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Research Article

Patterns of wildlife use by local people and its impacts on the future conservation of Jorgo-Wato Protected Forest, western Ethiopia

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Abstract

This study explored the patterns of wildlife products used by the local communities around Jorgo-Wato Protected Forest and its future impacts on the conservation of the forest. Data were collected from households located within a 3 km radius around the forest. Incidences of resource use encountered along the transects revealed that livestock grazing (6.59±3.80/km), debarking trees for beehive preparation (5.8±0.77/km), logging large trees over coffee plantation (5.41±0.35/km), girdling trees (4.66±0.33/km), poaching (4.02±3.32/km), and timber production (3.41±1.10/km) were identified as destructive resource use patterns in the area. However, the use of alternative sources of energy has a positive impact on the future conservation of the Jorgo-Wato Protected Forest. A significant negative relationship ($r(9) = -0.971$, $p < 0.05$) was recorded between fuelwood consumption and distances of households from the forest. The alternative sources of energy use could have a positive impact on the sustainable use of forest and non-forest products. However, a significant positive ($r(9) = 0.900$, $p > 0.05$) relationship was recorded between the mean number of livestock and mean annual income per household ($r(9) = 0.930$, $p > 0.05$) which could be attributed to their contribution as sources of income to reduce human pressure from resource extraction. Since the wildlife resource extraction system has not yet been reported from the study area, the finding of this study could provide baseline information for Oromia Forest and Wildlife Enterprise to implement wildlife laws and policies in the area.

Keywords: Forest products, local people, natural resource, protected area

Introduction

Human resource use impacts the management of protected areas. It ranges from timber felling to the collection of non-timber forest products, and from fishing to occasional or frequent hunting (Kothari et al., 2015; Sassen, Sheil, & Giller, 2015). Subsistence use of wildlife includes commercial, for recreation, education, research, teaching, and commercial purposes involving local or out trade. The types and degree of resource use around protected areas depend on lifestyles, occupations, culture, earlier or recent settlers, and tourists (Kothari et al., 2015, Baiyegunhi & Oppong, 2016). Resource use from the protected areas helps to sustain livelihoods and to maintain cultural connections to land and nature. Resources used for subsistence by the indigenous people might have vanished unless exploited in a sustainable manner (Kothari et al., 2015). Natural resources are often used as food, medicine, fuelwood, and income generation where very few alternatives are available, which make them a vital component of household livelihood and survival strategies (Sassen et al., 2015; Baiyegunhi & Oppong, 2016). Many protected areas lack a regulatory framework to enforce the rules of such agreements. Lack of resource use agreement may lead to an increase in illegal harvesting. In places where the regulatory framework is effective, resource extraction has caused a minimal impact on protected areas (Blokker, Bek, & Binns, 2015; Sassen et al., 2015).

Harvesting of resources in protected areas can provide impoverished communities with sources of traditional craft, construction materials, food, medicine, and fuel (Barany, Holding-Anyonge, Kayambazinthu, & Sitoe, 2005; Pienaar, Jarvis, & Larson, 2013). Moreover, harvesting programs can provide products that communities may not be able to access outside of the protected area. Without any reliable estimates of harvesting levels, it is difficult to determine the degree of sustainable use. Additionally, to balance the objectives of both conservation and benefits to the local people, the link between the economic benefits of the harvested resource and the resource base should be fully understood (Baiyegunhi & Oppong, 2016). Lack of empirical data about wildlife use patterns precludes management services attempted to make a reliable estimate of sustainable harvesting quantities. This knowledge gap leaves many resources at risk of unintentional over-exploitation (Van Wilgen & McGeoch, 2015), leading to a sudden loss of many wildlife species. Mostly, animals or plants are collected illegally from protected areas to alleviate poverty and food insecurity (Bruschi, Mancini, Mattioli, Morganti, & Signorinin, 2014). Under such circumstances, it is often difficult to quantify the resources removed. Lack of formal employment, poverty, and high human population density around protected areas led to an extensive harvest of wildlife resources.

In protected areas, identification and classification of wildlife resource use patterns, amount of resources collected, and the degree of local people's dependence on livelihood incomes have paramount significances (Sunderlin et al., 2005). These are mainly required when local people using the resources may conflict with protected areas and conservation plans (Naughton-Treves, Holland, & Brandon., 2005). The miss-utilization of the forest by the rural community aggravates the degradation of wildlife habitats and is a major threat to protected areas in developing countries (Evangelista, Swartzinski, & Waltermire, 2007; McElwee, 2010). Assessments of human resource use patterns are minimal at a global level, but an extrapolation of case studies from various regions suggested that a very large proportion of protected areas are likely to be inhabited and under resource use by the local people. However, issues about the amount and kind of resources used from protected areas leading to the fragility of ecosystems and wildlife populations are unknown (Kothari et al., 2015). In the present study area, an increase in the human population around Jorgo-Wato Protected Forest is the cause for the reduction of the forest size from 19,875 to 8,503.49 ha within three decades of its establishment. Moreover, patterns of wildlife resource use from the area have not been reported yet. In this study we hypothesized that the increased human population around Jorgo-Wato Protected Forest and the demand for wildlife use for subsistence and commercial purposes have posed an impact on the wildlife resources of the area. The present study aims to (1) investigate the patterns of wildlife use by the local people, (2) identify the common wildlife resources extracted from the study area, (3) identify sources of livelihood income by the local people, and (4) determine the main reasons for the extraction of wildlife resources from the study area.

