Survey and documentation of the potential and actual invasive alien plant species and other biological threats to biodiversity in Awash National Park, Ethiopia

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Abstract

The study was conducted at the Awash National Park (ANP) Ethiopia, to document Invasive Alien Species (IAS) and to assess the spread of *Prosopis juliflora* (Sw.) DC. A total of 64 sample plots were laid systematically along the altitudinal gradient of 750 to 1916 m. Potential IAS were recorded. IAS which may threaten biodiversity of the park includes species such as *Prosopis juliflora, Parthenium hysterophorus* L., *Cryptostegia grandiflora* Roxb. ex R. Br. , *Parkinsonia aculeata* L., *Senna occidentalis* (L.) Link, *Datura ferox* L. and *Xanthium strumarium* L. Except *P. juliflora* and *P. hysterophorus,* all others were not recorded in Ethiopia as IAS. *P. juliflora* was recorded in three plots with cover of 1% to 10%. *P. juliflora* was also found spread in different parts of the park particularly following the route of cattle movement. *P. hysterophorus* was recorded in and around nine sample plots. Plot 46, 47 and 48 were highly infested by *P. hysterophorus* which covered more than 60, 70 and 80% of the ground layer respectively. *C. grandiflora* was recorded in 11 plots with cover ranging from 1% to 35%. In view of all the natural as well as anthropogenic threats to the biodiversity of the Park, the ANP is at high risk. The rich biodiversity needs immediate management intervention.

Keywords

Cryptostegia grandiflora, Datura ferox. Parkinsonia aculeata, Parthenium hysterophorus, Prosopis juliflora, Senna occidentalis, Xanthium strumarium

Introduction

Ethiopia spans a remarkable number of the world's broad ecological regions due to its dramatic geological history, broad latitudinal spread and immense altitudinal range. This range from the depressions in the Afar (126 m below sea level) to the spectacular mountaintops of Ras Dashen in the north (4620 m) and the Bale Mountains in southeast Ethiopia (4272 m). This variety of habitats also supports a rich variety of different species which contributes to the overall biodiversity of the country (IBC 2005).

Biodiversity conservation is the protection, restoration and sustainable management of wildlife and natural resources such as forests and water and the biological diversity within it. Through the conservation of biodiversity not only the survival of many threatened species and habitats can be ensured, but also these valuable resources will be secured for future generations and also the well being of eco-system functions protected. *In-situ* is considered the most appropriate way of conserving biodiversity. Conserving the areas where populations of species exist naturally is an underlying condition for the conservation of biodiversity. That is why protected areas form a central element of any national strategy to conserve biodiversity.

Awash National Park (ANP) is one of the protected areas in Ethiopia. It shelters 81 mammal species such as Beisa Oryx (Fig. 1), Lesser Kudu, Waterbuck, Somme ring's Gazelle, Hamadryas and

Fig 1. Beisa Oryx, one of the many species with high conservation value of the Awash National Park.

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Anubis Baboon. There are also more than 460 bird species and several plant species including the endemic tree species *Acacia prasinata* Schweinf. In Ethiopia as a whole, the major threats to protected areas emanate from settlement within the National Parks/Sanctuaries or adjacent to them, crop cultivation, grazing and deforestation (Hillman 1993; Jacobs & Schloeder 1993; IBC 2005).

Most of the National Parks of Ethiopia are found in *Acacia-Commiphora* Woodland Ecosystems including the ANP (IBC 2005). This ecosystem is currently under strong environmental stress. Over forty taxa in this ecosystem are threatened (Ensermu Kelbessa et al. 1992). The failure to manage the expansion of Invasive Alien Species (IAS), such as *Prosopis juliflora* (Sw.) DC. to the ANP and the ecosystem in which it is included is threatening the biodiversity (IBC 2005). In order to obtain information for the management of IAS such as prevention, control, eradication and designing mitigation measures for the impacts. It is important to incorporate proactive assessment of IAS in vegetation studies in addition to other ecological parameters.

Currently compiled information on the current status of plant diversity of ANP as well as the spread of invasive plant species is not available. Due to the close proximity of ANP to Amibara (one of the Districts bordering it, where there is a high infestation of *P. juliflora*. Together with uncontrolled movement of both wild and domestic animals to the Park, the invasion of the Park by *P. juliflora* may be inevitable unless precautionary measures are taken at an early stage.

Therefore, this study was initiated to assess and document the Invasive Alien plant Species and the spread of *P. juliflora* in the Park and to identify other threats to the Biodiversity of the Park in order to provide information for appropriate decision making on the biodiversity conservation of ANP.

