

Threatened Woody Plant Species and Factor of Threat in Adjacent Area of Babile Elephant Sanctuary, Eastern Hararghe, Ethiopia

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Abstract: Protected areas plays important role in conservation of biological diversity. Assessment of threatened plant species and factor associated with this threat is of immense importance in managing protected area. This study was conducted on around Babile Elephant Sanctuary buffer zone located. This study aimed at documenting threatened plant species, factors of threat and challenges around BES. The data were collected from total number of informants 96 using semi-structured questionnaire, observation and guided field walks. The result of the assessment revealed a total of 61 threatened plant species among these 30 were shrub, 28 Tree, 2 climber and 1 herb and were represented by 25 families and 47 genera. *Fabaceae*, *Tiliaceae*, and *Capparidaceae* were the three dominant plant species respectively and each comprise 12, 4, and 3 species respectively. Regarding level of threatened plant species, 38 (45.7%) species were categorized under highly threatened, 23 (38%) species were categorized under medium threatened and 10 (16%) species were categorized under low/least threatened. The response of informants from six kebele suggested that the presence of ten factors which were exposing higher threat level on BES. Top three factors that threaten plant species includes agricultural expansion, illegal settlement, and Charcoal which accounts for 97.9%, 81.25%, and 62.5% respectively. Eight major challenges were identified for current conservation BES. Lack of alternative job as the major challenge as responded by communities 90 (93.75%) followed by Lack of community Incentive when elephant browsing and damage local crop 87 (90.62%) and Lack of strong regulation and relation of park administration with community was the third factor as responded by 85 (88.54%). The current study suggest that important intervention is necessary to conserve threatened plant species in BES.

Keywords: Diversity, Eastern Hararghe, Ethiopia, Challenge, Threat

1. Introduction

Establishment of protected areas is vital for in situ conservation of diverse native species. Protected areas play a major role in the conservation of biodiversity [24, 23]. Traditionally, protected areas have been established to safeguard important landscapes and seascapes, major species, and their habitats [12, 36]. In the last few decades, there has been a major increase in conservation areas to reduce biodiversity loss and enhance ecosystem integrity, function, and services [18]. Moreover, there is the Convention on Biological Diversity (CBD) of Aichi Biodiversity Target 11 to make 17% of the terrestrial surface and 10% of the marine

realm ecosystem into the protected area by 2020 [8]. These activities are undertaken for the purpose of education, research, and recreation. Moreover, these areas provide such essential items as fuel wood, building materials, forage, traditional medicines and wild foods.

Currently, the amount of area assigned as protected area globally is 17 million km² (12.7% of the land surface) and 6 million km² (1.6% of the marine surface) [8]. However, extra land to set aside for conservation of biodiversity are challenged by the globally rising demand for food and other purposes, creating trade-offs between areas dedicated to biodiversity conservation versus agriculture [5, 26]. Therefore, there is a need to find an optimal balance between

conservation and development especially in developing countries, where addressing widespread food insecurity and poverty is a regional priority.

In Ethiopia, protected areas cover approximately 16.4% of the country's surface area [32, 36]. There are 20 national parks, 3 sanctuaries, 2 wildlife reserves and 17 controlled hunting areas, 7 open hunting areas and 3 community conservation areas covering an area of about 65,531.4 km² [13]. However, except few, most of the protected areas exist on paper only and have declined in size and quality.

Protected areas have hardly been managed in Ethiopia due to population pressures [25, 11, 35]. Often, the decision made on protected areas do not take due consideration of the interest of stakeholders, especially communities who are dependent on the local resources [36]. As a result, uncontrolled expansion of agriculture and grazing coupled with illegal harvesting of vegetation and other products have been threatening the function of the protected area system in many parts of the country [37, 21]. Furthermore, overgrazing is exposing the land for severe erosion and retarding the recruitment and survival of tree seedling [20]. Lack of integration of the livelihood of the local people living around BES and the absence of law enforcement system are the major constraints to the overall conservation efforts.