Material and methods

Study area

Jorgo-Wato Protected Forest (JWPF) is located in the Oromia National Regional State of Ethiopia between West Wollega and Buno Bedele Administrative Zones. It is located at 509 km west of Addis Ababa, along the Addis Ababa–Gimbi–Assosa road, specifically, 68 km south of Gimbi town (Figure 1). The forest is located between Nole Kabba district (West Wollega zone) and Mako district (Buno Bedele zone) with much of the forest being in Nole Kabba. JWPF is situated between 8º 40’ 20’’ to 8º 48’ 06’’ N latitude and 35º 48’ 01’’ to 35º 56’ 40’’E longitude with an elevation ranging from 1780 to 2584 m asl (Geleta et al., 2019).

JWPF was proposed as one of the top National Forest Priority Areas (NFPA) in 1976 and demarcated in 1988 with an estimated total area of 19, 875 ha. According to the IUCN classification system of protected areas, JWPF is placed as Category VI where an area is managed mainly for the sustainable use of natural resources. People adjacent to the forest have been relocated during the Derg regime, to scale up the forest through the afforestation of forest glades and steep slope areas surrounding JWPF. Relocated people from JWPF returned back into their former land following the fall of the Derg regime in 1991, and started planting coffee in the forest. Moreover, due to extensive shifting to agriculture around JWPF, the forest has been re-demarcated in 2013. As a result, the later demarcation has reduced the area of JWPF to 8,503.49 ha.

The highland areas of the southwestern part of the country are categorized as moist evergreen Afromontane forest, which comprises broad-leaved evergreen species (Demissew & Nordal, 2010; Friis, Demissew, & Breugel, 2011). JWPF is one of these moist evergreen Afromontane forests located in the western parts of Ethiopia comprising natural and plantation forests. The moist evergreen montane forests of the south and southwest parts of Ethiopia are good sources of gene pools for several domesticated wild plants (NBSAP, 2005). Similarly, JWPF is a good reservoir of *Coffee arabica*, *Aframomum corrorima* and *Rhamnus prinoides*. Also, the forest harbors a diverse array of medium and large-sized mammals. JWPF is an island forest surrounded by more than six Peasant Associations.

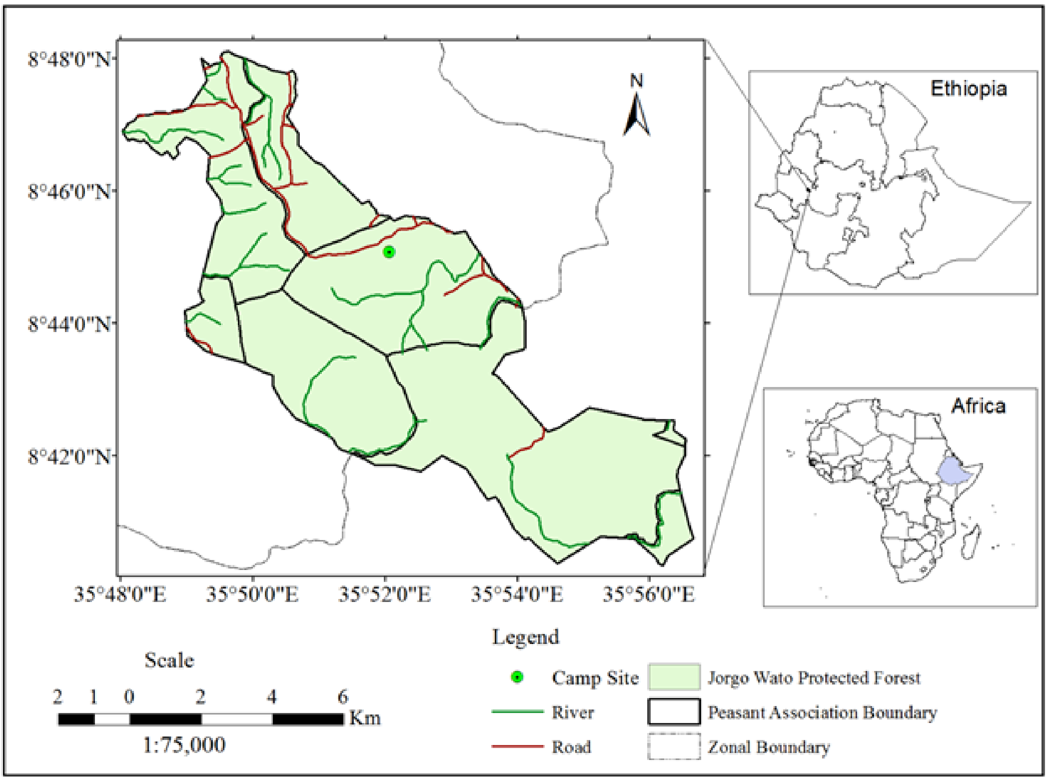

Figure 1. Location map of Jorgo-Wato Protected Forest (Geleta et al., 2019).

