37" E	4° 40' 01.23" N
VG18	7° 8' 22.69" E	4° 40' 03.31" N
VG19	7° 8' 48.03" E	4° 40' 06.51" N
VG20	7° 8' 48.10" E	4° 40' 04.64" N
VG21	7° 8' 20.35" E	4° 40' 12.45" N
VG22	7° 8' 46.35" E	4° 40' 05.58" N
VG23	7° 8' 45.85" E	4° 40' 07.14" N
VG24	7° 8' 18.48" E	4° 40' 12.01" N
VGC1	7° 9' 40.46" E	4° 41' 24.02" N
VGC2	7° 9' 50.90" E	4° 40' 14.78" N

2.2 Sampling Method (Fauna)

Sampling quadrats used for flora studies were equally used for fauna wildlife. Two main methods of fauna sampling were adopted. Direct evidence (sighting) and indirect evidence.

Direct observations: Visual encounter survey during nocturnal and diurnal expeditions and recognizing evidence of wildlife species presence through vocalization was undertaken. The Capture-recapture method was used for small mammals and some invertebrate fauna. Visual encounter survey consists of timed habitat search within a specified area. The number of observers, weather variables and start time of the survey is recorded and then personnel move

throughout the area, searching all potential habitats without spatially overlapping. Efforts are made not to disturb the animals seen and to avoid counting the same individual twice. Birds' species were sampled during the morning hours between the period 6:30 am -9:30 am which is the time that the birds are active in search of food and other requirements. The bird's species were observed, identified, and counted by opportunity (for those flying through/across), direct encounter in the niches and habitat along the created transects. On the other hand, direct field observation and enumeration was also repeated between the hours of 4pm – 6.30pm in the evening when the sun goes down. This is also another active period for avian species in terms of their interaction with their ecosystems.

Indirect Observations: Indirect signs such as footprints, scats/faeces, feeding activity, nests, tracks, holes/diggings or scratching, carcass. The recorded evidence was represented both by direct (collections and observations) and indirect (tracks, footprints, scats/faeces, feeding activity, nests, tracks, holes/diggings or scratching, carcass, and identification by local residents).

Examination of road kills and meat markets: Interview of hunters, farmers etc. to gain better insight into, the faunal distribution pattern, seasonal migration, local names, and economic importance. The conservation status and threats to biodiversity status of censored species was retrieved from IUCN. At their homes, the hunters were also urged to present for examination, animal remains or trophies including, horns, skins, skull/skeleton, shells, hoofs, etc in their bags as well as say the last time they sighted or killed each animal presented. Night sampling was also done to listen to the vocalization of nocturnal animals. Raking quadrants (2m x 2m) for litter amphibians and reptiles were also employed. Inspection of broad-leaved hydrophytes for tree frogs, lifting of stones, logs, plants, panels, plastics, etc for any hiding fauna were conducted. The use of appropriate field data sheets to capture information like date of sampling, block/plot number, species list with scientific, common, and local names, and abundance.

In addition, wildlife data were obtained from tracing of animals' routes/paths, scent/smell, burrows, nesting sites/nest, calls, scales, food cuttings, footprints, droppings, fur, and sighting. However, 60% of the checklists on mammalian, avian, rodentia and reptilian species were

obtained from hunters, farmers, and gatherers of non-timber forest products (NTFPs) in the community.

Moreover, other features of ecological importance to the environment were recorded with a high-resolution digital camera. Moreover, representative plant species were collected in polythene bags for subsequent analysis in the laboratory. Plants were also observed for disease symptoms/conditions. The Field equipment employed for the study included machetes, used newspapers, quadrants, digital camera, Binoculars, measuring tape, masking tape, presser, and booths etc.

DATA ANALYSIS

Data obtained from vegetation and wildlife species in the project environs was analyzed using descriptive statistics. The descriptive tool employed included tables, frequencies, graphs and charts, google earth imageries, and digital photographs.

QUALITY ASSURANCE

With regards to quality control, vegetation was sampled along designated quadrats and duly geo-referenced. Also, vegetation samples were taken to the herbarium for proper identification. Besides, vegetation samples were identified for disease and stress conditions in-situ. Caution was exercised, particularly on the use of machetes to avoid “near miss” and any action that may lead to accident.

VEGETATION CHARACTERISTICS

The study area contains modified and sand-filled areas (dominated by grasses and sedges) (**Plate 1**), patches/relics of riparian mangrove vegetation (**Plates 2 and 3**), and secondary forest consisting of mangrove swamps vegetation (across the river body, about 2.3 km away for the proposed project site) (**Plate 5**). Generally, the vegetation within the proposed project site is predominated by grasses (*Digitaria argillacea*, *D. longiflora*, *Panicum laxum*, *Paspalum conjugatum*, *Mariscus ligularia*, and *Eragrostis* spp.) and sedges (*Fimbristylis ferruginea*).



Plate 1: Overview of the vegetation inside the proposed project site



Plate 2: Patches of riparian forest vegetation in the proposed project site



Plate 3: Patches of mangrove vegetation in the proposed project site



Plate 4: Fringe of Mangrove and other vegetation along the Owo-Ogono water ways

FLORISTIC COMPOSITION OF THE STUDY AREA

MODIFIED AND SAND-FILLED AREAS

This is the majority of vegetation observed in the proposed project site. It is predominated by grasses (*Digitaria argiilacea*, *D. longiflora*, *Panicum laxum*, *Paspalum conjugatum*, *Mariscus ligularia*, and *Eragrostis* spp.) and sedges (*Fimbristylis ferruginea*) and few herbs namely *Gomphrena celosiodes*, *Emilia praetamissa*, *Euphorbia heterophylla*, *Bidens pinnata*, *Desmodium* spp.etc, and few shrubs viz. *Chromelaena odorata*, *Urena lobate*, etc (**Plate1**). Also, the puff mushroom was among the species in this area (**Plate 5**)



Plate 5: Mushrooms observed in the project site

PATCHES/RELICS OF RIPARIAN MANGROVE VEGETATION

In this forest system, mangrove species are juxtaposed with non-mangrove species and swamp forest vegetation. These mosaic-modified vegetation types exist on the bank of the river (southern flank, Q2, Q3, Q4 and Q5) of the proposed site (**Plates 2 and 3**). They are characterized by either seasonal or permanent flooding or tidal influence. They have scanty

species of *Rhizophora racemosa*, *Rhizophora mangle*, *Rhizophora harrisonii*, *Laguncularia racemosa*, *Avicinia Africana*, *Nypa fruticans*, *Acrostichum aureum*. Other plant species observed here include *Alchornea cordifolia*, *Chromolaena odorata*, *Hyptis lanceolata*, *Fimbristylis* spp., etc.

