Chapter 3

Non-Native Invasive Species as Ecosystem Service Providers

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Additional information is available at the end of the chapter

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Abstract

Non-native or alien species present a range of threats to native ecosystems and human well-being. Many such species have selective advantages over native species, such as faster growth and reproduction rates, higher ecological tolerance, or more effective dispersal mechanisms. However, these species are often inadvertently demonised without sufficient awareness of the ecological principles—disturbance, niche and competition—that contribute to species dominance in an ecosystem. Non-native species can provide services useful to humans, particularly in facilitating many contemporary needs of modern civilisation. In the present paper, the available records on the influence of non-native invasive species and the relationship between services lost and new services acquired due to their presence will be discussed.

Keywords: ecosystem service providers, new services, non-native invasive species

1. Introduction

An invasive alien species (IAS) is any species that is not native to that ecosystem and is capable of propagating itself, whose introduction causes or is likely to cause harm to the environment, economy, or human health [1]. IAS, as well as other species, are affected by climate changes. Predicted environmental changes, such as changing in precipitation and temperature, nutrient availability and soil disturbance, may enhance the susceptibility of habitats to invasion by non-native plant species [2]. Many studies have tried to predict future distributions of invasive species taking different approaches [2–4]. Since introduced species are more spread in disturbed ecosystems with reduced competition, it is crucial to consider the natural and human factors, such as economic activity, urbanisation, land use, overpopulation, migration, etc., associated with the occurrence of IAS [5]. In general, the invasion process is a complex series of events, reliant upon both the invasive capabilities of the species and the invasibility of the ecosystem [5]. Global environmental changes additionally complicate a continuous battle of governments and managers to detect and control invasive species [3].

The ecological influence of invasive alien species is manifested in different ways. Alien plant species inhabit the area of native species, alter the conditions in their habitat as well as the structure of their communities and interbreed with native species. Alien animal species can also compete for food and shelter with native species and transfer different diseases. Invasive species in general are highly adaptable to a new habitat, tolerate a wide range of climate

Figure 1. Negative effects of *Ailanthus altissima* on archaeological sites in Croatia.

conditions and usually occupy marginal and degraded habitats. They grow fast and have a high reproductive rate to ensure future survival. Although the economic cost of ecological damages caused by IAS is significant, their direct influence on human activities and sites is also relevant [3] (**Figure 1**). Some IAS also have a direct negative influence on human health, such as invasive allergens (e.g. *Ambrosia artemisiifolia* L.) [6], species that causes skin irritation [7], obstructions in freshwater traffic caused by water plants [8] or decreasing crop production caused by invasive weed species and diseases [9].

A fraction of established exotics become serious pests (e.g. the Eurasian zebra mussel *Dreissena polymorpha* Pallas), while others become well fitted and contribute to global and/or specific

