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Dominant Invasive Species and their Management Practice in Tigray Province, Northern Ethiopia

Tewelde F* and Mesfin M

Ethiopian Biodiversity Institute, Mekelle Center, Addis Ababa, Ethiopia

Research Article

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***For Correspondence**

Tewelde F, Forest and Range Land Plants Case Team, Ethiopian Biodiversity Institute, Mekelle Center, Addis Ababa, Ethiopia, Tel: +251116612244.

E-mail: fitsumbrhantewelde@yahoo.com

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ABSTRACT

Comprehensive assessment study was conducted in December 2016 to collect baseline information and observation of the dominant and type of management practice of the invasive species throughout the selected wereda in the catchment area of Mekelle biodiversity center. Primary data were generated from preliminary survey, fieldwork. A semi-structured and structured questionnaire, interview and group discussion were used as the primary data collection instruments. Field observation was also carried out in order to identify the physiological characteristic of invasive species and invaded land use. From each wereda, a total of 20 households of both genders who had the problems were participated using purposive sampling technique. Descriptive statistics, MS-Excel, SPSS version 20 were used for data presentation and analysis. Prosopis juliflora, Parthenium hysterophorus, Plectranthus barbatus, Lantana camara, Striga hermonthica and Ageratum conyzoyed were the most dominantly invasive species found in the nine surveyed wereda of Tigray regional state. Regarding their growth form, 66% of these invasive species were herbs while the remaining 17% belongs to the tree and shrub habit qually. Forest area agricultural land grazing land roadsides and riverside were the most dominantly affected land use in the study weredas. The perceptions of the local community were found well committed and ready to the management and eradication of invasive species. Coordinated management practice between government bodies and concerned stake holders need to be achieved for eradication of invasive species throughout the catchment.

INTRODUCTION

The cognizant or unintended introduction of non-indigenous species to new habitats has become an increasingly important aspect of global environmental change and can cause imperative economic, environmental and social losses [1-4]. Many research works have shown that invasive plant species have broad distribution throughout the world and can directly or indirectly affect the food security of local residents by destroying natural pasture, displace native trees, crops, and reduce the grazing potential of rangelands and set limitations for economic development [5,6]. Invasion is considered as the second most widespread threat to global biodiversity next to habitat destruction of natural ecosystems worldwide. Once an invasive species becomes firmly established, its control often becomes difficult and eradication is usually impossible [7,8]. Therefore, exotic species will forever be common components of every ecosystem on Earth. The impacts of alien species are enormous. They cause an alteration in ecosystem processes and community structure, the decline in abundance and richness of native flora [9,10]. Globally, the extent of damage caused by invasive species has been estimated to be £1.5 trillion per year, close to 5% of global GDP. In developing countries, where agriculture accounts for a higher percentage of GDP, the negative impact of invasive species on food security and economic recital can even greater which exacerbate poverty [11]. The types of invasive alien species are different in different countries regions and ecosystem zones. However, cause loss of biodiversity, reductions in crop yield, forage yields and displacing indigenous species of natural ecosystems are the common characteristics of all invasive species. The high spread of invasive plant species in Ethiopia becomes a great concern in national parks, lakes, rivers, power dams, and urban green spaces. They are causing huge economic and ecological losses. They had become major threats to biodiversity loss and socio-economic welfare of the Ethiopians. According to the Ethiopian National Biodiversity Action Plan, about 35 alien and indigenous invasive species have been identified in Ethiopia. These species are negatively affecting agricultural lands, rangelands, national parks, waterways, lakes, rivers, power dams, roadsides and urban green spaces with huge economic as well as social consequences on the national economy and local livelihoods. Furthermore, invasive species have been threatening local biodiversity and ecosystem services [12].