MANGROVE SWAMP VEGETATION

The mangrove ecosystem occupies the tidal flats in the water ways within the study area. The land system is dominated by mangrove forest. It is found on the southern flank of the proposed site and in the adjoining community settlements. It is dominated by *Nypa* sp and *Rhizophora* species and show zonation of the main species, roughly parallel to the coast, with *R. racemosa* at the coast and *R. harrisonii* and *R. mangle* successively further inland and *Nypa* sp on the outer fringe on the coast. Relatively, little ground vegetation occurs within the mangrove forests. The mangrove swamp forest was observed mainly at the control stations with little or small patches in quadrats (Q2, Q3, Q4 and Q5). The mangrove trees are the dominant vegetation type fringing the banks of creek and creek-lets (**Plate 4**). The mangrove forest consists of species, namely *Rhizophora racemosa*, *Rhizophora mangle*, *Rhizophora harrisonii*, *Laguncularia racemosa*, and *Avicinia africana*. Also, non-mangrove species were observed in this mangrove zone and include *Nypa fruticans*, *Acrostichum aureum*; grasses such as *Paspalum vaginatum*, and dicot herbs such as *Dalbergiaecastaphyllum*. The zoning of the mangrove swamp forest more is or less parallel to the shoreline. *Rhizophora racemosa* is the most abundant species in this ecosystem. Patches of *Acrostichum aureum* (mangrove salt fern plant) were distributed among the mangrove plants.

VEGETATION STRUCTURE

The life-form spectrum in this mangrove swamp forest is dominated by meso-phanerophytes, megaphanerophytes and microphanerophytes, constituting about 40% of the total life-form types and represented by *Rhizophora racemosa*, *Rhizophora mangle*, *Rhizophora harrisonii*, *Laguncularia racemosa* and *Avicinia africana*. This makes the forest woody. The non-mangrove species consist of *Nypa fruticans*, *Acrostichum aureum* and *Paspalum vaginatum* which constitute about 55%. The physiognomic features of this mangrove forest are stilt roots of

Rhizophora spp, which holds the plant firmly to the soft alluvial soil. The stilt roots also allow the passage of water and nutrients into the plant while acting as filter against salt. The viviparous nature of *R. racemosa* enables the seed to germinate while still attached to the parent tree and the seed develops a prominent and conspicuous radical before it falls onto the ground. Due to this advanced development of the seedlings, a relatively short time is required for it to establish itself in the mud. The mangrove forest is characterized by daily tidal immersion, mobility of the substrate, fluctuating salinity, and anoxia conditions.

VEGETATION DIVERSITY, EVENNESS, AND RELATIVE ABUNDANCE

The diversity of species in the study area using Shannon index showed that the control stations were the most diverse compared to the proposed project site. Also, the numbers of plant species identified in the control stations were more than the ones in the proposed project site. This is because the proposed project site is highly modified by sand-filling (**Table 1 and Appendix 1**). Similarly, the Shannon evenness for the control stations were the highest while quadrats-6 had the least number of species including Shannon index, and evenness. This is followed by quadrats-2 and 5. This is evident because these areas have highly modified habitats and contain mainly grassed and sedges introduced during the sand-filling of the proposed site.

The grasses (Poaceae, 33.05%) and the sedges (Cyperaceae, 27.55%) were the most abundant plant species identified during the sampling (**Fig. 2**). These are followed by Fabaceae (5.52%), Asteraceae (4.92%), Rhizophoraceae (4.78%), and Acanthaceae (3.13%), Rubiaceae (2.51%), Euphorbiaceae (2.32%), and Malvaceae (2.08%) families. The relative abundance of the mangrove species was more in control quadrats than the quadrats within the proposed project site. On the other hand, the abundance of grasses and sedges are more in the quadrats within the proposed project site. This can be attributed to the fact that the proposed project site is modified as a result of anthropogenic activities and the mangrove vegetation/species have been removed during the sand-filling and non-native grasses, sedges, and associated species introduced.

Table 1: Plant Species diversity and evenness

	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Quadrat 6	Control 1	Control 2
Number of species	32.00	18.00	21.00	26.00	17.00	9.00	36.00	38.00
Shannon diversity	2.89	2.29	2.55	2.41	2.00	1.69	3.36	3.36
Shannon evenness	0.84	0.79	0.84	0.74	0.71	0.77	0.94	0.92

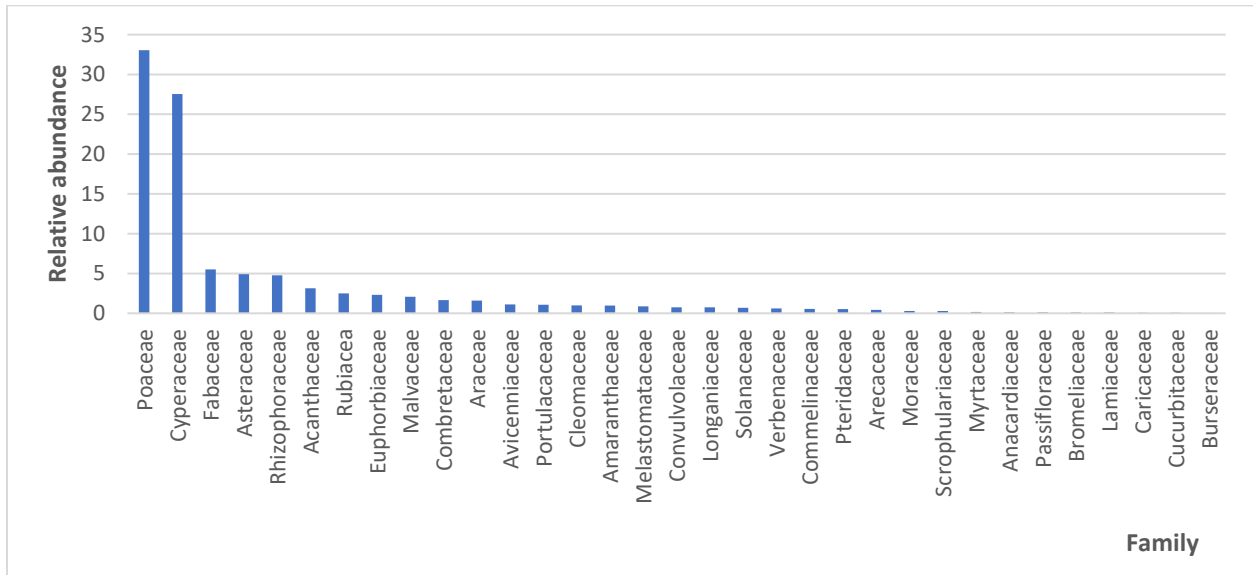


Figure 2: The relative abundance of different plant families in the study area

RIVERINE/ESTUARINE

The proposed project site is characterized with modified habitats with patches of riparian zone (**Plate 6a**), tidal plains (**Plate 6b**), and marshy areas (**Plate 6c and 6d**). The mollusks use the roots of the *Rhizophora* spp for breeding. Also, the crabs inhabit the tidal plains by borrowing into the soil/sediment (**Plate 7**). Furthermore, the floodplain serves as nursery ground for mangrove and *Nypa* seedlings. The riparian zone harbour some hydrophytes such as *Rhizophora* spp., *Sesuvium portulacastrum*, *Ipomoea pes-caprae*, etc (**Plate 9**).



Plate 6: Modified habitats within the proposed project site (A) patch of riparian zone, (B) tidal plains, and (C & D) marshy areas.



Plate 8: Crabs observed in the tidal plains during the fieldwork.

