



ECOLOGICAL ASSESSMENT OF TYPE, ABUNDANCE AND CURRENT DISTRIBUTION STATUS OF INVASIVE ALIEN PLANT SPECIES (IAS) IN EASTERN PART OF ETHIOPIA. WITH APPROPRIATE SUGGESTION OF INVENTORY AND MONITORING PROTOCOLS – INVASIVE ALIEN PLANTS

Yeneayehu Fenetahun¹, Wang Yongdong¹, Xu Xinwen^{1*}, Girma Eshetu²

University of China Academy of Science, Xinjiang Institute of Ecology and Geography

Ethiopian Biodiversity Institute (EBI), Harar Biodiversity center

Correspondence auteur Email: - sms@ms.xjb.ac.cn yeneayehu07@gmail.com

Abstract : Background: Biological invasion (in the context of this study) occurs when a non-native species is introduced to a new environment (ecosystem or habitat) and spreads causing damage – to native biodiversity that is being conserved. And the type and distribution of IAS in eastern part of Ethiopia become a very serious issue and infested with in a very high speed. Based on this cause the Ethiopia biodiversity institute try to established one center for appropriate follow up and awareness creation with the community and the stakeholders and the center need to identify the type, their abundance and current statues of this IAS with in the Eastern part of the country. Result: From this data we can understand that almost all part of eastern Ethiopia is highly infested by IAS. Conclusion: The issues need an immediate and fast response before it becomes totally damage the whole native biodiversity resource and also the community leave on that area become both economically, socially and healthy dependence due to the effect of those IAS on the other body. Key words: - IAS, Eastern Ethiopia, Biodiversity, land cover, Type

1. Background

Invasive alien species (IAS) are one of the most serious threats to ecosystems and economies worldwide (IUCN 2000, Pimentel 2005, Vilà *et al.* 2010). These problematic non-native species are known to have negative impacts on biodiversity, ecosystem functioning, and an array of other natural processes and human activities (Vitousek 1990, Hejda *et al.* 2009). The increasing threat of invasive plants is fueled by a diverse set of fast- and slow-paced human disturbance drivers including climate change (Thuiller *et al.* 2007), habitat alteration and fragmentation (With 2004), intentional introductions (Mack and Erneberg 2002), and an increasingly globalized horticulture trade (Bradley *et al.* 2012). Vines (herbaceous and shrubby climbing plants) can prove especially problematic upon establishment in novel areas. This is because of their fast growth rates, which facilitate their ability to out-compete host vegetation by blocking access to light,

ultimately reducing host survival and dramatically altering ecosystem structure. Early detection of invasive plants, facilitated through mapping efforts, is critical for rapid response and effective monitoring strategies (Kaplan *et al.* 2014). In Ethiopia, there are more than 22 invasive alien species (McFadyen, 1990). Among these invasive alien species Mesquites (*Prosopis juliflora*), parthenium weed (*Parthenium hysterophorus*), water hyacinth (*Eichhornia crassipes*), Lantana camara, and Acacia species are causing major problems in the country. Although not currently listed as an invasive alien species in Ethiopia (Invasive Species Compendium 2014), it potentially poses a major threat to biodiversity and local pastoral livelihoods in different part of the region eastern part of Ethiopia. Ethiopian Biodiversity Institute together with the community and different stakeholders recognize the need for effective control programmes to counter these impacts, and many attempts have been made to institute such

Academic Journal of Current Research

An official Publication of Center for International Research Development

Double Blind Peer and Editorial Review International Referred Journal; Globally index

