



Assessment of Threats to Survival of Biodiversity and Ecosystem Services in Stubbs Creek Forest Reserve, Akwa Ibom State

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Authors' contributions

This work was carried out in collaboration among all authors. Author NEU designed the study, wrote the protocol, managed literature searches, carried out field data gathering, performed the statistical analysis and wrote the first draft of the manuscript. Authors GCO and KOEU managed the analyses of the study. Author KOEU produced the site study map. All authors read and approved the final manuscript.

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ABSTRACT

Different climes are endowed with a myriad of biodiversity resources, ecosystem services and functions suited to sustenance of lives and providing assorted raw materials for sustainable development if effectively managed. There is global outcry about disappearing biodiversity and mismanaged fragile ecosystems. Human endeavours are strongly implicated in the resulting distorted ecological balance. This study therefore sets out to examine the cause and effects of the declining singular gazetted forest reserve in Akwa Ibom State, the Stubbs Creek Forest Reserve (SCFR). Threats to survival of biodiversity and ecosystem services (BES) were studied qualitatively (a combination of field observation and engagement with key stakeholders of SCFR). Community forest occupational user-groups, corporate players and the public sector were engaged. Outcomes

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of the study suggest that among other factors, institutional weakness and unsustainable consumption patterns may be of primary concern in tackling further degradation. A quick concerted intervention is required to reposition SCFR for alignment with global sustainable development goal 15, ecosystem restoration and climate change adaptation.

Keywords: Biodiversity and ecosystem services; climate change adaptation; conservation; livelihoods; sustainability.

1. INTRODUCTION

The survival of biodiversity and ecosystem services (BES) has become very topical both internationally and locally within the last three decades. Actions to stem the tide of steady and rapid BES loss have mostly been driven by non-governmental organizations (NGOs) and the public sector. Currently, the organized private sector, businesses and corporate organizations have started integrating BES considerations into their operations as a way of assuring net positive impact to BES in their footprint areas.

The Millennium Ecosystem Assessment [1] takes a close look at the inter-relationship between BES and gives the following definitions: Biodiversity is the variability among living organisms including diversity within and among species and diversity within and among ecosystems. It is the source of many ecosystem goods, such as food and genetic resources, and changes in biodiversity can influence the supply of ecosystem services. Ecosystem services on the other hand, are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as climate regulation, flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth.

The importance of ecosystem services for human well-being and climate adaptation in tropical countries are well documented and emphasized by The Economics of Ecosystems and Biodiversity (TEEB), The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and the Intergovernmental Panel on Climate Change (IPCC). However, the trend in BES management in these countries shows that the understanding of the changes in ecosystem processes and the relationship between changes in land use and land cover (LULC) and the provision of ecosystem services is poor [2]. Tropical ecosystems are being grossly degraded and lost due to the rapid changes in LULC and these have adverse impacts on the services these ecosystems provide [3;1].

Thus, the major challenges to the survival and sustainability of BES include habitat loss and degradation, climate change, excessive nutrient load and other forms of pollution, over-exploitation and unsustainable use, and invasive alien species. These five pressures somewhat intensify persistently without adequate signs of reducing BES loss as evidenced by governments reports of these direct drivers of biodiversity loss in different countries [4]. This research examined the outcomes of identified pressure on BES of the Stubbs Creek Forest Reserve (SCFR) in Akwa Ibom State, which has been under gradual alteration due to vigorous anthropogenic activities ranging from oil and gas exploration to unsustainable natural resource utilization. The focus of this study is to assess the threats to survival of BES in SCFR using a qualitative approach of data gathering and analyses to proffer sustainable management solutions to engender landscape planning and sustainable natural resource management.

1.1 Statement of the Problem

The primary contemporary drivers of tropical forest biodiversity loss include direct effects of human activities such as habitat destruction and fragmentation (land-use change), invasive species and over-exploitation, as well as indirect effects of human activities such as climate change [1,5]. Deforestation and habitat fragmentation are directly implicated in reduction of quality and quantity of forests [6,7;8] This affects species richness and survival especially those that are restricted in range [9]. Besides having effects at the species level, the network (interaction) level too can be affected [5]. Over-exploitation of particular species can result in local or global extinction. This is common in hunting large mammals for bush meat and tropical hardwood for timber [10;11]. Non-native species that have either established or introduced outside their natural range can cause extinctions, alter biotic environments, become pests or introduce diseases [12], and have the potential to dominate disturbed or open tropical forest areas, with negative impact on their