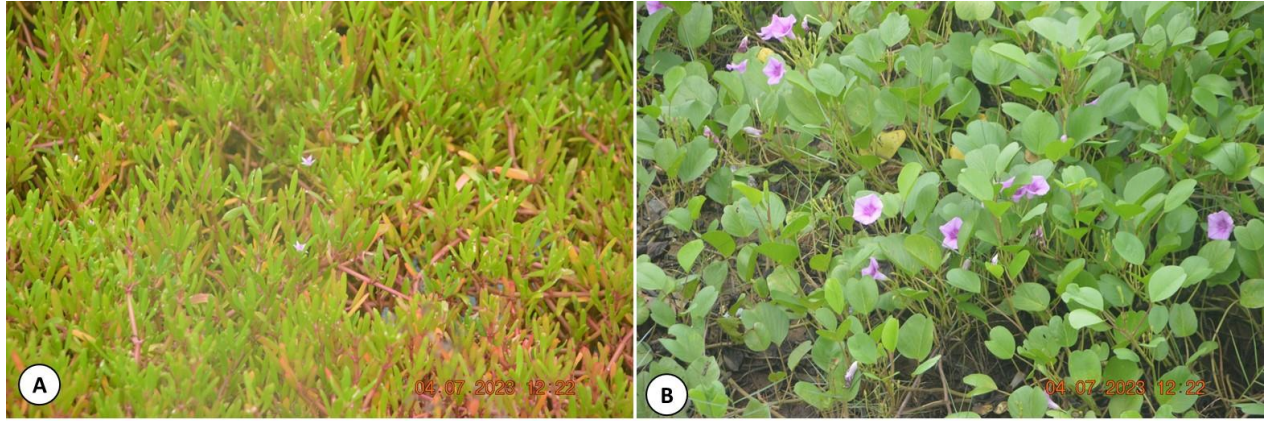


Plate 9: Some hydrophyte in the proposed project site (a) *Sesuvium portulacastrum* and (b) *Ipomoea pes-caprae*

PLANT DISEASES

The plants within the proposed project site were healthy and disease free.

CONSERVATION STATUS

None of the plants species identified in the study is the IUCN endangered (EN), vulnerable (VU), and Near Threatened (NT) list. Also, there is no conserved area within the proposed project site. There is no known biodiversity hotspot or shrines (Sacred groves), nor is there any flora of conservation concern within the study area.

FAUNA

FAUNA CHARACTERISTICS OF STUDY AREA

The birds constituted more than 75% of the fauna species physically observed during the fieldwork while the records of the other fauna were based on interviews with the hunters and workers in the adjoining facilities (**Plate 10, Table 2, 3, and 4**). Also, a lot of insect species thrive in the study area (**Plate 11**).

Table 2: Avian Resources of the Study Area

S/N	Common name	Scientific name	Family	IUCN status	Local Names
1	The sparrow hawk	<i>Accipiter nisus</i>	Accipitridae	LC	
2	West African goshawk	<i>Accipiter tachiro</i>	Accipitridae	LC	

S/N	Common name	Scientific name	Family	IUCN status	Local Names
3	African black swift	<i>Apus barbatus</i>	Apodidae	LC	
4	White-rumped swift	<i>Apus caffer</i>	Apodidae	LC	
5	Cattle egret	<i>Ardeola ibis</i>	Ardeidae	LC	
6	African spotted eagle-owl	<i>Bubo africanus</i>	Strigidae	LC	
7	Cattle Egret	<i>Bubulcus Ibis</i>	Ardeidae	LC	Áwára
8	Trumpeter hornbill	<i>Bycanistesbucinator</i>	Bucerotidae	LC	
9	Sand piper	<i>Calidoris spp</i>	Accipitridae	LC	
10	Sun bird (scarlet breasted)	<i>Chalcomitrasenegalensis</i>	Nectariniidae	LC	
11	Copper Sun Bird	<i>Cinnyris cupreus</i>	Nectariniidae	LC	Ágyéèb
12	Sunbird	<i>Cinnyris pulchellus</i>	Nectariniidae	LC	
13	African pied crow	<i>Corvus albus</i>	Corvidae	LC	
14	Sun birds (green headed)	<i>Cyanomitraverticalis</i>	Nectariniidae	LC	
15	African grey woodpecker	<i>Dendropicosgoertae</i>	Picidae	LC	
16	Little egret	<i>Egretta garzetta</i>	Ardeidae	LC	
17	The southern red bishop	<i>Euplectesorix</i>	Ploceidae	LC	
18	Falcon	<i>Falcon spp.</i>	Falconidae	LC	
19	Bush Fowl	<i>Fruncolinusbilacoratus</i>	Phasianidae	LC	
20	Bush Sparrow	<i>Gymnorisdentata</i>		LC	
21	White Throated Swallow	<i>Hirundoalbigularis</i>		LC	
22	Bee-eater	<i>Maropsnubicus</i>	Meropidae	LC	
23	African Black Kite	<i>Milvus migrans</i>		LC	
24	African Bush fowl	<i>Numida meleagris</i>	Numididae	LC	
25	Guinea fowl	<i>Numida sp</i>	Tetrameridae	LC	
26	Owl	<i>Otussenegalensis</i>	Strigidae	LC	
27	Village Weaver birds	<i>Ploceuscucullatusbohndorffi</i>	Ploceidae	LC	
28	Hawk	<i>Polyboroidesradiatus</i>	Accipitridae	LC	
29	African grey parrot	<i>Psittacus erithacus</i>	Psittacidae	LC	
30	Northern white-faced owl	<i>Ptilopsis leucotis</i>	Strigidae	LC	
31	Common garden bulbul	<i>Pycnonotus barbatus</i>		LC	bẹẹ²
32	Red-billed Quelea	<i>Quelea Quelea</i>		LC	Ogazi
33	Knobbed hornbill	<i>Rhyticeroscassisix</i>		VU	Hnà
34	Heron bird	<i>Scopus umbretta</i>	Scopidae	LC	
35	Laughing Dove	<i>Spilopeliasenengalensis</i>		LC	
36	Red-eyed dove	<i>Streptopreliasemitorquata</i>	Columbidae	LC	
37	African pied hornbill	<i>Tokusfasciatus</i>	Bucerotidae	LC	

S/N	Common name	Scientific name	Family	IUCN status	Local Names
38	Sandpiper	<i>Tringa</i> spp	Scolopacidae	LC	

Note: A - Abundant C – Common, O – Occasional, R – Rare, and LC - Least concern VU – vulnerable (Source: Fieldwork 2023)