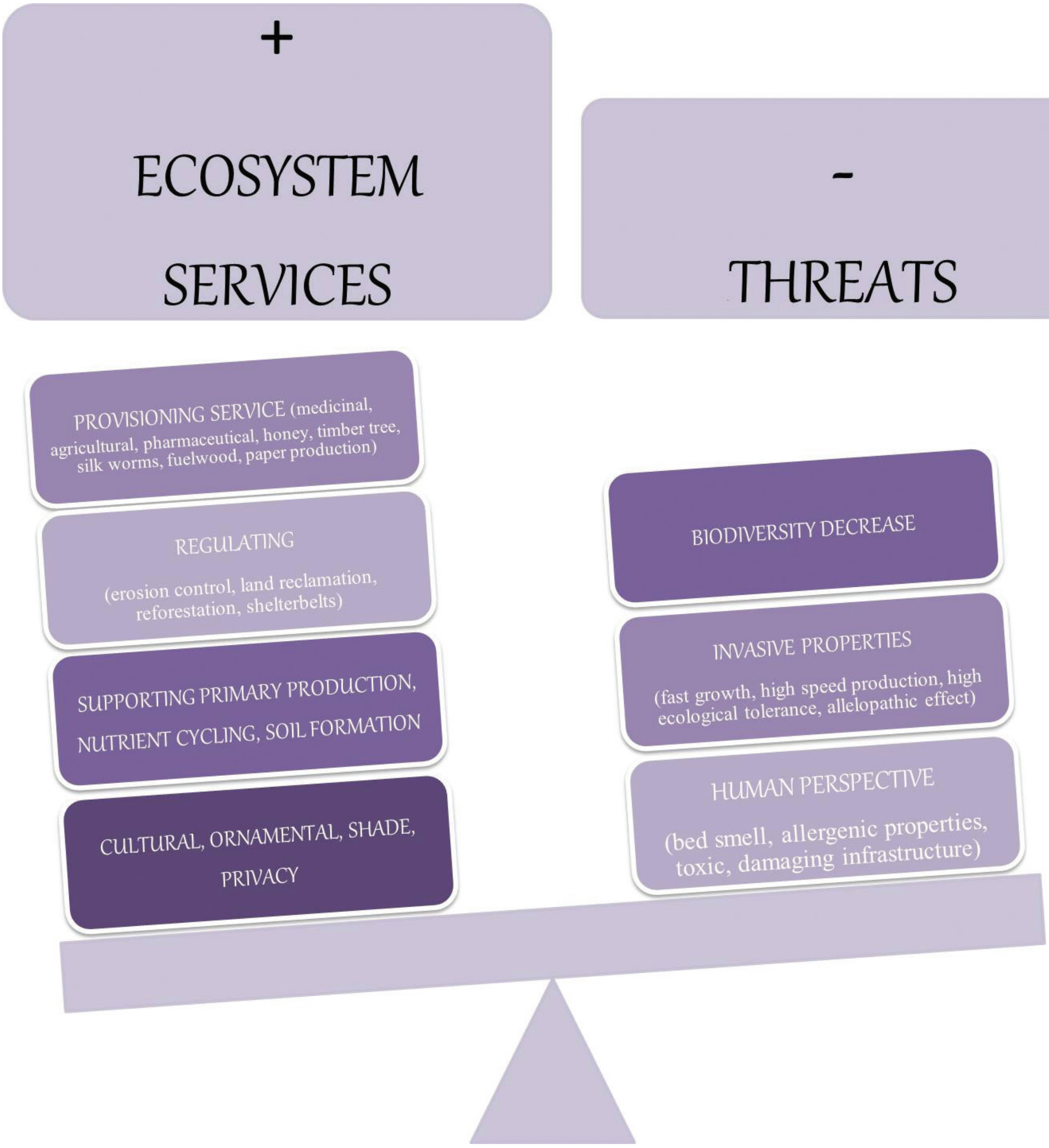

Figure 2. Positive and negative effects of alien invasive species on the scale.

ecosystem services (e.g. the persimmon fruit *Diospyros kaki* L. in the Mediterranean area). For example, *D. polymorpha* has both numerous negative and positive effects on natural ecosystems. Negatives include the economic costs of damage due to clogged water pipes and the fouling of ship hulls and aquaculture cages. This mussel is a predator that significantly decreases plankton abundance as a result of filter feeding. Studies have shown that other filter feeding species may experience competition for resources in the presence of *D. polymorpha*. On the other hand, filtration as a feeding mode may increase water clarity and therefore improve habitat characteristics [10].

In rapidly changing environments, the effects of both non-native and native species may vary with time [11]. The truth is that most human and natural communities consist of both native and new species and new ecosystems are constantly being formed. Many eradication attempts have failed in the past [11], and we must accept novel ecosystems with dynamic living components. Moreover, sometimes, the eradication of one species will not result in the desired outcome because species interactions can be altered [12].