recovery [13]. [14] corroborates the fact that climate change plays a part in range shifts to higher latitudes and elevations leading to expansion of species into areas of suitable climates while shrinking from warmer climates. The [1] states that the land use change mainly from deforestation hinders the carbon sequestration abilities of forest ecosystems because they are important carbon sinks. Climate change is also reported to have a variety of impacts on the distribution of forest organisms and populations as well as impact ecosystem function and composition. There is still a dearth in comprehending the depths and breadth of sustainable management of natural resources, especially tropical forest reserves in Nigeria *vis-à-vis* the services and functions of forest biodiversity and ecosystem services derivable therefrom. Species loss from an ecosystem also affects its interactions, and the ecological functions that result from these interactions, for example, seed dispersal. These interactions can be critical to the survival or functioning of other species or the ecosystem itself [5]. [15], reports that loss of interaction has pervasive effects on both ecosystem structure and functioning due to the relationship between species diversity, network structure and ecosystem functioning. Based on the foregoing, forest management regimes have not been planned, implemented and monitored effectively both at the government and the community levels. This study, therefore, evaluated the basic impediments and their projected outcomes to the sustainable management of SCFR.

2. MATERIALS AND METHODS

2.1 Study Area

The Stubbs Creek Forest Reserve (SCFR) was created in 1930 under order 45. This original order was subsequently amended by orders 16, 17, and 28 of 1941; E. R. L. N 236 of 1955 and E.R.L.N 56 of 1962. It is the only gazetted forest reserve in the state and covers an approximate area of 310.78 km². SCFR lies between the Cross River and the Qua Iboe River with the Atlantic Ocean marking the southern boundary. The Stubbs Creek and Weidenham Creek run across the reserve connecting to the Qua Iboe River and the Cross River respectively. Douglas Creek occurs south of the Stubbs - Weidenham Creeks and flow into the Qua Iboe River near Mkpanak. The SCFR abuts on the Atlantic Ocean to the south, bordered by Qua Iboe River to the west and the Cross River estuary to the East. There is no major river system on the

northern border. It is under tidal inundation by two major creeks – the Widenham Creek running east from the centre of the reserve to the Cross River estuary and the Stubbs Creek from the centre of the reserve to the Qua Iboe River. The southern approach is inundated by the Douglas Creek and the Atlantic Ocean. The reach between Widenham and Stubbs Creeks have a tidal delay of about 1 hour 20 minutes of Qua Iboe River with tidal amplitude of about one metre. The area lies within the low-lying coastal zone (elevation 16 to 22 m above sea level) with parallel beach-ridge sand deposits and intervening freshwater swamp forests. The ridges are impoverished in soil nutrients and have sparse plant growth while the swamps are thickly forested and almost impenetrable in many sections [16,17]. The communities sampled within the three Local Government Areas surrounding the study area include Mbo (Unyenge, Enwang, Abutong and Ibaka), Esit-Eket (Akpautong, Ntak Inyang, Odoro Nkid, and Edor) and Ibeno (Upenekang, Mkpanak and Inua Eyiet Ikot).

2.2 Method

The qualitative approach to data acquisition and analysis was used for this study. This involved survey (questionnaires, key informant interviews and focus group discussions) and field (naturalistic) observation to validate the narratives from respondents. SCFR habitat characterization was done using indicator species as spelt out in [18]. Both faunistic and floristic indicators of the different habitat types are presented in the results section. Three sets of discussion sessions were held with identified stakeholders involved in the usage of SCFR. The first group involved the forest occupational user-groups (traditional rulers, timber loggers, traditional medical practitioners, hunters, sand miners, fisher folks, farmers, women and non-timber forest product collectors). These set of respondents provided information on historical perspectives, natural resources, methods of exploitation, value of ecosystem services derived, threats to the survival of the BES in SCFR and institutional weakness. The second set of respondents were oil and gas industry workers who preferred anonymity. They corroborated the fact of institutional weakness and provided information on threats to the relics of BES in SCFR as well. The Akwa Ibom State Ministry of Environment, through the Department of Forestry provided information on the history and potentials of the forest reserve, management regimes and challenges.