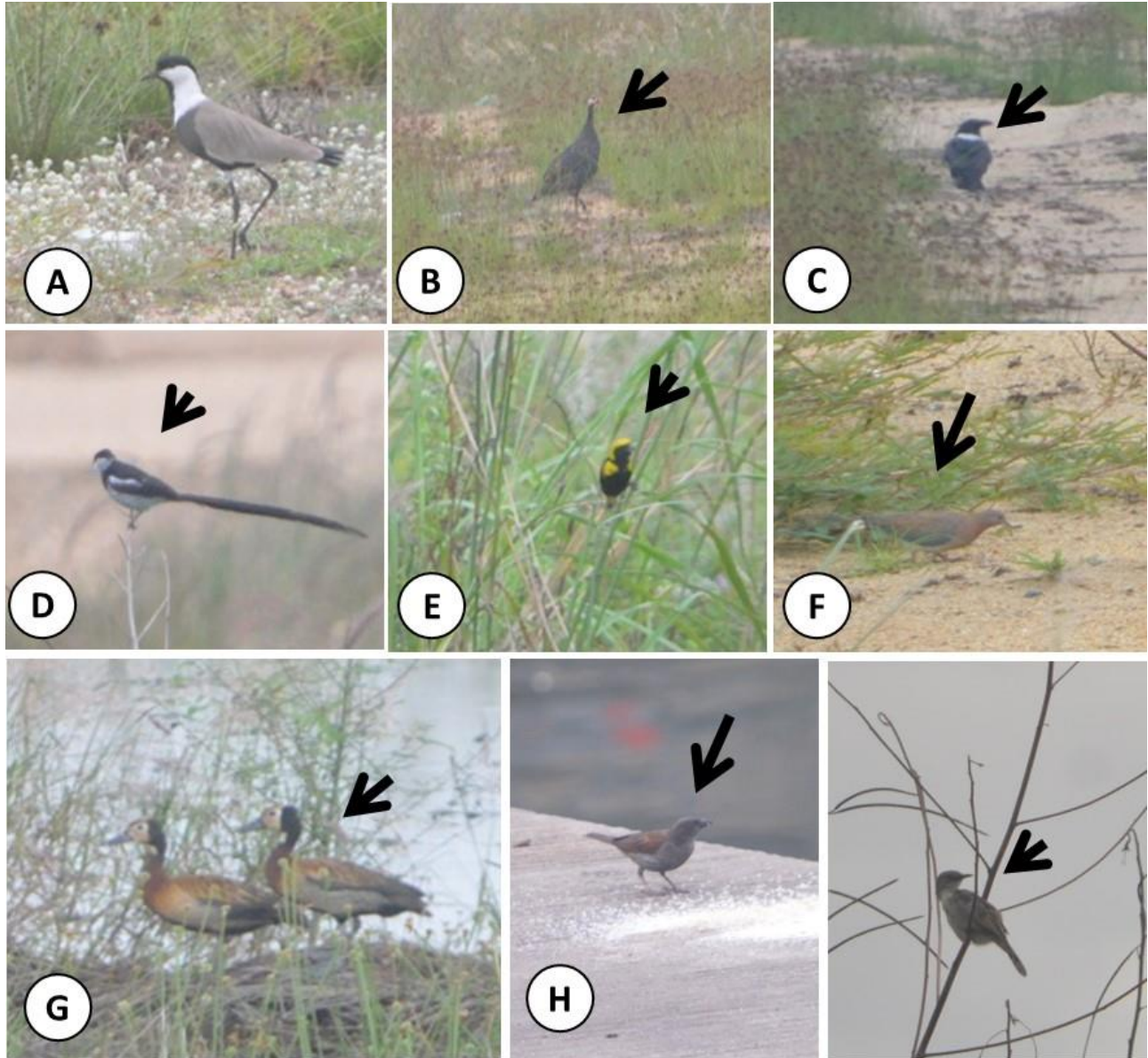


Plate 10: Avian Species observed in the Study Area (Source: Fieldwork 2023)

Table 3: Mammalian Resources of the Study Area

S/N	Scientific Name	Common Name	Family	IUCN Status	Local Name (Ogoni)
1	<i>Arvicanthis niloticus</i>	The Nile rat	Muridae	LC	
2	<i>Atherurus africanus</i>	Brush-tailed Porcupine		LC	Bínàhyúu
3	<i>Cephalophus spp</i>	Duiker		VU	Gbam
4	<i>Cercopithecus nictitans</i>	Putty Nose Guenon		EN	Hwìnì
5	<i>Civettictis civetta</i>	The African civet	Viverridae	LC	
6	<i>Cricetomysgambianus</i>	Gambian pouched rat	Nesomyidae	LC	
7	<i>Cricetomysgambianus</i>	Giant rat		LC	Lúé
8	<i>Crocidura sp.</i>	Shrew	Soricidae		
9	<i>Ctenosaurasp</i>	Iguana	Iguanidae	LC	
10	<i>Cypsiurus sp.</i>	African Palm Swift	Apodidae	LC	
11	<i>Epixerus Wilsoni</i>	Biafran Bight Palm Squirrel		LC	
12	<i>Epomophorus spp.</i>	Bat	Pteropodidae		
13	<i>Epomops sp.</i>	Bat	Chiroptera	LC	
14	<i>Funisciurus pyrropus</i>	African striped tree squirrel	Sciuridae	LC	
15	<i>Galago sp.</i>	Bush baby	Galagidae	DD	
16	<i>Geosciurus inauris</i>	African Ground squirrel	Sciuridae	LC	
17	<i>Lemniscomys Spp</i>	Striped Grass Mouse		LC	hyúu ²
18	<i>Lemniscomys striatus</i>	Spotted grass mouse	Muridae	LC	
19	<i>Micropteropus pusillus</i>	Fruit Bats		LC	Byãà
20	<i>Phataginus tetradactyla</i>	African, black-bellied pangolin	Manidae	VU	
21	<i>Philantomba maxwellii</i>	Antelope	Bovidae	LC	
22	<i>Potamochoerus larvatus</i>	Bush pig	Suidae	LC	
23	<i>Potamochoerus porcus</i>	Bush Pig		LC	Akpã
24	<i>Protoxerus stangeri</i>	The forest giant squirrel	Sciuridae	LC	
25	<i>Rattus rattus</i>	Common rat	Muridae	LC	
26	<i>Rattus fuscipes</i>	Bush Rat		LC	
27	<i>Scotophilus dinganii</i>	The African yellow bat	Vespertilionidae	LC	
28	<i>Taphozous pelti</i>	Giant Pouched Bat	Emballonuridae	LC	
29	<i>Thryonomys swinderianus</i>	Cane Rat	Thryonomyidae	LC	Bínà
30	<i>Xerus erythropus</i>	Striped Ground Squirrel	Sciuridae	LC	

Table 4: Reptalian Resources of the Study Area

S/N	Scientific Name	Common Name	Local Name (Ogoni)	Family	IUCN Status
1	<i>Agama agama</i>	West African Rainbow Lizard	Gbèrè	Agamidae	LC
2	<i>Amblyrhynchus cristatus</i>	Marine Iguana	Byã		V
3	<i>Amietophrynus superciliaris</i>	African giant Toad		Bufonidae	LC
4	<i>Bitis arietans</i>	Puff adder	Bom		V
5	<i>Chamaeleo africanus</i>	The African chameleon		Chamaeleonidae	LC
6	<i>Crocodylus niloticus</i>	Nile Crocodile	Atèkúró	Crocodylidae	LC
7	<i>Dendoaspis jamesoni</i>	The green mamba		Elapidae	LC
8	<i>Gastropyxissmaradgina</i>	Emerald, green snake,		Elapidae	LC
9	<i>GrayaSmithii</i>	Smith's African water snake			LC
10	<i>Hemidactylus kyaboboensis</i>	Forest gecko		Gekkonidae	LC
11	<i>Kinixys belliana</i>	Tortoise		Testudinidae	LC
12	<i>Lampropholis guichenoti</i>	Skink		Scincidae	LC
13	<i>Lycodon morphus inornatus</i>	Olive House Snake			LC
14	<i>Mabuyumaculilabris</i>	Skink		Scincidae	LC
15	<i>Naja nigricincta</i>	Spitting Cobra			LC
16	<i>Naja nigrocollis</i>	Black-necked spitting cobra		Elapidae	LC
17	<i>Osteolaemus tetraspis</i>	Dwarf Crocodile	Pa		LC
18	<i>Python Regius</i>	Royal python	hyóò		NT
19	<i>Python Sebae</i>	African Rock Python	hyóò		LC
20	<i>Sclerophrys regularis</i>	Common African Toad		Bufonidae	LC
21	<i>Tarentolagomerensis</i>	Wall gecko		Gekkonidae	LC
22	<i>Trachylepis affinis</i>	Skink		Scincidae	LC
23	<i>Trachylepis</i> sp.	Stripped Skink		Scincidae	LC
24	<i>Varanus niloticus</i>	Nile Monitor Lizard		Varanidae	LC
25	<i>Varanus varius</i>	Monitor lizard		Varanidae	LC