In this chapter, different aspects of the impacts of non-native invasive species are discussed in order to reopen the debate on new complex ecosystems that include both native and non-native species (**Figure 2**) (**Table 1**).

Ecosystem services provided by invasive species

Ecosystem service	Species	Origin	Reference
Reducing environmental pollution and phytoremediation	*Ailanthus altissima* (Mill.) Swingle	China	[19, 89, 90]
	Potamogeton illinoensis Morong	North America	[91, 92]
	Artemisia vulgaris L.	Euroasia	[93, 94]
Bioenergy	*Panicum virgatum* L.	Central and Eastern USA	[26–28]
	Arundo donax L.	Euroasia	[95, 96]
	Paulownia tomentosa (Thunb.) Steud.	China	[31, 38–40]
	Jatropha curcas L.	Central America	[97–99]
Art	*Alliaria petiolata* (M. Bieb.) Cavara and Grande	Europe	[40]
	Morus alba L.	North China	[100]
	Lonicera maackii (rupr.) Maxim	Western Asia	[100]
	Chamaedaphne calyculata (L.) Moench	Temperate and subarctic regions of the Northern Hemisphere	[100]
	Mahonia bealei (Fortune) Carrière	China	[100]
	Rosa multiflora Thunb.	Eastern Asia	[100]
	Hedera hibernica (G. Kirchn.) Bean	Atlantic region	[44]
Honey plants	*Robinia pseudoacacia* L.	North America	[52–54]
	Impatiens glandulifera Royle	Pakistan to India	[60, 61]

Ecosystem services provided by invasive species			
Ecosystem service	**Species**	**Origin**	**Reference**
Land reclamation and erosion control	*Ailanthus altissima* (Mill.) Swingle	China	[19, 63, 64]
	Casuarina equisetifolia L.	Malaysia, Vietnam, Australia and French Polynesia	[65, 69, 70]
	Crassostrea gigas Thunberg	Asia	[73, 74]
	Spathodea campanulata P. Beauv.	Africa	[101]
Fibre source	*Ailanthus altissima* (Mill.) Swingle	China	[18, 19]
	Spartina alterniflora Loisel	Atlantic coast of the South and North America	[102]
Medicinal use	*Opuntia stricta* (Haw.)	Caribbean region	[80]
	Ricinus communis L.	North-Eastern Africa	[80, 103]
	Datura stramonium L.	North America	[104, 80]
	Schinus molle L.	Peru	[80, 105, 106]
	Eriobotrya japónica (Thunb.)	China	[80, 107]
	Catharanthus roseus L.	Madagascar	[80, 108, 109]
	Ailanthus altissima (Mill.) Swingle	China	[83, 84, 86]
	Sambucus canadensis L.	North and Central America	[80]
	Melia azedarach L.	Australasia, Indomalaya	[80, 110–112]
	Argemone ochroleuca L.	Central America	[80]
Pharmaceutical use in agriculture	*Ailanthus altissima* (Mill.) Swingle	China	[9, 87]
	Chrysolina hyperici Forster	Europe and Asia	[113]
Ornamental	*Paulownia tomentosa* (Thunb.) Steud.	China	[31]
	Robinia pseudoacacia L.	North America	[48–50]
	Pueraria montana var. *lobata* (Willd.)	Asia	[114]

Table 1. Overview of the most relevant ecosystem references provided by invasive species and related references.

2. The most common myths about non-native invasive species

There are several myths concerned with non-native invasive species.

The most widely spread myth is that **invasive species intend to dominate ecosystems and exclude others more than native species do.** The truth is that only a minority of species introduced to a habitat will spread on their own (naturalise) and only a small percentage of those will spread enough to be called invasive [13]. All species rely on certain conditions for survival; therefore, it is not simply the origin of a species that determines invasiveness, but the interaction between a species' traits and the community of which it is a part [14]. One such example is the domination of a forest by alien trees in Puerto Rico for the first three or four decades of the invasion. However, these forests are also a habitat in which native trees can begin to thrive again. This case will be further explained below in the chapter on land reclamation [15].

