



The Status, Ecological and Biodiversity Impacts of Invasive Plant Species in Ethiopia: A review Paper

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ABSTRACT

With its dramatic geological history, extensive latitudinal unfold and substantial altitudinal range, Ethiopia spans a outstanding range of the world's extensive ecological regions. However, there are threats to biodiversity via way of means of invasive alien plant species (IAPS). These invasive alien species (IAS) pose the biggest threat to biodiversity after habitat destruction and series threats to ecology, agriculture (crop and livestock), livelihoods and human health in the country. This paper aimed to addresses the ecological impacts of IAPS on biodiversity, and socio –economic impacts of the species as well as their distribution status of the species through critical review of different literature ,document and reports . Recently, there are approximately 35 IAPS in Ethiopia. Some of those species consist of *Prosopis juliflora*, *Parthenium hysterophorus*, *Eichhornia crassipes*, *Lantana camara*, and *Acacia* species, that are the fundamental threats to biodiversity losses. Water bodies, lakes , wetlands, range land ,grass land and agricultural land are under threat of IAPS nowadays in the country. To decrease and manipulate such invasions, exclusive techniques are being carried out such aspreventions method and mechanical control (quarantine method) in different parts of the country. To preserve the sustainability of participation of all stockholders and multidisciplinary studies processes inside and throughout countries were needed.

Keywords: Biodiversity, Ecosystem, Ethiopia, Impact, Invasive

1. INTRODUCTION

Ethiopia consists of a outstanding amount of the world's big natural areas due to its dramatic geological history, big latitudinal dispersion, and widespread altitudinal variation. From the Afar depressions (115 metres below sea level) to the breathtaking mountaintops of Ras Dashen in the north and the Bale Mountains in the southeast, these are all present[1]. Ethiopia, own 6000 species of better plants, 10% of which might be indigenous. There are currently 1,225 species of arthropods, 201 species of fish, 200 species of reptiles, 63 species of amphibians, and 200 species of fish. 861 species of birds and 284 species of wild animals live in this country. Ethiopia is home to endemic species of 29 wild animal, 18 bird, 10 reptile, 40 fish, 25 amphibian, and 7 arthropod species [2].

The country is a center foundation for cultivated plants, which encompass coffee, tef, and enset, and a center of range for mass crop species, which incorporate durum wheat, barley, and sorghum. However Ethiopia's biodiversity are under threat due to habitat conversion, unsustainable utilization of Biodiversity resources, invasive species, alternatives to nearby types and breeds, weather extravagance, and pollution indirect reasons for biodiversity loss within the United States are demographic change, poverty, and a lack of knowledge and coordination[1]. According to[3] and[4], invasive species are one of the main dangers to native species and ecosystems around the world.

Similarly, according to [5], invasive alien species (IAS) are non-native plants, animals, or microorganisms that pose a threat to biodiversity, food security, human health, or economic growth. Because they may expand quickly, are fiercely competitive, and quickly colonize new areas, invasive species are a source of concern. Global worry exists due to the type and intensity of these species' effects on society, the economy, human health, and cultural heritage [5]. Invasive alien species, according to [6] are brought outside of their natural habitat either knowingly or unknowingly. Once there, they have the potential to establish themselves, invade, out compete local species, and take over the new ecosystem. Invasive species are currently thought to be the second biggest global danger to biodiversity, behind habitat degradation [7, 8].

They have now impacted every type of ecosystem on the globe. Besides posing a threat to ecosystem services and biodiversity, invasive species have a big social, ecological, and economic impact. They lessen crop yields, irrigated farmland, grazing areas, water availability, and they also help vector-borne diseases spread. There are roughly 22 invasive alien species in Ethiopia [9]. The country's agriculture (crop and livestock), way of life, and public health are all seriously threatened by these invasive alien species (IAS), which are the second greatest threat to biodiversity after habitat degradation [10].

Parthenium weed (*Parthenium hysterophorus*), Mesquites (*Prosopis juliflora*), Water hyacinth (*Eichhornia crassipes*), and Lantana camara are some of the invasive alien species producing serious issues in the nation. By eradicating or displacing native/ species through accelerated reproduction and spread, lowering agricultural yields, impeding irrigation systems, and promoting the development of other crop pests, alien species seriously harm agriculture and biodiversity in Ethiopia [1]. So that, this review provides the detail information about the status and effects of invasive species on biodiversity in Ethiopia. Also it provide the future forwarding line to minimize any effects on native species and as great care must be taken in the selection of introduced species may provided by the review to prevent further loss of native biodiversity.

1.2. Objective of the Review

- ✓ To review the major dominant invasive species in Ethiopia.
- ✓ To analysis the status of invasive plant species in Ethiopia.
- ✓ To review major socio-economic threats caused by invasive alien plant species In Ethiopia.
- ✓ To pin out management practice taken to control and eradicate invading species.

1.3. Reviewing Methodology

This review article is based on document analysis through a depth review of related literature from different sources. Data were obtained from the review of related literature on the Web of Published articles, researches, books, and reports. A total of 295 papers are searched from Scopus, Web of Science, and other indexed journals using keyword selection concepts of invasive and status, invasive, and biodiversity, protected areas, sacred religious forests, effects of invasive species and historical over view of the species. This review study also looked at invasive species in Ethiopia's, as well as management practices were among the search terms and keywords. We used i) English-language publications and ii) papers published in peer-reviewed scientific journals to define the criteria for screening the relevance of available materials. However, we have also included official website reports, conferences, theses, and unpublished data due to a lack of published literature in peer-reviewed journals.