The knowledge of the factors involved in the deterioration of the ecosystems found inside protection areas are fundamental for appropriate management. Disturbances can lead to vegetation degradation and subsequent reduction of desirable characteristics of an area for nature conservation [2, 6]. Babile Elephant Sanctuary (BES) is one of the protected areas in the semi-arid region of eastern Ethiopia, which has highly declined in size and quality [3, 10, 33]. The sanctuary was established to protect the only known population of the isolated and ecologically distinct subspecies *Loxodonta africana orleansi* [7]. Recent socio-economic and land use changes in BES such as the demand for more area for agriculture have reduced the woodland area, increasing the severity of impact both humans and elephants have on woody vegetation. Erer Valley, which is the largest part of the Babile Elephant Sanctuary. This valley is the most extensive part of the sanctuary where it is currently subject to increasing settlement pressure from all buffer zone since it had high prize of underground. Both the human and livestock population have increased dramatically [3]. Highly dependent of local community on vegetation's for fencing, medicine, construction, temporary settlement, charcoal and fuel wood for subsistence daily livelihood. At the same time, large mammals such as the African elephant selectively utilize the woody vegetation's, capable of affecting the vegetation of the region they inhabit [28]. More over currently this existence of high prize of underground water become increasing agricultural investment around buffer zone and the computation expansion boundary between Ethio-Somale and Oromiya woreda around buffer zone subject for deterioration of protected area. So, this study was aimed to assess threatened woody plant species, factor of threat, and challenges around buffer zone of BES which is

critical in developing action plans that will restore sustainable utilization of plant resources on the sanctuary.

2. Materials and Methods

2.1. Description of Study Area

Babile Elephant Sanctuary (BES), in the eastern lowlands of Ethiopia, is part of the Somali-Masai centre of endemism [7]. The underlying rocks are mainly marine in origin and soils are characterized by cambisols, luvisols, nitosols, orthic solonchakes, fluvisols, vertisols and xerosols [22]. The sanctuary is situated at the semi-arid trans-boundary of Oromia and Somali Regions, at about 560 km from Addis Ababa. It is delimited with coordinates of latitudes 08°22'30" - 09°00'30" N and longitudes 42°01'10" - 43°05'50" E and its elevations ranges between 850 and 1,785 m a.s.l. [27, 34].

When the sanctuary was established in 1970, it covered an area of about 6,984 km² [27, 14] between the Eastern Hararge high mountain i.e. Mt. Gara- Muleta to the west and the Ogaden Desert to the southeast. Four main drainage river valleys (Fafem, Daketa, Erer and Gobelle) rise from Garamuleta-Harar-Gursum Highlands and extend southwards through the sanctuary to join Wabi Shebelle River Basin (Figure 1).

2.2. Flora and Fauna

The vegetation of the sanctuary was represented by Acacia-Commiphora woodland, semi-desert scrubland and evergreen scrub ecosystems [27]. More recent data indicated that the riverine species in the upper Erer Valley are comprised of *Acacia robusta* Burch. *Tamarindus indica* L., *Oncoba spinosa* Forssk. *Acokanthera schimperi* (A. DC.) Schweinf. and *Capparis tomentosa* Lam. (Anteneh Belayneh, 2006). The Sanctuary is prized for hosting species of interest like the African elephant, Black-manned lion, Leopard, Hamadryas baboon and Menelik's Bushbuck, the only endemic subspecies for the sanctuary. Based on a direct count, [35] had reported the presence of about 324 elephants in the sanctuary with indications that the number could rise to 400.

2.3. Climate

The BES is generally characterized by semi-arid climatic condition. The mean annual temperature is about 19.6°C, ranging from a mean minimum of 11.9°C to mean maximum of 27.2°C. There is only a slight difference in temperature throughout the year, with the hottest months in April to June (maximum 29°C) and the coldest months during October to December (minimum 7.8°C). The mean annual rainfall is 702.9 mm year-1, with high variation from year to year, ranging from 451.7 to 1,115.9 mm year-1. Rainfall is bimodal occurring from March to April (short rain season) and June to September (long rain season) (source: [4]).

2.4. Sampling and Sampling Design

The study was conducted on around Babile Elephant Sanctoury buffer zone located in two region of Ethiopia

namely Ethio-Somale and Oromia region which border the BES. Accordingly, purposive sampling method were employed to select six kebeles from the two region for data collection purpose. Among the six kebeles two kebeles were from Ethio-Somale Babile Woreda includes Dendema and Biqo kebele and the other four kebeles were from Oromiya region Babile woreda include Erer Ebada, Ibada Gamachu, and from Fedis woreda Riski and Aneni.