The second myth implies that **all native species are good and useful and all from outside are invasive.** This is not true for several reasons. First, many local species could and would become invasive when introduced to another habitat [13]. On the other hand, invasiveness is linked to the role of human activity in spreading species and changing the environment. Any species' distribution relies on certain conditions for survival which must be met. Many species that we nowadays consider local have been relocated from around the world, both accidentally and intentionally. A few hundred years ago, European explorers brought turkeys, potatoes, corn, tobacco and tomatoes from America to Europe. In turn, species such as horses, cows, sheep, goats, pigs, wheat, soy and grapes were transferred from Europe and the Middle East to America. Plants used in horticulture for ornamental purposes also play a major role in the global spread of species. From these examples, we can see that non-native species should not always be targeted as something bad and unwanted.

Another myth considers ecosystems to be static organisations. There is also a false idea that ecosystems were previously rich in diversity and the introduction of an alien species is responsible for any such losses. Ecosystems are dynamic and are subject to many human and natural disturbances, including fires, climatic changes, flooding, tropical cyclones, construction, tree logging, mining and pollution. As ecosystems change, older inhabitants may die, thus creating a new niche for new organisms to move in. Successions, both primary and secondary, are natural changes in ecological communities which have happened in the past and which will continue to occur in the present and future. However, currently, these changes may be occurring faster due to disturbances, and we can expect an increased dynamism in natural processes.

3. Complete role of non-native invasive species

Biological invasions must be considered within the larger set of environmental issues [3]. Knowing the complex ecology and different potential harms and benefits to society, in general invasive species, can teach us important lessons about how we use the planet [13]. Some authors [16] state that alien species as newcomers in urban areas are not a threat to urban ecosystems; in contrast, there is a chance for increasing biological diversity and thus achieving conservation objectives [12]. In the past half century, biological invasions together with other related environmental problems have become interesting study subjects because they provide natural experiments at temporal and spatial scales [3]. There has been an explosive development in the science of invasion in recent years, and many symposiums, articles and books have been prepared. However, there is still substantial controversy regarding the role of invasions in natural as well as human-shaped environments.

4. Ecosystem services provided by invasive species

Not all non-native species are invasive. There are numerous examples of introduced organisms that are not a threat but have been beneficial. There are many systems trying to list and categorise biological services to humans. One of the most used is the Millennium Ecosystem Assessment from 2005 [17]. Its objective is to assess the consequences of ecosystem change for human well-being and create a scientific basis for environmental conservation and sustainable use of those systems. According to this system, ecosystem services are divided into four categories: provisioning, regulating, cultural and supporting. Invasive species can provide one or several of these services and make itself beneficial to the ecosystem [18]. It is sometimes difficult to isolate different services as there is continual interaction between them.

4.1. Environmental conservation

Non-native species can be useful catalysts for ecosystem restoration and increase the structural heterogeneity or complexity of an area. Such species can also function as biocontrol agents by limiting the spread of agricultural pests [12].

Some IAS, such as *Ailanthus altissima* (Mill.) Swingle, tolerate poor, dry soils, support relatively high levels of air pollution and may be able to sequester some pollutants [19].

Moreover, IAS are a good solution in disturbed sites. They can adapt rapidly to the novel ecological conditions due to their ability to tolerate and adapt to a broad range of biotic and abiotic conditions [12].

4.2. Bioenergy

The world's energy needs are growing every day, and according to the US Energy Information Administration (EIA) projections, between 2015 and 2040, the world's energy consumption will grow by 28% [20]. Conventional fuels such as natural gas, coal and nuclear energy are limited and unsustainable in the long run. In the USA, the US renewable energy initiative announced a new impetus for the identification of biofuel crops as important sources of energy [21].