Material and Methods

Description of the study area

The study was conducted in ANP, located between 8°45′ to 9°15′ N and 39°45′ to 40°5′ E in the Middle Awash Basin at the southern tip of Afar Regional State and northeastern part of Oromia Regional State. The Park is located in the geographical boundaries of Awash-Fantale and Kereyu-Fantale Districts of Afar and Oromia Regional States respectively.

The ANP was established in 1966. It is located 225 kilometers east of Addis Ababa with its southern boundary along the Awash

Resumen

El estudio se llevó a cabo en el Parque Nacional de Awash (ANP) en Etiopia, con el objetivo de documentar Especies Exóticas Invasoras (IAS) y evaluar la propagación de *Prosopis juliflora* (Sw.) DC. Se establecieron sistemáticamente un total de 64 parcelas de muestreo a lo largo de un gradiente altitudinal de 750 a 1916 m, registrando posibles IAS. Las IAS que pueden amenazar la biodiversidad del parque incluye especies como *Prosopis juliflora, Parthenium hysterophorus* L., *Cryptostegia grandiflora* Roxb. ex R. Br. , *Parkinsonia aculeata* L., *Senna occidentalis* (L.) Link, *Datura ferox* L. y *Xanthium strumarium* L.. Excepto *P. juliflora* y *P. Hysterophorus,* el resto no estaban registradas en Etiopia como IAS. *P. juliflora* se registró en tres parcelas con coberturas del 1% al 10%, encontrándose dispersa en diferentes partes del parque siguiendo la ruta de movimiento del ganado. *P. hysterophorus* se registró en el interior y alrededor de nueve parcelas de muestreo; las parcelas 46, 47 y 48 fueron intensamente infectadas por *P. hysterophorus* abarcando más del 60, 70 y 80% de la superficie, respectivamente. *C. grandiflora* se registró en 11 parcelas con una cobertura del 1% al 35%. En vista de todas las amenazas naturales y antropogenicas de la biodiversidad del parque, el ANP presenta un riesgo elevado, precisando de medidas de gestión inmediatas..

Palabras clave

Cryptostegia grandiflora, Datura ferox. Parkinsonia aculeata, Parthenium hysterophorus, Prosopis juliflora, Senna occidentalis, Xanthium strumarium.

River, and covers 756 km^2. The vegetation of the study area is described as open grassland, bushland/shrubland and riverine vegetations (Jacobs & Schloeder 1993), woodland and grassland with altitudinal range between 750 and 1916 m.a.s.l. (Gamachu 1977).

The main rainy season is from July to September, with a short rainy season from February to April. The nature of rainfall in the study area is irregularly distributed and the mean annual rainfall is 550.9 mm (Ebro et al. 2004).

Sampling Design and data collection

During the reconnaissance survey, based on visual observation and by consideration of the vegetation and other environmental gradients, the ANP was grouped into seven vegetation stands. Data collection was conducted during October to November 2008 and March 2009. The assessment was conducted along altitudinal gradient ranging from 750 to 1916 m by using systematic sampling design. Nine transect lines were established systematically at different places based on identified vegetation stands. In nine transects, 64 sample plots each with a size of 20 x 20 m were established at every 200 m interval along the transect or 50m altitudinal drops when there is a steep slope. All woody vascular plant species as well as IAS encountered in each sample plot were recorded and their cover was recorded by visual estimation of the percentage foliage cover of each species in the sampling plot and recorded as percentage. Sampling sites in ANP. Park areas where distributed among grasslands such as the Illala Sala area. Other inaccessible areas and areas with security problems were excluded from sampling.

Data Collection

The following environmental parameters were measured for each sampling plot:

-Altitude**,** by using pocket altimeter and Garmin GPS;

-Slope**,** by using clinometer and

-Geographical coordinates, by using Garmin GPS.

The average cover abundance of plant species from 64 sampling plots recorded by visual estimation of the percentage foliage cover of each species in the sample plot and recorded as percentage.

Results and Discussion

Average cover abundance of three most abundant alien plant species is shown in Fig. 2. Appendix 1 shows the relative coverage of the species recorded in the relevés. The results showed the greater abundance of *Parthenium hysterophorus* L., *Cryptostegia grandiflora* Roxb. ex R. Br. and *Prosopis juliflora* (Sw.) DC.