A total of 10 informants were selected randomly and 6 key informants were selected purposively from each kebele with total number of informants 96 were selected following [19].

2.5. Data Collection Methods

Data were collected from both primary and secondary data. Primary data were collected through Semi-structured interview, focus group discussions, and guided field walks with informants were employed following [19, 1, 9] and field

observation was carried out with local field guide assistant who have the skill of local language. Secondary data were collected from BES office, Ethio-somale Babile woreda and Babile and Fedis woreda from Oromia region and publish and unpublished literature survey. During formal and informal interview the respondents we requested to categorize level threat for all of the forest species into three categories: High, Medium and low. Where 'High' represent highly threatened plant species, when the population of the plant is rare and declining in the study area. Where 'medium' represent near threatened plant species, when the population of plant species some was present but, not much abundant generation. Where 'low' represent least threatened plant species, when the population of plant species has good regeneration. To help the respondents to categorize the species key questions like trends of plant species, the origin of plant species and importance of individual species were asked.

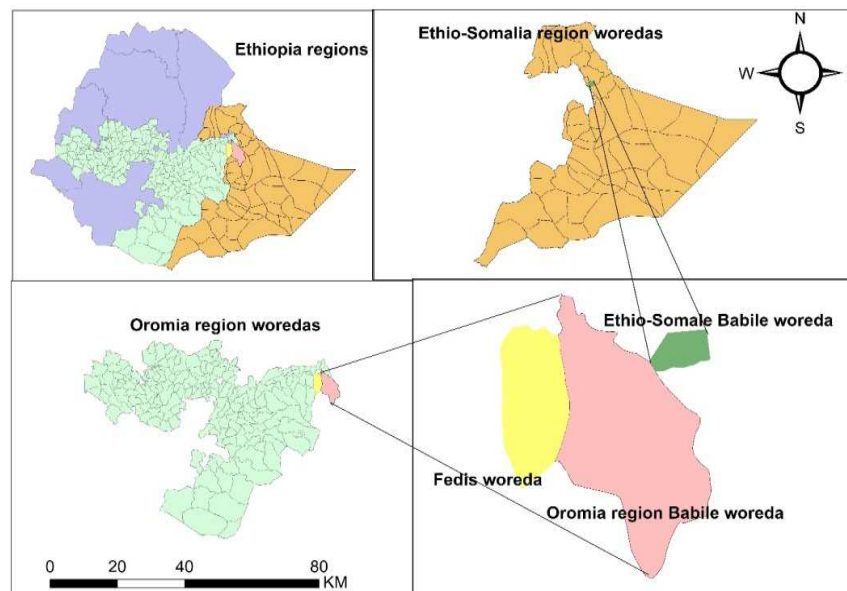


Figure 1. Map of study area (By: Abdurazak Sufiyan).

Table 1. Location of sampling.

No	Name of sampling site	Location		Altitude	
		Latitude (N)	Longitude (E)		
1	Erer ibada	42.25228	9.12095	1,274	
2	Ibada gamachu	42.25228	9.12095	1,274	
3	Riski	42.03472	9.04000	1,500	
4	Aneni	42.04750	8.98556	1,556	
5	Biqo	42.37584	9.05277	1,415	
6	Dendema	42.39151	8.93193	1,462	



Figure 2. Researcher discuss with focal person and local community (photo: by Tahir Abdala).

2.6. Data Analysis

The collected data entered into Excel spreadsheet 2007 and summarized by Descriptive statistics like table, percentage and graph. Preference ranking and paired comparison were computed following [1] to analysis factor threatened woody plant species and most threatened plant species.