Note: A - Abundant, C – Common, O – Occasional, R – Rare, NT – Near threatened, and LC - Least concern (Source: Fieldwork 2023)

RELATIVE ABUNDANCE OF FAUNA

Among the fauna groups (mammalian, reptilian, avian, and mollusks), the avian constituted 38 species (40%), mammalian 30 species (31%), and the reptilian 25 species (26%) (Fig. 3). The avian are more frequently seen and reported by the locals. This could be attributed to the fact that they are not easily restricted by barriers. Also, during fieldwork, we observed the majority of the bird species in the open areas of the proposed site.

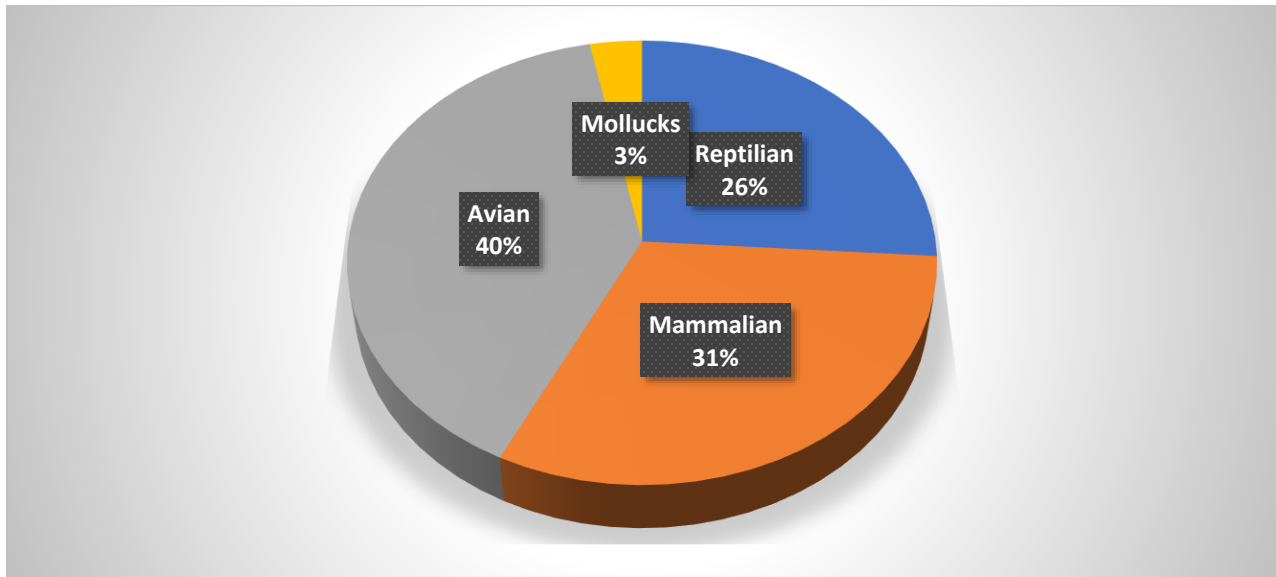


Figure 3: Relative abundance of mammalian, reptilian, avian, and mollusks

CONSERVATION STATUS FAUNA

It is worthy to note that the proposed project site does not have enough vegetation that can serve as habitats that can harbour the fauna species (mammalian, reptilian, and avian). Also, there is no known biodiversity hotspot or Important Bird Area (IBA), nor is there any flora of conservation concern within the study area. Furthermore, the IUCN status of all the avian species identified in the study area Least concern (LC) except *Rhyticeros cassisix* which is on the vulnerable (VU) status. The IUCN status of the mammalian species indicated that *Cephalophus spp* and *Phataginus tetradactyla* are vulnerable (VU), *Cercopithecus nictitans* is endangered (EN) while other mammals identified are on the least concern category. Among the reptiles, *Amblyrhynchus cristatus* and *Bitis arietans* are on the the vulnerable (VU) list while *Python Regius* is on the Near threatened (NT) list. Other reptile species are on the Least concern (LC) list.

These particular mammalian, reptilian, and avian species were not sited within the proposed project site but were only reported by the hunters as one the fauna seen in the secondary forests which are more than 2.0km away from the proposed site. This however asserts that the proposed project area is not inhabited by these species and the birds sited during the fieldwork are not resident in the proposed site since there is no nest or breeding sited observed in the proposed site.

ECOSYSTEM SERVICES

The biodiversity of the area includes both flora and fauna species and its ecological complexes which they are part thereof. The value and uses of flora diversity in the area as stated by the indigenous peoples and residents of the area ranged from economic, social, cultural, and environmental to health. However, the value and uses were in the areas of food, medicine, timber, fuelwood and energy, ornamentals, gums, protection of streams and water bodies and soil erosion prevention.

The faunal value and uses were source of protein (meat/fish), income, animals hide and skin for cultural activities, feathers, medicine, dispersion of seeds, spores, buds and stems for further regeneration, pollination, and cultivation of plants. The faunal species play roles in ecosystem functionality, resilience, adaptation, longevity, and stability. Beyond the socioeconomic and cultural gains of biodiversity, the ecosystem services extend to regulating hydrological cycles regime, local and ambient air quality, carbon sequestration, recreation, and environmental aesthetics.

The ecosystem of the proposed project environs is modified. However, the direct and indirect ecosystem services offered by the biodiversity in the area were also enumerated and ascertained by the locals as shown table below.