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The prominent invasive species in Ethiopia includes *Parthenium hysterophorus, Prosopis juliflora, Eichhornia crassipes, Lantana camara and Acacia species (A. drepanolobium and A. melifera*). Accordingly, the predominantly affected ecosystems by alien invasive species of Ethiopia include Acacia comiphora woodland Dessert and semi-desert and aquatic ecosystems. Early detection of invasive plants, facilitated through mapping efforts, is critical for rapid response and effective monitoring strategies [13,14]. For that reason, this study intended to carry out on dominant invasive alien species and their management practice regarding the impact on the biodiversity in the whereas of Tigray regional state. This survey was also supposed to be the cornerstone to make a detailed study on the dominant invasive species and propose controlling management of invasive species in the catchment area of Mekelle biodiversity center. Moreover, the general objective of this survey was to study types of dominant of invasive species found in the catchment area of Mekelle biodiversity center of selected whereas and the type of management practice taken by local residents. Specifically, this survey was tried to address the following pertinent objectives:

- To identify the type of dominant invasive species found in the selected weredas.
- To assess the perception of local resident about the control of invasive species.
- To pinpoint the types of land use invaded by invasive species in the surveyed wereda.

MATERIALS AND METHODS

Study Area Description

This survey study was done in the catchment area of Mekelle biodiversity center to assess the dominant invasive species in Tigray regional states, Ethiopia. Accordingly, nine study sites from five zones of Tigray were selected for investigation based on the recommendation from the wereda agricultural office experts and the researcher own observation. The specific area of study with their relative location selected for investigation was listed below **(Table 1)**.

Table 1. Study area with their corresponding zones and relative location.

Wereda	Specific site	Region	Zone	Relative location Northing	Easting
Raya Alamata	Timuga	Tigray	Southern	12°25'32.69"	39°36'14.93"
Amba Alaje	Adishihu	Tigray	Southern	12°56'14.79"	39°30'52.62"
Endirta	meseget	Tigray	South eastern	13°27'09.05"	39°39'10.89"
Kilte Awlaelo	hayelom	Tigray	Eastern	13°46'21.56"	39°30'11.51"
Qola Tembien	begashka	Tigray	Centeral	13°37'14.93"	38°49'25.12"
Adwa	May tiem	Tigray	Centeral	14°66'15.61"	38°53'48.06"
Mereb Leke	East of Rama	Tigray	Centeral	14°22'50.99"	38°48'04.41"
Tahtay Koraro	Selam	Tigray	Northwestern	14°04'12.09"	38°13'43.37"
Asgede Tsimbla	Lemlem	Tigray	Northwestern	14°00'51.09"	38°12'54.66"

The selected wereda for assessment were Asgede Tsimbla, Tahtayy Koraro, from north western zone while Adwa, Merebe Leke, and Qola Tembien weredas were from the centeral zone of Tigray. Kilte awlaelo wereda was selected from Eastern zone of Tigray. Endirta wereda selected from south eastern zone and Raya Alamata and Amba Alaje wereda were selected from southern zone of Tigray **(Figure 1)**.