In October 2014, the European Council set a new framework for climate and energy in which the EU committed to having 27% of energy obtained from renewable sources by 2030. One of the main energy policy targets of the European Union is to increase renewable energy sources by enhancing the development of biofuel cropping systems in order to produce biomass for energy [22]. Biofuel crops, particularly using non-native species, must be introduced with an understanding of possible risks to the environment. The policies may conflict because traits deemed ideal in a bioenergy crop are also commonly found among invasive species.

Before cultivation of biofuel crops, it is necessary to ensure that such plants do not "escape" from plantations and become invasive. Therefore, biofuel crops should be subjected to a Weed Risk Assessment (WRA) before cultivation [23]. There are many WRA systems used around the world to predict the invasiveness of a plant species [24]. The Australian WRA system has been tested in several countries since its introduction in 1997 and is internationally recognised as one of the best systems to determine the risk of invasion [24, 25].

A great number of plant species have been proposed for biofuel cultivation in different countries. *Panicum virgatum* L., commonly known as switchgrass, is native to most of the central and eastern USA [26]. Since the 1990s, there has been growing interest in using this plant for bioethanol in California and the Pacific Northwest. This species could become invasive if it is not properly managed or due to changes in local climate parameters [27]. *P. virgatum* is known for its ability to improve soil quality, sequester carbon and mitigate greenhouse gas emissions [28]. It grows in a wide range of suitable habitats, from 5 to 25°C mean annual air temperature and 300–1500 mm mean annual precipitation, and has relatively low nutrient requirements [26, 28]. Such attributes make this plant very suitable for cultivating in marginal and highly disturbed lands with poor soil. Deep fibrous root systems, slow decomposition rates and root biomass make *P. virgatum* a great agent for carbon sequestration [29, 30].

Paulownia tomentosa (Thunb.) Steud., known as princess tree, is another proposed biofuel crop. *P. tomentosa* is native to eastern and central China where it is used as an ornamental tree. It was introduced to the USA in the 1840s and soon become very invasive, covering disturbed natural areas, forests and river banks [31, 32]. The first record of *P. tomentosa* in the EU was in the 1980s; currently, this species appears less invasive. The EU Regulation on invasive species did not include *P. tomentosa* on the list of Invasive Alien Species of Union concern [33] although recent studies have shown significant spread. The species population has been recorded in urban areas, along railways, and near industrial sites in several European cities in Austria, SW Germany, Switzerland, Italy and SW Slovenia [34–36]. In Croatia, it has also been noticed at several sites near large cities, but currently does not show traits of invasiveness [37].

P. tomentosa became important as a biofuel crop because of its fast growth rate and high wood quantity generated in a short time period [38]. Timber biomass contains high cellulose and hemicellulose concentrations which are the main source of ethanol production [39]. Therefore, this species is highly preferred for the production of raw material for biofuel [40]. Studies have shown that the calorific value of *P. tomentosa* timber biomass is higher than that of coal (20.90 and 14.64 kJ/g, respectively) and thus more environmentally friendly [38, 41].

4.3. Turning invasive species into art

Invasive weeds can be used as material for art activities. Invasive removal programmes of some weeds result in plants that are usually dismissed as unwanted. However, if the act of weeding can be replaced into an act of harvesting, it changes the purpose and gives it a new meaning. Some plants have strong and flexible fibres that can be used for natural basketry [42]. Another attractive example of artistic approaches to invasive species is their use in art photography, in which they are used for making paper on which the photos of the shadows of rare or threatened plants are printed [43]. Some artists use invasive species [white mulberry, *Morus alba* L.; Irish ivy, *Hedera hibernica* (G. Kirchn.) Bean; multiflora rose, *Rosa multiflora* Thunb.; Amur honeysuckle, *Lonicera maackii* (Rupr.) Maxim.; leatherleaf mahonia, *Mahonia bealei* (Fortune) Carrière] for the production of pigments, ink, wood blocks, paper or other kinds of fibre [44].