2. Result and Discussions

2.1. What is an alien species?

Throughout the records of humankind, human beings were journeying and buying and selling with goods. In the remaining century, with the improvement of state-of-the-art way of transport, worldwide alternate has converted the worldwide economy. In the final hundred years, there has been at the least a 40-fold boom in worldwide export. One of the major environmental concerns of globalization is the movement and translocation of live organisms to new environments. In biology, species delivered to new environments with direct or oblique help of humans, are referred to as alien species. They may belong to any group of organisms – viruses, fungi, plants, animals, and the pathways of their introduction vary greatly [11].

The Regulation (EU) No 1143/2014 on the prevention and management of the introduction and spread of invasive alien species contains the following definition Alien species means any stay specimen of a species, subspecies or decrease taxon of animals, plants, fungi or micro organisms added outdoor its herbal range; it consists of any part, gametes, seeds, eggs or propagules of such species, as well as any hybrids, varieties or breeds that might survive and subsequently reproduce [12]. The term "local species" is described with the aid of using the International Union for Conservation of Nature (IUCN): Native species is a species, subspecies or decrease taxa, which lives at the territory of its usual (beyond or gift) herbal distribution, despite the fact that it's far gift best sporadically. This additionally applies to the regions which the species should have reached with the aid of using the herbal range expansion,

both with the aid of using walking, flying, shipping with the aid of using water or wind or another methods of dispersal [13, 14].

The overall concepts of invasive alien plant Species

Table 1 Recommended terminology in plant invasion ecology

Introduction	.As A Result Of Dispersal, Propagules ... Arrive At A Site Beyond Their Previous Geographical Range And Establish Populations Of Adult Plants
Colonization	The Plants In The Founding Population Reproduce And Increase In Number To Form A Colony That Is Self-Perpetuating
Naturalization.	The Species Establishes New Self-Perpetuating Populations, Undergoes Widespread Dispersal And Becomes Incorporated Within The Resident Flora[15].
Alien plants	Plant taxa in a given area whose presence there is due to intentional or accidental introduction as a result of human activity (synonyms:exotic plants, non-native plants; nonindigenous plants)
Casual alien plants	<i>Alien</i> plants that may flourish and even reproduce occasionally in an area, but which do not form self-replacing populations, and which rely on repeated introductions for their persistence (includes taxa labelled in the literature as ‘waifs’, ‘transients’, ‘occasional escapes’ and ‘persisting after cultivation’, and corresponds to [16] usage of the term ‘adventive’
Naturalized plants	<i>Alien plants</i> that reproduce consistently (cf. <i>casual alien plants</i>) and sustain populations over many life cycles without direct intervention by humans (or in spite of human intervention); they often recruit offspring freely, usually close to adult plants, and do not necessarily invade natural, seminatural or human-made ecosystems.
Invasive plants 3	<i>Naturalized plants</i> that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants (approximate scales: > 100 m; < 50 years for taxa spreading by seeds and other propagules 4; > 6 m/3 years for taxa spreading by roots, rhizomes, stolons, or creeping stems), and thus have the potential to spread over a considerable area
Weeds	Plants (not necessarily <i>alien</i>) that grow in sites where they are not wanted and which usually have detectable economic or environmental effects (synonyms: plant pests, harmful species; problem plants). ‘Environmental weeds’ are <i>alien plant</i> taxa that invade natural vegetation, usually adversely affecting native biodiversity and/or ecosystem functioning [17,18].
Transformers	A subset of <i>invasive plants</i> which change the character, condition, form or nature of ecosystems over a substantial area relative to the extent of that ecosystem.
Exotic	

Source : Richardson et al., 2000

2.2. Historical Perspectives of Invasive Alien Plants

Plant invasion is a strong threat to the species diversity around the world during the 21st century after habitat loss. Large quantity species of IAP are added to local us of a with inside the international and few of these become problematic; they are introduced in to a country either through human or natural (e.g. winds, birds, animals, water) [19,20]. Thousands of plant species had been transported through human beings to regions a long way from their herbal habitats; by accident or intentionally (e.g. agro-forestry, horticulture, forestry, and animal husbandry purposes). However, invasions via way of means of IAPS are certainly considered one among the most important threats to the ecosystems of the earth, and the services. 15 Few competitive IAPS which can be threatening biodiversity in Ethiopia and someplace else with inside the global are mentioned with inside the following sections [21,22].

Latana camera

Lantana camara is a perennial, erect sprawling or scandent, shrub which generally grows to around 2 metres (6 1/2 feet) tall and form dense thickets in a variety of environments. Under the right conditions, it can scramble up into trees and can grow to 6 m (20 ft) tall. It may also affect native vegetation indirectly through changes in soil properties [23]. In addition to the loss of biodiversity, interference with seed germination and early growth, Lantana camara L. Can lessen the effectiveness of improvement via way of means of choking irrigation canals, putting constraints on sustainable development, poverty alleviation, and meals safety inside the country [24]. Invasive alien species constitute one of the principal threats to biodiversity and all financial

sectors. *Lantana camara* has been ranked as the highest impacting invasive plant species[25].