3. Result and Discussion

3.1. Diversity and Status of Threatened Plant Species

The result of the assessment revealed a total of 61 threatened plant species as shown in (Table 2). Among this 30 were shrub, 28 Tree, 2 climber and 1 herb as indicated in (figure 4) and were represented by 25 families and 47 genera. *Fabaceae*, *Tiliaceae*, and *Capparidaceae* were the three dominant plant species respectively and each comprise 12, 4, and 3 species respectively. Eight family

include two species each those were *Rhamnaceae*, *Balanitaceae*, *Boraginaceae*, *Burseraceae*, *Apocynaceae*, *combretaceae*, *sapindaceae* and *euphorbiaceae* and the other plant families were only represented by a single species. The genus *Acacia* and *Grewia* were represented by 10 and 4 species respectively while genus *Balanite* and genus *Commiphora* were represented by 2 species each. Other genera were only represented by one species each as indicated in (Table 2). The list of all surveyed threatened plant species around BES was shown in Table 2 and the dominant family of threatened plant species around BES was shown in figure 3. This study was supported by review made on floristic diversity and threatened plant species in Babile Elephant Sanctuary [30] and also with assessment made on forest biodiversity resources and level of threat in Hararge Area [29].

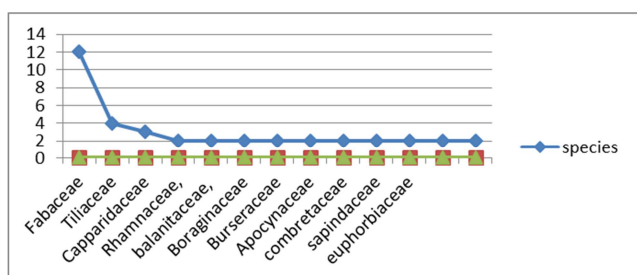


Figure 3. Dominant family plant species around BES.

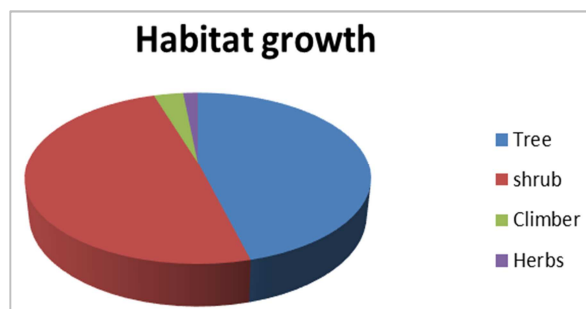


Figure 4. Growth habit of threatened plant species.

As shown in the Table 2, 61 total number of threatened plant species were identified from respondents. The identified threatened plant species and their level of threat were determined by knowledge of local community. Regarding level of threatened plant species, 38 (45.7%) species were categorized under highly threatened, 23 (38%) species were categorized under medium threatened and 10 (16%) species were categorized under low/least threatened.

3.2. Factors of Threats to Plant Species Around BES

According to (Table 3) and (figure 5), the response of informants from six kebele suggested that the presence of ten factors which were exposing higher threat level on BES. Among them, agricultural expansion was become highly threat the park and score 97.9% followed by illegal settlement 81.25%. and also Charcoal was the 3rd factors currently targeted accounting 62.5% and invasive scored 60.4% followed by investment and selective cut for construction (59.37%), Elephant browsing (46.87%), fire wood (43.75%), drought (41.66%), and Honey collection (16.6%). This finding was similar to [4] and it is also supported by [16] in which most of the threatened protected areas such as natural forests and mountainous ecosystem protected areas have been degraded through livestock grazing and deforestation. The result obtained from Abijata-Shalla National Park of Ethiopia was also similar to this study [17]. According to this study, excessive exploitation of natural resource by human was the main reason for changing the park habitat. Threats to wildlife and their habitat was increased due to subsequent increase in human activity [31, 15]. According to [17], human activities caused threats to biological resources through competition with wildlife, deterioration of their habitats and environmental degradation.

3.3. Current Challenges of BES Conservation

The survey revealed that Lack of alternative job 90 (93.75%), Lack of community Incentive when elephant browsing and damage local crop 87 (90.62%), and Lack of strong regulation and relation of park administration with community 85 (88.54%) were the three top factor that caused the threats responded by communities. The other challenges including Lack of Awareness, Lack of community participation for conservation, Dependence of local community on agriculture, Existence of park between two region, and Lack of clear boundary demarcate accounts for 80 (83.33%), 76 (79.1%), 68 (70.83%), 65 (67.70%), and 57 (59.37%) respectively. Table 4 shows that not only community related factor are causing the factor but also management bodies contribute for biological resource depilation. This indicate that lack of cooperation, integration, and collaboration between communities and management bodies in conservation of biological resources of the sanctuary. Lack of cooperation and coordination among stakeholders minimize the success of conservation activities [16, 21, 15]. Participation of communities on decision making process may be necessary so that they perceive the own the resource otherwise conservation of biological resources is unsuccessful [16].