Sustainable or science art is a great tool to communicate complex scientific concepts, such as the complex relationships between native and invasive species, to the wider public. In that sense, IAS also can be used for public education on possible negative impacts of the spread of non-native species. Thus, attractive collages of invasive species prepared from invasive plant materials are a great example of art with an environmental message [45].

4.4. Honey plants

Insect pollination is an important ecosystem service to agriculture and horticulture [46]. In the past decade in Europe, studies have shown a decrease in wild pollinator diversity due to the use of pesticides, habitat degradation and climate change [47]. To help solve this problem, some invasive alien plant species can serve as pollination providers.

Robinia pseudoacacia L. also known as black locust, is a species native to North America where it was used to control erosion, for reforestation, and as an ornamental tree. Nowadays it has been widely naturalised all across Europe, South Africa, Asia, Australia and New Zealand [48–50]. Currently, in Europe, this species is not listed on the list of Invasive Alien Species of Union Concern but is already considered invasive in most EU countries [50]. *R. pseudoacacia* is pioneer, fast-growing species that tolerates a diverse range of soil and climate conditions [51, 52]. The flowering period occurs in late spring with fragrant white to yellow flowers. These flowers contain fruit nectar which attracts bee pollinators, from which they then produce a honey [53]. *R. pseudoacacia* honey is one of the most highly prized types of honey for taste and flavour. The liquid honey is transparent, and the aroma is fruity, light and refreshing [54]. Because this honey contains a higher ratio of fructose than glucose sugar, it slowly crystallises and can remain as a liquid for several months. This helps bees to survive all winter [55].

Impatiens glandulifera Royle or Himalayan balsam is a perfect example of a species used as an ornamental plant that "escaped" from its native habitat [56]. Originally from North-West Pakistan to northern India, it has naturalised and invaded most countries of the EU, part of North America and New Zealand [57]. A large population has been recorded in the UK, Germany, Sweden, Austria and throughout the Baltic [56, 58, 59]. *I. glandulifera* is listed on the list of Invasive Alien Species of Union concern; within 18 months from the listing, the member states have an obligation to establish effective management measures [33]. It grows mainly in riparian zones, disturbed areas, river banks and forest edges. On the other hand, *I. glandulifera* flowers have the highest sugar nectar production per flower than any native European plant species, which attracts bumblebees, honeybees and moths [60, 61]. Flowering starts in August and thereby fills the gap between the end of the summer and the autumnal crop season [62]. In the future, this plant may serve as a significant seasonal pollen and nectar resource for honeybees and other insects.

4.5. Land reclamation

Nowadays we are increasingly faced with rapid land degradation due to anthropogenic intervention, pollution and pesticide use, deforestation, natural disasters and climate change. Land and soil reclamation is a slow process that often takes several years and greatly depends on conditions in the natural environment.

Some invasive species can be used to control erosion on slopes or along edges of traffic lanes, for reclamation of landfill sites and mine spoils, the establishment of protective forest shelterbelts and the conversion of disturbed land back to its original state [63, 64]. *A. altissima* is known for its ability to grow in barren, inhospitable and highly disturbed sites. It is also suitable for afforestation of the arid sites, as its root system contributes to soil drainage, slowing water run-off. Due to its resistant but soft and easy wood, it contributes to soil stabilisation because it generates lower pressure on the soil [19, 63].

Casuarina equisetifolia L. is an evergreen conifer-like tree native to Malaysia, Vietnam, Australia and French Polynesia. It was introduced in Florida, USA, in 1898 by the US Department of Agriculture plant explorer for coastal landscaping and erosion control [65]. Today it is one of the most invasive species in South Florida, self-seeding in disturbed areas [66]. *C. equisetifolia* colonises sandy habitats near shores and barrier islands, ruderal habitats and vacant lots and is extremely resistant to salt spray [67, 68]. Salt resistance and desiccation avoidance in countries such as Egypt, China and India turned out to be a benefit for the reforestation of coastlines [69, 70]. Thus, *C. equisetifolia* controls the movements of sand dunes, reduces wind erosion and finally starts the process of land reclamation. Florida is often affected by hurricanes and heavy storms which erode sands offshore. Native species usually are not able to colonise the beach as rapidly after such natural disasters [71]. In the future, invasive species such as *C. equisetifolia* can potentially help in this initial colonisation of new coastal plant communities.