This study used a combination of both qualitative and quantitative methods which include, transect in the forest, focus group discussion, questionnaire survey, and key informant interviews. The study area was classified into six zones based on their local wards. A total of 44 line transects laid in the forest along which illegal human activities were enumerated to determine intensities of destructive resource use patterns in the area. The length of each transects ranges between 0.5-1.5km and the total length is 34 km. All incidences or signs of human-wildlife harvest along the transects were identified and recorded. The frequency of incidences of wildlife harvest encountered were recorded along the transects. The extent of destructive resource use pattern was determined by counting each incidence of wildlife harvest encountered along transects walked in the forest. Encounter rate was estimated as the total number of signs of resource harvested per the total distance walked in the study area (Lee, Alonso, Dallmeier, Cambell, & Pauwels, 2006; Ofori Attuquayefio, & Owusu, 2012). The difference in the local resource use was calculated using the frequency of harvest encountered and rankings (Thompson & Juan, 2006). Also, an interview was conducted with households of five Peasant Associations located within a distance of 3 km from the forest. In each Peasant Association, households found closer to the forest were purposively selected since they have access to the resource and information on patterns of wildlife use in the area. Besides, field observation was carried out around the forest to describe the different types of wildlife used by the community.

Households interviewed about the wildlife resources they are extracting from the forest and the average prices of wildlife products in the local markets. Household family size, their sources of income and educational level were noted. Besides, the study also used qualitative interviews with village key informants and focus group discussions with forest wardens. Based on the income obtained from the forest, household forest dependency level was categorized as high, medium, and low if they have income from the forest represents respectively 50-100%, 25-50%, and <25% of their annual income, respectively. Statistical analyses were performed using a combination of statistical tools such as PAST Version 3.15 software and Epi-InfoTM-7. Kruskal-Wallis was used to know the difference in the forest dependence level and livelihood sources of income among Peasant Associations in the study area. Pearson's correlation coefficient was used to test the relationship between different socioeconomic characteristics of households in the studied villages. All statistical data was tested at the 0.05 confidence level.

Results

Demographic and socioeconomic characteristics of respondents

Out of 165 respondents, 132 (80.00%) and 33 (20.00%) were males and females, respectively. Concerning age, 24 respondents (14.55%) were between 18-25 years, 37 respondents (22.42%) were between 26- 33 years, 51 (30.91%) were between 34-41 years, 39 (23.64%) were between 42-49, and 14 (8.50%) were above 50 years of age. On the other hand, one hundred one (62.0%) of the respondents never joined the school, 42 (25%) of the respondents had some level of primary school education, 10 (6.10%) of them had attended junior secondary school, and 12 (7.27%) had secondary school education. However, none of the respondents had attained tertiary level education. Moreover, this study showed that 116 (70.3%) of the respondents were agro-pastoralists, 30 (18.2%) depended only on subsistence agriculture, 12 (7.3%) depends on livestock trading, and the remaining 7 (4.3%) engaged in other activities (Table 1). Almost all the respondents belong to the Oromo nation. The average family size per household was 6.5 people.

The highest mean annual income in Ethiopian Birr (18489 ETB, 578US$) per household was recorded in Arbu Abba Gada Peasant Association, whereas the least was (7413 ETB, 232US$) in Asgori Sora. Most households of the study area had engaged in livestock rearing because it plays a vital role in the economy of the local people. However, the mean number of livestock recorded in the different villages showed no significant variation. Accordingly, a mean maximum of 10.2 livestock was owned by Arbu Abba Gada village residents, followed by Siba Silassie (9.1), Siba Dalo (8.7), and Siba Kobi (7.8). The least mean livestock (5.5) was recorded in Asgori Sora. Furthermore, the mean number of livestock recorded in the study area showed a significant positive relationship ($r(n) = 0.900$, $p > 0.05$) with the mean annual income obtained per household. The common livestock reared by people in the study area includes cattle, horses, donkeys, sheep, goats, and mules. The average size of land cultivated/ household in the studied villages ranged from 3 to 5 ha. The average size of land owned per household revealed a strong positive relationship ($r(9) = 0.930$, $p > 0.05$) with the mean annual income obtained per household but indicated a significant negative relationship ($r(9) = -0.842$, $p < 0.05$) with the amount of kerosene used per households per month.

Table 1. Demographic and socioeconomic characteristics of respondents around JWPF (HAG =Arbu Abba Gada, SS = Siba Silassie, SD = Siba Dalo, AS = Asgori Sora, SK =Siba Kobi).

Variable	Villages

	AAG	**SS**	**SD**	**AS**	**SK**
Occupation					
• Agro-pastoralist	62.85	80	69.5	64.71	76.67
• Subsistence agriculture	22.86	10	22.22	17.65	16.67
• Livestock trading	5.71	6.67	8.33	11.76	3.3
• Other activities	8.57	3.33	0.0	5.9	3.3
Number of household respondents	35	30	36	34	30
The average family size/household	6.5	5.6	6.3	7.6	6.4
Average annual income/household (ETB)	18489	17575	12640	7413	8965
Average number of livestock/household	10.2	9.1	8.7	5.5	7.8
Average distance traveled from the forest(km)	3	2	1.5	2.5	1.5
The average size of landholding/ household (ha)	5	4.5	4	3.5	3
Average fuel wood consumption/household/day (kg)	11.8	13.7	15.5	12.6	14.6
Average beehives/household	7.4	11.9	14.8	8.3	13.4
The average number of households using solar energy	0.2	0.1	0.01	0.02	0.01
Shuen Fel SF toorchlight battery used/household	26.2	24.5	20.8	18.9	19.7
Average kerosene used/household/month (L)	1.2	2.1	1.9	2.3	2.5