Even though, not all alien species will become invasive or threaten the environment, this is an area in which an early investigation should be made to reduce the potentially wide-ranging impacts when they do become invasive, and because of the difficulties, including financial costs and in reversing the impacts. Invasive Alien Species are species which are an introduced species which invades natural habitats, non-native (or alien) to the ecosystem and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

The study showed that, in the ANP there are plant species which are known to be invaders, noxious weeds and escape from cultivation that became semi naturalized. Plant species which were observed in different parts of the Park and which are alien to the ecosystem in general and to the ANP in particular; with actual and future invasive potential and which needs serious management measures are *Prosopis juliflora* (Sw.) DC., *Parthenium hysterophorus* L., *Cryptostegia grandiflora* Roxb. ex R. Br., *Parkinsonia aculeata* L., *Senna occidentalis* (L.) Link, *Datura ferox* L., *Xanthium strumarium* L. Except

Prosopis juliflora and *Parthenium hysterophorus* which were recorded in Ethiopia as IAS, the other five species were not so far recorded as IAS in Ethiopia. Even *Parkinsonia aculeate* is grown by many government and non-government nursery sites and being distributed to growers in different parts of the country.

Among the different altitudinal ranges covered, all the IAS were observed in the intermediate to low altitude between 770 to 1047 m a.s.l. which are plain areas, river sides, foot of mountains and road sides. The higher altitude (1094 to 1916 m a.s.l.) from the middle of Mount Fentale to the top up to the edge of the volcanic crater, which is mainly dominated by the endemic tree species *Acacia prasinata* Schweinf. is so far free from such IAS. This may be because of its inaccessibility.

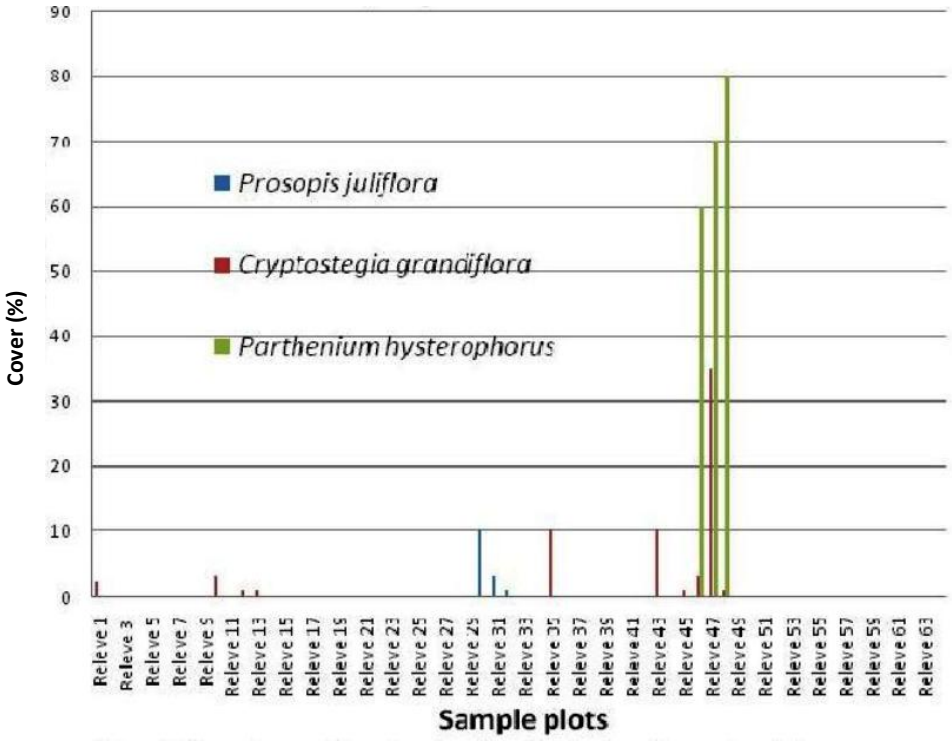

Fig. 2. Cover (%)of three Invasive Alien Species from 64 sampling plots

***Prosopis juliflora* (Sw.) Dc. (Fabaceae)**

Prosopis juliflora is one of the IAS which becomes a threat globally as well as locally in Ethiopian. In Ethiopia *P. juliflora* has become a problematic species expanding at an alarming rate in Afar and Somali regions. *P. juliflora* is extensively spreading following the main road of Djibouti - Addis Ababa, passing several towns like Mille, Gewaine and others. It has reached to Awash and Metehara towns where the ANP is located in between. Among the 64 sample plots of the study, *P. juliflora* was recorded in plots 30, 31 and 32 with cover percentage of 10, 3 and 1% respectively (Fig. 2). It is extensively emerging in places where cattle overnight for long period of time. Also out of the sample plots there are several parts of the Park were *P. juliflora* is growing (Fig. 3).