Available www.cird.online/AJCR: E-mail: AJCR@CIRD.ONLINE



programmes in many parts of the the country. Some have been relatively successful but many others have been dismal failures. It would be useful if the factors that determine success or failure could be understood and documented to guide management in future. There are many factors that complicate management: these include the occurrence of unplanned events such as fires, drought, excessive rainfall and flooding; uncertainties around budgets and the levels of funding that will be available to carry clearing programmes forward once they have begun; uncertainties around the impacts of treatments such as felling or burning that may lead to unexpected results; and differences in the levels of capability and commitment amongst the workers tasked with carrying out clearing programmes. These complicating factors often mean that clearing programmes become an exercise in trial-and-error, which can be expensive and may have consequences that can be ill afforded — there is a clear need to develop a set of best practices guidelines that draw on a wide range of past experience, and that will assist in at least avoiding mistakes that have been made elsewhere. So in order to plan and implement the appropriate management plan and practice with regarding to IAS the first thing is that the type, abundance and the distribution status should be clearly understood. Therefore, the main aim of this assessment

was that in order to assess the type, current infestation rate, and to estimate the general abundance of IAS in the eastern part of Ethiopia (Esatarn haraghe, western hararghe, Harari region and Ethiopian Somail region) and in order to take or plan appropriate measurement methods and in the long run it is important for policy makers to take over an immediate action.

2. Materials and Methods

2.1. Assessment Data Collection

This assessment was addressed to farmers, agricultural, environmental and forest professionals from four (4) zonal administration (East Hararghe zone and West Hararghe zone), Harari Regional State and Ethiopian Somail region of eastern Ethiopia. Three target groups were considered in this study: (1) local farmers; (2) zonal, regional and woreda agricultural experts; (3) Zonal, regional and woreda environment and forest experts. The assessment data were collected from local farmers and stake holders or experts through semi-structure questionnaire, face to face interview and focus group discussion based methods.

2.2. Data Analysis

All data were analyzed in Access and Excel databases based on the type and the land coverage abundance of IAS.



3. Result

3.1. Western Hararghe region

Table1:- Type, Current infestation status and total area coverage of IAS in hectare in Western Hararghe region of Eastern Ethiopia.

Total area of the region is 1,723,000 hectare and total woerda in the region are 15.

No.	List of Woreda	Total area of Woerda (ha)	Type, and current coverage stage of IAS in each Woreda (Ha)					Total area that cover with IAS (ha)
			Striga (Akenchera)	Lantana camara (Yewof kolo)	Prosopis juliflora (Yewoyani Zafe)	Parthenium hysterophorus	Others (not scientifically identified)	
1.	Wani	27,600	10.5	-	-	20		30.5
2.	Gmibi bordadi	93,460	7,430	675	200	9,086		17,391
3.	Boki	86,940	7,150	3,775	-	2,964		13,889
4.	Awi Gudina	309,840	--	--	--	---		---
5.	Geba Kuricha	64,220	7,430	675	--	9,186		17,291
6.	Ebro	69,020	8,500	--	--	10,000		18,500
7.	Beki Intu	256,630	--	---	---	----		----
8.	Anchar	98,510	525.5	285	---	7,650		8,460.5
9.	Choki	58,850	1,500	930	--	15,597	3,195(wonjel)	21,222
10.	Hirna	46,710	2,240	2,620	--	--	-	4,860
11.	Woela	67,390	668	500	---	2,575		3,743
12.	Woda Bultu	237,090	3,258	8,500	---	5,810		17,568
13.	Deba	77,690	35	----	--	5,700		5,735
14.	Gemches	97,270	40	100	---	200		340
15.	Daro lebu	131,780	5,280	2,500	---	15,280		23,050
Total	15	1,723,000	44,067	20,560	200	84,068	3,195	152,090 =8.83% of the total