Fuelwood is the most common energy source among rural communities in Ethiopia. Similarly, people around the study area use fuelwood either for cooking, heating and or as a lamp. Average fuelwood collection in Siba Dalo, Siba Kobi, Siba Silassie, Asgori Sora, and Arbu Abba Gada was recorded as 15.5, 14.6, 13.7, 12.6, and 11.8 kg, respectively. The local people traveled an average distance of 1.5 to 3 km to collect fuelwood and other forest products every day. A significant negative relationship ($r(9) = -0.971$, $p < 0.05$) between fuelwood consumption and distance of households from the forest has been recorded in the studied villages. Fuelwood is mostly collected during the dry season and stacked under the roof of the house. In addition to fuelwood, the local people use Shuen Fel SF torchlight batteries and kerosene as home lamps. Among these, the local people mostly used Shuen Fel SF torchlight batteries as lamps. Moreover, the three alternative sources of energy used (Shuen Fel SF torchlight battery, kerosene, and solar energy) also varied among the studied villages. For instance, an average Shuen Fel SF torchlight batteries used/household was 26.2, 24.5, 20.8, 18.9, and 19.7 in Arbu Abba Gada, Siba Silassie, Siba Dalo, Asgori Sora, and Siba Kobi villages, respectively. A significant positive relationship between Shuen Fel SF torchlight battery use and income ($r(n) = 0.976$, $p > 0.05$), and Shuen Fel SF torchlight battery use and mean the number of livestock/ household ($r(9) = 0.862$, $p > 0.05$) have been recorded in the study villages. Similarly, a significant positive relationship between solar energy users and the amount of income/ household ($r(9) = 0.847$, $p > 0.05$) and mean size of landholding/ households ($r(9) = 0.877$, $p > 0.05$) has been recorded in the study area. However, a significant negative relationship ($r(9) = -0.938$, $p < 0.05$) was recorded between Shuen Fel SF torchlight battery and solar energy users in the area (Table 2).

Table 2. Pearson's correlation coefficient (r) indicating the relationship between the different socioeconomic characteristics of people around JWPF.

Variable	Family size/ household	Income/ household	Livestock/ household	Distance from the forest	Size of land/ household	Fuel wood used/ household	Solar energy users	Shuen Fel SF battery	Kerosene used/ household
Family size/household	1								
Income/household (ETB)	-0.685	1							
Livestock/household	-0.754	0.900	1						
Distance from the forest	0.379	0.377	0.124	1					
Size of land/ household	-0.396	0.930	0.752	0.606	1				
Fuel wood used/household	-0.389	-0.290	-0.026	-0.971	-0.478	1			
Solar energy users	-0.269	0.847	0.711	0.768	0.877	-0.719	1		
Shuen Fel SF battery	-0.569	0.976	0.862	0.531	-0.478	-0.466	-0.938	1	
Kerosene used/household	0.022	-0.612	-0.365	-0.589	-0.842	0.412	-0.570	-0.580	1

Sources of income

The sources of income for the local people were agricultural products (94.72%), livestock (84.48%), and poultry (51.48%). Almost all the respondents from the five Peasant Associations reported that agriculture was the key source of income in the study area (Table 3). Besides, beekeeping (36.96%), non-timber forest products (26.34%) and livestock trading (10.88%) were reported as sources of income for the local people around Jorgo-Wato Protected Forest. However, a Kruskal-Wallis test revealed that there was no significant difference in the livelihood sources of income identified among surveyed villages in the study area ($H(4) = 0.302$, $p > 0.05$).

People in the study area use many wild plants and animal species to fulfill their livelihood needs. Around JWPF, respondents identified 19 plants and 5 mammalian species commonly extracted for a variety of purposes (Table 4). Of the plant species, *Pouteria adolfi-friederici*, *Cordia africana*, *Prunus africana*, *Croton macrostachyus*, *Syzygium guineense*, *Ekebergia capensis* and

Ficus sur were predominantly harvested for timber and construction materials in the area. On the other hand, *Olea welwitschii*, *Croton macrostachyus*, and *Ekebergia capensis* were debarked to construct traditional beehive. However, all the tree species were used for fuelwood, and various local tools (farming and other tools used at home level). Mammalian species such as *Potamochoerus larvatus*, *Tragelaphus scriptus*, *Hylochoerus meinertzhageni*, *Sylvicapra grimmia*, and *Syncerus caffer* were commonly hunted by the local hunters to subsidize their protein needs, whereas *Potamochoerus larvatus* and *Hylochoerus meinertzhageni* were hunted for both subsistence and medicinal purposes.

Table 3. Major sources of households' livelihood income around Jorgo-Wato Protected Forest (AAG =Arbu Abba Gada, SS = Siba Silassie, SD= Siba Dalo, AS = Asgori Sora, SK =Siba Kobi, N= number of respondents).