Introduced species may in some occasions act like ecosystem engineers and help with the re-establishment of a new habitat [15]. *Crassostrea gigas* Thunberg or the Pacific oyster is an oyster native to Asia that settles on rocky coastlines in dense aggregations. Since the eighteenth century in the European Wadden Sea, oyster fisheries overexploited the native oyster *Ostrea edulis*. *C. gigas* was introduced in Europe and Australia for the aquaculture industry but today has become highly invasive in Scandinavian coastal waters, North America and Australia [72]. This oyster is known for its high rates of growth and reproduction. It acts as an ecosystem engineer by colonising un-vegetated mudflats, generating new solid reefs [73]. Consequently, new reefs are increasing densities of native invertebrate species relative to native oyster beds [74].

Recently in Puerto Rico, a large area of the native forest was destroyed by farming. In attempts to nurture back this degraded land, native trees do not have pioneering potential as soil and climate conditions are often poor and inhospitable. On the other hand, *Spathodea campanulata* P. Beauv., also known as the African tulip tree, has colonised the area instead [75]. *S. campanulata* is native to tropical forests in sub-Saharan Africa and was introduced in Puerto Rico in the 1920s. Soon it became the prevailing tree on abandoned farmlands, but studies have shown that *S. campanulata* forests provide new habitat to native species [76]. Several native forest fauna populations have recovered, such as the endangered frog *Peltophryne lemur* Cope and parrot *Amazona vittata* Boddaert [77, 78]. The leaf litter in *S. campanulata* forests can bring back forest invertebrates to deforested sites and other animals like bats and reptiles [76]. According to past experiences, these new forests remain dominated by alien trees for the first three or four decades. After 60–80 years of growth, Puerto Rican forests will become mixtures of both alien and native trees [15].

4.6. Fibre sources

Wood fibres are extracted from trees and used to make materials including paper. Different plant species or species' blends are best suited to provide the desirable sheet characteristics. Among different tree species, some non-native and also invasive species have the potential to be used as a fibre source. *Ailanthus altissima* has potential as a raw material for papermaking [19]. It produces paper with properties similar to those of *Eucalyptus globulus*, the most common species used for this purpose in temperate regions [18]. This tree species has several desirable properties (tolerance of poor soil, drought and pollution) for use in degraded environments and so can be used simultaneously for paper production and aid in conservation issues.

Paulownia tomentosa (Thunb.) Steud. is also thought to have potential for paper production, especially considering its extremely rapid growth rates [39].

4.7. Medicinal use

Plants used in herbal medicine have been discovered and used in traditional practices since historic times. For example, since 1968, in Africa, weeds and exotic plants have been used as medicines by specialist and non-specialist healers [79], a practice which has been conducted for centuries.

Some invasive alien plants are used by local inhabitants as a substitute for scarce indigenous plants. A study conducted in the Waterberg District investigated medicinal usage of several invasive plants in the South African Republic. It revealed that *Schinus molle* L., *Catharanthus roseus* L., *Datura stramonium* L., *Opuntia stricta* Haw., *Opuntia ficus-indica*, *Sambucus canadensis* L., *Ricinus communis* L., *Melia azedarach* L., *Argemone ochroleuca* and *Eriobotrya japónica* species are used for treatment of various diseases such as chest complaints, blood purification, asthma, hypertension and infertility. These plants inhabit poor land sites and are adaptable to different environments and climate conditions. Due to its high regenerative capacity, they are difficult to eradicate. Therefore, these invasive alien plants can be utilised by communities to combat various diseases in humans, thereby reducing pressure on heavily harvested indigenous plants [80].