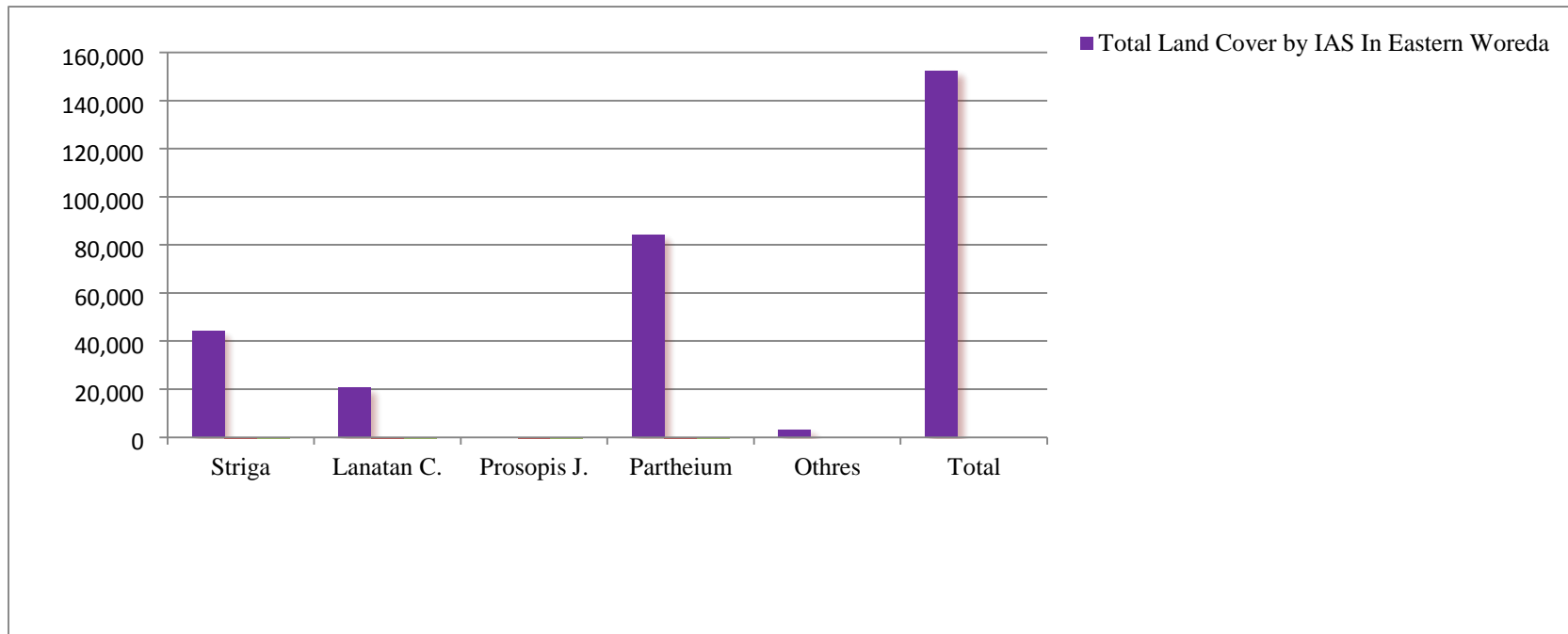


Fig1:-The total land cover of IAS that are found in western Hararghe zone

The above table and figure (1) indicates that in weastern haraghe region the major IAS are Partheium, striga,prosopis Juliflora, lanatana Camara and other non-identified species are found. And from the figure we can understand that partheium, striga and Lanatana camara are the dominant IAS in the area respectively and among this partheium is the most infested and dominate IAS.

Table2:- Type, Current infestation status and total area coverage of IAS in hectare in Eastern Hararghe region of Eastern Ethiopia.

Total area of the region is 1,628,725 hectare and total woerda in the region are 20.

No.	List of Woreda	Total area of Woerda (ha)	Type, and current coverage stage of IAS in each Woreda (Ha)					Total area that cover with IAS (ha)
			Striga (Akenchera)	Lantana camara (Prosopis juliflora (Yewoyani	Parthenium hysterothorus	Others (not scientifically identified)	