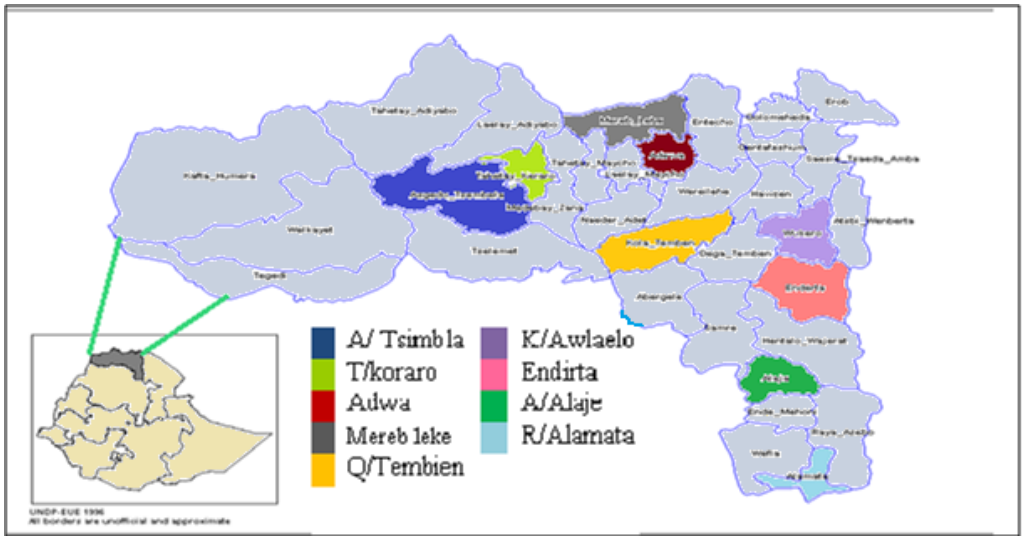

Figure 1. Map of the study catchment area (Tigray region).

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Data source and material

To investigate the relative ecological distribution, socioeconomic and ecological impacts of invasive species primary data sources were used. Primary data were generated from preliminary survey, field work and the responses of the local people and agricultural experts who are involved directly or indirectly with the problems. The questionnaire, interview, and group discussion were used as the primary data collection instruments.

Field data collection

Reconnaissance survey and group discussions were carried out with the residents of the selected weredas. This was conducted in December 2016 to collect baseline information and observe the dominant and their management practice of the invasive species throughout the selected wereda in the catchment area of Mekelle biodiversity center.

Field observation

Field observation was carried out in order to identify the physiological characteristic of invasive species and invaded land use. Identification of the well-known dominant invasive species was made in the field by using a dichotomous key and comparing with the published volumes of Flora of Ethiopia and Eritrea [15-18].

Socioeconomic survey

The socioeconomic data were collected to assess the perception and awareness of the local people towards the invasive species, and data were collected through semi-structured questionnaires and participatory rural appraisal (PRA) interview was used [19]. From each wereda, a total of 20 households of both sexes who have problems against the invasion were participated to be represented using purposive sampling technique.

Data Analysis

Descriptive statistics were used for data presentation and analysis. MS-Excel was also used for drawing bar graph and charts. The quantitative structural analysis was made using the informants' familiarity with invasive species. SPSS version 20 was used to correlate the familiarity of informants with age and observations about invasive species.

RESULTS AND DISCUSSION

Type of Dominant Invasive Species and Invaded Land Use

The type of invasive species most dominantly invaded in the southern zone of Tigray region were *Prosopis juliflora*, *Plectranthus barbatus, Parthenium hysterophorus* identified from Raya Alamata and Amba Alaje weredas. Forest area, agricultural land, and grazing land were the invaded land use by the aforementioned dominant invasive species. According to *Prosopis juliflora* is now considered the most horrible invasive species in Afar and one of the most damaging invasive plants in Ethiopia, having numerous direct and indirect economic, ecological, and local livelihood impacts [20,21]. *Parthenium* has been rapidly invaded grazing land, wastelands and cultivated areas, roadsides, recreation areas, railway tracks as well as river banks and floodplains [22]. *Parthenium hysterophorus* weed was also known to defectively distress crop production, biodiversity, animal husbandry, human health and even ecosystem integrity [23]. Among all weeds species, *Parthenium hysterophorus* was highly dominant species in Gamo Gofa, Ethiopia [24]. During the survey study in Raya alamata, the infestation status of *parthenium hystophorus* was high. Although the invasion of this weed was not new to the local community, the status of being its invasion was not controlled as required. The special adaptations made by the weed include serving as forage for cattle, for a honey bee to suck on the flower, very rapid reproduction mechanism and a high tolerance for a harsh condition. Despite its importance, the local people observed major problems including decrease crop production, animal health, quality of honey bee and biodiversity. Several characteristics, such as wide adaptability, drought tolerance, strong competition and allelopathy, high seed production ability, small and light seeds capable of long-distance travel through, water, winds birds' vehicles made successfully. Regarding the southeastern zone, *Plectranthus barbatus* and *Parthenium hysterophorus* were the dominant types of invasive species while Forest area, agricultural land, and grazing land were the highly invaded land use **(Table 2)**. *Plectranthus barbatus*, *Parthenium hysterophorus* were the dominant of invasive species and Forest area, agricultural land, and grazing land were the invaded land use in Kilte Awlaelo wereda, the eastern zone of Tigray province. *Plectranthus barbatus, Parthenium hysterophorus*, *Ageratum conyzoides* and *Lantana camara* were the dominantly infested invasive species in the centeral zone of Tigray Ethiopia while *Striga hermonthica*, Lantana camara, *Ageratum conyzoides*, *Plectranthus barbatus* were the frequently occurred invasive species in the northwestern zone of Tigray. Forest area, agricultural land grazing land, and other communal area were the invaded land use by the above-mentioned type of invasive species in both central and northwestern zone of Tigray.

