Assessing local people's perceptions and preference for ecosystem services to support management plan in Omo Biosphere Reserve, Nigeria

Opeyemi Adeyemi [a,c,*], Paxie W. Chirwa [a], Folaranmi Dapo Babalola [a,b]

[a] Department of Plant & Soil Sciences, University of Pretoria, Pretoria, South Africa

[b] Department of Forest Resources Management, University of Ilorin, Ilorin, Nigeria

[c] Department of Forestry and Wood Technology, Federal University of Technology Akure, Nigeria

* Corresponding author. Email: adeyemiadetunjiopeyemi@gmail.com

Highlights

- Implementation of ecosystem services studies in management and planning requires an insight of local people's interest.
- Majority of the respondents indicated that provisioning ecosystem services were essential to their daily wellbeing.
- Crops, water, firewood, timber, vegetables, fruits, bush meat and medicinal plants were the preferred ecosystem services.
- People's preferences toward ecosystem services are crucial for decision-making and management prioritisation.

Abstract

Little attention has been given to local people's perception of and preferences for ES, especially in developing countries. Such disregard of local community's priorities for ecosystem services (ES) can lead to non-coherent development plans and minimise community participation in ES-based conservation. Therefore, this study conducted an ES assessment to understand how local people perceive the importance of ES and how they prioritise ES. A questionnaire survey was conducted among 302 residents in 65 enclaves of Omo Biosphere Reserve (OBR), Nigeria. Data analyses including logistic regression analysis and spatial analysis were carried out to explain the residents' responses to survey items. Respondents identified crops, fruits, water, firewood as the preferred ES. The explicit spatial maps showed a high priority for ES around the North-Western, Eastern and Southern region of the Reserve. Gender, age group, education level, income level and household size all played essential roles in the importance of ES. Income and household size were the only sociodemographic factors that influenced the willingness of the local people to conserve ES. This study could help to make an informed decision on the management of the resources and facilitate the provision of ES in the reserve. Thus, this research could contribute to the effective implementation of the Lima Action Plan (LAP) in OBR.

Keywords: Nigeria; Local people; Local knowledge; Ecosystem services assessment; Biosphere reserve

1. Introduction

Indigenous people and local communities, which are about half of the world's total population, depend primarily on the benefits derived from the natural environment for livelihood and wellbeing (World Bank, 2017). More than 80% of the people living in sub-Saharan Africa rely on traditional medicines (WHO, 2013), while fuelwood, charcoal, crop residues and cow-dung provide 90% of the cooking energy (WHO, 2015). Ecosystem services (ES) are not only essential for their contribution to local people's wellbeing and livelihood but also because of its impact and contribution to sustainable development. Thus, ES and the socio-economic wellbeing of humans are interlinked (Sangha et al., 2015). ES include provisioning such as food, fresh water, fibre and fuel; regulation including water purification, climate and disease control; cultural services, for instance recreational, aesthetic, educational and spiritual; and supporting services such as soil formation, nutrient cycling and primary production (MEA, 2005; de Groot et al., 2010).

Despite the importance of ES to indigenous people, local communities and sustainable development in general, the last two decennia have experienced a considerable decline in the availability of ES. Besides, several studies have indicated that humans, through their unsustainable use of ES, have substantially altered the land use resulting in global ES degradation (see Polasky et al., 2011; Lawler et al., 2014; Fu et al., 2015). For example, the Millennium Ecosystem Assessment reported that 14 out of the 25 ES investigated were declining (MEA, 2005). This degradation negatively impacts on the wellbeing of rural population and poses a considerable barrier to achieving the sustainable development goals (Geijzendorffer et al., 2017).

Martín-López et al. (2012) explained that to establish successful policies for sustainable ecosystems, the user's perception, preferences and attitudes towards ES must be understood. Until recently, understanding the concept of ES as it relates to user's demand and relative ranking has received limited attention (Lamarque et al., 2011). Moreover, improving such understanding could enhance practical ES-based conservation efforts (Sodhi et al., 2010) and could help policy makers respond to stakeholders' priorities (Lamarque et al., 2011). Hence, the need for studies that could provide more insights into the user's perception of and preferences for ES.

Though several studies have analysed stakeholders' perceptions of ES, developed countries have mostly been the geographical focus, often assessing a narrow range of ES (Zhang et al*.,* 2015). For instance, ES studies incorporating local communities' perception have previously been reported in Finland (Vihervaara et al., 2010), France (Lugnot and Martin, 2013), the Israeli Jordanian border (Sagie et al., 2013), Spain (Casado-Arzuaga et al., 2013) amongst others. Fewer studies (see Ouédraogo et al., 2014; Mensah et al., 2017; Ouko et al., 2018; Adhikari et al., 2018), have assessed ES perceptions in developing countries, particularly in sub-Saharan Africa where it is becoming profound to manage the ecosystem sustainably and to alleviate poverty. In Nigeria, however, there is little empirical evidence on local people's perception and awareness of the importance as well as prioritisation of ES. For example, Arowolo et al. (2018) assessed local communities' awareness and perceptions of a broad range of ES in relation to land use on a national scale. While these studies provided general

information on people's understanding of ES for different land use, it failed to identify the important and prioritised ES necessary information needed to manage ES effectively.