Sources of livelihood income	Percentage contribution (%)					Mean	Rank
	AAG (N=35)	SS (N=30)	SD (N=36)	AS (N=34)	SK (N=30)		
Agricultural products	98.6	97.5	92.4	90.9	94.2	94.72	1
Livestock and their products	84.6	86.3	79.8	88.4	83.3	84.48	2
Poultry	42.8	45.9	58.4	49.6	60.7	51.48	3
Bee keeping	30.5	25.4	42.3	36.8	49.8	36.96	4
Timber and non-timber forest products	15.2	20.4	34.6	24.7	36.8	26.34	5
Livestock trading	21.4	12.5	8.7	3.5	8.3	10.88	6

In the present study, the main reasons for which wildlife resources were extracted around JWPF were identified. Respondents revealed that wildlife is harvested mainly for commercial timber (89.75%), beehive preparation (80.43%), construction materials (72.62%), and domestic tools (66.90%). Fuelwood was also commonly harvested (45.3%) for home use, but it was less likely for commercial purposes. However, only a few respondents (7.54%) reported trees harvest for charcoal production in the area (Figure 2).

Concerning the dependence level of households on the forest and non-timber forest products, the majority (65.24 ± 4) of respondents revealed that households around JWPF were moderately dependent, whereas 13.64±1.8 reported as they were highly dependent on the forest. However, the survey exhibited that 21.16 ± 14 of households around JWPF had a low dependence level on the JWPF (Figure 3). The outcome of this investigation demonstrated that the forest dependency level among Peasant Associations did not show a significant difference in the study area ($H(4) = 0.567$, $p > 0.05$).

Destructive resource use patterns impacting future conservation of JWPF

Selective debarking of plant species, for beehive preparation, selective logging of trees over coffee plantations, livestock grazing, signs of poaching activities, cutting trees for timber production, and girdling trees and expansion of coffee plantation recorded as destructive resources use patterns in the JWPF. During this study, incidences of resource extractions recorded along the transect walked revealed that livestock grazing (6.59±3.80/km) was the most prevalent destructive resource use system, followed by debarking of trees for beehive preparation (5.8±0.77/km), selective logging over coffee plantation (5.41±0.35/km), and girdling trees (4.66±0.33/km). Incidences of poaching (4.022±3.32/km) and cutting trees for timber (3.41±1.10/km) were the rarest destructive resource use systems impacting the future conservation activities of JWPF (Fig. 4).

Table 4. Wildlife commonly extracted for livelihood support and their utility value as described by the local communites arround JWPF (WF = Wild food; M = Medicine; R = Rope; Bh = Beehive; T = Timber; Cm = Construction materials; FW= Fuelwood; DT= Domestic tools).

S.No	Parts used	Purpose or values of the resource

	Scientific name		**WF**	**M**	**R**	**Bh**	**T**	**Cm**	**FW**	**DT**
	Plants									
1.	*Pouteria adolfi-friederici*	Stem					*	*	*	*
2.	*Olea welwitschii*	Bark				*			*	*
3.	*Cordia africana*	FS	*				*	*	*	*
4.	*Prunus africana*	Stem					*	*	*	*
5.	*Croton macrostachyus*	Stem and bark		*		*	*	*	*	*
6.	*Syzygium guineense*	Fruit and stem	*				*	*	*	*
7.	*Hibiscus spp.*	Fibre			*	*		*	*	*
8.	*Aframomum corrorima*	Fruit	*							
9.	*Rhamnus prinoides*	Leaf	*							
10.	*Clematis simensis*	Stem/ flower		*		*		*		*
11.	*Ekebergia capensis*	SB				*	*	*	*	*
12.	*Hyparrhenia spp.*	Whole				*		*		
13.	*Coffee arabica*	Seed	*							
14.	*Ficus sur*	Fruit and stem	*				*	*	*	*
15.	*Rubus spp.*	Fruit	*							
16.	*Embelia schmperi*	Fruit	*	*						
17.	*Brucea antidysenterica*	Root		*						
18.	*Calpurnia aurea*	Leaf	*							
19.	*Clausena anisata*	Leaf	*							
	Animals									
20.	*Potamochoerus larvatus*	Meat	*	*						
21.	*Tragelaphus scriptus*	Meat	*							
22.	*Hylochoerus meinertzhageni*	Meat	*	*						
23.	*Sylvicapra grimmia*	Meat	*							
24.	*Syncerus caffer*	Meat	*							