				Yewof kolo)	Zafe)			
			200	2,384	-	2000	192	
1.	Babile	207,217	106	--	-	2011.5	-	4,584
2.	Kersa	46,103.63	2801	--	80	4300	-	2,117.5
3.	Gursum	59,850.17	928	610	-	783	-	7,101
4.	Bedno	97,300	452.5	3,900	-	1150	1,024	2,321
5.	Meta	75,397	480	4,417	-	3450	2,787	6,526.5
6.	Melka bolo	139,591	30	1,237	-	--	-	11,134
7.	Muti	21,954	3002	1,812	-	--	-	1,267
8.	Miga tola	29,453	--	394	-	385	-	4,814
9.	Chenagesen	77,887,	6250	1,494	-	540	-	779
10.	Fidus	110,502	--	18,000	-	--	62	8,284
11.	Haramaya	55,400	--	4,693	-	1200	-	18,062
12.	Deder	67,428	--	3,665	-	--	-	5,893
13.	Goergultu	54,123	--	--	-	--	-	3,665
14.	Gerawa	110,941	--	2,905	-	--	-	--
15.	Kurfa chela	30,345.36	--	--	-	--	-	2,905
16.	Saremaw	257,687	--	-	-	--	-	--
17.	Kumbi	29,790	--	924	-	--	-	--
18.	Goloda	59,790	--	9,463	-	--	-	924
19.	Komebolcha	46,461	--	-	-	--	-	9,463
20.	Jarso	51,506	14,249.5	55,898	80	19,819.5	4,065	--
Total	20	1,628,725						94,032=5.8% from the tptal

Fig 2:- The total land cover of IAS that are found in Eastern Hararghe zone

The above table and figure (2) indicates that in Eastern haraghe region the major IAS are Partheium, and lantana Camara and also other non-identified species are found. And from the figure we can understand that Lanatana camara is the most dominant IAS in the area followed by Parthenium species.

Table3:- Type, Current infestation status and total area coverage of IAS in hectare in Harari region of Eastern Ethiopia.



Total area of the region is 34,326 hectare and total woerda in the region are 9.

No.	List of Woreda	Total area of Woerda (ha)	Type, and current coverage stage of IAS in each Woreda (Ha)					Total area that cover with IAS (ha)
			Striga (Akenc hera)	Lantana camara (Yewof kolo)	Prosopis juliflora (Yewoyani Zafe)	Parthenium hysterothorax	Others (not scientifically identified)	
1.	Sofi	Not exactly known	160	1040	-	1000	211	1511
2.	Genila	“	10	12	4.5	-	-	26.5
3.	Abader	“				-		
4.	Eror	“	81	165		424.5	126	796.5
5.	Abubeker	“				-		
6.	Awohakim	“				-		
7.	Aminur	“				-		
8.	Shenkor	“	-	9	-	-	-	9
9.	Dagiteyara	“				129		
Total	9	“	251	1,226	4.5	1,553.5	337	2,343=6.83% from the total