The direction of the introduction of *P. juliflora* into the Park also coincided with the major direction of pastoralist movement to the Park, which is from the northeast and south part of the Park by Afar and Kereyu/Ituu pastoralists respectively.

Even though, there is no written document when and at which place of the Park was *P. juliflora* first observed, the age of the trees shows that it is a recent introduction which could be during the last three to five years. As it is shown in the map the direction of the spread of *P. juliflora* coincide with the pastoralist's movement given by Jacobs & Schloeder (1993), except a single tree observed around Kereyu lodge which is found in area where there is no cattle movement. The two major possible introduction and direction of spread of *P. juliflora* are expected to be from northeast and south part of the Park by Afar and Kereyu/Ituu pastoralists respectively.

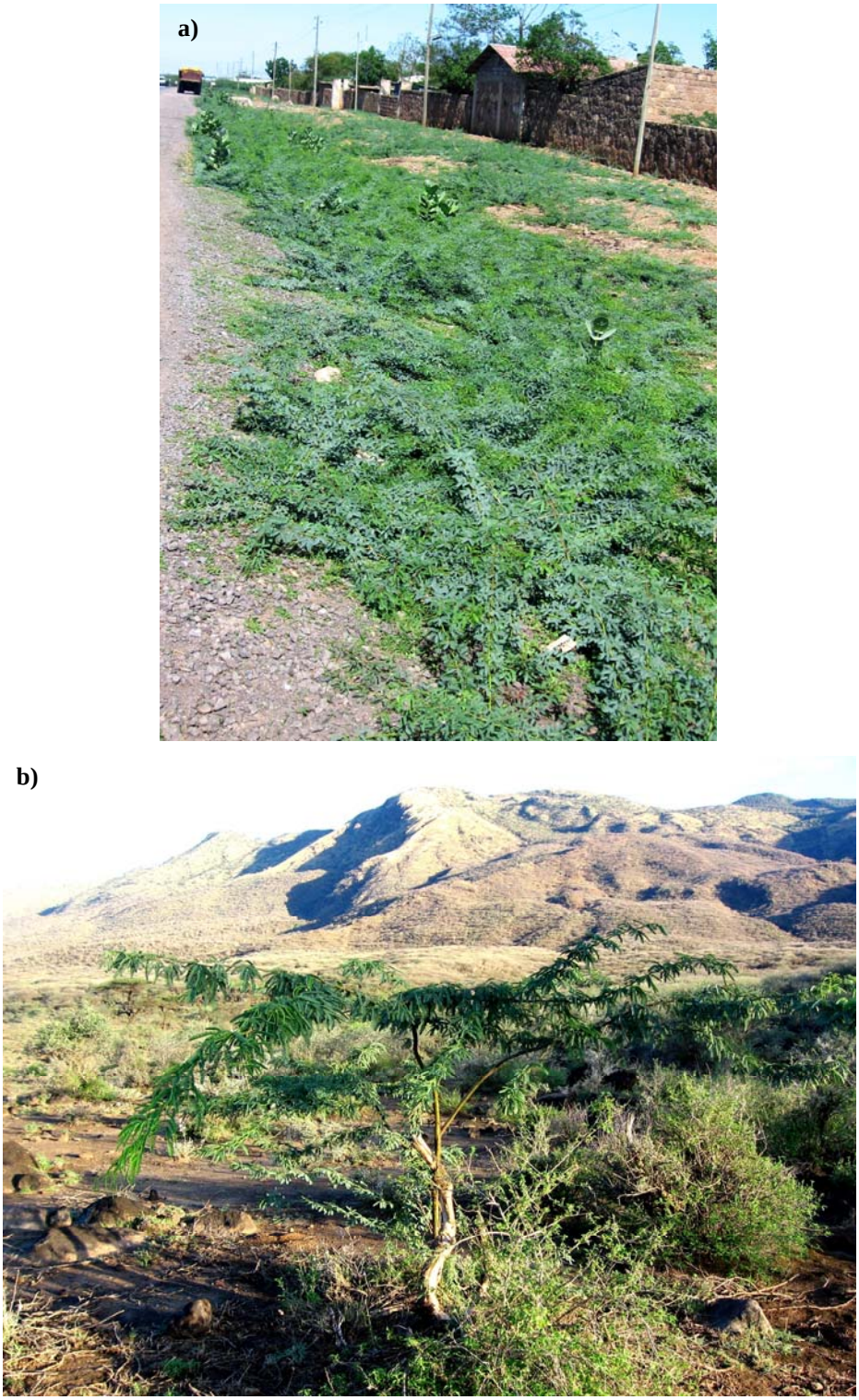

Fig. 3. *P. juliflora* spreading along the road side of Awash town (a), *P. juliflora* on the foot of Mount Fentale, part of Awash National Park (b).