Table 2. List of threatened plant species around BES buffer zone.

No	Scientific name	Family name	Local name	Growth habitat	Status
1	<i>Acacia albida</i>	Fabaceae	Garbi	T	High
2	<i>Acacia brevispica</i>	Fabaceae	Hamareysa	S	High
3	<i>Acacia bussei</i>	Fabaceae	Halloo (Or)	T	High
4	<i>Acacia mellifera</i>	Fabaceae	Bilaila (Or)	S	Medium
5	<i>Acacia nilotica</i>	Fabaceae	Serkema	S	Medium
6	<i>Acacia oerfota</i>	Fabaceae	Ajoo	S	Medium
7	<i>Acacia robusta</i>	Fabaceae	Wangeyoo	T	Medium

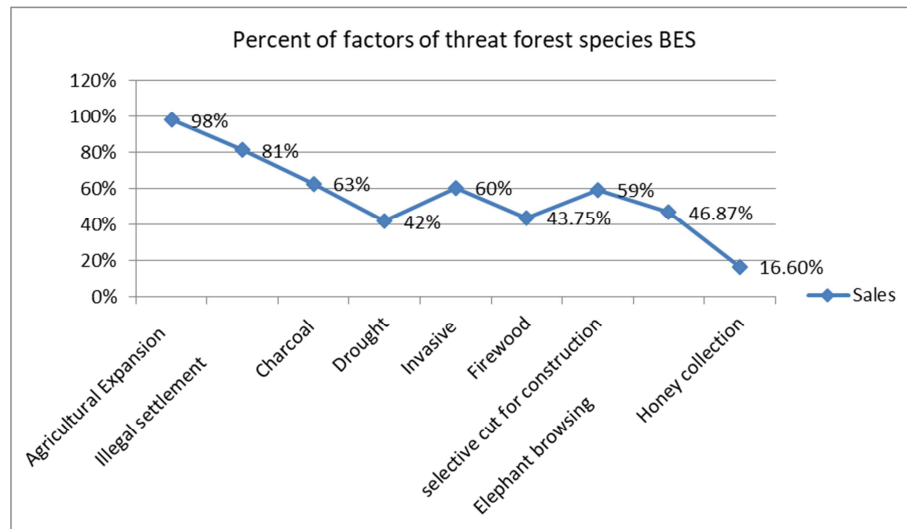
No	Scientific name	Family name	Local name	Growth habitat	Status
1	<i>Acacia albida</i>	Fabaceae	Garbi	T	High
8	<i>Acacia Senegal</i>	Fabaceae	Soppensa	S	Medium
9	<i>Acacia seyal</i>	Fabaceae	Wachu	T	Medium
10	<i>Acacia tortilis</i>	Fabaceae	Dhadacha	T	High
11	<i>Acokanthera schimperi</i>	Appocynaceae	Qaraaru	T	High
12	<i>Aloe pirottae</i>	Aloaceae	Hargeysa	S	Medium
13	<i>Allophylus rubifolius</i>	Sapindaceae		H	High
14	<i>Azadirachta indica</i>	Meliaceae	Kinina	T	Low
15	<i>Bascia minimifolia</i>	Capparidaceae	Meygag	T	Medium
16	<i>Balanites aegyptiaca</i>	Balanitaceae	Bedeno	T	Medium
17	<i>Balanites glabra</i>	Balanitaceae	Kutka	T	High
18	<i>Barleria hildebrandtii</i>	Acanthaceae	Dhaallaa	S	High
19	<i>Berchemia discolor</i>	Rhamnaceae	Jajeba	T	High
20	<i>Cadaba farinose</i>	Capparidaceae	Kelkelcha	S	High
21	<i>Combretum molle</i>	Combretaceae	Rukkeysa	T	High
22	<i>Commiphora erythrae</i>	Burseraceae	Kedhon (S)	T	Medium
23	<i>Commiphora schimperi</i>	Burseraceae	Dekero	T	High
24	<i>Capparis tomentosa</i>	Capparidaceae	Gamooraa	C	High
25	<i>Carissa edulis</i>	Apocynaceae	Agamsa	S	Low
26	<i>Cordia monoica</i>	Boraginaceae	Medhero	S	Low
27	<i>Celtis africana</i>	Ulmaceae	Mataqooma	T	Medium
28	<i>Cussonia holstii</i>	Araliaceae	Harfattuu	T	High
29	<i>Dodonaea angustifolia</i>	Sapindaceae	Edechaa	S	Medium
30	<i>Dichrostachys cinerea</i>	Fabaceae	Jirime	S	Medium
31	<i>Ehretia cymosa</i>	Boraginaceae	Huulaga	T	Medium
32	<i>Euclea racemosa</i>	Ebenaceae	Mi'esaa	S	High
33	<i>Euphorbia burger</i>	Euphorbiaceae	Hadami	S	Medium
34	<i>Ficus thonningii</i>	Moraceae	Dambii	T	Medium
35	<i>Flacourtia indica</i>	Flacourtiaceae	Hudhaa	S	Medium
36	<i>Flueggea virosa</i>	Euphorbiaceae	Kechachile	S	High
37	<i>Grewia bicolor</i>	Tiliaceae	Haroresa,	T	Low
38	<i>Grewia ferruginea</i>	Tiliaceae	Bururi, Ogemdi	T	High
39	<i>Grewia kakothamos</i>	Tiliaceae	Midhayoo	S	Low
40	<i>Grewia schweinfurthii</i>	Tiliaceae	Mudhugurre	S	Medium
41	<i>Grewia villosa</i>	Tiliaceae	Ogomoodi	S	Low
42	<i>Justicia schimperiana</i>	Acanthaceae	Dhumugaa	S	Low
43	<i>Kirkia tenuifolia</i>	Simaroubaceae	HudhaaSawwa	S	High
44	<i>Kleinia squarrosa</i>	Acanthaceae		S	Medium
45	<i>Lannea schimperi</i>	Anacardiaceae	Handarakkuu	T	Medium
46	<i>Olea europaea</i>	Oleaceae	Ijersa	T	High
47	<i>Oncoba spinosa</i>	Flacourtiaceae	Jilboo	S	High
48	<i>Opuntia ficus-indica</i>	Cactaceae	Tiini	S	Low
49	<i>Ozoroa insignis</i>	Anacardiaceae	Rukeylu	T	Medium