ECOSYSTEM SERVICES AND PROVISIONING IN THE STUDY AREA

S/N	FLORA	FAUNA	AVIFAUNA	MULLUSC	INSECTS
1	Herbs for medicine	Meat	Production of feathers	Source of food for man and animals	Pollination
2	Gums	Fats and oil for medicine	Pest control	Sources of protein	Plants dispersion
3	Timber	Cultural	Pollination	Income and	Production of

S/N	FLORA	FAUNA	AVIFAUNA	MULLUSC	INSECTS
		affiliation and belief systems (dances, totem, masquerades, rhymes, and rhythms)		revenue	honey
4	Organic matter	Hide and skin	Seed dispersion	Substrates for animal feed production	Food and source of protein
5	Regulation of local climate	Pets	Meat and food	Used for decoration	Environmental indicators
6	Regulation of hydrological cycle	Soil forming factors and processes	Planters of trees and fruits	Soil forming factors and processes	Soil forming factors and processes
7	Soil aeration and moisturization	Addition of nutrients to the soil	Cultural attachments and indication of progress via continuous nesting	Soil aeration and moisturization	Decomposers and detritus's feeders
8	Fruits, nuts, seeds, and snacks	Guardian spirits	Production of eggs and source of protein	Detritus feeders and decomposers	Pest and weed control
9	Edible leaves and vegetables	Pollination	Nutrient recycling	Landscaping and aesthetics	Maintenance of wildlife species
10	Spices	Seed dispersal	Provision of organic matter	Medicine	Provides food for other organisms especially birds and insect eating animals
11	Shelter for wildlife	Pest and weed control	Environmental beauty	Provision of shelter and protection for other insects against predators	Nutrients cycling
12	Recreation and leisure		Community timekeepers and regulators	Shells used for jewelries	
13	Watershed protection		Natural town criers/informants		
14	Materials for cultural artifacts		Pets and partners		
15	Environmental aesthetics and beautification		Ecosystem indicators/restorers		

In summary, the ecosystem services associated with the study area include provisioning (timber, genetic resource, firewood, wild food, bush meat, fisheries, medicinal plants, and water supply), supporting (habitat for fishes, nursery ground for mangrove and *Nypa* species, and primary production), and regulating (nutrient cycle, and erosion control) (**Plates 11 and 12**)