Furthermore, the methodological development in ecosystem assessment is mostly focused on the stock and the capacity of the ecosystems to supply ES (Seppelt et al., 2011). Information on the potential demands on the ecosystems is still incomplete (Burkhard et al., 2012) and this has made assessing the actual ES exploited a significant challenge (Geijzendoeffer and Roche, 2014). Though the number of studies assessing, and mapping ES demands are growing, these studies largely depend on the use of proxy such as land use/land cover map, mostly because it is available. Generally, researchers have raised serious concern on the accuracy of proxy-based ES assessment which could lead to poor management decision if such results were applied (Nelson et al., 2009; Eigenbrod et al., 2010; Martínez-Harms and Balvanera, 2012). Humans are an integral part of the ecosystems, but they are often neglected when carrying out ES studies or assessments. To address this, we adopted an innovative approach to assess and map ES demands using primary data obtained from direct users of ES. We strongly believe that the implementation of ES studies in policy, management and planning requires the contribution of the direct users, that is, the local people and other stakeholders. Such incorporation and contributions could help to increase the practical application and policy relevance of the ES concept in operational management.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) under the Man and the Biosphere (MAB) programmes set up an empowerment programme (in Nigeria, Ghana and Tanzania) through the Green Economy in the Biosphere Reserve (GEBR). This programme provided alternative means of livelihood for local people in the reserve to reduce the pressure on forest resources. However, the study by Adepoju et al. (2018) revealed that the adoption level of the alternative programme in Nigeria was below average. That could be because alternatives were not what the people preferred. Within this context, this study carried out ES assessment using the Omo Biosphere Reserve (OBR), Nigeria as the case study to understand how local people perceive the importance of and prioritise ES. Case studies are essential for capturing local variations (Lamarque et al., 2011) because perceptions and preferences of ES can be location-based, depending on the locality, cultural attributes, moral beliefs and/or experiences (Daily, 1997). More importantly, to understand how local people perceive the benefits from the ecosystems, a landscape such as the Biosphere Reserve where the benefits are available and accessible would be an appropriate study area. The main aim of this study were achieved by providing answers to the following research questions: (1) how do local people rank the importance of ES for their livelihoods and how are the sociodemographic factors associated with these perceptions? (2) what ES are prioritised by the local people and what are the perceived changes in the availability of the ES over the years? (3) how are the prioritised ES spatially distributed over the study area? (4) to what extent are local people willing to contribute to the conservation of ES, and how can socio-economic attributes hinder or facilitate this willingness?

2. Methods

2.1. Study area

Omo Forest Reserve was designated as a biosphere reserve by the UNESCO MAB programme in 1977 (UNESCO, 2001). The reserve derived its name from river Omo that traverses it, located between latitude 6° 35′ to 7° 05′ N and longitude 4° 19′ to 4 °

40′ E. The biosphere reserve is about 80 km east of Ijebu-Ode and 180 km of north-east of Lagos, Nigeria. The altitude ranges between 15m and 150m above the sea level, mainly dominated by an undulating topography of up to 15% slope. The mean annual rainfall reaches up to 175 mm, with a mean relative humidity of about 80% and mean daily temperature of 26.4 °C between March and October.

Tropical humid forests are the primary forest ecosystem present, comprising several habitats. One of the major habitats located in the north side is covered with dry evergreen mixed deciduous forests and consists of tree species such as *Spondianthus preussii*, *Anthonotha macrophylla*, with *Pinus caribaea* and *Gmelina arborea*. Furthermore, the south of this reserve is covered with wet lowland evergreen forests and consists of tree species such as *Strombosi a pustoulate*, *Octolobus angustatus*, as dominant plantation species (UNESCO, 2001; Sonubi et al., 2014). OBR has high biodiversity, which underpins the supply of basic needs such as food, fuel, fibre and wood for the communities within the reserve. For instance, according to Ola-Adams (2014), there are 46 species of mammals including African Forest Elephant (*Loxodonta Africana)* and African Buffalo (*Syncerus caffer nanus*); an Important Bird Area (IBA), with about 203 bird species; about 71 species of insects; over 350 plant species (137 trees, 52 climbers and 63 shrubs) in the reserve.

2.2. Questionnaire design

A semi-structured questionnaire was adopted for collection of primary data in this study. The questionnaire was designed and reviewed with colleagues (scientists in socioeconomics of natural resources management) and the OBR Field Manager. The questionnaire was designed to gather the following: (i) sociodemographic information such as - gender, age, education level, income, household size and composition, occupation-of the respondents; (ii) identification of ES and level of importance based on individual perception; (iii) preferences for ES and perceived changes in the availability of ES and; (iv) willingness to participate in conservation activities of the ES. Additionally, to understand in another way the ES that were important to the local people, they were asked to state the ES they were willing to conserve and the reason for their preference. The questionnaire was piloted in Fowowa community, which is one of the major communities within the OBR before it was administered and the questionnaire took about 15 min on the average to complete.