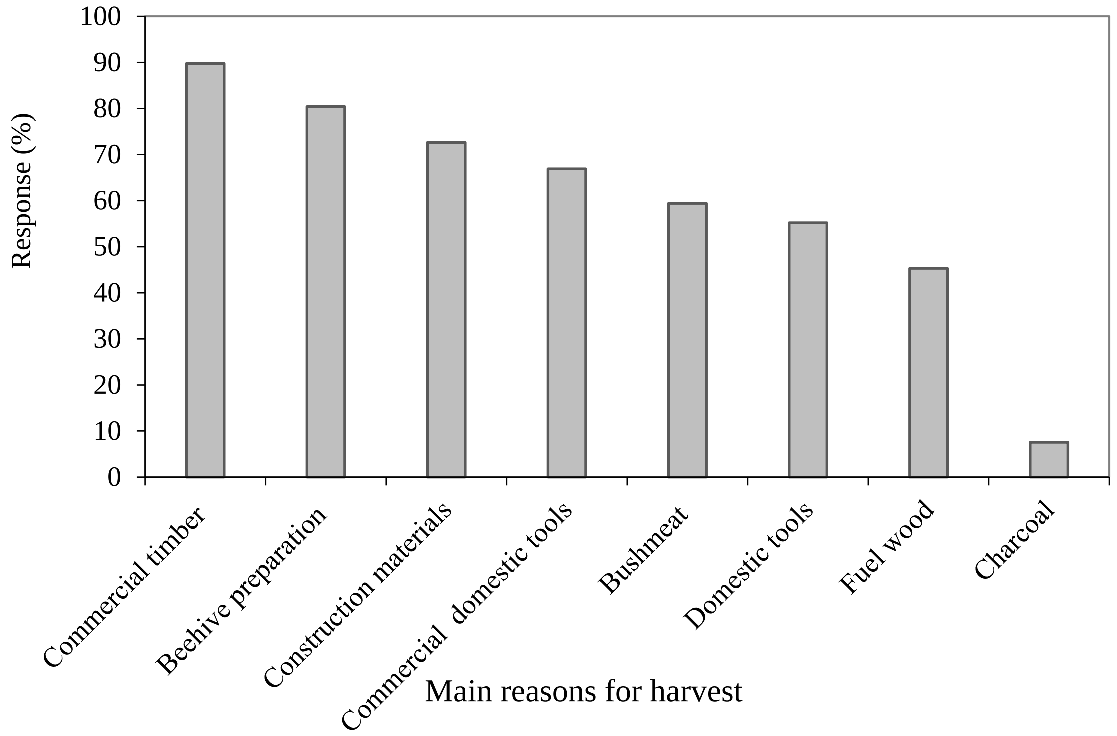

Figure 2. The major reasons for the extraction of wildlife resources from JWPF (N = 165)

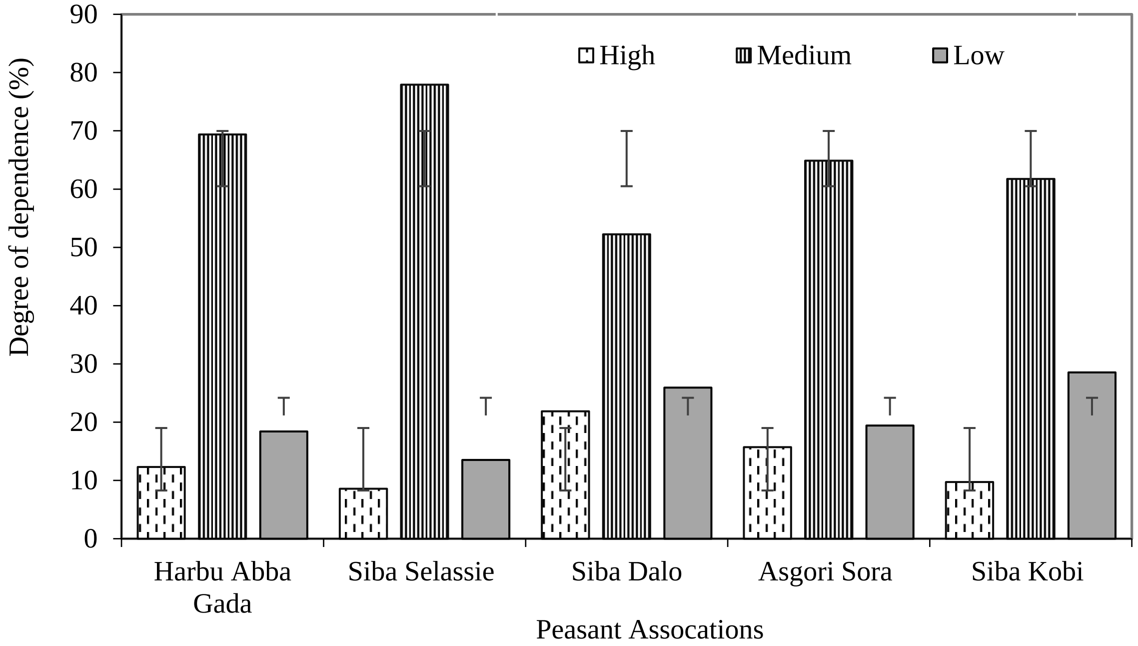

Figure 3. Dependence on wildlife resources of the households in the villages around the JWPF.