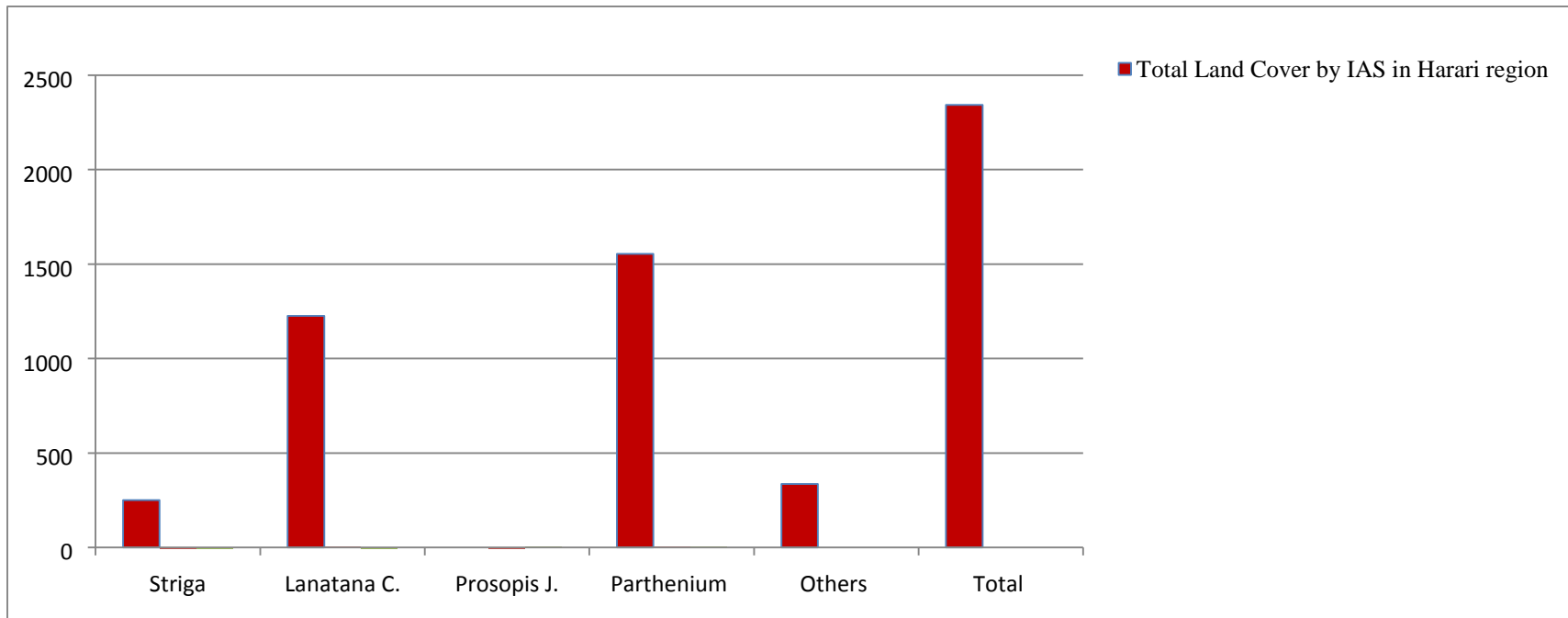


Fig 3:- The total land cover of IAS that are found in Harari region

As we have seen from the above (table 3) the total area (ha) of each woerad in harair regional state of Ethiopia is not well known yet, as a result it is difficult to get the exact amount of area coverage by IAS from the total area of each region. And such like problem also faced in Ethiopian Somali region .And when we see the existence of IAS in the area Partheium and lantana camara are the most seriously infested species of IAS and it needs fast response from the whole community unless it becomes over dominant and affected the whole area of the region.

Table4:- Type, Current infestation status and total area coverage of IAS in hectare in Ethiopian Somail region of Eastern Ethiopia.

Total area of the region is **3,500,000** hectare and total woerda in the region are 35(Currently there is no the exact data, but this are the major area)

No.	List of	Type, and current coverage stage of IAS in each Woreda (Ha)



	Woreda	Total area of Woerda (ha)	Striga (Akenchera)	Lantana camara (Yewof kolo)	Prosopis juliflora (Yewoyani Zafe)	Parthenium hysterophorus	Others (not scientifically identified)	Total area that cover with IAS (ha)
1.	Keberidar	Not well known yet	√	-	√	-	-	2
2.	Shayesasi	”	√	-	√	-	-	2
3.	Shelayibo	”	-	-	√	-	-	1
4.	Wareder	”	-	-	√	-	-	1
5.	Danan	”	-	-	√	-	-	1
6.	Godi	”	-	-	√	-	-	1
7.	Kalafo	”	-	-	√	-	-	1
8.	Mantihali	”	-	-	√	-	-	1
9.	Babile	”	-	√	-	√	-	2
10.	Ferefer	”	-	-	√	-	-	1
11.	Doload	”	-	-	√	-	-	1
12.	Emyegalebed	”	-	-	√	-	-	1
13.	Ayadel	”	-	-	√	-	-	1
14.	Shenliye	”	-	-	√	-	-	1
15.	Hadagaile	”	-	-	√	-	-	1
16.	Denbel	”	-	-	√	-	-	1
17.	Ayesha	”	-	-	√	-	-	1
18.	Afedam	”	-	-	√	-	-	1
19.	Beki	”	-	-	√	-	-	1
20.	Megi	”	-	-	√	-	-	1
15.	Hadagaile	”	-	-	√	-	-	1
16.	Denbel	”	-	-	√	-	-	1
17.	Ayesha	”	-	-	√	-	-	1