***Parthenium hysterophorus* L. (Asteraceae)**

Parthenium hysterophorus has spread over many parts of the ANP, especially along road sides, seasonally inundated areas, following the riverbank of Awash above the camping site, around Kudu valley and in places where cattle overnight for long period of time. Figure 4 shows part of the Park which is invaded by *P. hysterophorus*, a place which was used by Pastoralists as a "Cattle Barn". This shows that animals play a great role in transporting and disseminating certain weeds like *P. hysterophorus*.

Parthenium hysterophorus was recorded in and around the following nine sample plots 22, 23, 24, 25, 35, 46, 47, 48 and 49 (Fig. 2). The first four plots are located along the road from ANP main gate on the way to Kereyu Ras Hotel and the last four plots are located along the riverbank of Awash around 7 km above the water fall on the way to Ajotere (Wario Asebo) kebele. Plots 46, 47 and 48 were highly infested by *P. hysterophorus* which covered more than 60, 70 and 80% of the ground layer respectively (Fig. 2). This may be due to the seasonal overflow of the Awash River which may bring seeds of *P. hysterophorus* from the infested areas above the Park such as Welenchiti and others.

***Cryptostegia grandiflora* Roxb. ex R. Br. (Asclepiadaceae)**

Fig. 2 shows that in ANP *Cryptostegia grandiflora* was recorded in 11 plots with cover percentage ranging from 1% to 35%. The two highly invaded sample plots were plot 43 (10%) and plot 47 (35%) of the ground cover was

occupied by *C. grandiflora.* These plots are similarly infested with *Parthenium hysterophorus* which are found along the Awash riverbank. This may be an indication that the weed is being dispersed by water particularly by the Awash river.

Cryptostegia grandiflora is a climber, growing extensively in ANP along rivers and seasonally inundated areas. It is quite common in a number of spots along the Awash River down to the lower Awash basin. Afar and Kereyu pastoralists around ANP and Amibara District are complaining of its invasiveness, toxicity to domestic animals and mechanical barrier to animal movement to water sources (Fig. 5). The main impact of *C. grandiflora* observed during the present study was that it strangle and kill the native trees by climbing over them and completely eliminating access to light. It has been introduced to most tropical and subtropical regions by humans because of its attractive flowers and the fact that its latex contains commercial quality rubber gives its common name Rubber Vine.

***Parkinsonia aculeata* L. (Fabaceae)**

Parkinsonia aculeata is a thorny tree of lime green appearance that has zigzagged branches, yellow petaled flowers, produces brown seed pods, 1-3 seeds/pod, slender leaf branches and oblong leaves. The tree can grow to 10 meters, however, 2-8 meters is the average range (Nathan & Robert 2007). In Australia *P. aculeata* has been recognized as a Weed of National Significance. It continues to threaten the invasion of 70% of Australia's mainland. Dense impenetrable thickets are still forming along river ways and wetlands completely changing ecosystems. In 2001 the Lake Eyre basin Coordinating Group expended $295,000 for controlling *P. aculeata* in the Lake Eyre Basin (Nathan & Robert 2007).

Fig. 4. Partial view of parts of the Park invaded by *P. hysterophorus.*

Though, *P. aculeata* was not recorded in all sample plots it was

Fig. 5. *C. grandiflora* encroachment .

Fig. 6. *P. aculeata*, Planted as ornamental around Kereyu lodge of ANP has grown in some parts of the Park as semi naturalized plant.

planted as ornamental tree around Kereyu lodge, and also it has grown as escape or semi naturalized plant along the road side of Addis Ababa - Djibouti which crosses the Park (Fig. 6). This shows that unless serious control measures are taken, it may control large area of the Park in the near future.

***Senna occidentalis* (L.) Link (Fabaceae)**

In ANP, *S. occidentalis* is found along the road side of Addis Ababa - Djibouti, which passes through the Park. At present *S. occidentalis* do not occupied large area, but as the seeds are dispersed by grazing animals (Sánchez & Uranga 1993); it may colonize large area in the future, if the movement of grazing domestic animals in the Park is not restricted.