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Table 2. Type of invasive identified and invaded land use by invasive species.

Woreda	type of dominant invasive species identified	Affected land use
Raya Alamata	*Plectranthus barbatus, Parthenium hysterophorus Prosopis juliflora*	F, A, G
Emba Alaje	*Plectranthus barbatus*	F, A, G, W, O
Endirta	*Plectranthus barbatus*, *Parthenium hysterophorus*	A, G, O
Kilte Awlaelo	*Plectranthus barbatus*, *Parthenium hysterophorus*	F, A, G, O
Qola Tembien	*Plectranthus barbatus*, *Parthenium hysterophorus, Ageratum conyzoides*	F, A, G, O
Adwa	*Plectranthus barbatus*, *Lantana camara*	F, A, G, W, O
Mereb Leke	*Parthenium hysterophorus, Latana camara*	F, A, G, O
Tahtay Koraro	*Striga,Lantana camara,Ageratum conyzoides, Plectranthus barbatus*	F, A, G, O
Asgede Tsimbla	*Striga hermonthica, Ageratum conyzoides*	F, A, G, O
Note: Key F= Forest, O =other area, A =agricultural land, G= grazing land, W= semi wet land		

Profile of Informants

Regarding the informants on educational level and gender, 2% of the informants were tertiary level complete, 10% secondary level complete, 36% primary educational level complete and 52% were illiterates, 78% of the informants were male and 22% were females **(Figure 2)**.

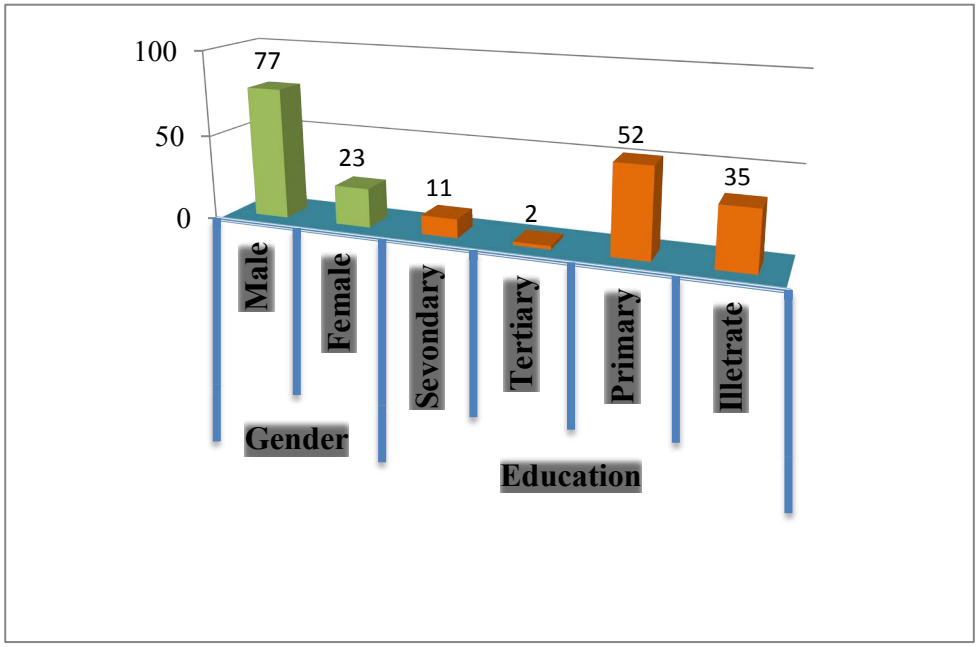

Figure 2. Back ground information of informants.