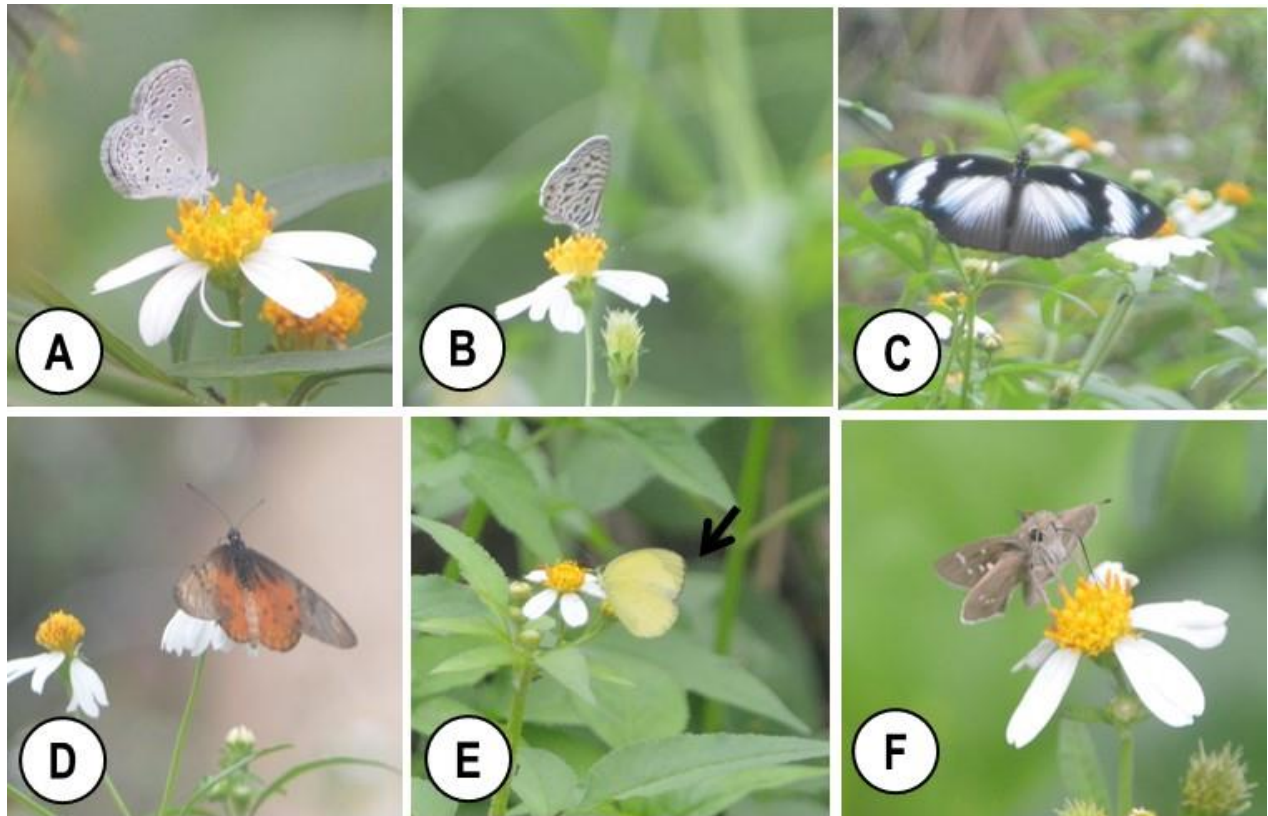


Plate 11: Some insect pollinators observed in the study area

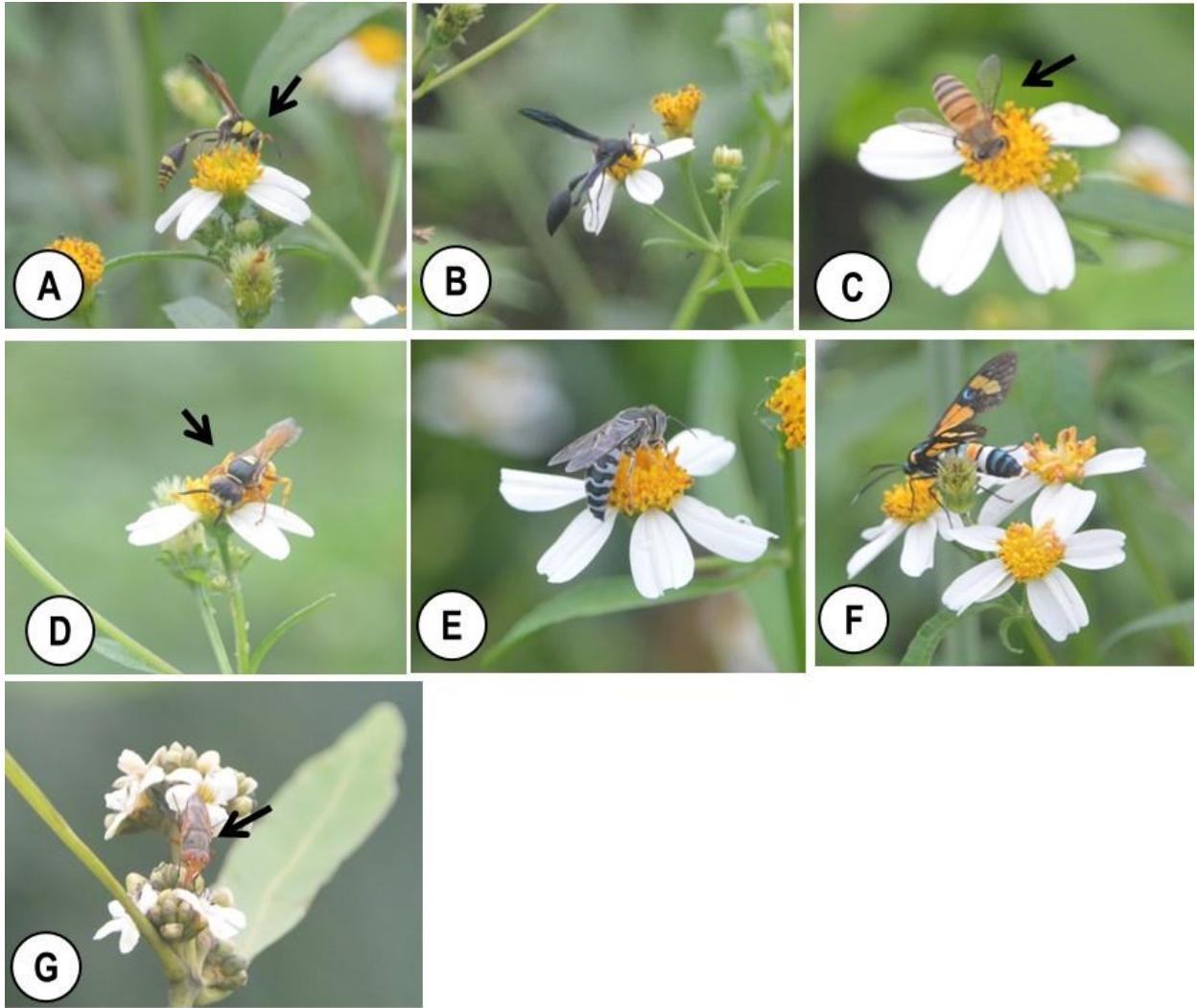


Plate 12: Some insect pollinators observed in the study area.

POTENTIAL ENVIRONMENTAL IMPACTS OF THE PROJECT AND MITIGATION MEASURES

The potential environmental impacts and the mitigative measures are presented in the Table below.

S/N	POTENTIAL ENVIRONMENTAL IMPACTS	MITIGATION MEASURES
1	Loss of fauna and flora habitats, ecological niches, ecosystems, and biodiversity loss.	The project should be restricted to the acquired and sand-filled area allocated to the proposed project site
2	Depletion of fauna and flora species through spillage/leakage of the Urea or Ammonia.	Proper mechanism for handling and operating the Urea or Ammonia should be put in place in order to avoid biodiversity damage, loss, degradation and erosion.
3	Invasion of the area by alien plants and animal species which could bring negative impacts to the native colonizers considering limited environmental resources and space.	The source of the raw materials especially the sand for the construction of the facility should be sort locally to prevent the introduction of non-native species of plants and animals
4	The processes of construction will usher in threats to the functionality and ecosystem sustainability of the area due to distortion, reduction and destabilization of pollinators and dispersal organisms.	Biodiversity Management Plan should be developed and implemented.
5	Poor management and handling of industry wastes which when allowed getting into the surrounding environment can enhance and exacerbate fast growth and development of exotic/alien/invasive species. This can further inhibit the survival and sustainability of the indigenous species.	Waste management plan to be developed and implemented. Developed greeneries.
6	Loss of means of livelihood by the locals	Livelihood sustainability options and enhancement schemes should be put in place especially for those who solely rely on biodiversity (species, organisms, genes, ecosystems and habitats) in order to cushion the socio-economic effect. This can be achieved through skill acquisition programs as well as alternative means of livelihood such as animal husbandry, fish farming, and poultry. Enviably Corporate Social Responsibilities of Indorama should be sustained.

S/N	POTENTIAL ENVIRONMENTAL IMPACTS	MITIGATION MEASURES
7	<p>Upon the decommissioning of the facility, the abandoned structures and possible wastes, hollows, tunnels, and other materials that may provide shelter and possible hideout for reptiles and rodents, storage of water etc. can bring about invasive plants and animals species in the area, thereby causing environmental decay and nuisance to biodiversity.</p>	<p>Upon decommissioning of the facility, the international best practices and guidelines should be adopted and followed to a logical conclusion as this will help in restoration of the initial ecosystem over time. There should be a decommissioning plan in place for the facility approved by relevant authorities.</p>

Appendix 1: Checklist of plants identified in the study area, relative abundance, diversity and evenness.

S/N	Species Name	Family	Q1	Q2	Q3	Q4	Q5	Q6	Cont. 1	Cont. 2	Rel. Abundance
1	<i>Acanthus</i> sp	Acanthaceae	0	0	0	0	10	0	0	4	0.33
2	<i>Acrosticum</i> aureum	Pteridaceae	0	0	0	0	27	0	26	9	0.53
3	<i>Ageratum</i> conyzoides	Asteraceae	10	3	0	8	0	0	19	0	0.96
4	<i>Amaranthus</i> sp	Amaranthaceae	0	0	0	0	3	0	9	0	0.29
5	<i>Ananas</i> comosus	Bromeliaceae	0	0	0	0	0	0	5	0	0.12
6	<i>Andropogon</i> tectorum	Poaceae	12	7	0	0	0	0	0	0	0.45
7	<i>Asystasia</i> gangetica	Acanthaceae	0	0	0	9	0	0	12	28	1.17
8	<i>Avicennia</i> africana	Avicenniaceae	0	0	0	3	6	0	8	30	1.12
9	<i>Bidens</i> pinnata	Asteraceae	48	37	0	0	0	0	0	0	2.03
10	<i>Bulbostylis</i> barbata	Cyperaceae	0	34	39	0	0	0	10	0	1.98
11	<i>Cajanus</i> cajan	Fabaceae	4	0	0	0	0	0	0	0	0.10
12	<i>Carica</i> papaya	Caricaceae	0	0	0	0	0	0	3	0	0.07
13	<i>Chamaecrista</i> mimosoides	Fabaceae	0	0	0	0	0	0	0	5	0.12
14	<i>Chromolaena</i> odorata	Asteraceae	0	0	0	0	0	7	0	0	0.17
15	<i>Cintrocema</i> purbesense	Fabaceae	3	0	7	0	0	0	0	34	1.05
16	<i>Cleome</i> viscosa	Cleomaceae	0	23	0	0	0	19	0	0	1.00
17	<i>Colocasia</i> esculenta	Araceae	0	0	0	0	0	0	12	0	0.29
18	<i>Commelin</i> spp	Commelinaceae	0	0	0	0	0	0	13	10	0.55
19	<i>Cyathula</i> prostrata	Acanthaceae	0	0	0	0	0	0	45	10	1.31
20	<i>Cynodon</i> dactylon	Poaceae	0	0	0	16	0	0	12	0	0.67
21	<i>Dacryodes</i> edulia	Burseraceae	0	0	0	0	0	0	2	0	0.05