18.	Afedam	”	-	-	√	-	-	1
19.	Beki	”	-	-	√	-	-	1
20.	Megi	”	-	-	√	-	-	1
21.	Eror	”	--	√	-	√	-	2
22.	Jiggiga	”	-	√	-	-	√	2
23.	Tahilgadi	”	-	-	-	√	-	1
24.	Kebrbya	”	-	-	-	√	-	1
25.	Gursum	”	-	√	-	-	√	2
26.	Haroroyes	”	-	-	-	√	-	1
27.	Togowechalie	”	-	-	-	√	-	1
28.	Awobrie	”	-	-	-	√	-	1
29.	Hararo	”	-	-	-	√	-	1
30.	Dehabure	”	-	-	√	-	√	2
31.	Berkot	”	-	-	√	-	√	2
32.	Warder	”	-	-	-	√	-	1
33.	Denbel	”	-	-	√	-	-	1
34.	Ayesha	”	-	-	√	-	-	1
35.	Hodagala	”	-	-	√	-	-	1
Total	35	”	2	4	24	9	4	43

Note:- ‘√’= indicates the existence of IAS whereas ‘- ’indicates the absence of IAS

Fig 4:- The total number of woerda’s that f IAS are found in Ethiopian Somail region (But not in total land cover in hectares’)

As I mentioned earlier above in the Ethiopian Somail region the total area of each woerda as well as the total number in hectare that covered by IAS is not recorded yet. And this is one of the basic challenging issues during the data collection and also the implementation of appropriate methods to avoid those IAS that are found within the woerda. So due to this problem I simply try to identify the type of IAS found in each area without the exact number of area coverage. Therefore the above table and fig.(4) shows that the type of IAS found within the woerda and the total number of woerda’s that are affected by those IAS either one or more than one. And from the figure we can understand that *Prosopis juliflora* is occurred in most woerad and highly affected the existing area followed by *Parthium speices*



4. Inventory & Monitoring Protocols – Invasive Alien Plants on the existing area

Survey Level	Questions	Methods	Products
1.Preliminary (office-oriented)	-What invasive alien plant taxa are known to occur in the unit? - What plant communities at the unit are known to be Invaded by invasive alien plants?	-Conduct literature and database searches -Consult with knowledgeable persons and agencies -Review any existing documents for the site -Visit herbaria	-A list of invasive alien plant taxa that have been documented in the unit from past site visits or Studies.
2.Reconnaissance (field-oriented)	-What invasive alien plant occurrences exist at the unit?	-Walk-through, drive-by, fly-over, and look at photos of the site -Create a list of invasive plant taxa observed during site visits for help with identification of some invasive taxa and eradication techniques). - Have experts verify taxa in question. -Take general photos	-Products of the Preliminary Level plus: -A list of invasive alien plant taxa observed at the site during site visits - Completed annual inspection & questionnaire -Rapid assessment of invasive alien plant occurrences
3. Baseline (field-oriented)	-Where are the invasive alien plant occurrences located in the unit? -Is the invasive alien plant occurrence new or absent compared to previous years? - Is there an apparent change in the taxon or its habitat at the site of the occurrence compared to previous years? -What is the areal extent of the invasive alien plant occurrences in the unit? -What is	-Methods outlined in the Preliminary Level plus: -Visit the unit with aerial photographs and topographic maps and systematically search the suitable habitat on foot during the appropriate blooming period (for taxa that must be blooming for proper identification). - Establish photo stations, make general observations of the site, and note associated taxa. -Use the Sawyer-Keeler-Wolf plant communities Classification system to identify plant at the unit where invasive alien plant taxa are observed. -Use a Global Positioning System (GPS) unit to create a map of plant taxa locations as points in GIS. Map and number each occurrence.	-comprehensive list of the invasive alien plant taxa occurrences at the unit and the associated taxa. -A comprehensive list of the plant communities at the unit where invasive alien plant taxa occurrences exist. -GIS map with invasive alien plant taxa locations at the unit mapped as points or polygons. - A map of the surveyed area. -Photos of taxa and/or populations