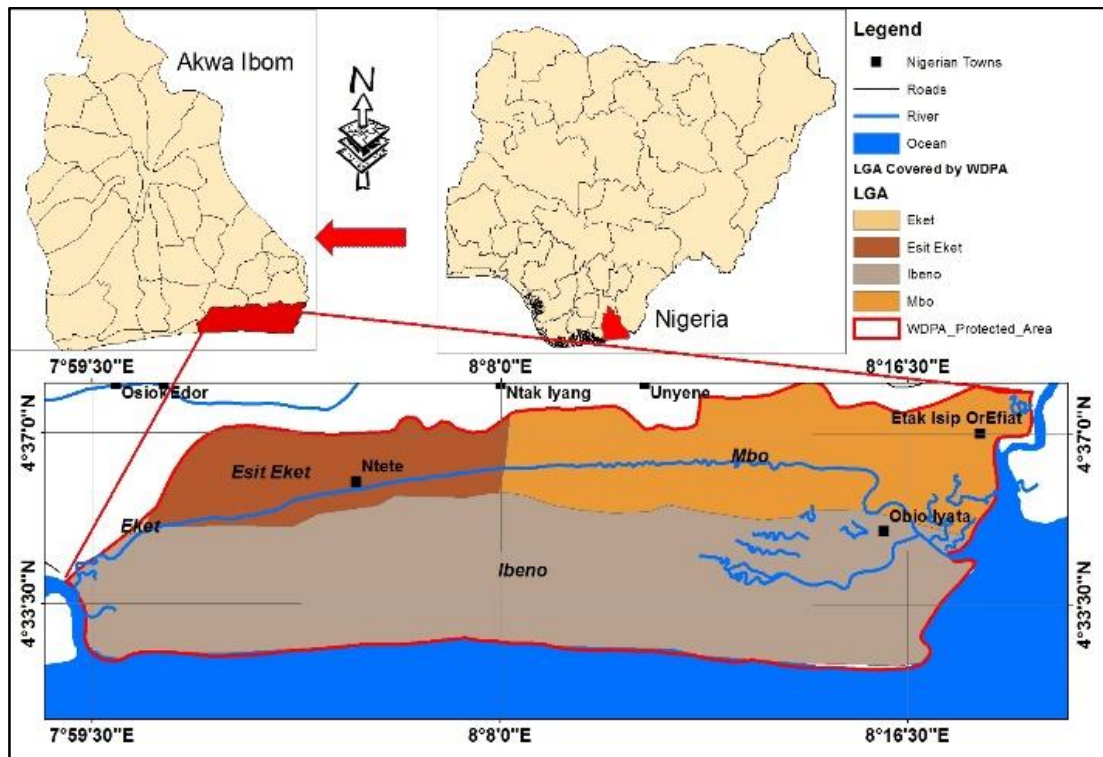


Fig. 1. Map of the study area (Stubbs Creek Forest Reserve) showing surrounding LGAs of the WDPA

3. RESULTS

3.1 Field Visit

Transect walks through the four cardinal points of the SCFR revealed an extensive anthropogenic activity resulting in serious modification of the original estate. These human interventions have left in its trail different types of vegetation cover. These are: a highly fragmented low land rain forest zone, a freshwater swamp (levee) forest zone and a fairly intact rain forest core dominated by tropical hard wood species (Plate 1). Others include a Gmelina plantation, farms (mostly with cassava and maize, Plate 2) and abandoned farmlands at various stages of vegetation succession. The transect walk along the coastal beach showed two main vegetation types – the barrier island dominated by *Terminalia catappa*, *Delbergia sp*, *Ipomoea sp* and *Paspalum* species and mangrove swamp forest consisting mostly of *Nypa fruiticans*, *Avicennia germinans* and *Rhizophora* species (Plate 3).

Crocodylus frontatus, *Python sebae*, *Naja nigricollis*, *Varanus niloticus* and *Agama agama*), amphibians (*Ptychadena*, *Xenopus laevis*, *Bufo regularis*, and *Chiromantis rufescens*), and aves (*Egretta garzetta*, *Corvus albus*, *Milvus migrans*, *Necrosyrtes monachus* and *Psittachus erithacus*). The mammalian species include *Sclater's guenon*, *Cercopithecus sclateri*, *Arctocebus calabarienses* and *Galago alleni*.



Plate 1. A patch of fragmented lowland forest area with fairly intact innermost forest core dominated by hardwood species

A checklist of the faunistic characteristics of SCFR include reptiles (*Osteolaemus tetraspis*,



Plate 2. Farms (mostly with cassava and maize) within the heart of the forest



Plate 3. Atlantic shoreline boundary, south of the SCFR with exotic *Nypa fruticans*



Plate 4. Massive but unregulated logging transported through the creek at unyenge axis

3.2 Visible Threats to BES

The current trend of unabated human activity in SCFR as seen during the study is somewhat difficult to expect the forest to remain within the next 15 – 20 years. The most readily observed threats include unregulated timber exploitation

(Plate 4), increased oil and gas activity within the forest (Plate 5), and reckless forest reclamation for unsustainable agricultural practices (Plate 6).