Familiarity of the Informants with Invasive Species

The familiarity of informants with invasive species was assessed using the terminology generally informed, well informed and informed in a little way. Accordingly, 53.3% of the informants were generally familiar with invasive species, 17% were little familiar and only 29.4% were well familiar with invasive species that existed in their surrounding area **(Table 3)**. However, the local people in Afar were Local people were not informed about the invasive nature of the tree at first and were not advised on management practices to minimize its spread [25].

Table 3. Familiarity of the informants with invasive species.

Description	Frequency	Percent	Valid Percent	Cumulative Percent
Well informed	53	29.4	29.4	29.4
General	96	53.3	53.3	82.8
Lit	31	17.2	17.2	100.0
Total	180	100.0	100.0	

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Correlation of Age and Observation

A Pearson correlation was computed between the variable age, observation on invasive species and the familiarity of invasive species to test their relationship. Accordingly, the observation of informants on invasive species positively significantly correlates with their familiarity with invasive species **(Table 4)**. When the status of the infestations were observed, they had the ability to familiar with that invasive species regarding negative impact, beneficial value and proposed management practice. However, the familiarities of informants on invasive species were negatively correlated with their age. The negative correlation indicated that the informants at a higher age level were able to familiar with invasive species infestation, negative impact and the beneficial value it had while those at a lower age group were not. According to Prosopis becomes a Serious invading weeds when introduced into non-native areas without proper management [26].

Table 4. Correlations of informants observation, familiarity and age.

Variables		Familiarity	Observation	Age
Familiarity with invasive species	Pearson Correlation	1	.252**	-.004
	Sig. (2-tailed)		.001	.955
	N	180	180	180
Observation on invasive species	Pearson Correlation	0.252**	1	-.019
	Sig. (2-tailed)	0.001		.796
	N	180	180	180
Age of informants	Pearson Correlation	-0.004	-0.019	1
	Sig. (2-tailed)	0.955	0.796	
	N	180	180	180
****.** Correlation is significant at the 0.01 level (2-tailed)				

Management System and Informants Perception

According the informants perception towards the management of invasive species, 81% of them said both government and the local community (BOTH) should take part, 17% of the respondent confirmed only the local community (CO) should take part while 2% of the informants said only the government (GO) should be done the controlling management practice **(Figure 3)**. Based on the result there was good awareness and commitment of household toward the eradication of invasive species from various types of land use. An integrated way of invasive species controlling mechanism had a profitable to the eradication of invasive species from a habitat. In a more detail, the type of management practice used to control the impact of invasive species varies. *Parthenium hysterophorus* controls by uprooting and then used to decompose for later use as compost. For *Prosopis juliflora*, they use it repeatedly for, charcoal production fire wood to cook food and both as dead and live fences at an alarm rate this could decrease their infestation status. As reported that the wood is an excellent fuel, the timber is hard and Compares favorably with finest hardwoods such as Teak and Mahogany [27]. At the national level, however, there is no clear policy or strategy for the control and Management of invasive species and little attempt has been made in terms of their research and management [28].