	<p>the change in areal extent of the invasive alienplant</p>	<p>-Outline the surveyed area by hand onto a topographic map.</p>	
	<p>occurrences</p>	<p>Methods outlined in the Preliminary Level plus: -Map the stand or population perimeters as polygons using a GPS unit (some stands of larger taxa may be mapped using digital imagery in ArcView or ArcInfo). -Map entire area surveyed on a topographic map or GIS map, or by using digital imagery in ArcView or ArcInfo. -Create a GIS map using the ArcView or ArcInfo software. -Repeat the above periodically and compare results to previous years (Monitoring).</p>	<p>-Products of the Preliminary Level plus: - GIS map of invasive alien plant occurrences and the entire area surveyed. - Calculation of acreage of each occurrence or of all occurrences of a particular taxon using GIS</p>



<p>4. Comprehensive (field oriented)</p>	<p>-How many individuals of the invasive alien taxon are present in each occurrence? - What is the phenology of the taxon, and condition of individuals in the occurrence? -What is the species composition or richness, dominant taxa, condition of habitat, percent cover by species, relative abundance, height classes, distribution of the taxa,</p>	<p>Methods outlined in the Preliminary Level plus: -Establish transects and/or quadrats to collect data on numbers, phenology, disease, predation, mortality, etc., -Establish transects and/or quadrats to collect data on %cover, relative abundance, recruitment, height classes, mortality or disease.</p>	<p>Products of the Preliminary Level plus: - Data on abundance, frequency, density, richness, cover, condition of occurrence and habitat, mortality, etc. -Detect changes and trends in the above. -Map of transect and quadrat locations</p>
<p>5. Intensive (field and laboratory oriented)</p>	<p>-Questions related to demographics, genetics, energy/nutrient cycling, pollination biology, etc. -How are the population demographics or other attributes changing?</p>	<p>-Methods will be dependent upon the nature of the question and the taxon. Standard protocols, when available and applicable, should be employed. -Repeat the above periodically and compare results to previous years (Monitoring).</p>	<p>-Detailed and intensive studies and reports on an attribute of interest with regard to an invasive alien plant taxon or occurrence specifically. - Detect changes and trends.</p>



5. Conclusion

In general the diversity and infestation rate of IAS in Ethiopia is much diversified and rapidly invaded any type of area and affect the biodiversity resource and economically, socially, healthy impact is very crucial issue. And The eastern Part of Ethiopia is one of the most affected area as compared to other part of the country and since most of the community are pastoral and agro-pastoral this IAS infested the area and the communal range land become totally useless and covered by those IAS. From the above data we can understand that almost each woreda was affected by one or more type of IAS and it covered very large amount of the woerda land and reached very high stage of dominance over the native biodiversity resource. So this issue needs the participation of every community and stake holders including the higher officials and take appropriate management techniques at least to keep as it is, unless with in few years all of the eastern part of the country land covered by IAS. Finally, we highly recommend as it is not time to keep silent and everybody should be take an action and also the issue included with in the education curriculum of the country and more awareness creation should be done before we lose our native biodiversity resource and before we become totally infected both economically, socially, and our health system. And finally I would like to recommend all the community as well as stakeholders to identify and understand the full features of IAS to use the above inventory and monitoring methods and easily identify the species from native flora .

6. Acknowledgements

We thank both the local community and stakeholders of each zone and woreda for their viable support and provide appropriate evidence.

7. Funding

This study was supported by Ethiopian Biodiversity Institute (EBI), Harar Biodiversity Center from its annual budget.