Plate 5. Gas flaring indicating active oil and gas production activity within the forest



Plate 6. Slash and burn agricultural practices within the SCFR is a consistent feature

Plate 7 below illustrates the unregulated hunting of high-profile endemic wildlife species from the reserve. Other forms of natural resource utilization are shown on Plates 8 and 9.



Plate 7. Unregulated hunting of endemic and endangered wildlife such as *Sclaters' guenon* is persistent around the SCFR

Source: [19]



Plate 8. A fisherman with his fishing gear at Ibeno beach



Plate 9. Sand mining within the reserve is common feature

The common occurring fish species for the freshwater limits within the study area are both fin and non-fin fishes. The non-fin fishes observed include *Macrobrachium felicinum*, *M. vollenhoveni*, *Callinectes aminicola*, *Desmocariss trispinosa*, *D. bislineata* and land and sand crabs *Cardisoma armatum* and *Ocypoda* sp respectively. The fin fishes include *Tilapia zillii*, *Tilapia mariae*, *Sarotherodon melanotheron*, *Chrysichthys nigrodigitatus*, and *Ethmalosa fimbriata*. Plate 10 below shows a picture of roasted *Chrysichthys nigrodigitatus* known by the indigenous people as ibat on sale.



Plate 10. Roasted *Chrysichthys nigrodigitatus* (ibat)

3.3 Feedback from Stakeholder Engagements

Table 1 presents the demographic characteristics of respondents consulted for this study. A total of 300 respondents were engaged from key stakeholder groups comprising representatives from communities in the three local government areas, public servants, oil and gas industry workers, and forest occupational user-groups. The male folks accounted for 170 (56.7%) while the female folks were 130 (43.3%). A total population of 60 (20%) of respondents were public servants from the State Forestry Department, Local Government staff, Academics as well as health workers while 30 (10%) of the respondents were from the oil and gas industry doing business around/within the study area. The remaining 210 (70%) of respondents comprise of the various forest occupational user groups within the SCFR.

3.4 Key Research Questions

Six (6) key questions were customized to elicit frank responses and accurate outcomes from focal persons engaged either by questionnaires or personal interviews. Transcripts of responses are presented below.

The transcript below summarizes responses to Question 1.

3.4.1 Verify the authenticity of SCFR

- i. Is the entity SCFR in existence?
- ii. Is it rich in biodiversity and ecosystem services?
- iii. Is it necessary to conserve the SCFR?

Give reasons for your answer.

3.4.1.1 Responses from Respondents

- i. There is an entity called SCFR and it straddles 3 Local Government Areas namely Esit-Eket, Ibeno and Mbo.
- ii. SCFR is very rich in biodiversity because it provides several communities with drinking water, firewood, non-timber forest products such as fruits, spices, seeds, bushmeat, herbal medicines, etc.
- ii. There is presence of ""big animals"" such as monkey, chimpanzee, manatee, bush pig, antelope, pangolin, pythons, mambas, and there is always game to hunt by hunters.

- iic. There are different types of ""bush"" (vegetation types) that serve different purposes for different people including herbs for medicines, vegetables, timber. The mangroves are home to a lot of species such as fish, periwinkles, bivalves (shellfish), clams, etc and provide firewood as well.
- iid. Many families are depending on the forest resources for daily livelihoods due to paucity of job opportunities and poverty."
- iiia1. It is necessary to conserve the forest to preserve the natural resources for future generations.
- iiia2. Conservation of SCFR will help the timber and forest generally to mature.
- iiia3. Conservation will allow all the ""big animals"" to return to the SCFR.
- iiia4. It is necessary to conserve the forest to help combat climate change and serve as an ecotourism centre.
- iiib1. There is no need to conserve the forest because we will be deprived of our means of livelihood.
- iiib2. There is no need to conserve the forest because a greater part of the forest has been de-reserved by government and given as concession to timber merchants and oil and gas industries for exploitation."

3.4.2 Key Research question 2

What are the key faunal and floral species in SCFR?

Key faunal species listed include white-throated monkeys, manatees, chimpanzee, crocodiles, alligators, bush pigs, elephants, antelopes, tortoise, tilapia, red-snapper, pythons, parrots, pied crow, waxbills, turtles, porcupines, and African civet.

The floral species include cedar, iroko, red iron wood, mahogany, achie, bush mango, oil palm, Indian almond, morning glory, red mangrove, nypa palms, African pear, raffia palm, bitter cola, and coconut.