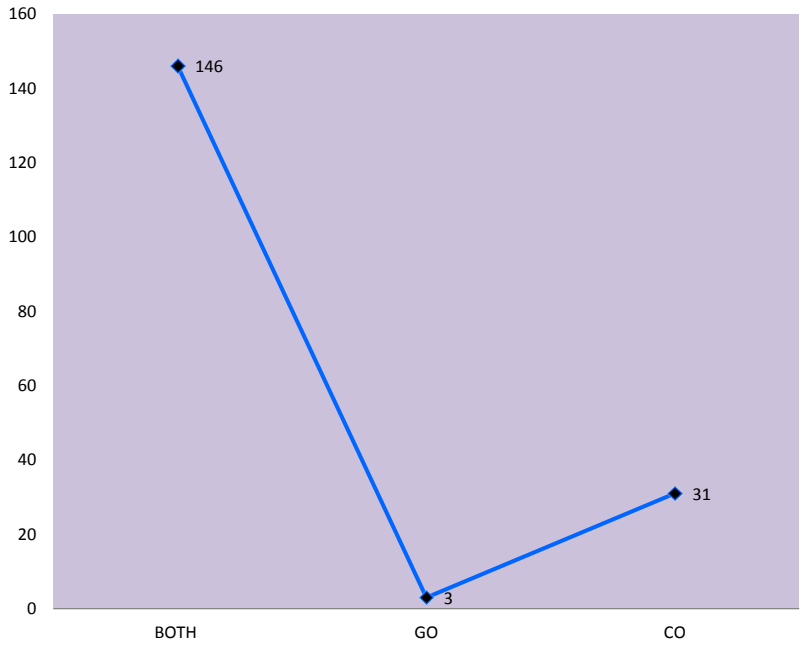

Figure 3. Perception of informants on management practice.

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Lantana can be removed mechanically or physically in several ways, including stickraking, bulldozing, ploughing and grubbing. On the idea of the respondents the controlling mechanism of *plectranthus barbatus* was made by uprooting. The other controlling mechanism for invasive species was that by repeatedly used for various use. For example, *Parthenium* can be utilized as a potential source of green manure for rice before they set seed i.e., either in the vegetative stage or in the early stage of flowering. This might be due to the favorable effect on total bacteria and phosphorous solubilizing bacteria [29]. Coumaran isolated from the *Lantana camara* can be used as bio-pesticide. Coumaran inhibit the acetyl cholinesterase at the cholinergic synapses of the insects and act as biofumigant against stored grain pests [30]. Prosopis is known to provide various socioeconomic benefits. These include wood products (firewood, fuelwood, charcoal, fence posts, poles, sawn timber, furniture, flooring and craft items), as well as non-wood products [31,32].

Floristic Classification of Dominant Invasive Species

The result of the study revealed that six most frequently dominat invasive species (IS) that boldly invade large area and belong to five families were identified from nine wereda of Tigray region. Moreover, 66% of those invasive species were herbs, 17% accounted trees and shrubs for each **(Table 5)**. The local community classified for invasive alien species from their observation and experience.

Table 5. Botanical description of invasive species.

Botanical /etic/ name of IS	Family name	local /emic/ name	habit
Plectranthus barbatus Andrews,	Lamiaceae	Arekibe/kilteawlaelo	Herb
Prosopis juliflora (Sw.)'DC.	Fabaceae	Eshok/prosopis	Tree
Parthenium hysterophorus L.	Asteraceae	Qinche	Herb
Lantana camara (SW.)DC.	verbanacecae	Alalimo/yeeregna kolo	Shrub
*Striga hermonthica (*Delile*)*Benth.	orobanchaceae	Metselem	Herb
Ageratum conyzoyed L.	Asteraceae	Hagayfetewe	Herb

Morphological Description of the Dominant Invasive Species

Plectranthus barbatus is one of the newly introduced invasive species identified in all the surveyed wereda. According the informant response from the study site no palatable by animals but highly reproduced in a short period of time. It have stem of Erect, herbaceous, highly branched, hairy and quadrangular and leaves whorls decussate, simple **(Figure 4)**.

Figure 4. Morphological view of plectranthus barbatus /photo by Fitsumbirhan Tewelde.

CONCLUSION

Invasive alien species are a major threat to natural ecosystem, human and animal health, and habitat. Identification of the most dominant one is the most important procedure to give priority for controlling. The kind of controlling management used to

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eradicate also depends on the type of invasive species. The involvements of all apprehensive stakeholders during community mobilization have a great value to bring fruit full management.

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CONFLICT OF INTEREST

In this article there is no "conflict interest", either in relation to the contents of the text, tables, graphics and location of the research, or matters related to the title of the article. The Author asserts that this article is free of the Conflict Interest.

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