8. Availability of data and materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

9. Authors' contributions

Yeneayehu Fenetahun and Girma Eshetu designed the study and collection the data and write the initial draft, Xu Xinwen and Wang Yongdong, edit and approved the final work. All authors read and approved the final manuscript.

10. Ethics approval and consent to participate

Not applicable.

11. Consent for publication

Not applicable.

12. Competing interests

The authors declare that they have no competing interests.

13. Reference

- Bradley, B. A., D. M. Blumenthal, R. Early, E. D. Grosholz, J. J. Lawler, L. P. Miller, C. J.
- B. Sorte, C. M. D'Antonio, J. M. Diez J. S. Dukes, I. Ibanez, and J. D. Olden. 2012. Global change, global trade, and the next wave of plant invasions. *Frontiers in Ecology and the Environment* 10(1):20-28. <http://dx.doi.org/10.1890/110145>
- Hejda, M., P. Pyšek, and V. Jarošík. 2009. Impacts of invasive plants on the species richness, diversity and the composition of invaded communities. *Journal of Ecology* 97(3):393-403. [http:// dx.doi.org/10.1111/j.1365-2745.2009.01480.x](http://dx.doi.org/10.1111/j.1365-2745.2009.01480.x)
- International Union for Conservation of Nature (IUCN). 2000. IUCN Guidelines for the Prevention of Biodiversity Loss caused by Alien Invasive Species. Information Paper from the Fifth Meeting of the Conference of the Parties to the Convention on Biological Diversity, approved by the 51st Meeting of Council, February 2000, Gland, Switzerland.
- Invasive Species Compendium. 2014. *Cryptostegia grandiflora* datasheet. Invasive Species Compendium, Wallingford, UK. [online] URL: <http://www.cabi.org/isc/datasheet/16378>
- Kaplan, H., A. van Niekerk, J. J. Le Roux, D. M. Richardson, and J. R. U. Wilson. 2014. Incorporating risk mapping at multiple spatial scales into eradication management plans. *Biological Invasions* 16(3):691-703. <http://dx.doi.org/10.1007/s10530-013-0611-z>
- Mack, R. N., and M. Erneberg. 2002. The United States naturalized flora: largely the product of deliberate introductions. *Annals of the Missouri Botanical Garden* 89:176-189. [http://dx. doi.org/10.2307/3298562](http://dx.doi.org/10.2307/3298562)



- McFadyen, R. E., and G. J. Harvey. 1990. Distribution and control of rubber vine, *Cryptostegia grandiflora*, a major weed in northern Queensland. *Plant Protection Quarterly* 5(4):152-155.
- Pimentel, D., R. Zuniga, and D. Morrison 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52:273-288. <http://dx.doi.org/10.1016/j.ecolecon.2004.10.002>
- Thuiller, W., D. M. Richardson, and G. F. Midgley. 2007. Will climate change promote alien plant invasions? Pages 197-211 in W. Nentwig, editor. *Biological invasions. Ecological studies*, Vol. 193. Springer-Verlag, Berlin, Germany. http://dx.doi.org/10.1007/978-3-540-36920-2_12
- Vilà, M., C. Basnou, P. Pyšek, M. Josefsson, P. Genovesi, S. Gollasch, W. Nentwig, S. Olenin, A. Roques, D. Roy, P. E. Hulme, and DAISE partners. 2010. How well do we understand the impacts of alien species on ecosystem services? A pan-European, cross-taxa assessment. *Frontiers in Ecology and the Environment* 8:135-144. <http://dx.doi.org/10.1890/080083>
- Vitousek, P. M. 1990. Biological invasions and ecosystem processes: towards an integration of population biology and ecosystem studies. *Oikos* 57:7-13. <http://dx.doi.org/10.2307/3565731>
- With, K. A. 2004. Assessing the risk of invasive spread in fragmented landscapes. *Risk Analysis* 24(4):803-815. <http://dx.doi.org/10.1111/j.0272-4332.2004.00480.x>