***Datura ferox* L. (Solanaceae)**

Datura ferox is widely found around "Addis Ketema", a small town in front of Metehara Sugar Factory. It may be an escape from cultivation where it is grown as an ornamental plant or it may be introduced with vehicles. In ANP, *D. ferox* is observed aggressively growing together with *D. stramonium* but localized only around an old "Cattle Barn" in the Park, used by pastoralists (Figure 7) to sustain their cattle during the dry season. This shows that the movement of domestic animals in the Park could create serious impact on the Park biodiversity. Therefore, the movement of cattle and other domestic animals in the park should be regulated or restricted.

As that of other national Parks and protected areas in Ethiopia, apart from the natural threats such as wildfire, drought, bush encroachment and others; the major threats to the biodiversity of the ANP originate from anthropogenic factors, although it must be noted that there are several root causes that lead the people around the Park to take such actions. Some of the human actions which are highly affecting the Park biodiversity are:

Settlement within and areas adjacent to the Park

Agricultural expansion within and around the Park

Grazing and browsing by domestic animals

Deforestation, illegal charcoal production and fire wood collection form the Park

In reality it is very difficult to differentiate the real (exact) border of the Park, the buffer zone and core area of the Park; there are a lot of settlements in the Park (Figure 8). Strikingly, anywhere in the Park starting from down in the Awash gorge to the top of Mount Fentale there are a variety of domestic animals: Sheep, Goats, Camels, Cattle and Donkeys (Fig. 9). Also forest destruction and charcoal production are affecting the Park

Fig. 7. *D. ferox* grown as an escape in the ANP near an old "Cattle Barn".

biodiversity (Fig. 9). This is a strong alarm which warns that the Park is under grave risk.

Conclusions

In addition to the natural threats to biodiversity such as: wildfire, drought, bush encroachment and others; anthropogenic factors such as settlement within the Park, agricultural expansion, grazing and browsing by domestic animals, deforestation, illegal charcoal production and fire wood collection are the major threats to the ANP. Potential invasive species which may threaten biodiversity of the Park includes species such as *Prosopis juliflora, Parthenium hysterophorus, Cryptostegia grandiflora, Parkinsonia aculeata, Senna occidentalis, Datura ferox and Xanthium strumarium.* The direction of the introduction of *P. juliflora* into the Park also coincided with the major directions of pastoralist movement to the Park, which are from the northeast and south part of the Park by Afar and Kereyu/Ituu pastoralists respectively.

In view of all the above natural as well as anthropogenic threats to the biodiversity of the Park, it is not overstating the matter to say that the ANP is at high risk. The rich biodiversity needs immediate management intervention with the participation of the local community as well as local government for the immediate action.

Recommendations

1) Due attention should be given for the prevention of actual and potential Invasive Alien Species from establishing themselves in the ANP. It may be difficult to eradicate them once established. The case of

Fig. 8. Partial view of settlements in the ANP.