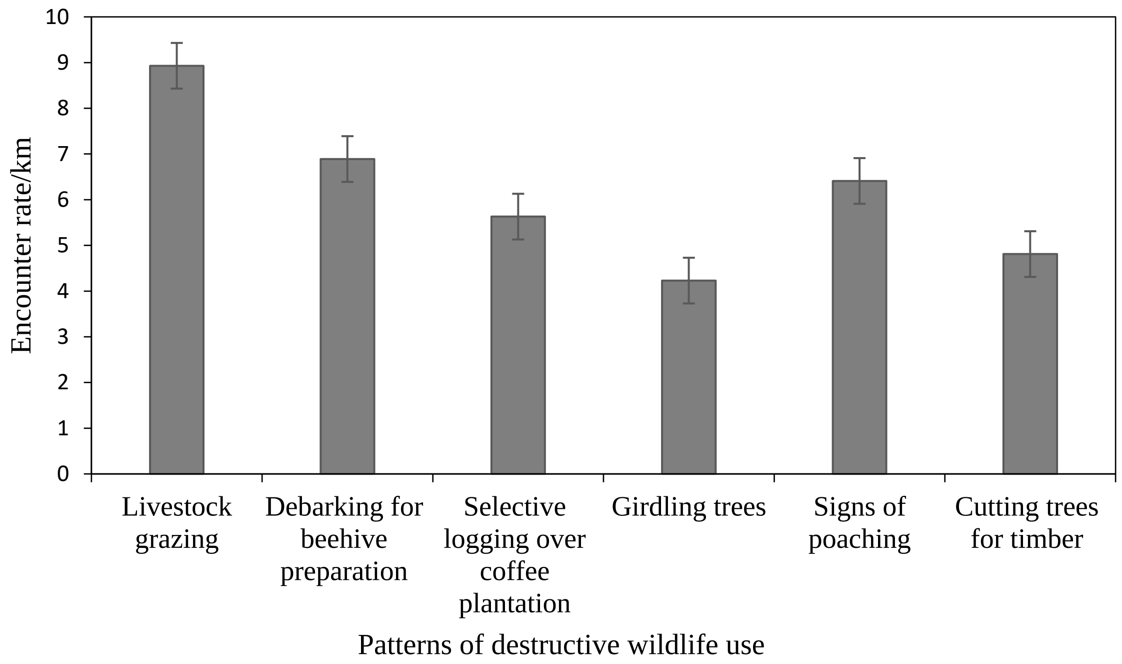

Figure 4. Destructive resource use patterns impacting the future conservation activities of JWPF

Commonly harvested trees

In the current study, the most commonly harvested species were *O. welwitschii* (8.23/34 km) and *P. adolfifriedericii* (6.54/34 km), followed by *R. prinoides* (13.8/34 km) and *C. arabica* (11.7/34 km) (Figure 5). Both *O. welwitschii* and *C. macrostachyus* were the most debarked trees, whereas *P. adolfi-friedericii*, *C. africana*, *P. africana*, *S. guineense* and *E. capensis* were the most selectively logged tree species in the area. Moreover, other resources such as domestic fuelwood, domestic tool materials, and other household items (pen for domestic animals, house fencing, crop fencing, fibers, lianas, and wild honey) were collected from non-specific tree species.

Discussion

In the present study, none of the respondents had attended tertiary level education. Individuals who had completed tertiary level education might have left their families searching for governmental or non-governmental work rather than engaging in agricultural activities. Engaging in agricultural activities after the completion of tertiary level education is reprehensible in society. These might be the cause for the absence of qualified individuals in agro-pastoralism in the study area. The local people settled closer to the forest seeking fertile soil and land for livestock grazing. Gradually this leads to an irreversible impact on the forest and could be the cause of human-wildlife conflicts around JWPF. Moreover, encroachments close to the JWPF could increase illegal access and aggravate resource extraction from the forest.

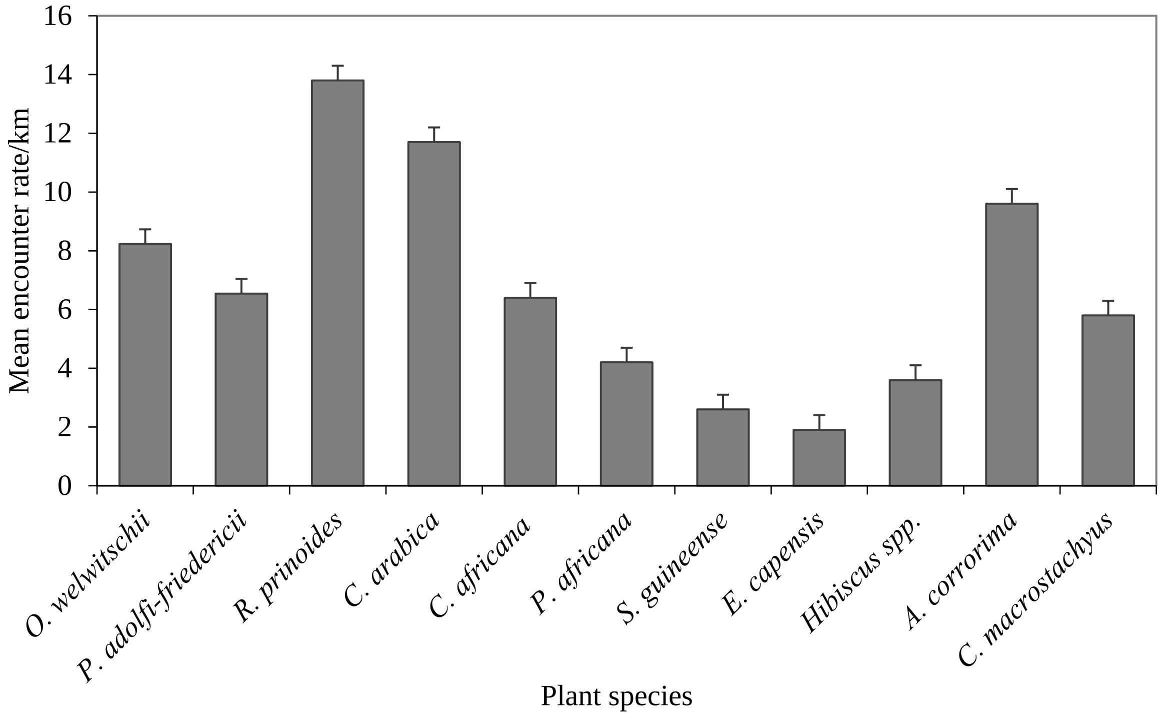

Figure 5. Major plant species commonly extracted and their mean encounter rates along the transects walked in JWPF