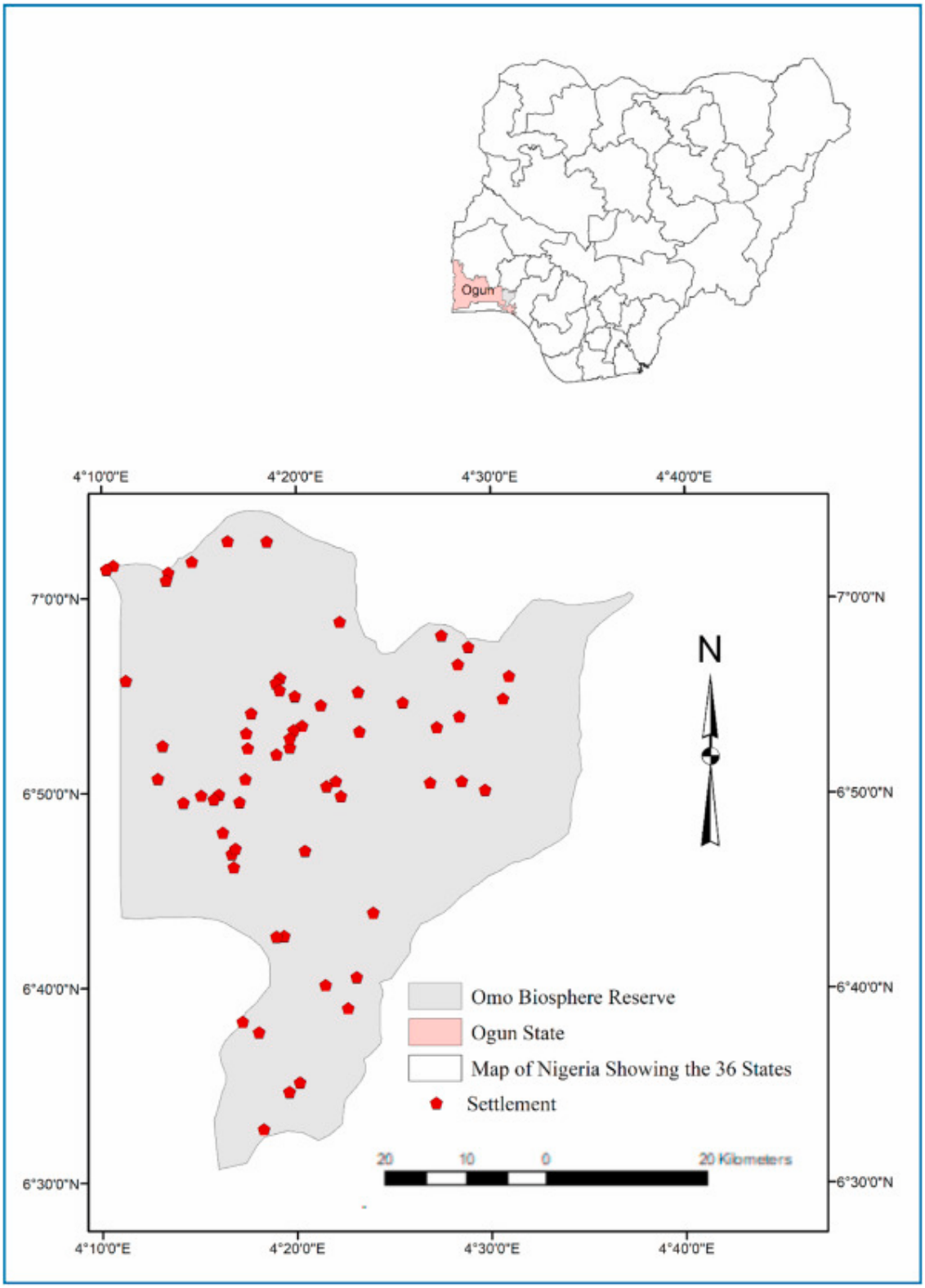

Fig. 1. Map showing Omo Biosphere Reserve with surveyed communities.

2.3. Sampling technique

An earlier study reported a total number of 45 communities within the OBR (Ola-Adams, 2014). However, 65 communities were identified during the reconnaissance survey for this study (Fig. 1). This showed that new enclaves and/or settlements have sprung up within the four-year interval. This study therefore employed a combination of purposeful and snowball sampling methods. In previous studies, a combination of sampling methods has also been commonly used as an approach in the assessment of ES (see Asah et al., 2014; Quyen et al., 2017; Stålhammar and Pedersen, 2017). A total of 302 respondents with an average of 5 adults per community were selected. Key informants (village heads and chiefs) were purposefully selected in each of the community. These key informants further helped in guiding the recruitments of other potential respondents in their respective communities. The recommendations of the key informants on who should be referred were based on the following criteria; (1) Adult who has been living in OBR for at least ten years; (2) Individual who has a strong connection with the OBR and its ecosystem for livelihoods. These criteria were set to get knowledgeable and appropriate respondents to increase the validity of the data and strengthen the results without compromising diversity. While selection of the village heads and chiefs was an important cultural requirement, we acknowledge that this could lead to gender bias as only 5 of the communities were represented by female heads.

English was the major language adopted for the study. However, there was translation of the questions to Yoruba language during questionnaire administration to the respondents that could not understand English. Yoruba is the main language spoken by the people in the communities. Enumerators were Yoruba-speaking and appropriately trained prior to administering the question.

2.4. Ecosystem services priority and spatial distribution

The respondents were asked to enter additional information based on a 3-level Likert scale (high, medium and low) to understand their preferences for ES in each of the communities. The ES commonly used and essential to livelihood of the local people with no alternative were ranked as high, the ES preferred but with an alternative were ranked as medium while the ES that are important but they can do with or without were ranked as low, based on the hierarchy developed by Kandel et al. (2018). In addition to this approach, mapping of highly prioritised ES was carried out to provide an insight into what and where prioritised ES are demanded. Therefore, a handheld Garmin GPS was used to collect the geographical coordinates of each of the respondents to link their responses to a spatial location on the map.

2.5. Data analysis

The sociodemographic attributes (gender, age group, education level, income level, occupation, household size) of the respondents and the observed change(s) in the availability of the prioritised ES were computed using descriptive statistics. The data collected on the importance of ES and ES priorities were subjected to frequency distribution analysis and ranked based on the number of frequency (respondents). The spatial distribution of the prioritised ES was done in ArcMap 10.6.1. Based on the frequency

distribution, the eight most prioritised ES were mapped by linking individual responses with the geographical coordinates collected. The map was plotted using graduated symbols to denote high, medium and low priorities.

To determine how the sociodemographic attributes are associated with the perception of the importance of ES, ordered logistic regression model was used. Predictors for the model were gender, age group, education level, income level and household size. Also, binary logistic regression analysis was done to predict if any significant association exist between the sociodemographic factors such as gender, age group, education level, income level, household size, occupation and the willingness to contribute to the conservation of ecosystem services. The model predicts the logit of the response variable Y (Y = 1 if yes, 0 if no) from the independent exploratory variables X (X = sociodemographic variables). The logit regression model is expressed as:

$$\ln\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n \quad (1)$$

Where π is the probability of Y happening and 1-π is the probability of Y not happening. β_0 is the intercept, β_n is the coefficient associated with explanatory variables.

3. Results

3.1. Demographic profile of the respondents

About two-thirds of the respondents were male, female participants accounted for one-third, 31% were youths, 49% were adults, and 19% were elderly (Table 1). Household size of fewer than three persons represented 9%, 3–4 represented 41%, 4–6 represented 19%, and more than five persons represented 29% of the sampled population (n = 302).

The academic qualification of the respondents was skewed towards secondary school (52%). In addition, 17% had tertiary education, 24% had primary school education while only 5% never had exposure to formal education. The majority (72%) of the respondents were farmers while artisans accounted for 15% with other four occupations representing 11% of the total population. The highest percentage (42%) of the respondents earned between ₦10,000 and ₦30,000, 18% earned less than ₦10,000, 21% earned between ₦30,000 and ₦50,000 and only 16% of the respondents earned more than ₦50,000 per month (see Table 1 *USD 1 = ₦ 386.93)*).