Table 3. List of threatened plant species around BES buffer zone.

No	Scientific name	Family name	Local name	Growth habitat	Status
50	<i>Premna oligotricha</i>	Lamiaceae	Urgessaa	S	Medium
51	<i>Plectranthus cylinderaceus</i>	Lamiaceae	Barbarisha		
52	<i>Rhoicissus revoli</i>	Vitaceae		S	Low
53	<i>Rhus natalensis</i>	Anacardiaceae	Laalu	C	High
54	<i>Sterculia Africana</i>	Sterculiaceae	Dobobeysaa	S	Low
55	<i>Salvadora persica</i>	Salvadoraceae	Geri	T	Medium
56	<i>Tamarindus indica</i>	Fabaceae	Ade	T	High
57	<i>Terminalia brownie</i>	Combretaceae	Roka	T	High
58	<i>Withania</i>	Solanaceae	Bireysaa	T	High
59	<i>Somnifera</i>	Rhamnaceae	Hidi gudeye	S	High
60	<i>Ziziphus spina</i>	Rhamnaceae	Kurkura	T	High
61	<i>Ziziphus mucronata</i>	Rutaceae	Kurkura gabbro	T	High

Table 4. Factors of threats Cited By respondent from the sample of six kebele (N=96).

NO.	Factors Of Threat	Kebele Of Respondent						Total Respondent	% of (R)	Rank
		Dendema	Erer Ibada	Riski	Ibada gamachu	Aneni	Biqo			
1	Agricultural Expansion	16	17	19	19	11	12	94	97.9	1
2	Illegal settlement	12	11	16	14	15	10	78	81.25	2
3	Investment	10	15	8	8	11	5	57	59.37	5
4	Charcoal	12	9	7	7	10	15	60	62.5	3
5	Elephant browsing	5	5	5	9	7	14	45	46.87	6
6	Invasive	9	7	6	12	14	10	58	60.4	4
7	Drought	13	4	4	4	9	6	40	41.66	8
8	selective cut for Construction	10	8	4	13	13	9	57	59.37	5
9	Firewood	8	4	5	11	3	11	42	43.75	7
10	Honey collection	3	3	3	5	1	1	16	16.6	9

**Figure 5.** Percentage of factors threat BES.**A.** Forest Species Dried by Drought**B.** charcoal production**C.** Over grazing by animal**D.** Forest area destructed for agriculture**E.** Firewood collected and brought to market**F.** Herds of Camel come for grazing**Figure 6.** Picture recorded during field as factor of threat (photo: Tahir Abdala).