Lantana camara affected severely the diversity and composition of invaded flora in the study area. The impacts of *Lantana camara* on native biodiversity is highly marked because of the species' invasive characteristics, such as rapid vegetative growth, aggressive competitive ability, high seed production, and proliferation throughout the year in ideal environmental conditions[26,27].

Impact of *Lantana Camara* on Biodiversity

Lantana camara L. Colonizes disturbed sites, impacting croplands, and variety lands. It generates allelopathic chemical substances through roots within the soil through root exudates [28]. These allelopathic chemical substances (like phenolic acids and alkaloids) inhibit the germination, growth, and yield of neighboring flora via the mechanism known as non-resource mediated interference and this may adversely affect plant species diversity by displacing mature vegetation or limiting juvenile recruitment[29].

The other mechanism by which *Lantana* can affect biodiversity is through competition for resources (e.g. water, nutrients, sunlight). In addition to allelopathy, its fast growth and unpalatable nature (due to its unpalatability the weed experiences relatively little pressure from natural predators compared to those which have evolved in their native land favored the weed to affect biodiversity by competing out native species[27].

Water hyacinth.

The WH, a large, free-floating aquatic weed found either on the surface of fresh waters or anchored in mud, is a tropical aquatic plant with attractive purple flowers, 10–15 cm wide and bright, shiny green leaves on long petioles. The mature WH consists of roots, stolons, petiole, leaves, leaf sheath, peduncle of the flower spike, inflorescence, adventitious roots, daughter plants, and fruit clusters[30].

The root morphology is highly plastic and fibrous, having one single main root with many laterals, forming a huge root system. Because each lateral root has a root tip, WH may exploit nutrients in a low-nutrient water body, which makes the lateral roots longer and denser at low phosphorus concentrations [31]. It can replicate both sexually by seeds and asexually by vegetative implying budding and stolon generation [30]. Root morphology is incredibly plastic and fibrous, having one unbranched essential root with many laterals, forming a massive root system. Because every lateral root has a root tip, WH might also additionally take advantage of vitamins in a low-nutrient water body, which makes the lateral roots longer and denser at low phosphorus concentrations [31]. It can replicate each sexually with the aid of using seeds and asexually with the aid of using vegetative implying budding and stolon generation[30]. Both duplicate structures have a huge manufacturing potential, inside a completely quick duration of time. The uniparental replica device occurs through vegetative replica. In vegetative reproduction, 3.4 million flowers may be produced in approximately two hundred days and forty three daughter clusters of leaves in 50 days [30].

Three-figure flora can supply as much as 3000 new developing flora in 50 days, and two-figure flora can offer as much as 30 offspring after 23 days. The sexual replica of the weed is through the manufacturing of seeds from its plant life through the marketers of insects. Single WH plant can supply flower in 26 days. The seed unfold may be through some mechanisms together with people and the legs of birds [31]. Propagation via way of means of seeds might also additionally make a contribution to the unfold of WH and may be an effective supply of reinfestation[30].

Socioeconomic Impacts

Water hyacinth has increasingly spread in Lake Tana since 2011, covering large parts of the lake shores. The water hyacinth invasion had negative impacts on agricultural production, livestock feeding, water supplies, fisheries, and the health of local people and livestock. The scale of socio-economic problems caused by weeds generally suggests real impacts on the lives of local communities and the economic development of the country[32]. Examined in the same way [33]. Water hyacinths cover much of Lake Tana, negatively impacting the livelihoods of thousands of rural families. Empirical studies have been conducted on the socio-economic impacts of water hyacinth. Research shows that weed has dichotomous socioeconomic impacts. Most previous studies have reported various negative socioeconomic impacts of weeds. One of the effects of water hyacinth is its negative impact on the production of rice plants [34,35] reported that this plant affected rice production, destroying it, preventing germination, and interrupting the harvest. The weed has also affected fishing and fish-related commercial activities ([34]. Reducing water supplies and degrading water quality[36]. In addition, the floating plant and its mats have led to worsening human health conditions by providing a breeding ground for mosquitoes, worms and snails, hindering electricity production and blocking access to recreational areas [36].

Environmental Hazards

The spread of WH weeds impacts the ecological stability and adjustments in herbal diversity. These modifications threaten the survival of many flowers and marine existence as weeds compete with natives for food, daylight and space [37]. This consequence is an imbalance within the aquatic micro ecosystem and often consequences with the extinction of a number of faunas whose existence is primarily based totally on quite a number plant life. This not only suppresses the growth of native plants and birds and negatively impacts microbes, but also prevents the growth and abundance of phytoplankton beneath large mats, negatively impacting fisheries [38]. Large WH mats save you the switch of oxygen from the air to the water floor or

lessen oxygen manufacturing with the aid of using different flora and algae [38]. Oxygen solubility can attain low concentrations which can be dangerous to fish that reply to such changes. Furthermore, low dissolved oxygen situations trigger the release of phosphorus from the mud, which then accelerates eutrophication and can lead to increased algal or WH blooms [39].