Table 1. Demographic characteristics of respondents

Demographic Variables	Frequency	Percentage (%)
Sex		
Male	170	56.7
Female	130	43.3
Total	300	100
Age		
21-40	78	26
41-60	147	49
>61	75	25
Total	300	100
Highest Educational Background		
Non-Formal Education	57	19
Primary Education	59	19.6
Secondary Education	83	27.7
Vocational/ Technical Education	39	13
Tertiary Education		
College of Education	35	11.7
Polytechnic / University	27	9
Total	300	100
Occupation		
Crop farmers	35	11.7
Fishermen	25	8.3
Hunters	17	5.7
Trado-Medical Practitioners	10	3.3
Poultry	18	6
Piggery	6	2
Non-Timber Forest Product (NTFP) Harvesters	34	11.3
Loggers	25	8.3
Sand Miners	20	6.7
Artisans	20	6.7
Oil and Gas Industry Workers	30	10
Public Servants	60	20
Total	300	100

Field data gathering 2019

Table 2. Key research question 1

Key Research Question 1	Responses			
	Yes	No	Unsure	Total
Verify the authenticity of Stubbs Creek Forest Reserve.				
Is the entity SCFR in existence?	300	0	0	300
Is it rich in BES?	300	0	0	300
Is it necessary to conserve the SCFR?	170	100	30	300

3.4.3 The responses key question 3 are transcribed in Table 3

Table 3. Responses to key research question 3

Key Research Question 3	Responses			
	Yes	No	Unsure	Total
In your own view, what are the challenges of BES conservation in the reserve?				
Lack of awareness of sustainable utilization of natural resources.	178	57	65	300
Poor program implementation by government.	260	0	40	300
Non-involvement of community members in management of the reserve.	300	0	0	300
Unacceptance of conservation by community members.	14	276	10	300
De-reservation and land concession granted to oil and gas industry operators.	246	20	34	300
Weak implementation of existing though obsolete forest management legislation.	287	5	8	300
Land encroachment in search of means of livelihood through farming, sand mining, lumbering, logging, chemical fishing, hunting, grazing, etc.	230	26	44	300
Absence of compensation and alternative means of sustainable livelihoods for forest dependent communities.	290	0	10	300
Lack of assistance from the corporate bodies doing business around the reserve.	196	56	48	300
Noise pollution due to indiscriminate use of chain saw for felling timber.	217	0	83	300
Noise pollution due to activities of oil and gas companies.	185	0	115	300
Impacts of oil and gas industry such as continuous gas flaring and oil spill.	200	22	78	300

3.4.4 Key research questions 4 and 5

Responses to question 4 alluding to the various activities that have impacts on the reserve are presented in Table 4 below while Table 5 describes the impacts of these activities and the impact rating.

3.4.5 Key research question 6

What actions should be taken to reduce or remove these threats and impacts? Discuss freely.

The summary transcript of responses for this question is presented below.

1. Proper demarcation and delineation of the reserve.
2. Stop granting concession to the companies and developers in the remaining portions of the forest reserve.
3. Training of field officers for efficiency, empowerment and adequate policing of the reserve.
4. Tripartite partnership involving Government, Industry and Communities for conservation of SCFR.

5. Large scale employment opportunities for the forest-dependent people.
6. Provision of micro-credit scheme for micro-enterprises and massive skill acquisition schemes.
7. Adequate Community-Based BES legislation and implementation of policies.
8. Active and focused reforestation of SCFR.
9. Moratorium on logging and hunting in the reserve.
10. Payment of royalty to the communities for development.
11. Adequate awareness campaign to arouse and sustain the interest of the people in conservation.
12. Creation of a wildlife sanctuary within the forest reserve.
13. Construction of erosion control/ shoreline embankment and wave breakers to halt the encroachment of the sea on the reserve.

The responses from questionnaires and personal interviews were further examined along 3 major groupings namely forest occupational-user groups, workers in the oil and gas industries around the reserve and public sector players.

This was to establish the thought pattern among homogenous stakeholder groupings.

3.5 Responses from Forest Occupational User-groups

This stakeholder group comprises traditional rulers, timber loggers, trado-medical practitioners, hunters, sand miners, fisher folks, farmers, women and non-timber forest product collectors. Interaction with this group revealed that the degradation and fragmentation of SCFR has been a gradual but steady process dating back about three decades ago owing to continuous struggle for survival. The indigenes posited that the forest has been and remains their only source of livelihood. Major concerns include poverty level and need for increased income and alternative livelihoods, population

increase and need for settlement expansion, hunger and the need for increased farmlands, unsustainable exploitation of resources such as chemical fishing, uncontrolled logging, marine transportation, and absence of government intervention to re-demarcate acceptable boundaries, check incessant depletion of forest resources as well as continuous concession to oil and gas operators to install facilities within the forest. Equally important is the impact of gas flaring and oil spills on the faunal and floral resources of the reserve. Others include diminishing respect for tradition, continuous increase in the price of kerosene and the need for steady supply of fuelwood for domestic activities, and inadequate knowledge and understanding of the merits of environmental/ BES conservation and management.