Table 1. Summary of the sociodemographic profile of the respondents.

Attribute	Category	% of Respondents
Gender	Male	65.6
	Female	34.4
Age group (years)	18–35	30.8
	36–55	49.3
	>55	19.9
Education level	No education	5.3
	Primary	24.5
	Secondary	52.6
	Tertiary	17.5
Income level (₦)	<10,000	18.9
	10,000–30,000	42.7
	30,000–50,000	21.9
	>50,000	16.6
Household size	1–2	9.9
	3–4	41.4
	4–6	19.5
	>6	29.1
Primary Occupation	Farming	72.8
	Hunting	0.3
	Artisan	15.9
	Private Company	3.6
	Trader	2.6
	Civil Servant	4.6

₦ denotes Nigerian currency Naira (USD 1 = ₦ 386.93).

3.2. Identification and ranking the importance of ES

Overall, 25 ES were identified in the study. These were listed as provisioning (13) regulating (6), supporting (1) and cultural (5) services. More than 90% of the respondents were aware of the provisioning ES such as crops, fruits, water, firewood, medicinal plants as benefits derived from nature. In contrast, the level of perception of other ES groups were lower with less than one-third of the respondents being aware of pest and disease control, erosion and flood control, spiritual and religious and aesthetic values. The level of importance of each ES to the sustenance and wellbeing of the respondents were ranked as shown in Fig. 2. More than 80% of the respondents indicated that provisioning services, including water, crop, fruit, vegetable, firewood and medicinal plants were essential to their daily livelihood. In parallel, other services.

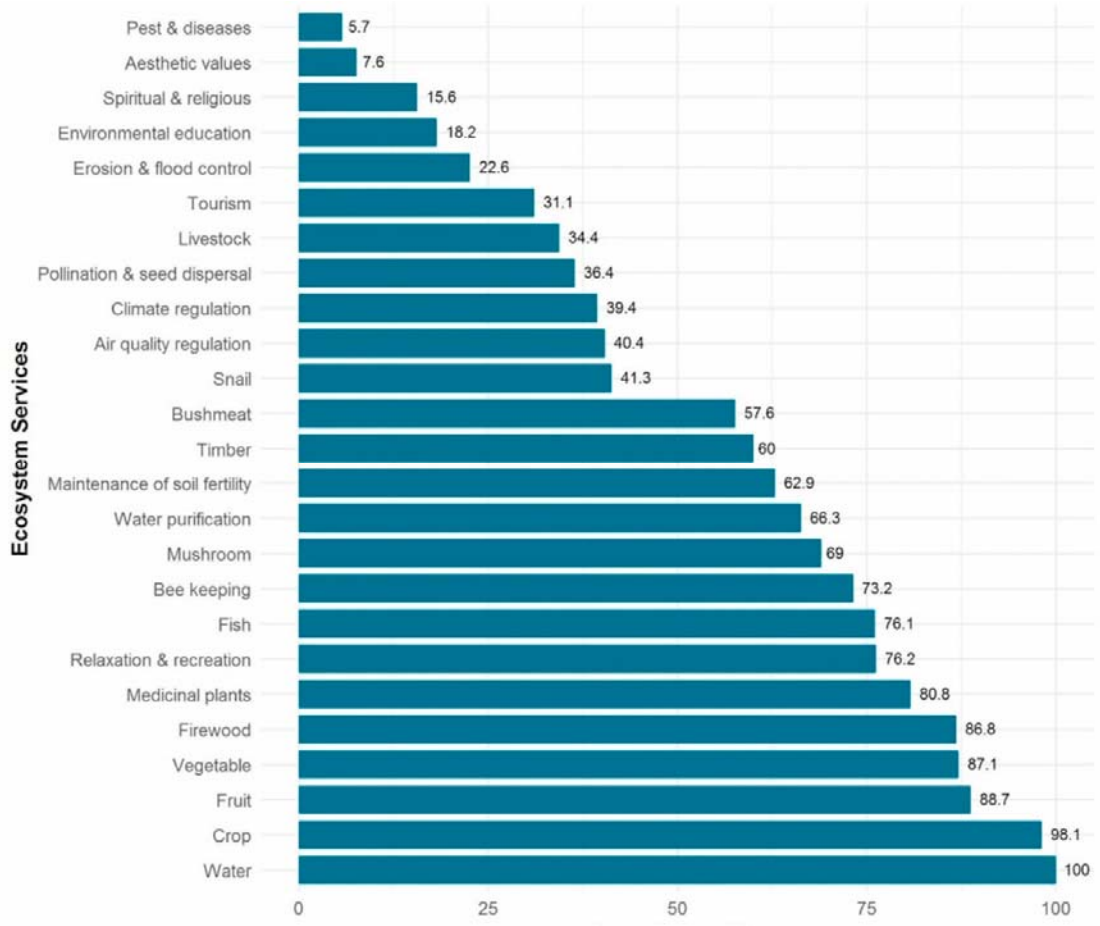

Fig. 2. Level of importance of ecosystem services for the local people.

3.3. Sociodemographic factors associated with the perceived importance of ecosystem services

Results from the ordered logistic regression models were summarised in Table 2. Using the model fitting information, we excluded thirteen (13) ES since the final model was not significantly different from the baseline model. The sociodemographic factors that influenced respondents' perceived importance of ES were age group, income level and household size while gender and education level had minor influence. The regression coefficient showed that males were significantly and positively (r = 0.617) associated with firewood and significantly or negatively (r = - 0.582) associated with erosion and flood control. This suggests that males, as compared with females, perceived firewood as more important and erosion and flood control as less important.

For the education level category, no education level only had a significant and negative correlation (−1.599) with fruit, primary education had significant and positive (1.204) effect on fish and significant and negative (- 0.929) effect on vegetable. Furthermore, secondary education had a highly significant and positive effect on fish (0.925) and erosion and flood control (1.182). Age group revealed a positive perception of young and adult people towards fruit and mushroom. In contrast, all the income level revealed a negative

perception of all ES. The results further showed that all the categories of household size had a negative perception of the important ES.