4. Conclusion and Recommendations

The study was conducted on proximity adjacent six kebele of BES. From this study 61 forests plant species were identified. According to this all identified plant species level of threatened plant species were determined by knowledge of local community. Among all determined plant species 38 (45.7%) species were categorized under highly threatened, 23 (38%) species were categorized under medium threatened and 10 (16%) species were categorized under low/least threatened.

The study revealed 11 major factors of threat and among this agricultural exposition held the 1st rank followed by Illegal settlement and Over Grazing as 2nd. Charcoal making and tree cutting the 3rd factors followed by invasive. In

addition currently, investment is 5th factors followed by Elephant browsing held as 6th factors followed by Construction, Firewood and Honey collection held the rank 7th, 8th and 9th respectively. *A. tortilis* and *A. seyal* seem to be widely used and important. These resources are still widely available, but ecological (frequent and prolonged drought conditions) and human-related factors (charcoal production, clearance for agriculture and unsustainable utilization) are potential threats to their future availability. Generally, agricultural expansion, illegal settlement, Charcoal production, invasive species, investment and selective cut for construction, Elephant browsing, fire wood, drought, and Honey collection were the main threats in the sanctuary.

Table 5. Community and focal person perception on challenges of conservation of biological resources in BES (NCR-96).

No	Challenges	Column3			
		Yes		No	
		No	%	No	%
1	Lack of community participation for conservation	76	79.1%	20	20.8%
2	Lack of Awareness	80	83.33%	16	16.66%
3	Lack of community Incentive	87	90.62%	9	9.3%
4	Lack of alternative job	90	93.75%	6	6.25%
5	Lack of strong regulation and relation of park administration with community	85	88.54%	11	11.45%
6	Existence of park between two region	65	67.70%	31	32.29%
7	Lack of clear boundary demarcate	57	59.37%	39	40.62%
8	Dependence of local community on agriculture	68	70.83%	28	29.16%

Eight major challenges were identified for current conservation BES. Among them, Lack of alternative job as the major challenge as responded by communities 90 (93.75%) followed by Lack of community Incentive when elephant browsing and damage local crop 87 (90.62%) and Lack of strong regulation and relation of park administration with community was the third factor as responded by 85 (88.54%). The current study suggest that important intervention is necessary to conserve threatened plant species in BES. In order to alleviate the existing problem, the authors forwarded the following recommendation:

- 1) Rehabilitation by plantation especially the indigenous multi-purpose tree species that are highly threatened but still available in the valley should be given emphasis;
- 2) Alternative livelihood has to be created for surrounding local community to reduce agricultural expansion;
- 3) Awareness creation program has to be done to the local community about the importance of protected area conservation and devise a mechanism by which human impacts can be minimized through discussion and consultation with the local people;
- 4) Provision of incentives for local communities to support protected areas;
- 5) In collaboration, protected area staff, local people, governments and the general public should:
 - a) Carry out further studies on the patterns of ecosystem functioning, biology and ecology of the key stone species to be able to restore the composition and

structure of the forest;

- b) Enforcement of the rule of law with respect to protection.
- 6) Mechanism should be devised by respective organization through which communities participate in every aspect of protected area management such as planning;
 - 7) Increasing cooperation and collaboration between the two regional state that bound the sanctuary for effective conservation of the sanctuary as a general and its biological diversity particularly;
 - 8) Participation of communities on decision making process may be necessary so that they perceive the own the resource;
 - 9) Revising government management plan may be necessary to identify gaps.

Declarations

Competing Interests

The authors declared that they have no competing interests.

Availability of Data and Material

The recorded raw data used for analysis and supplementary information files is available at the author's hand and within the article.

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