Table 4. Key activities impacting SCFR

Key Review Question 4	Responses			
	Yes	No	Unsure	Total
What are the key activities that impact the SCFR?				
Unregulated hunting	230		70	300
Reckless logging/lumbering	300	0	0	300
Farming	300	0	0	300
Fishing	240	0	60	300
Bush burning	300	0	0	300
Alien invasive species	170	0	130	300
Sand mining	198	0	102	300
Continuous gas flaring	300	0	0	300
Deforestation for development and settlement	300	0	0	300
Oil and Gas exploration	300	0	0	300

Table 5. Enumerated impacts and their severity on SCFR

Key Review Question 5	Responses				
	Yes	No	Unsure	Impact rating	Total
What are the impacts of these activities and the level of seriousness (High, Medium, Low) of the impacts on forests?					
Habitat fragmentation	288	0	12	High	300
Habitat alteration/ conversion	300	0	0	High	300
Deforestation	246	7	47	High	300
Biodiversity Loss	200	54	46	High	300
Disappearing endemic faunal and floristic species	300	0	0	High	300
Overfishing	267	0	33	High	300
Pollution (Noise)	278	0	22	High	300
Pollution (Oil Spill)	160	78	62	Medium	300
Pollution (Light - continuous gas flaring)	271	0	29	High	300
Encroachment of the sea into the forest	210	0	90	High	300

3.6 Responses from Workers in the Oil and Gas Industry

These group of stakeholders agree that SCFR is under serious threat of total disintegration and that the government doesn't seem to take conservation of the reserve seriously.

3.7 Responses from the Public Sector

Interaction from the responsible government organs revealed the willingness to protect the SCFR and its resources on one hand and lack of fiscal resources from appropriate quarters to fund conservation projects on the flip side. Equally disturbing is the many concessions given to players in the oil and gas industry which has exerted a lot of pressure on BES of the reserve.

4. DISCUSSION

A critical look at the context of responses from all three sectoral stakeholders reveals that the prevailing scenario of utilization of BES in SCFR may be largely due to institutional weakness [20] and unsustainable consumption patterns [21;22]. In-depth interactions with stakeholders show that the issue of sustainable natural resource management ranks low on government's scale of preference. This is evident in absence of relevant BES conservation enabling legislation, near-absence of enforcement of existing though obsolete forestry laws, and a somewhat total negligence of the only gazetted forest reserve in the State. The continuous licensing and land concession to oil and gas industries to operate within SCFR only suggests that government is still heavily dependent on finite and non-renewable oil and gas resources to the detriment of renewable natural resources which do not only accentuate sustainable development but assists in climate change adaptation [23]. The delay in re-demarcation of the extents of patches that can still be protected only encourages extensive secondary impacts of oil and gas extraction. The areas of SCFR which hitherto were largely inaccessible have largely been brought down by timber merchants, farmers, hunters, sand miners as seen during the field visit. Encroachment into the core zone of the reserve has thrived unchecked over a period of time with attendant modification and /or distortion of ecosystems conditions which may result in reduction or elimination of the services and functions derived from such systems.

Furthermore, methods of exploitation of the forest resources are uncontrolled. In most cases, tree saplings have been prematurely cut for sale due to the absence of matured timber. Slash and burn farming practices only fragment and degrade the previously pristine and contiguous SCFR. This may exacerbate climate change rather than mitigate owing to the fact that forests are carbon sinks [24;25]. The SCFR habitat fragmentation and degradation may have contributed to migration or disappearance of endemic species such as *Cercopithecus sclateri* (Sclater's guenon - white throated monkey). Other high-profile species including *Trichechus senegalensis* (manatee) and *Pan troglodytes* (chimpanzee) have not been sighted in many years. Particularly striking is the fact that hunters attribute the paucity in availability of wildlife and bush meat trade to disappearing vegetation (deforestation, habitat fragmentation and degradation) and continuous gas flaring which makes the animals unsettled at night seasons. This is a factor in species migration. Farmers also alluded to the fact that indicator species such as dung beetles and certain insects are "rarely seen these days". This observation lends credence to the fact that "land-use change may both confound and compound the influence of global climate change on biodiversity," due to deforestation [26].