Ailanthus altissima, a plant known for its useful ecosystem services, can also be used for medicinal purposes. *A. altissima,* known as the Tree of Heaven, is a deciduous wood native to central China that was introduced to Europe and America in the mid-eighteenth century. It was planted as an ornamental tree throughout cities because of its resistance to pollution, fast growth and ability to thrive in nutrient-poor conditions [81]. Due to its rapid growth and prolific seed production, it quickly escaped cultivation and soon became one of the most invasive species in the world [82]. *Ailanthus altissima* produces toxins in its roots, bark and leaves which inhibit the growth of other nearby plants. Chemical analysis revealed the presence of alkaloids, terpenoids and aliphatic bioactive compounds as major constituents of the plant [83]. From plant extracts, scientists isolated quassinoids, ailanthone and 6-aplha-tigloyloxychaparrinone, which have shown strong activity against strains of *Plasmodium falciparum* in vitro [84]. The major quassinoid constituent, ailanthone, has potent anti-amoebic activity against *Entamoeba histolytica* both in vitro and in vivo [85]. On the other hand, fresh plant parts can also have active medicinal usages, like fresh stem bark for the threat of diarrhoea and dysentery; root bark for heat ailments, epilepsy and asthma; fruits to threat ophthalmic diseases; and leaves used in lotions for seborrhoea and scabies treatments [86]. In Asia, extracts of *A. altissima* bark and fruits are used as an antimicrobial, anthelmintic and amoebicide [85].

4.8. Pharmaceutical use in agriculture

Some invasive plants have, due to their chemical composition, herbicidal properties. Their high invasive potential is determined by many properties, such as tolerance for a wide span of ecological conditions and pollution; high reproduction, growth and regeneration rates; and a production of secondary metabolites with herbicidal and insecticidal activities. For example, the main component responsible for a herbicidal effect in *A. altissima* is shown to be ailanthone, a chemical in the group of quassinoids [9] mainly present in the Simaroubaceae family. Several studies have shown that ailanthone is toxic for many plant species, including weeds, crops and trees [9, 87]. It is believed that, by producing and releasing ailanthone through its tissues largely through the roots, *A. altissima* has an allelopathic effect on nearby plant species, slowing their growth and outcompeting them [9]. Considering its high phytotoxicity, ailanthone shows potential as a possible future natural product herbicide, although its nonselectivity observed in multiple studies would present an obstacle if not resolved in some way. In addition, its rapid biodegradability could be a positive feature from the conservational aspect as it has a short, lasting effect in the environment but a negative one if possible applications as a herbicidal compound would be taken into account [88].

4.9. Ornamental

Many non-native species have been introduced for intentional ornamental and horticultural purposes (e.g. *Ailanthus altissima* and *Paulownia tomentosa*) [31, 48, 81]. Such species, due to their reproductive potential and regenerative capacity, soon increase in density. After some years of their uncontrolled spread, the cultivation loses importance; thus legal introduction and commerce are stopped.

5. Conclusion

IAS management must take into account all impacts of new species in a certain ecosystem. Natural resource management bodies should base their management plans on the real effects of a particular species in an ecosystem and not on traditionally repeated claims of non-selective negative effects of alien species. All species have some useful potential in an ecosystem, and many have easily defined services. Although some non-native species can cause serious problems that should be taken into account, a wider perspective on the role of each species in an ecosystem is needed. Their role is also mixed with new challenges arising from other environmental changes such as climate changes and human interventions. Land managers must focus more on the function of a species in an ecosystem than on their origin. As our understanding of biological invasions is growing, our capability to describe the ecological and economic consequences is more precise enabling the environmental managers to make objective decisions about IAS management.

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Conflict of interest

The authors declare no conflict of interest related to the present paper.

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