Parthenium Hysterophorus

It aggressively colonizes: herbal and artificial ecosystems, disturbed webweb sites and reasons foremost terrible affects on grassland habitats, open woodlands, riverbanks, flood plains, flora and fauna parks, and open area of agreement regions, naked regions alongside street sides, crop fields, and gardens closely stocked regions round yards and watering points. The allelochemicals launched from the weed or from seed leaching inhibit germination of different flora and the growth of pasture grasses, legumes, cereals, and vegetables, other weeds and even trees [40]. Parthenium influences nodulation in legumes because of inhabitation of pastime of nitrogen solving and nitrifying micro organism Viz., Rhizobium, Actinomycetes, Azotobacter and Azosprillium.

It become mentioned to motive yield losses of as much as 40% in numerous plants and is mentioned to lessen forage manufacturing with the aid of using as much as 90% in India.33 Parthenium produces massive amount of pollen (on common 624 million/plant), It is over excited at the least to short distance in clusters of 600-800 grains and determine the vegetative and floral parts, which includes stigmatic floor inhibiting fruitsetting in crops like tomato, beans and maize when its pollen grains are deposited on the stigmatic surfaces[41].

In Ethiopia, the yield in Sorghum bicolor grain changed into decreased via way of means of 40-97% whilst P.Hysterophorus changed into left out of control all through the seaso [42]. The weed poses extreme fitness risks to farm animals and if eaten can ruin their milk and meat. Some farmers in Ethiopia additionally declare that they have got misplaced farm animals for the duration of dry periods whilst there has been little to be had grazing and the animals had eaten Parthenium out of desperation. Parthenium also can purpose extreme allergenic reactions in folks that come into touch with the weed on a everyday basis.34 It induces to adjust withinside the bodily and chemical houses of soil such as Soil texture, soil pH, soil natural matter, soil nitrogen, soil potassium, and soil phosphorus [41].

Gebeyeh (2008)[43], reported that P.Hysterophorus became observed to be the maximum common and dominant species on avenue sides, grazing land and crop fields with essential price indices of 102%, 77.5% and 74.5% respectively out of sampled instances in Adami Tulu-Jido Kombolcha Woreda of Ethiopia. Under crop fields, the responses of wheat and teff (63.1% for each crops); maize (6.9%) to Parthenium weed have been much less than grass weeds, like Cynodon dactylon L. (72.5%) withinside the examine area. The end result confirmed that a few species have extra sociability or resistance than different species. In Southern Ethiopia at Gedeo Zone, the effect of P.Hysterophorus weed on biodiversity become additionally assessed. It confirmed that during exceedingly infested regions the effect became extra seen than the slight and occasional infested regions [44].

Prosopis juliflora (Sw.) DC. Fabaceae (Mesquites)

It is a perennial evergreen multipurpose dry land tree or shrub native to the Caribbean, North and South America. It Introduced to Africa in 1822 in Senegal; South Africa (1880), Egypt (1900) and Kenya changed into in 1973. sixteen It delivered to Eritrea from the Sudan, possibly at some point of the early 1980s. It delivered in Ethiopia withinside the past due Seventies at Goro nursery- Dire-Dawa. Prosopis end up planted over massive areas until 1982, continued through manner of manner of the Food for Work Programme from 1986 to 1988. This species is now normally observed in Afar, Oromia, Amhara, Somali, Dire-Dawa areas and Sothern Nations and Nationalities. Nowadays, it's miles again and again pronounced to be one of the invasive and difficult trees in the Afar Region and progress to Rift Valley of Ethiopia[22]. It is the maximum competitive weed that motive brilliant devastation to subtropical grasslands and became notion to had been brought to Ethiopia during The established order of irrigation water improvement mission at Middle Awash as wind break, colour and shelter [45]. Now a day, this species is spreading to Oromia, Amhara, Somali, and Diradawa areas of Ethiopia [46].

Environmental outcomes of Prosopis juliflora

Dense impenetrable thickets of P.Juliflora compete with local plant species and harms surroundings consequently disrupt surroundings features and services. The species affected soil properties, hydrology, land use and land cowl changes, rangelands, great and availability of animal feeds, threat to fertile agricultural lands and lack of their productivity, lessen biodiversity, invaded flora and fauna reserves and country wide parks, have an effect on human and livestock health, the economic system of the us of a and the general livelihoods of pastoralists, social conflicts and cerate political instability, lessen hen diversity, blocks roads of each animal and inhabitants, lessen city amenity, however set off carbon sequestration with inside the invaded areas [47].

Rangeland Quality and Availability of Animal Feeds

P.Juliflora changed neighborhood biodiversity in numerous spots in Afar rangelands and riversides [48, 49]. In such habitats, the grasslands had no greater used for grazing and environment features of rangelands have been modified to thickets of P. juliflora. These made Afar pastoralists moved in

addition from their domestic and pasture fields. mentioned that during Amibara woreda of Afar region, *P. Juliflora* significantly invaded dense *Acacia* woodlands, riverine forests, and agricultural lands. These may be chance and the adaptability of the species and its first arrival in the sooner woreda than the later. Similarly, in border united states Eritrea, observe through Harnet ,2008 suggests that the invasion of *P. Juliflora* invaded each dry season and moist season rangelands and roadsides in lowlands [50].