The main sources of income for the local people are agricultural products, livestock, and livestock products. The main crops cultivated were teff, maize, wheat, and sorghum. Mean land size owned per household revealed a positive relationship (r (n) = 0.930, $p > 0.05$) with the mean annual income obtained per household. This highlights the fact that owned more land have more income than those who have low land size. Moreover, households who did not fully cultivate their land probably gave part of their land to others as a lease for a year or more. Hence, households with large land sizes are assumed to have high income and used solar energy or Shuen Fel SF torchlight battery as house lamp instead of kerosene. Livestock farming and poultry play vital roles in the economic improvement of the local people as reported by Tola (2018). Rearing of domestic animals such as cattle, horses, donkeys, sheep, goats, mules, and poultry increase their income and cover different livelihood needs of the local people. The possession of many livestock is a symbol of economic growth and development in rural areas as reported by Sharma, Gairola, Ghildiyal, & Suyal (2009), from Garhwal Himalaya villages, India.

Households found closer to the forest have easy access and transportation of fuelwood. The use of fuelwood would decrease as the distances of households from the forest increases. A similar study has also shown that it is less likely that villages located distant from the forest are dependent on fuelwood as reported by Sharma et al. (2009). In addition to fuelwood, Shuen Fel SF torch light battery and kerosene are used only as the home lamp in the study area. As income increases, the capacity of households to use solar energy and Shuen Fel SF torchlight battery would increase in the area. Noteworthy, the use of alternative sources of energy has significant positive impacts on the conservation of JWPF. Plant resources were mostly utilized for timber, beehive preparation, and construction materials. *P. adolfi-friedericii* and *C. africana* were the two most preferred tree species for timber production in the area. Moreover, beehive preparation from the bark was also presented as the second reason for the extraction of wildlife resources in the area. The barks of *O. welwitschii* and *C. macrostachyus* were used for the preparation of traditional beehives as the preparation of beehive from the bark is easier, less time consuming, requires fewer resources, and has a long life as compared to other traditional beehives. More importantly, the bark of *O. welwitschii* is especially preferred for beehives because its bark has a pleasant fragrance that attracts honey bees from distance. People extracts animal resources for different reasons and purposes though the pattern of resource use varied as revealed by Erena et al. (2020).

Destructive resource use patterns impacting future conservation of JWPF

Livestock grazing

Repeated livestock grazing in the forest seriously degrading JWPF as described by Kumar & Shahabuddin (2005). As stated by McElwee (2010), grazing in the protected areas had a moderate to high conservation impact as grazing animals can alter forest species composition and hinder the new growth of species. Uncontrolled grazing and overstocking causes slow regeneration on degraded habitats, loss of species diversity and potential ecological disasters (Glatzel, 1999; Roder, Gratzer, & Wangdi, 2002; Kumar & Shahabuddin, 2005).

Debarking of trees for beehive preparation

Almost all households around JWPF prepared beehive from the barks of different trees. This might be because the preparation of beehive from the bark is easier and has long-lasting service compared to traditional beehives made of *Vernonia leopardi* and grass. Moreover, from a single *O. welwitschii* tree, about 6-8 beehives are produced as debarking is done at 1 m interval along its length. As revealed by households, the activity of debarking for beehive preparation had been handed down from elders.

Selective logging over the coffee plantation

In all peripheral parts of JWPF, the local people are planting coffee, and then remove large tree species in consecutive years to reduce shade over coffee plantations. This leads to the removal of herbs and shrubs, which could further reduce understory cover and small mammals dwelling in it. The lack of law enforcement to restrict such illegal activities in the area will be a bad lesson for the adjacent villages to plant coffee in the future. Coffee plantations and selective logging of trees have significant negative impacts on species diversity, richness, and wildlife habitats in the area.

Timber

The incidences of illegal cutting of trees for timber in JWPF were high, which could be ascribed to loosen implementation of law about illegal extraction of wildlife in the study areas. Individuals caught as a result of illegal timber harvest have not been charged in the area because the local militias did not want to lose the social relationship, he or she had with timber harvester. Such social relationship among the societies could be the reason for loosening implementation of wildlife laws as reported by Naughton-Treves et al. (2006).

Poaching

Poaching is considered as the destructive method of harvesting wild mammals in the area because it mostly caught the non-targeted animals as reported by Lindsey, Dutoit, Pole, & Romanach (2009). Many economically significant wild mammals are suffering from poaching in JWPF as described by Staub, Binford, & Stevens (2013). Species of large animals that have slow rates of reproduction and growth could be highly prone to population decline and extinction. Slow population growth rates coupled with poaching, habitat loss, and diseases have a significant negative impact on the populations' persistence (Cardillo et al., 2005).

Conclusion

The local people collect dried and fallen trees only for domestic fuelwood, which could have a positive impact on the sustainable conservation of the forest. Also, the production of charcoal around the study area was minimal since the demand for charcoal is low since the town is far from the forest. The study revealed that patterns of wildlife use were not sustainable since the local people use destructive methods that threatened the future existence of the forest and wildlife habitats. However, the alternative techniques used as sources of energy in the area were promising to reduce future wildlife extraction in the area. To sustainably conserve wildlife resources in JWPF, participatory forest management programs shall be applied to develop a spirit of ownership among the adjacent local communities. The local authorities should also enforce the implementation of wildlife laws and community rights on the utilization of resources from the protected area. Wildlife laws and policies could be effective through the participation of the local communities in the planning and management activities of the forest.

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