S/N	Species Name	Family	Q1	Q2	Q3	Q4	Q5	Q6	Cont. 1	Cont. 2	Rel. Abundance
22	<i>Derris</i> sp	Fabaceae	14	0	0	7	12	0	0	45	1.86
23	<i>Desmodiumscorpiurus</i>	Fabaceae	0	5	0	0	0	0	0	0	0.12
24	<i>Desmodium</i> sp	Fabaceae	10	0	0	0	0	0	0	0	0.24
25	<i>Desmodiumtortuosum</i>	Fabaceae	0	0	0	0	0	0	12	0	0.29
26	<i>Digitariaargillacea</i>	Poaceae	59	20	0	0	299	0	0	0	9.03
27	<i>Digitarialoniflora</i>	Poaceae	0	0	69	0	74	0	19	0	3.87
28	<i>Diodiasarmentosa</i>	Rubiacea	0	0	0	0	0	0	0	15	0.36
29	<i>Eclipta alba</i>	Asteraceae	3	0	19	0	0	0	19	0	0.98
30	<i>Elieasguinnessis</i>	Arecaceae	0	0	0	0	0	0	5	13	0.43
31	<i>Eluesineindica</i>	Poaceae	0	0	0	19	0	0	25	0	1.05
32	<i>Emilia praetermissa</i>	Asteraceae	5	0	17	0	0	0	0	4	0.62
33	<i>Eragrostis</i> sp	Poaceae	0	208	0	89	75	0	0	0	8.89
34	<i>Euphorbia heterophylla</i>	Euphorbiaceae	10	0	0	0	0	0	0	34	1.05
35	<i>Ficus</i> sp	Moraceae	2	0	0	5	0	0	0	5	0.29
36	<i>Fimbristylis</i> sp	Cyperaceae	100	0	56	8	4	96	13	0	6.62
37	<i>Fimbristylisferruginea</i>	Cyperaceae	38	20	25	90	59	70	0	0	7.22
38	<i>Finbristylislitterolis</i>	Cyperaceae	45	84	0	0	207	10	0	0	8.27
39	<i>Gomphrenacelosioides</i>	Amaranthaceae	4	10	0	0	0	0	0	15	0.69
40	<i>Heritierasp</i>	Malvaceae	0	0	0	0	10	0	0	7	0.41
41	<i>Heterotisrotundifolia</i>	Melastomataceae	0	0	0	9	0	0	19	9	0.88
42	<i>Hyptislanceolata</i>	Lamiaceae	0	0	0	0	0	5	0	0	0.12
43	<i>Ipomoea aquatica</i>	Convulvolaceae	0	0	3	0	0	0	5	14	0.53

S/N	Species Name	Family	Q1	Q2	Q3	Q4	Q5	Q6	Cont. 1	Cont. 2	Rel. Abundance
44	<i>Ipomoea pes-caprae</i>	Convulvolaceae	6	0	4	0	0	0	0	0	0.24
45	<i>Kyllingaperuviana</i>	Cyperaceae	13	13	20	0	0	0	0	0	1.10
46	<i>Lagunculariaracemosa</i>	Combretaceae	19	0	0	6	0	0	15	4	1.05
47	<i>Lumnitzera</i> sp	Combretaceae	2	0	0	3	0	0	2	10	0.41
48	<i>Mangifera</i> indica	Anacardiaceae	0	0	0	0	0	0	3	1	0.10
49	<i>Mariscus</i> ligularia	Cyperaceae	30	0	6	0	0	0	8	55	2.37
50	<i>Mimosa</i> invosa	Fabaceae	0	4	4	0	0	0	0	0	0.19
51	<i>Mimosa</i> pudica	Fabaceae	5	0	0	0	0	0	0	0	0.12
52	<i>Momordica</i> charantia	Cucurbitaceae	0	0	3	0	0	0	0	0	0.07
53	<i>Nelsonia</i> canescens	Acanthaceae	0	0	0	0	0	4	0	10	0.33
54	<i>Nypa</i> fructicans	Araceae	3	0	0	5	0	0	15	19	1.00
55	<i>Oldenlandia</i> herbecea	Rubiacea	0	33	0	0	0	0	3	18	1.29
56	<i>Panicum</i> laxum	Poaceae	0	34	0	78	0	0	23	12	3.51
57	<i>Panicum</i> maximum	Poaceae	3	0	0	18	0	0	0	0	0.50
58	<i>Paspalum</i> conjugatum	Poaceae	0	17	0	0	67	0	0	16	2.39
59	<i>Passiflora</i> foetida	Passifloraceae	3	0	3	0	0	0	0	0	0.14
60	<i>Pennisetum</i> pedicellatum	Poaceae	20	0	13	0	0	0	0	0	0.79
61	<i>Persea</i> americana	Anacardiaceae	0	0	0	0	0	0	2	0	0.05
62	<i>Phyllanthus</i> amarus	Euphorbiaceae	0	0	2	0	0	22	0	29	1.27
63	<i>Psidium</i> gujava	Myrtaceae	0	0	0	0	0	0	7	0	0.17
64	<i>Pterocarpus</i> santaloides	Fabaceae	0	0	1	3	0	0	0	7	0.26
65	<i>Puraria</i> phaseoloides	Fabaceae	3	0	0	0	18	0	0	5	0.62

S/N	Species Name	Family	Q1	Q2	Q3	Q4	Q5	Q6	Cont. 1	Cont. 2	Rel. Abundance
66	<i>Rhizophoraharrisonii</i>	Rhizophoraceae	0	0	0	5	4	0	32	39	1.91
67	<i>Rhizophora mangle</i>	Rhizophoraceae	0	0	0	3	5	0	23	47	1.86
68	<i>Rhizophoraracemosa</i>	Rhizophoraceae	0	0	0	2	0	0	17	23	1.00
69	<i>Rhynchelytrumrepens</i>	Poaceae	0	0	0	2	0	0	0	0	0.05
70	<i>Rice grass</i>	Poaceae	30	0	13	0	0	18	0	0	1.46
71	<i>Schwenckiaamericana</i>	Solanaceae	0	0	0	0	0	0	17	12	0.69
72	<i>Scopariadulcis</i>	Scrophulariaceae	0	0	0	4	0	0	8	0	0.29
73	<i>Sesuviumportulacastrum</i>	Portulacaceae	45	0	0	0	0	0	0	0	1.08
74	<i>Seteria pumila</i>	Poaceae	0	0	13	3	0	0	0	0	0.38
75	<i>Sidaacuta</i>	Malvaceae	0	18	0	2	0	0	0	0	0.48
76	<i>Spermacoceverticilata</i>	Rubiacea	12	0	10	7	0	0	0	7	0.86
77	<i>Spigeliaanthelmia</i>	Longaniaceae	0	18	0	0	0	0	0	14	0.76
78	<i>Stachytarphetacayennensis</i>	Verbenaceae	0	0	0	0	5	0	0	21	0.62
79	<i>Terminalia catappa</i>	Combretaceae	0	0	0	2	0	0	0	6	0.19
80	<i>Tridaxprocumbense</i>	Asteraceae	7	0	0	0	0	0	0	0	0.17
81	<i>Trimphettacordifolia</i>	Malvaceae	0	0	7	0	0	0	20	0	0.65
82	<i>Urenalobata</i>	Malvaceae	0	0	5	0	0	0	15	3	0.55
83	<i>Vignasp</i>	Fabaceae	5	0	0	4	0	0	0	0	0.22
84	<i>Vignasp2</i>	Fabaceae	0	0	2	0	0	0	3	9	0.33
85	<i>Xanthosomamaffafa</i>	Araceae	0	0	0	0	0	0	13	0	0.31
Number of Species			32.00	18.00	21.00	26.00	17.00	9.00	36.00	38.00	
Shannon Index			2.89	2.29	2.55	2.41	2.00	1.69	3.36	3.36	

S/N	Species Name	Family	Q1	Q2	Q3	Q4	Q5	Q6	Cont. 1	Cont. 2	Rel. Abundance
Shannon Evenness			0.84	0.79	0.84	0.74	0.71	0.77	0.94	0.92	