Table 2. Ordered logistic regression results showing the determinant sociodemographic variables influencing the perceived importance of ES.

ES	Gender	Education Level			Age Group (yrs.)		Income Level (₦)			Household Size		
	Male	No	Primary	Secondary	Young	Adult	<10,000	10,000–30,000	30,000–50,000	1–2	3–4	5–6
Crop	−0.327	17.296	−1.929	28.999	21.309	−1.456	0.047	2.166	3.095	−4.872*	−4.652**	−1.934
Fruit	0.124	−1.599*	−0.155	0.583	1.682**	0.916*	−0.537	−0.564	0.955*	−2.012**	−0.08	0.214
Water	0.77	0.503	−1.619	0.086	0.256	1.636	0.408	−16.805	−2.777*	−16.036	−0.723	−1.994
Firewood	0.617*	0.099	−0.001	0.715	−0.860*	−0.320	−0.072	−0.483	0.417	0.137	−0.666*	−0.66
Mushroom	−0.299	−0.672	−0.06	0.286	0.960**	0.587*	0.362	0.186	0.155	−0.800*	−0.803**	−0.627*
Fish	−0.09	0.968	1.204**	0.925**	0.191	−0.038	−1.015*	−0.818*	−0.902*	0.025	0.175	−0.726*
Vegetable	0.004	0.081	−0.929*	−0.404	0.369	0.473	1.079*	−0.154	0.062	−0.237	−0.074	0.462
Livestock	−0.167	−0.34	−0.233	0.388	−1.108**	−1.194**	−0.666	−0.697*	−1.028*	−1.12*	−0.364	−0.622
Bush Meat	−0.137	−0.684	0.058	−0.003	0.074	0.139	0.007	−0.619	−1.016**	−1.158**	−0.196	−0.658*
EF	−0.582*	1.176	0.895	1.182**	0.849*	0.405	−2.46**	−1.469**	−1.291**	−0.029	0.192	0.603
EE	0.182	0.824	−0.51	−0.635	0.415	−0.25	−1.533*	−0.995*	−0.721	−1.232	0.041	−1.569**
SR	0.43	1.106	0.246	−0.181	−0.425	−0.821*	0.743	0.274	0.618	−1.692*	−0.342	0.205

*P < 0.05 and **P < 0.01.

Female, Tertiary, Old, >50,000 and > 6 were used as reference variables.

EF = Erosion and flooding; EE = Environmental education; SR= Spiritual and religion.

₦ denotes Nigerian currency Naira (USD 1 = ₦360.93).

3.4. Prioritised ecosystem services and perceived changes in availability

There were many ES identified as important by the local communities. Nonetheless, individuals prioritised the important ES differently depending mostly on the ES connected to their activities. From the results, the most prioritised ES in the OBR was crop (91%). About half of the total respondents observed an increase in the availability of the prioritised ES when compared to previous years. Majority of the respondents felt there were no changes in the availability of water over the years. Aside crops, fruits, firewood, and vegetables were

perceived to have increased, while other prioritised ES were perceived to have decreased (see Fig. 3).

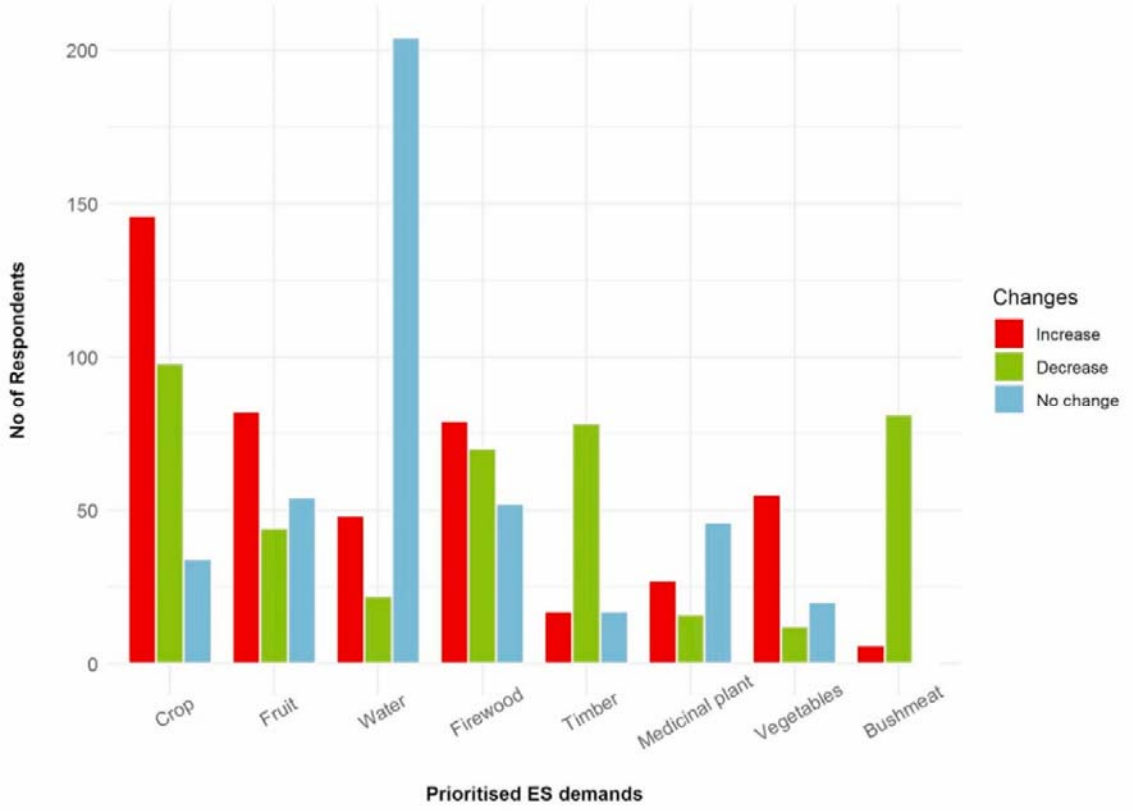

Fig. 3. Ranking ecosystem services and the perceived changes in availability.