Effect of *P. juliflora* on Human Health

P. Juliflora thorns are risky and inflict ache this is like being bitten with the aid of using a snake[51]. For instance, amongst human injuries, 8.4% in Awash Fentale and 5.2% family respondents in Amibara woreda mentioned that pricked via way of means of thorns of *P. juliflora* [47]. . Furthermore, the research additionally highlighted the complexity of the motive of Anopheles' courting with invasive alien flora which includes *P. Juliflora* that multiplied malaria incidences[52] . These have implications to the manufacturing of anopheles insect in thickets of *P. Juliflora*, which threatened human fitness with inside the invaded areas of the country.

Effect of *P. Juliflora* on animal health Due to the lack of great pasture lands, hundreds of goats were rendered Toothless and died from hunger following tooth loss, which has been reduced their number [53]. .Nevertheless, families in Awash Fentale and Amibara woredas answered that pods/seeds had been the maximum palatable a part of *P. juliflora* by animals[47]. Most of them argued that leaf of *P. Juliflora* become the maximum poisonous and killed their animals after consumptions [54].

3. The Management of Invasive Alien Species

Responding to invasions

With increasing studies in invasion biology, there is a growing body of evidence that invasive alien species are one of the main and increasing threats to biodiversity, food security, and human and animal health[29]. As the drivers of biological invasions will continue to contribute to the introduction and spread of alien species, countries have to develop more effective mechanisms to respond to these threats. Management measures can be introduced in any invasion stage. However, the possibilities to effectively manage alien species decline when populations increase and spatially expand. As invasiveness is difficult to predict and is linked to many uncertainties, a precautionary approach should be applied to decisions regarding an authorised intentional introduction or when making decisions on the management of alien species which were already introduced. Depending on the invasion stage, there are several management options: prevention, early warning and rapid response, eradication and control[55,56].

Prevention

The preferred management option is always prevention which is also the most cost-effective approach. Prevention can include any measures to prevent the introduction of alien species. This can involve any legal restrictions on the intentional introduction of alien species, or at least these are only authorised after a risk assessment has been made. For species for which there is already clear evidence of their invasiveness, a legal ban can be imposed, prohibiting transporting or importing a limited set of species. Any measures affecting free trade must be scientifically justified with a risk assessment, to fit into the legal framework constituted by the rules on the Single Market and obligations of the World Trade Organisation. From 2016 onwards, the European Union introduced a ban on several alien species of Union concern, for which the rules of the EU IAS Regulation 1143/2014 apply. The species are determined with the Commission Implementing Regulations, and the list is periodically updated. Until March 2021, 66 species were listed as invasive alien species of EU concern³². Restrictions on movement and introduction also apply to some of the pests of alien origin. Under the phytosanitary rules, which aim at preventing the introduction of plant pests, there are strict quarantine and border controls [55,56,57].

Early warning and rapid response

The next level of defence against invasive alien species is an early warning and rapid response, aiming to detect incoming alien species in the early invasion stages. As alien species are rare in the early stages, detecting species can be challenging. Early detection requires active searching for alien species, for example, in areas where they are more likely to show up (e.g. ports, airports) or in areas of nature conservation importance where alien species' presence is even less desirable. Once an alien species is discovered, the level of threat should be assessed. If the species is (potentially) invasive, eradication measures should be initiated as soon as possible. If measures of early warning and rapid response are not successful, alien species may quickly spread beyond control. Early warning and rapid response require significant institutional capacities. Roles and mandates have to be clearly divided so that the chain of command is clear at the moment of discovery of an alien species. Rapid response protocols can be developed to define the roles clearly [55,56].

Eradication and Control

Once alien species are present in the environment, attempts can be made to remove them. This requires substantial financial resources, as the eradication actions usually have to continue for several years. When alien species becomes more spread, it is usually impossible to eradicate. However, control measures can be introduced to mitigate the impact of alien species. If their populations are reduced, it usually also reduced impacts to an acceptable level. Control measures are costly and perpetual and can impose a significant financial burden on countries. Many eradication and control methods are in use. The choice depends mainly on the biology of the species, characteristics of the site and legal possibilities. It is beyond the scope of this manual to describe these methods in detail. In general, methods are divided into mechanical methods (e.g., digging, mowing, cutting, trapping), chemical (use of pesticides) or biological control (introduction of a specific pest that is affecting the invasive species[56 58,59]).

4. For Wording Line

The following tips are recommended to prevent, manage the already invaded ecosystems in Ethiopia and some other place with inside the world:

- ✓ Sustainable and effective research is needed to have information of species invasions.
- ✓ Create focus for stakeholders approximately the history, purpose and affects IAPS could be very important.
- ✓ Government have to have powerful coverage to higher recognize IAS and devise mechanisms for higher prevention and control.
- ✓ Close tracking and control of all herbal and agro-ecosystems from disturbances to lessen the appearance and colonization of IAPS.
- ✓ Secure quarantine measures desires to be brought in boarder regions wherein tourism, trade, travels retailers are flowing.
- ✓ Countries with IAPS international locations percentage data and running relationships to be able to manage the switch of IAPS from one to another.
- ✓ The society should be awared not to use the land for grazing or browsing more than its carrying capacity.
- ✓ As disturbance with inside the shape of herbivory is observed to be the essential element facilitating invasion and encroachment of the species.
- ✓ Provision of education on a way to use the species to enhance biophysical and socioeconomic environment.
- ✓ Planting the native tree on eroded areas for rehabilitation of the areas, and to prevent erosion.
- ✓ Removing it earlier than seed manufacturing for seed manufacturing is the important way of encroachment to un invaded areas.