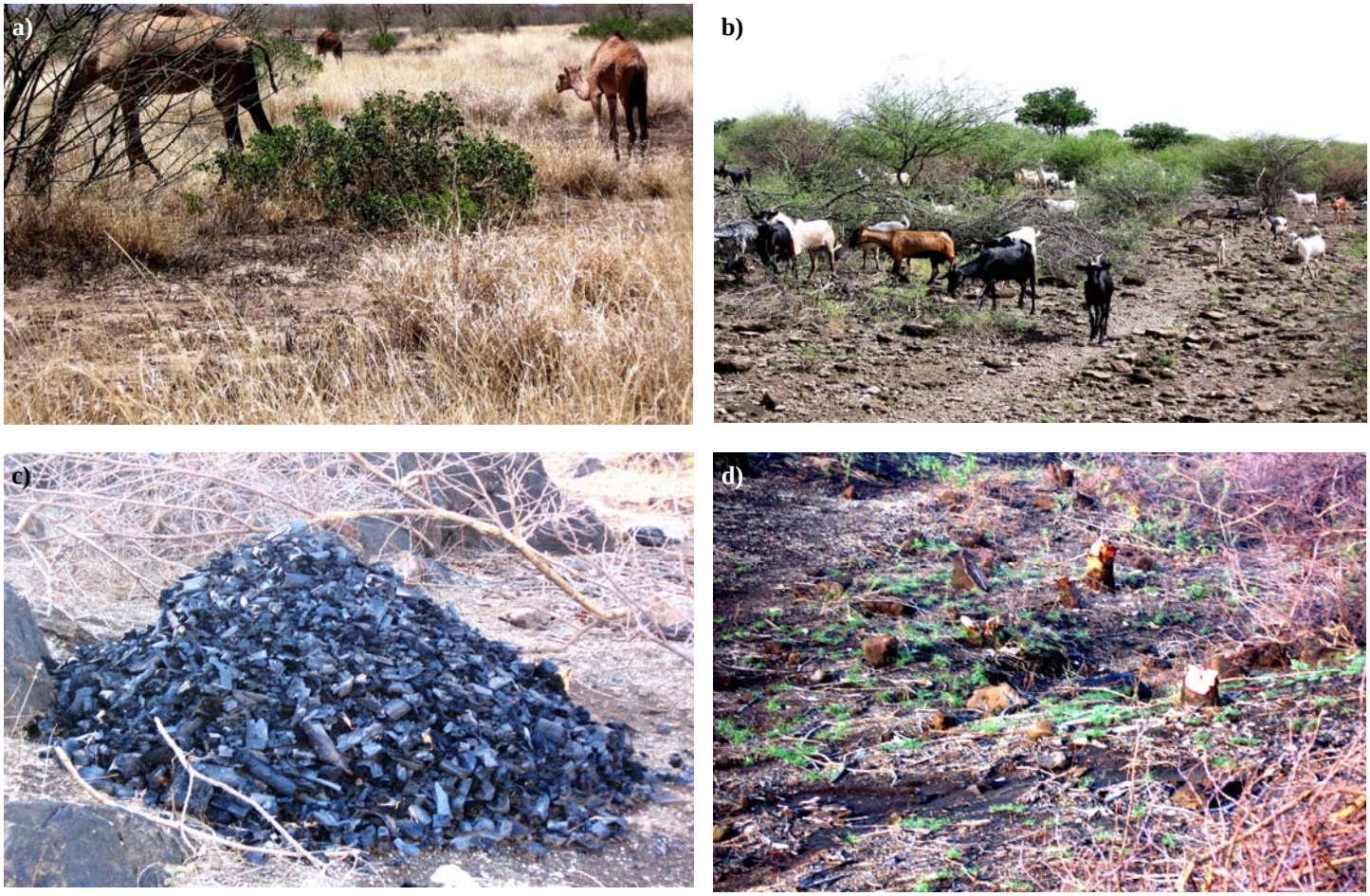

Fig. 9. Pictures which shows the impacts of domestic animals on the Park biodiversity (A and B), Illegal charcoal production and deforestation (C and D).

Prosopis juliflora in Afar Regional State is a good lesson for us, which continues invading several thousands of hectares of grazing lands despite of the efforts being made to control it.

2) Great care should be taken while planting or introducing new plant species into the Park. Even though, so far there is no binding legislation which regulates the use of alien species; national parks should have there own mechanisms to regulate the introduction of new plant species into the Park. Since the IAS *Parkinsonia aculeata* was also found planted as ornamental plant around Kereyu lodge (Kereyu Ras Hotel) found in the ANP. There is a need for periodical assessment of the road sides of the Addis Ababa - Djibouti road which crosses the Park. Eradication of the IAS detected in such places is the easy, fast and effective way to reduce the propagule pressure and likelihood of new invasion, since it may be the potential entrance for IAS.

3) The major anthropogenic threats to the biodiversity of ANP are settlement within the Park, agricultural expansion, grazing and browsing by domestic animals, deforestation, illegal charcoal production and fire wood collection. These human actions have association with the sustenance of local communities and their livestock. This issue should be the core focus and major objective of the Park management and should be settled with the active participation of the local communities, political and administrative bodies to have sustainable management of the resources and for better utilization.

4) Since there are two antagonistic interests in the ANP i.e. to conserve the biodiversity of the Park on one side and the strong

need to use land for human activities on the other side; this conflicting interest and the anthropogenic degradation of the area will lead to subsequent increase of IAS establishment. Thus, there is a need to compromise between these two conflicting interest. Therefore:

a) areas should be prioritized to those which are most in need of conservation, better to identify local biodiversity "hotspots".

b) The actual boundary of the Park should be re-delineated.

c) Core area and buffer zones should be identified.

d) Continuous awareness creation campaigns should be conducted in order to enable the local communities to know and implement sustainable resource management, to reduce dependency on Park resources and to soften and improve the relationship between the Park and local communities.

e) Alternative livelihood options for local communities which do not compete with the Park resources and also which do not have much impact on the Park should be identified for better conservation and sustainable utilization of the resources by the government as well as by the local communities.

f) On the buffer zone of the Park, it is better to practice a Community-Based Natural Resource Management which is a process through which grass roots institutions are involved in the decision making process with rights to manage and control their environment. Also sharing the benefit accrued from the Park to the local communities through community services is very important for its sustainability. Conservation to be successful and sustainable there needs the strong involvement of local communities.