3.5. Spatial distribution of priority ecosystem services

The spatial distribution of the four (4) prioritised ES in the study area are depicted in Fig. 4. Crop, timber, fruit and firewood were of high priority to the majority of the local communities. However, timber, medicinal plants, vegetables and bushmeat, were of medium to low priorities to the people in the area. Generally, the eight prioritised ES were distributed around the communities in the centre of OBR. Crops, water, fruits and firewood were highly concentrated around North-West, East and South of the OBR.

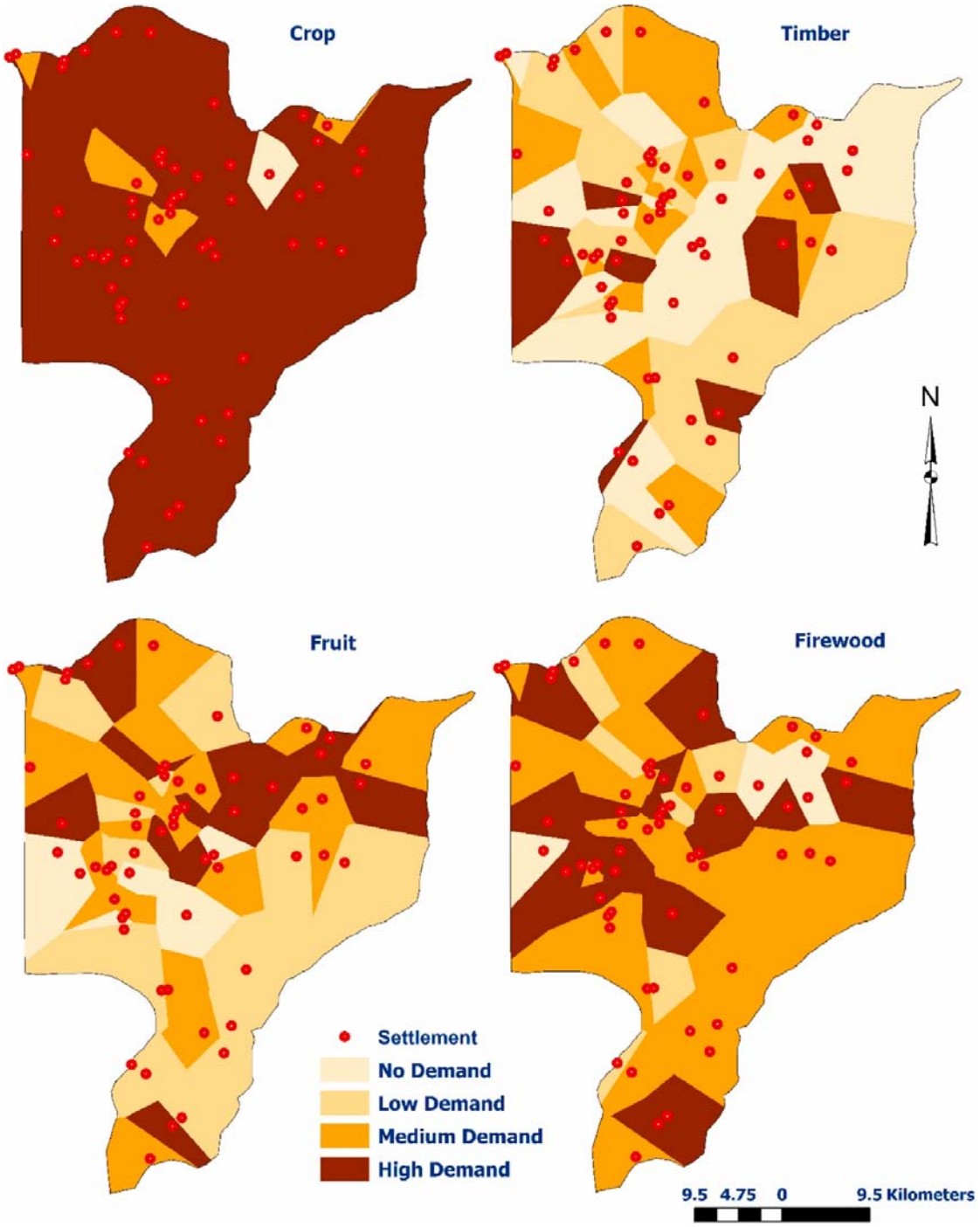

Fig. 4. Spatial distribution of prioritised ecosystem services in OBR.

3.6. Willingness to contribute to the conservation of ecosystem services

Almost all the 302 local people who participated in the study believed it was essential to give conscious effort into the conservation of ES. Majority of the people (95%) were willing to contribute at any capacity to ensure ES are sustainable. Of the 289 respondents who were willing to contribute to the conservation of ES, 42% were willing to conserve crops

more than any other ES. Conversely, 11% were willing to conserve both crops and fruits, 8% were willing to conserve crops and water, 5% for crops and vegetable and 4% for timber.

3.7. Factor influencing willingness to contribute to ecosystem services conservation

There were several reasons responsible for the choice of ES to conserve, but the most frequent reasons were livelihood (35%) and income (24%). The results of the binary logistic regression analysis (Table 3) showed that there was a significant and positive association between income level (₦10,000 - ₦30,000) and willingness to conserve ES, indicating that an increase in people earning between ₦10,000 to ₦30,000 would increase the contribution to ES conservation. Additionally, household size of not more than two persons was significantly but negatively correlated with the willingness to contribute to conserving ES. This means that willingness to contribute to conserving ES would decrease where more households had fewer than two persons. The omnibus tests of model coefficient showed that the model was statistically significant ($p = 0.040$). The Nagelkerke R square of the model ($r^2 = 0.109$) explained that the sociodemographic variables accounted for 10% variation in the local people's willingness to contribute to ES conservation.

Table 3. Factors influencing willingness to contribute to the conservation of ecosystem services through logistic regression analysis.