5. Conclusion

Ethiopia has numerous ecosystems which might be domestic to massive wide variety of flora, fauna and microbial species. However, there are threats to surroundings offerings and biodiversity loss because of habitat conversion, invasive species, Unsustainable usage of biodiversity resources, substitute of neighborhood types and breeds, and weather alternate and pollution. Invasive alien species together with plant life are special which can be added intentionally or by chance outdoor their herbal habitat obviously or thru human activities. In new areas, invasive alien species are colonizing the local ecosystems; have both high quality and poor effects at the atmosphere services. Invasive alien species are found in all taxon or organisms and exist everywhere in the worldwide in all ecosystems. Recently, 35 invasive weed species are diagnosed in Ethiopia, and they're posing terrible influences on local biodiversity, agricultural and variety lands, country wide parks, water ways, lakes, rivers, strength dams, street aspects and concrete inexperienced areas with massive reasonable in addition to social consequences. Some of those species include: mesquites (*P.Juliflora*), parthenium weed (*P.Hysterophorus*), water hyacinth (*E. crassipes*), lantana weed (*L.Camara*), Acacia species, and different weeds together with *Orobanche* and *Cuscuta* species which can be recognized as essential plant invaders. These IAPS are greater competitive in disturbed, arid and semiarid plant life ecosystems like Acacia- *Commiphora* woodlands, aquatic, wetlands, agro-ecosystems and rangelands in Ethiopia. IAPS characterized by high completion and nutrient utilizations. As the result, they've influences on biodiversity, social offerings and fitness troubles each on human and animals in all ecosystems with inside the new areas. In order to combat such threats having management policy is so important.

Reference

- [1] EBI (Ethiopian Biodiversity Institute). Ethiopian's fifth national report to the conservation biodiversity. 2014.
- [2] Tessema, M.E., Wakjira, K. & Asefa, A. 2019. Threats and their relative severity and driving forces in the African Elephant range wildlife protected areas of Ethiopia. *International Journal of Biodiversity and Conservation*, 11(7): 187-198.
- [3] Kathiresan, R. M.,(2004). Invasive weeds in agro-ecosystems of South India [Abstracts]. In: *National Workshop on Invasive Alien species and Biodiversity in India*, Banaras Hindu University, Vanarasi, India. 149 p.
- [4] Kathiresan, R. M., Gnanavel, I., Anbhazhagan, R., Padmaria, S. P., Vijayalakshmi, N. K. and Arulchezian, M. P., (2005). Ecology and control of *Parthenium* invasion in command area. In: *Proceedings of Second International Conference on Parthenium Management 5-7 Dec 2005*. Bangalore, India. pp 77-80.
- [5] McNeelley, J. A., Mooney, H. A., Neville, L. E., Schei, P. and Waage, J. K., 2001. Global Strategy on Invasive Alien Species. UCN – the World Conservation Union, Gland
- [6] CBD (Convention on Biological Diversity), (2005). Invasive Alien Species. Convention on Biological Diversity. <http://www.biodiv.org/programmes/crooscutting/alien>.
- [7] Essa, S., Dohai, B., and Ksiksi, T., 2006. Mapping dynamics of invasive *P. juliflora* in the Northern Emirates of the UAE: An application of Remote Sensing and GIS