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Bio-sketch

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Appendix 1. Average percent coverage of species recorded from 64 sample plots.

Species Name	Cover percentage
Acacia oerfota (Forssk.) Schweinf.	2.01
Acacia etbaica Schweinf.	4.89
Acacia mellifera (Vahl) Benth.	1.27
Acacia nilotica (L.) Willd. ex Del.	0.16
Acacia nilotica (L.) Willd. ex Del. subsp.kraussiana (Benth.) Brenan	0.23
Acacia nilotica (L.) Willd. ex Del. subsp. indica (Benth) Brenan	2.42
Acacia prasinata Schweinf.	2.01
Acacia robusta Burch. subsp. *usambarensis* (Taub.) Brenan	2.34
Acacia senegal (L.) Willd.	13.84
Acacia seyal Del.	1.11
Acacia tortilis (Forssk.) Hayne	2.94
Balanites aegyptica (L.) Del.	0.31
Balanites rotundifolia (Van Tieghem) Blatter	1.41
Berchemia discolor (Klotzsch) Hemsl.	0.42
Boswellia papyrifera (Del.) Hochst.	1.98
Cadaba farinosa Forssk. subsp. *farinosa*	0.03
Cadaba rotundifolia Forssk.	0.13
Capparis tomentosa Lam.	0.33
Celtis toka (Forssk.) Hepper & Wood	0.89
Cissus rotundifolia (Forssk.) Vahl	0.03
Clerodendrum myricoides (Hochst.) Vatke	0.08
Combretum molle R.Br. ex G. Don	0.52
Commiphora africana (A. Rich.) Engl.	0.27
Cordia monoica Roxb.	0.32
Cordia myxa L.	0.03
Cryptostegia grandiflora Roxb. ex R. Br.	1.05
Dalbergia lactea Vatke	0.45
Dicrostachy cinerea (L.) Wight and Arn.	0.72
Dobera glabra (Forssk.) Poir.	1.08
Dodonaea angustifolia L. f.	0.06
Ehretia braunii Vatke	0.02
Ehretia obtusifolia Hochst. ex DC	0.09
Euclea racemosa Murr. subsp. *schimperi.* DC) White	0.01
Euphorbia nigrispinioides M. Gilbert	0.19
Ficus sycomorus L.	3.17
Greiwia erythraea Schweinf.	0.56
Grewia schweinfurthii Burret	2.34
Grewia flavescens Juss.	0.05
Grewia tenax (Forssk.) Fiori	2.58
Grewia trichocarpa Hochst. ex A. Rich.	0.53
Grewia villosa willd.	4.05
Heracleum abyssinicum (Boiss.) Norman	0.02
Hyphaene thebaica (L.) Mart.	5.00
Jasminum grandiflorum L. subsp. *floribundum*	0.02
Lantana viburnoides (Forssk.) Vahl	0.01
Maerua angolensis D.C.	0.50
Manikara butugi Chiov.	3.67
Olea europaea subsp. cuspidata (Wall. ex G. Don)	0.16
Osyris quadripartita Decn.	0.02
Ozorea insignis Del.	0.31
Parthenium hysterophorus L.	3.28
Pentarrhinum sp.	0.02
Pergularia daemia (Forssk.) Chiov.	0.02
Prosopis juliflora (Sw.) Dc.	0.22
Rhus retinorroea Oliv.	0.72
Salvador persica L.	0.72
Sarcostemma viminale (L.) R. Br.	0.02
Solanum glabratum Dunal	0.03
Solanum incanum L.	0.16
Solanum somalense Franch.	0.20
Sterculia africana (Lour.) Fiori	0.08
Tamarindus indica L.	4.38
Tamarix nilotica (Ehrenb.) Bunge	0.02
Terminalia brownii Fresen.	0.63
Trilepisium madagascariense DC.	0.41
Vernonia bipontini Vatke	0.02
Vernonia cinerascens Sch. Bip.	0.23
Ziziphus sp.	1.05
Ziziphus mucronata Willd.	0.03