5. CONCLUSION

SCFR is one rare entity in the country and therefore deserves to be preserved. The juxtaposition of a mosaic of ecosystems and species with attendant services and functions derivable therefrom makes it a BES hot spot. Absence of relevant community-based BES enabling legislation with corresponding implementation hinders the effective and sustainable management of the reserve. The results obtained from this study also indicate that the field officers tasked with the responsibility of monitoring the activities in the forest need adequate training and empowerment for their functions. It is also important that a new and acceptable forest demarcation and delineation be done to secure the sections of the reserves that can still be managed. This will ensure compliance by all stakeholders to SCFR and alignment with the Global Sustainable Development Goal #15 with its core at "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss".

6. RECOMMENDATIONS

Environmental Impact Assessment [27] prescribes a full Environmental Impact Assessment (EIA) study for Category 1 projects which includes projects with potentials of major alteration to the environment and BES or projects located in environmentally sensitive areas among other criteria. The EIA predicts potential direct and indirect impacts of the proposed projects and makes recommendations as to the appropriateness of projects and their proposed sites, and concludes with a working document called the Environmental Management Plan which ensures that the environment is managed responsibly with minimal adverse impacts. The case of SCFR doesn't seem to reflect this due environmental sustainability process based on the outcomes of the various human interventions within the reserve. This study therefore recommends that:

- AKSG reviews her existing forestry laws to suit the purpose of sustainable and community-based forest management. This will aid the recovery and enhancement of the relics of BES in the reserve.
- AKSG develops appropriate indicators and adopt modern technology for periodic LULC changes and BES monitoring at all levels including species, habitat and landscape trends as well as activities of concessionaires around the reserve.
- The various oil and gas industry players doing business within and around the reserve demonstrate compliance to State BES laws including the Flare Gas (Prevention of Waste and Pollution) Regulations 2018 as well as Oil and Gas Producers' (OGP) Industry Environmental Standards within their footprints SCFR [28, 29].
- AKSG urgently seeks out an appropriate location within the State to establish BES offset programs.
- The responsible government ministry/ department articulates sustainable management and harvesting standards for the forest-dependent folks.
- A concerted effort among the various stakeholders of SCFR be activated to rescue it from total disintegration. Income generating schemes such as ecotourism and establishment of scientific research programs targeting the involvement and ownership by indigenous forest-dependent

locals will foster regeneration and sustainability of SCFR as well as preserve its rich heritage.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Millennium Ecosystem Assessment Ecosystems and human well-being: biodiversity synthesis. Washington, DC: World Resources Institute; 2005.
2. Wells J, Wilson KA, Abram N, Nunn M, Gaveau D, Runting R, Tarniati N, Mengersen K, Meijaard E. Rising floodwaters: Mapping impacts and perceptions of flooding in Indonesian Borneo. *Environmental Research Letters*. 2016;11:064016. Available:<http://dx.doi.org/10.1088/1748-9326/11/6/064016>
3. FAO. State of the World's Forests 2011 (Rome: Food and Agriculture Organization of the United Nations); 2011.
4. Global Biodiversity Outlook; 2010. Available:<https://www.cbd.int/gbo3/?pub=6667§ion=6711> Available:http://www.calwater.ca.gov/Admin_Record/E-002108.pdf Available:http://shodhganga.inflibnet.ac.in/bitstream/10603/5500/6/06_chapter%201.pdf Available:<https://www.cbd.int/forest/CC.shtm>http://www.calwater.ca.gov/Admin_Record/E-002108.pdf Available:http://shodhganga.inflibnet.ac.in/bitstream/10603/5500/6/06_chapter%201.pdf
5. Morris RJ. Anthropogenic impacts on tropical forest biodiversity: a network structure and ecosystem functioning perspective. *Philos. Trans. R. Soc. Lond. B. Biol. Sci.* 2010;365:3709–3718.
6. Sala OE, Chapin FS 3rd, Armesto JJ, Berlow E, Bloomfield J, Dirzo R, Huber-Sanwald E, Huenneke LF, Jackson RB, Kinzig A, Leemans R, Lodge DM, Mooney HA, Oesterheld M, Poff NL, Sykes MT, Walker BH, Walker M, Wall DH. Global biodiversity scenarios for the year 2100. *Science* 2000;287:1770–1774