- [8] Raghubanshi, A.S., Rai, L.C., Gaur, J.P., and Singh, J.S., (2005) Invasive alien species and Biodiversity in India: *Current Science* **88**(4).
- [9] Mckee, J. 2007. Ethiopia: Country Environmental Profile. Addis Ababa, Ethiopia.
- [10] Haysom, K.A. and Murphy, S.T., 2003. The status of invasiveness of forest tree species outside their natural habitat: a global review and discussion paper. Forest Health and Bio-security Working Paper FBS/3E. Forestry Department. FAO, Rome
- [11] Kus Veenliet, J.(2021). Invasive Alien Species and their Management Ljubljana, a training course manual, EuroNatur Foundation and Institute Symbiosis, so. e. Available at: <https://savaparks.eu/sava-ties-7448>.
- [12] EC, (2014). Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R1143&from=EN>
- [13] IUCN, (2000.) IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species. Available at: <https://portals.iucn.org/library/efiles/documents/Rep-2000-052.pdf>
- [14] Afrin, S., Sharmin, S. and Mowla, Q.A., (2010), September. The environmental impact of alien invasive plant species in Bangladesh. In *Proceedings of International Conference on Environmental Aspects of Bangladesh (ICEAB10), Japan* (pp. 62-64).
- [15] Richardson David M. , Petr Py Sek. , Marcel Rejmánek, Michael G. Barbour, F. Dane Panetta And Carol J. (2000). Westnaturalization And Invasion Of Alien Plants: Concepts And Definitions. *Diversity and Distributions* (2000)**6** , 93–107.
- [16] De Candolle, A.P. (1855) *Géographie Botanique Raisonné*, vol. 2. V. Masson, Paris.
- [17] Humphries, S.E., Groves, R.H. & Mitchell, D.S.1991. Plant invasions of Australian ecosystems. *Kowari*, **2**, 1–134.
- [18] Randall, J.M.(1997). Defining weeds of natural areas. *Assessment and Management of Plant Invasions* (ed. by J.O. Luken & J.W. Thieret), pp. 18–25. Springer-Verlag, New York
- [19] Sebua S Semanya, Milingoni P Tshisikhawe, Martin T Potgieter (2012). Invasive alien plant species: A case study of their use in the Thulamela Local Municipality, Limpopo Province, South Africa. *Scientific Research and Essay*. 2012; 7(27):2363–2369.
- [20] Moyo HPM, Fatunbi AO.(2010). Utilitarian perspective of the invasion of some South African biomes by *Acacia mearnsii*. *Global Journal of Environmental Research*. 2010;4(1):6–17..
- [21] Sonya Afrin, Subarna Sharmin, Qazi Azizul Mowla, editors. The environmental impact of alien invasive plant species in Bangladesh. *Proceedings of International Conference on Environmental Aspects of Bangladesh; 2010 Sept Japan. ICEAB10; 2010*.
- [22] Shiferaw W, Demissew S, Bekele T, Aynekulu EI (2022) Community perceptions towards invasion of *Prosopis juliflora*, utilization, and its control options in Afar region, Northeast Ethiopia. *Plos One*; 2022;**17**(1): e0261838
- [23] Wekhanya, M. N. (2016). The effect of invasive species *Lantana camara* on soil chemistry at Ol-Donyo Sabuk National park, Kenya, A thesis submitted in partial fulfillment of the requirements for award of the degree of masters of Science (Plant Ecology) in the school of pure and applied sciences, Kenyatta University, Kenya.
- [24] Keefelegn, H. (2015). Invasive Alien Weed Species Impacts on Biodiversity and Socio-Economic Aspect in Ethiopia : A Review. 4(10), 2179–2185.
- [25] Assefa, A.S. and Molla, E.L., (2021). Impact of invasive alien plant species, *Lantana camara*, on the species composition, richness and evenness of invaded plant communities in Sidama, Gamogofa and Gedio Zones, Ethiopia.
- [26] Nel, L.(2015). *Effects of a highly invasive plant (Lantana camara) on an agricultural flower visitation network* (Doctoral dissertation, Stellenbosch: Stellenbosch University).
- [27] Abebe, F.B., 2018. Invasive *Lantana camara* L. shrub in Ethiopia: ecology, threat, and suggested management strategies. *Journal of Agricultural Science*, **10**(7), pp.184-195.
- [28] Mihertu, Y. F. (2018). Ecological assessment of type , abundance and infestation status of invasive alien species (IAS) in eastern part of Ethiopia ; suggestion of inventory and monitoring protocols-IAS. December. <https://doi.org/10.15406/mojbm.2018.03.00102>
- [29] Gemedda, W., Demissew, S., & Bekele, T.(2019) Socio-Ecological Impacts of Invasive Plant Species in Ethiopia : A Review Paper *Journal of Agriculture and Forest Socio-Ecological Impacts of Invasive Plant Species in Ethiopia : A Review Paper*. February 2020, 1–6
- [30] Gaikwad, R.P. and Gavande, S., (2017). Major factors contributing growth of water hyacinth in natural water bodies. *International Journal of Engineering Research*, **6**(6), pp.304-306.
- [31] Bakrim WB, Ezzariai A, Karouach F, Sobeh M, Kibret M, Hafidi M, et al. *Eichhornia crassipes* (mart.) solms: A comprehensive review of its chemical composition, traditional use, and value-added products. *Frontiers in Pharmacology*. 2022;**13**:842511. DOI: 10.3389/fphar. 2022.842511
- [32] Enyew BG, Assefa WW, Gezie A (2020) Socioeconomic effects of water hyacinth (*Eichhornia Crassipes*) in Lake Tana, North Western Ethiopia. *PLoS ONE* **15**(9): e0237668. <https://doi.org/10.1371/journal.pone.0237668>
- [33] Damtie, Y.A., Berlie, A.B. and Gessese, G.M.(2022) Impact of water hyacinth on rural livelihoods: the case of Lake Tana, Amhara region, Ethiopia. *Heliyon*, **8**(3), p.e09132.
- [34] Jones R. (2009) The impact on biodiversity, and integrated control, of water hyacinth, *Eichhornia crassipes* (Martius) Solms-Laubach (Pontederiaceae) on the Lake Nsezi–Nseleni River System. M.Sc. Thesis, Rhodes University, South Africa. 2009. Available: <https://core.ac.uk/download/pdf/145041891.pdf>
- [35] Jafari N. (2010). Ecological and socio-economic utilization of water hyacinth (*Eichhornia crassipes* Mart Solms). *Journal of Applied Sciences and Environmental Management*. 2010;**14**: 43–49.
- [36] John-Stephen B, Fred-Masifwa W, Fredrick-Jones M. 2009. Impacts of Water Hyacinth and Water Quality Change on Beneficial Uses of Lake Victoria, Uganda. 13th World Lake Conference, Wuhan, China 1–5 November. Wuhan; 2009. pp. 1–8.
- [37] Nega DT, Venkata Ramayya A, Manenti F, Amaral AF(2021) . Turning curse into cure: Potential of water hyacinth for bio-refining-a contextual investigation of lake tana. *Environmental. Challenges*. 2021;**5**:100387
- [38] Harun I, Pushiri H, Amirul-Aiman AJ, Zulkeflee Z. (2021). Invasive water hyacinth: Ecology, impacts and prospects for the rural economy. *Plants*. 2021;**10**(8):1613
- [39] Dersseh MG, Melesse AM, Tilahun SA, Abate M, Dagnew DC. (2019). Water hyacinth: Review of its impacts on hydrology and ecosystem services-lessons for management of lake tana. *Extreme Hydrology and Climate Variability*. 2019:237-251