Variables	β	S.E.	Wald	Sig.	Exp (β)	95% CI.	
Constant	3.329	0.61	29.75	0.000	27.92		
Income							
₦10,000-₦30,000	1.444	0.694	4.334	0.037	4.239	1.088	16.513
> ₦50,000	1.236	1.081	1.306	0.253	3.441	0.413	28.642
Household size							
1–2	−1.936	0.867	4.986	0.026	0.144	0.026	0.789
3–4	−1.146	0.712	2.59	0.108	0.318	0.079	1.284

β = coefficient, S.E. = standard error, Sig. = significance level, C.I. = confidence level.

N = 302; Total percentage of correct estimated predictions = 95.7%.

Log-likelihood = 97.204; Wald Chi-square = 10.011.

₦ denotes Nigerian currency Naira (USD 1 = ₦360.93).

4. Discussion

4.1. Identification and ranking the importance of ES

This study investigated how indigenous people and local communities within OBR perceived and ranked the importance of ES. The findings showed that local people's awareness of ES varied among individuals. This variation could be accounted for by the availability and usage of ES as well as the sociodemographic characteristics of the people. In this study, 25 ES were identified. The identified ES was in congruent with the results of previous studies (Vihervaara et al., 2010; Burkhard et al., 2012; Hartel et al., 2014; Koto et al., 2015; Adhikari et al., 2018). For example, Burkhard et al. (2012) identified 22 ES in a study to map ES

supply, demand and budget at Leipzig-Halle in Germany. Vihervaara et al. (2010) identified 23 ES in Finnish Forest Lapland. Information on indigenous people's knowledge of ES could help to plan educational programmes geared towards improving the understanding and active participation in conservation activities.

Findings from previous studies (see Ouko et al., 2018), and the results of this study, showed that local people appreciate provisioning ES (crops, fruits, water, firewood and medicinal plants) more than other types of services. In addition, local people depend largely on provisioning ES for their daily living (Hartel et al., 2014). These outcomes could be explained from the results of the importance of ES, such that the ES identified interrelated with the ES ranked as important to the daily livelihood of the local people. Thus, an increase in knowledge of ES could enhance attitude towards conservation and management of ES in the study communities. Besides, increasing local people's knowledge of ES is essential because there are several ES people enjoy without identifying or demanding them, for instance, many of the regulating services (Geijzendorffer and Roche, 2014).

It is crucial to identify the ES which are provided from within any landscape (Adhikari et al., 2018), as a prerequisite for effective ES management. Also, to improve the conservation attitudes of the local people and to encourage active participation in ecosystems conservation, we recommend that local people should be educated and enlightened on the importance of ES. More importantly, educate on the non-consumptive benefit because people easily identify services for consumptive use when compared to the non-consumptive services.

4.2. Sociodemographic factors associated with the perceived importance of ecosystem services

One of the objectives of this study was to understand the sociodemographic characteristics behind the perceived importance of ES. Gender, age group, education level, income level and household size all played important roles in the importance of ES. These results agree with some recent studies that found gender, age group and income level as a predictor of people's perceptions towards ES (Allendorf and Yang, 2013; Meijaard et al., 2013; Mensah et al., 2017). Most of the significant predicting models were for the provisioning ES, indicating the higher interest and connection of local people for provisioning ES as also revealed in Mensah et al. (2017).

Older people in the local communities had a more positive perception of spiritual and religion function of the ecosystem than other age group. This may be explained by the fact that older people, in general, support and take spiritual rituals more seriously. We detected that males had more positive perception of firewood than females. This is quite surprising since females are expected to have a positive perception of the importance of firewood since they do more of the collections than males. While it is true that females collect firewood more than males, there are few exceptions to that. For instance, from available data and report by FAO, it was reported that in Madagascar and Nicaragua, males do more of firewood collection than females (UN, n.d.).

4.3. Priority ecosystem services and perceived changes in availability

People prioritise ES differently depending on the landscape features, interests, professional activities and background (Casalegno et al., 2014; Adhikari et al., 2018). Therefore, it becomes necessary to understand how the inhabitants of OBR prioritise ES to account for people's preferences for ES in management plan. Our findings present crops, water, firewood, timber, vegetables, fruits, bush meat and medicinal plants as the most preferred ES in OBR. A similar study in a community-managed forest in central Nepal identified timber, firewood, freshwater, carbon sequestration, water regulation, soil protection, landscape beauty and biodiversity as the priority ES (Paudyal et al., 2015).

The results of this study revealed a high percentage of the people who believed that crops, fruits, and vegetables had increased in terms of the land area while the availability of timber and bushmeat had decreased. This meant that trade-offs might have taken place between agricultural lands for crops, fruits and vegetable cultivation and forestlands for timber and bushmeat. These trade-offs could be attributed to agricultural practices adopted and increasing number of settlements in the reserve. Notably, our results indicated that three-quarters of respondents engaged in farming activities and from our field observation, it was evident that shifting cultivation was the agricultural practice adopted in the communities within the reserve. On the one hand, to address the conversion of forestlands to agricultural lands, there is a need to advocate and encourage sustainable agricultural intensification. This could help to increase agricultural production without necessarily increasing the land area. In addition, multiple land use system such as agroforestry could be encouraged (Chirwa and Adeyemi, 2019). On the other hand, the challenge with this sustainable approach could be availability and access to farm inputs such as fertilisers, which are necessary for undertaking such an approach.

While some studies agreed that services such as regulating services could be challenging to identify, thus, cannot be a priority (Close et al., 2009; Orenstein and Groner, 2014), others argued that such difficulty only applies to those landscapes solely depending on provisioning services (Iniguez-Gallardo et al., 2018). We believe that perception and preference of ES could be influenced by a person's or community's involvement in conservation activities of natural resources or farming activities as also corroborated by Díaz et al. (2011). For instance, a community dominated by agriculturists would prioritise provisioning services than other types of ES. However, from our findings, the prioritisation of ES differed and this was dependent on the occupation and education level of the respondents. It was observed that those involved in farming activities and/or people with less or no formal education preferred provisioning ES, whereas few individuals with paid jobs and exposure to formal education were inclined to other ES. This is probably because learned people can access information from media sources on other types of ES aside provisioning services. Whereas the preference for provisioning might be because of the direct dependent on the ES.