- DOI:10.1126/science.287.5459.1770
[PubMed]
7. Lawton JH, Bignell DE, Bolton B, Bloemers GF, Eggleton P, Hammond PM, Hodda M, Holt RD, Larsen TB, Mawdsley NA, Stork NE, Srivastava DS, Watt AD. Biodiversity inventories, indicator taxa and effects of habitat modification in tropical forest. *Nature* 1998;391:72–76
DOI:10.1038/34166
 8. Barlow J, Gardner TA, Araujo IS, Ávila-Pires TC, Bonaldo AB, Costa JE, Esposito MC, Ferreira LV, Hawes J, Hernandez MIM, Hoogmoed MS, Leite RN, Lo-Man-Hung NF, Malcolm JR, Martins MB, Mestre LAM, R. Miranda-Santos, A. L. Nunes-Gutjahr, Overal WL, Parry L, Peters SL, Ribeiro-Junior MA, da Silva MNF, da Silva Motta C, Peres CA. Quantifying the biodiversity value of tropical primary, secondary, and plantation forests. *Proc. Natl Acad. Sci. USA* 2007;104:18555–18560
DOI:10.1073/pnas.0703333104
[PMC free article] [PubMed]
 9. Ewers RM, Didham RK. Confounding factors in the detection of species responses to habitat fragmentation. *Biol. Rev.* 2006;81:117–142.
DOI:10.1017/S1464793105006949
[PubMed]
 10. Milner-Gulland EJ, Bennett EL. The SCB Annual Meeting Wild Meat Group 2003 Wild meat: the bigger picture. *Trends Ecol. Evol.* 2002;18:351–357
DOI:10.1016/S0169-5347(03)00123-X
 11. Asner GP, Knapp DE, Broadbent EN, Oliveira PJC, Keller M, Silva JN. Selective logging in the Brazilian Amazon. *Science* 2005;310:480–482
DOI:10.1126/science.1118051
 12. Bradshaw CJA, Sodhi NS, Brook BW. Tropical turmoil: a biodiversity tragedy in progress. *Front. Ecol. Environ.* 2009;7:79–87
DOI:10.1890/070193
 13. Ghazoul J, Sheil D. Tropical rain forest ecology, diversity, and conservation. Oxford, UK: Oxford University Press; 2010.
 14. Wilson RJ, Davies ZG, Thomas CD. Insects and climate change: processes, patterns and implications for conservation. In *Proc. Royal Entomological Society's 23rd Symp. Insect Conservation Biology* (eds Stewart AJA, New TR, Lewis OT), ch. 2007;11:245–279. Wallingford, UK: CABI Publishing.
 15. Memmott J, Gibson R, Gigante Carvalheiro L, Henson K, Huttel Heleno R, Lopezaraiza Mikel M, Pearce S. The conservation of ecological interactions. In *Proc. Royal Entomological Society's 23rd Symp. Insect Conservation Biology* (eds Stewart AJA, New TR, Lewis OT, editors.), ch. 2007;10:226–244. Wallingford, UK: CABI Publishing
 16. AKSG. Akwa Ibom State; physical background, soil, land-use and ecological problems. Technical Report of the Taskforce on soils and land use survey. Akwa Ibom State Government. 1989; 603.
 17. Ndoho JT, Umoren VE, Adu E. Spatial Analysis of Illegal Resource Extraction. In: Stubbs Creek Forest Reserve. In: Akwalbom State. *Nigerian Journal of Agriculture, Food and Environment.* 2009; 5(2-4), 72-78.
 18. Nyananyo BL. Plants from the Niger Delta. Onyoma Research Publications, Port Harcourt, Nigeria; 2006.
 19. Environmental Impact Assessment for Joint Venture Power Plant Project for ExxonMobil; 2013.
 20. Onyenenwa Cyprian Eneh. Managing Nigeria's Environment: The Unresolved Issues. *Journal of Environmental Science and Technology.* 2011;4:250-263.
 21. Available: <http://www.sustainable-environment.org.uk/Society/Consumption.php>
 22. Available: <https://www.eea.europa.eu/highlights/unsustainable-consumption-2013-the-mother>
 23. Available: https://www.ccfm.org/pdf/Edward_s_PreparingForFuture_FinalEng.pdf
 24. Available: <https://www.giz.de/en/worldwide/29916.html>
 25. Available: <http://www.americanforests.org/blog/forests-carbon-sinks/>
 26. Larsen Trond H. "Upslope Range Shifts of Andean Dung Beetles in Response to Deforestation: Compounding and Confounding Effects of Microclimatic Change." *BIOTROPICA.* 2011;1–8.
10.1111/j.1744-7429.2011.00768.x

27. Environmental Impact Assessment Decree 1992;86:8-11. International Association of Oil & Gas Producers; 2016
28. IPIECA-IOGP. International Petroleum Industry Environmental Conservation Association: Biodiversity and Ecosystem Services Fundamentals – A Guidance Document for the Oil and Gas Industry. Available:<http://www.ipieca.org/our-work/environment/bes-issue-management/>
29. Available:<https://assets.kpmg/content/dam/kpmg/ng/pdf/tax/Flare-Gas-Regulations-2018.pdf>

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