- [40] Shiferaw W, Demissew S, Bekele T. (2018) Invasive alien plant species in Ethiopia: ecological impacts on biodiversity a review paper. *Int J Mol Biol Open Access*. 2018;3(4):169–176. DOI: 10.15406/ijmboa.2018.03.00072
- [41] Gnanavel L. *Parthenium hysterophorus* L: a major threat to natural and agro-ecosystems in India. *Science International*. 2013;1(5):124–131.
- [42] Tamado, T., Ohlander, L. and Milberg, P., (2002) Interference by the weed *Parthenium hysterophorus* L. with grain sorghum: influence of weed density and duration of competition. *International Journal of Pest Management*, 48(3), pp.183-188.
- [43] Gebeyehu, A.K., (2008). *The distributions of parthenium weed (Parthenium hysterophorus L. Asteraceae) and some of its socio-economic and ecological impacts in the Central Rift Valley, Adami Tulu-Jido Kombolcha Woreda; Ethiopia* (Doctoral dissertation, Addis Ababa University).
- [44] Seta, T., Assefa, A., Mesfin, F. and Balcha, A., (2013) Distribution status and the impact of parthenium weed (*Parthenium hysterophorus* L.) at Gedeo Zone (Southern Ethiopia). *African Journal of Agricultural Research*, 8(4), pp.386-397.
- [45] Berhanu A, Tesfaye G. The *Prosopis juliflora* dilemma, impact on dryland biodiversity and some controlling methods. *Journal of the Dry Lands*. 2006;1(2):158-164.
- [46] EPP, 2006. Proceeding of the Workshop on Afar Pastoralist *Prosopis* Project Immerging Issues.
- [47] Shiferaw W, Bekele T, Demissew S, Aynekulu E. (2020) Phenology of the alien invasive plant species *Prosopis juliflora* in arid and semi-arid areas in response to climate variability and some perspectives for its control in Ethiopia. *Polish Journal of Ecology*. 2020;68:37-46. DOI: 10.3161/15052249PJE2020.68.1.004
- [48] Berhanu A, Tesfaye G. The *Prosopis juliflora* dilemma, impact on dryland biodiversity and some controlling methods. *Journal of the Dry Lands*. 2006;1(2):158-164.
- [49] Zeray N, Legesse B, Mohamed HJ, Aredo KM. Impacts of *Prosopis juliflora* invasion on livelihoods of pastoral and agro-pastoral households of Dire Dawa Administration, Ethiopia. *Pastoralism: Research, Policy, and Practice*. 2017;7(7):1-14. DOI: 10.1186/s13570-017-0079-z
- [50] Zerga B. (2015) Degradation of rangelands and rehabilitation efforts in Ethiopia: The case of Afar rangelands. *Journal of Advances in Agricultural Science and Technology*. 2015;3(6):81-94
- [51] Seid O, Haji J, Legesse B. Rural households' perception on the effects of *Prosopis juliflora* invasion: The case of Amibara District of Afar National Regional State, Ethiopia. *Pastoralism: Research, Policy, and Practice*. (2020) ;10:21. DOI: 10.1186/s13570-020-00174-1
- [52] CBD. WHO Biodiversity and health. State of Knowledge Report. 2015;2015:1-4
- [53] Obiri JF. (2011) Invasive plant species and their disaster-effects in dry tropical forests and rangelands of Kenya and Tanzania. *JAMBA*. (2011;3(2):417-428
- [54] Pasiecznik NM, Felker P, Harris PJC, Harsh LN, Cruz G, Tewari JC, (2001). *The Prosopis juliflora - Prosopis pallid Complex: A Monograph*. UK: HDRA;2001. p. 172
- [55] Zidar, S., J. Malovrh, J. Kus Veenliet, M. de Groot, (2020). LIFE ARTEMIS Project - Awareness Raising, Training and Measures on Invasive Alien Species in Forests.
- [56] Kus Veenliet, J. (2021). *Invasive Alien Species and their Management Ljubljana*, a training course manual, EuroNatur Foundation and Institute Symbiosis, so. e. Available at: <https://savaparks.eu/sava-ties-7448>.
- [57] Jeschke J, Pyšek P. (2018) Tens rule. In: Jeschke JM, Heger T (eds) *Invasion biology: hypotheses and evidence*. CAB International, Wallingford, 124–132
- [58] Abdullah MM, Ute AJ, Regasa T. (2017.) *P. juliflora* (Sw.) DC distribution, impacts and available control methods in Ethiopia. *Tropical and Subtropical Agroecosystems*. 2017;20(1):75-89.
- [59] Maslo S, Wong L J, Pagad S (2020). GRIIS Checklist of Introduced and Invasive Species - Bosnia and Herzegovina. Version 1.3. Invasive Species Specialist Group ISSG. Checklist dataset <https://doi.org/10.15468/uuzhvt> accessed via GBIF.org on 2021-03-16.