The UNESCO MAB implemented Green Economy in Biosphere Reserves (GEBR) in Nigeria, Ghana and Tanzania to address issues of alternative livelihood in the biosphere reserves. This alternative livelihood programme is geared towards achieving sustainable development through biodiversity businesses and engaging local communities in biodiversity conservation plans. The information provided in this study on the prioritised ES could help management

introduce alternative means of livelihood for communities in the reserve. This could lessen the effects of demand on the services provided by the natural resources in the reserve. Adepoju et al. (2018) assessed the adoption status of these businesses in the reserve and reported that the percentage of people willing to engage in green alternative livelihood such as grasscutter, tree seedling, snail and mushroom production was below average except for honey production (60%). We recommend that such intervention should first seek to know what ES are important and of priority to the local people and communities as this study has set out to do. In addition, proposing alternatives related to those ES ranked as prioritised ES may enhance the adoption of the alternative livelihood programme.

This study has provided insights into local knowledge perspective on ES prioritised by the inhabitants of Omo Biosphere Reserve and the respective changes in the availability of the ES. Prioritisation of ES is essential to prepare an evidence-based decision making that could incorporate both management of ES as well as the needs and preferences of different stakeholders.

4.4. Spatial distribution of priority ecosystem services

Understanding the demand for ES across specific locations is necessary to define priority areas for maintaining critical ES. Also, such knowledge could assist to indicate where management interventions should be focused (Chan et al., 2006). The result of the spatial distribution showed that ES prioritised as medium to high were distributed in most of the communities, but concentrated in the North-East, Central and South of the reserve. This finding provides information on what service(s) people prioritised and how close to the biodiversity hotspot, which is crucial for the management of the biodiversity resources in the reserve. Reserve managers can utilise the spatial information to specify where future monitoring and management strategies could be stricter and concentrated in the reserve.

We took a simple yet useful approach to map the ES prioritised, using data collected from the questionnaire survey. Although land cover variables are the most commonly used sources of data for mapping ES (Martinez-Harns and Balvanera, 2012), there is an uncertainty in the relationship between land cover variables and ES provision (Nelson et al., 2009). Eigenbrod et al. (2010) explained that using land cover variables can have a wide divergent result when compared to results from the field survey, especially when applied at the local scale. However, Anton et al. (2010) argued that one of the key gaps in ES assessment is related to mapping multiple ES by incorporating socio-economic (survey) and biophysical (land cover variables) data. Therefore, there is a need for further studies to incorporate biophysical and socio-economic data for mapping ES prioritised to validate the most accurate method. Nonetheless, the spatial distribution of ES prioritised mapped in this study show where ES prioritised were being demanded to better support ES management plan.

4.5. Factors influencing local people's willingness to contribute to ecosystem services conservation

Although there were no or little biodiversity conservation activities (such as preservation of natural forests) beyond the core area in the OBR, a greater proportion of the respondents

expressed willingness to conserve ES. We further examined the influence of sociodemographic attributes on the willingness to conserve ES. The results showed that income level (₦10,000 - ₦30,000) was positively and significantly correlated with the degree of willingness to conserve ES. This could be because more people were within this income class. These were predominantly farmers depending on the benefits derived from the ecosystems. On the other hand, household size of fewer than three persons was negatively and significantly correlated. This is because more people in a household could increase the chances to participate in conservation activities requiring physical inputs. This result matches the findings of Ouko et al. (2018), who reported that increase in family size increased the probability of the community member in Northern Kenya to participate in forest conservation. Other factors, such as knowledge of ES, economic value of ES amongst others that could contribute to willingness to conservation efforts, were not accounted for in the model. It is important that future studies consider these other potential factors that can influence people's willingness to contribute to ES conservation in the study area.

5. Conclusion

The identification, prioritisation and mapping of ES in any landscape are essential for practical management efforts at both local, regional and global levels. Our study was able to understand local people's perceptions and preferences for ES in Omo Biosphere Reserve. The findings showed that provisioning ES were given higher priority than other types of ES. This information can enhance policy implication since people's perception and prioritisation of ES can influence the utilisation and the value placed on ecosystems. It is indicative of the management strategies that could be adopted for the conservation of specific and important ES. The novelty of the research presented ES demands, using local knowledge to map the prioritised ES in the reserve. Though the approach was simple, it undoubtedly provided a practical guide for local decision maker to manage specific areas with prioritised ES.

The principle of sustainable environment maintains that man lives in harmony with its environment. This principle is not different from the one envisaged for the BRs. However, it is important that the human population that each BR can sustainably support should be calculated, and the number maintained. If OBR and other BRs will not be a mere bureaucratic label, the carrying capacity of each designated BR must be calculated and maintained, else, the increasing human population and their quest for livelihood will ultimately override conservation goal, leading the way back to status quo. Therefore, future studies should consider assessing the number of people OBR can sustainably support.

The impact of management strategies in a BR could affect the attitude of local people towards the reserve and conservation. This suggests the need to consider local communities' involvement in the management and running of BRs. Such integrated management could increase the acceptability of conservation plan and provide a platform for local people to have a stake in the success of the reserve (Adeyemi 2017). Besides, when the cultural rights of local people are violated, especially when they are not carried along with the management of BRs, they may withdraw their support for conservation goals. *No long-term management strategy is effective without the involvement of all stakeholders, particularly those who live in the immediately adjacent areas.* – Sinclair and Walker (2003).

This is particularly true for BRs management, where local people are an integral component of the BR structures. Moreover, central to LAP is open and participatory selection, planning, and implementation of BRs and BRs must have a clear communication plans and mechanisms to achieve this participatory stakeholder engagement.

Author statement

Opeyemi Adeyemi: Conceptualization, Methodology, Data Analysis and Writing, Paxie W Chirwa.: Supervision and Reviewing, Folaranmi D Babalola: Reviewing and Editing

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Informed consent

Informed consent was obtained from all individual participants involved in this research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Compliance with ethical statement.

Data availability

Data will be made available on request.

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