Impacts, threats, and potential benefits of invasive plant species

Peter, Anamarija; Šurić, Jona; Dujmović Purgar, Dubravka; Brandić, Ivan; Voća, Neven

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Anamarija Peter, Jona Šurić, Dubravka Dujmović Purgar, Ivan Brandić, Neven Voća

University of Zagreb Faculty of Agriculture, Svetošimunska cesta 25, Zagreb, Croatia (apeter@agr.hr)

Abstract

Vast migrations caused the first movement of plants and animals from one region to another, along with the seeds of food crops and livestock. Most of these species, especially invasive ones, have significant direct and indirect impacts on the economy, agriculture, and health. Monitoring and controlling invasive alien species is estimated to cost billions of dollars annually worldwide. After habitat destruction, climate change, and pollution, invasive alien species are one of the greatest threats to biodiversity. A fraction of the money spent on monitoring, controlling, and eradicating invasive alien species could be recouped by integrating these species into the circular economy, generating value-added products or energy, and obtaining high-value specialized metabolites.

Keywords: invasive alien species, biomass, energy crisis, circular economy

Introduction

Globalization, migration, trade, and increased transportation are all variables that contribute to the potential spread of alien species and thus the possibility of biological invasions (Hulme, 2009). These species can be spread either intentionaly or accidentaly. Unintentional introduction occurs via a vector (vehicles, ships, airplanes, clothing, shoes, feathers, hair, other species, etc.) as opposed to intentional introduction (ornamental plants, food, exotic fruits and vegetables, timber industry, research, etc.). Two-thirds of alien plant species have been intentionally introduced into Europe (Novak, 2018.). Humans have triggered the irreversible spread of species across the planet, overcoming geographic limitations. Human activities have indirectly contributed to the spread and invasion of alien species. Little space remained uninhabited by new species, some of which exhibited the characteristics of invasiveness (Jurković, 2012.). Native and alien species differ according to habitat. Most introduced species cannot survive outside their native growing conditions. For every 100 alien species introduced, an average of 10 survive in the new environment, while 1 become invasive. Whether a species becomes invasive in a new region depends on its characteristics and ecology (Keller et al., 2011.). Accordingly, an invasive alien species (IAS) would be an invader, i.e., a stranger. Although IAS are the main problem today, native species can also be harmful. Some native plants can become invasive under altered environmental conditions (e.g., soil nutrient supply, colonization by IAS) (Pyšek et al., 2004.). Species that can overcome barriers, reproduce and spread in the new habitat, have a negative impact in the new habitat, disrupt ecosystem processes, have negative impacts on humans, plants, and wildlife, and reduce biodiversity are referred to as IAS. The Convention on Biological Diversity defines an IAS as a species that has spread outside its normal range and threatens biodiversity (CBD, 2010.; CBD, 2020.). According to the EU regulation, an IAS is one whose introduction or spread threatens or negatively affects biodiversity and associated ecosystem services. After habitat destruction, climate change, and pollution, IAS are one of the greatest global threats to biodiversity (HAOP, 2020).

Because of all these invasive and aggressive capabilities, IAS are fast-growing species that continuously spread and produce a large amount of biomass while taking space from other plant and animal species. Their growing biomass and intended use are inextricably linked, which is why they are mainly considered pests. Their annual biomass production is a major problem because it must be disposed of as waste. IAS biomass is not waste, only a solution for its use must be found (Miguez et al., 2022.). Studies show that IAS biomass can be used for various purposes. It can be used to produce textiles, animal feed, medical preparations, firewood, biochar, biogas, etc (Van Meerbeek et al., 2015.). This is an interesting consideration as a major energy crisis is looming and energy sources are difficult to access. But IAS biomass can serve as a solution to this problem as it offers huge amounts of annual biomass (Ahmed et al., 2020.). Besides the ecological (pedological, climatological, botanical, zoological, etc.), health (allergies, poisoning

and diseases) and economic (agriculture, forestry, tourism, infrastructure, human health, etc.) impacts, it can also be concluded that the use of their biomass could reduce agricultural and economic losses, which are relatively high (Duncan et al., 2014.). Due to the high population growth rate, ability to spread rapidly over large areas, and invasiveness of IAS, uncontrolled production of biomass could lead to a viable solution to the energy dilemma, such as thermochemical generation of biofuels and energy from such wastes (Okoro et al., 2020.).

Impacts

Since the discovery and colonization of the New World, the problem of IAS has intensified, and in the twenty-first century they have become one of the greatest threats to biodiversity (CBD, 2020.). An increasing number of studies (Vila et al., 2011.) have analyzed the characteristics of IAS prone to invasion and have significant negative impacts on the ecosystem and human welfare. Duncan et al., (2014) stated that the impact of IAS in a given region can be observed in terms of plant community fertility and productivity, species diversity, influence of allelopathic compounds, displacement of native species, threats to certain species that enable them to reproduce, competition for food and habitat, transmission of diseases, hybridization with native species, and alteration of ecosystem structure and function. Bradley et al (2010.) emphasize that climate change may also affect the ability of IAS to survive in certain regions and their ability to compete with native species. In addition to ecological conditions (pedological, climatological, botanical, zoological, etc.), there are also health and economic impacts (allergies, poisonings, and diseases) (Duncan et al., 2014.).

Without neglecting the full spectrum of ecological problems caused by IAS, their spread into areas inhabited by native species is particularly noteworthy. In addition to displacing native species, IAS consume light, water, and nutrients; alter habitat conditions through increased soil erosion, accumulation of silt in freshwater systems, and shading of native species; alter conditions in the structure and composition of biological communities; have a predatory/parasitic relationship with native species; and their presence causes extinctions of native species, which can have cascading effects on ecosystems (Flory and Lockwood, 2020.).

Threats

There are numerous ways in which IAS cause harm to the environment in which they occur. When a new, aggressive species is introduced into an environment, it often has no natural enemies, there are no effective management or control methods, and it destabilizes the ecosystem (MINGOR, 2022.). These species enable and support rapid reproduction and spread, occupy vast areas, and smother native or indigenous vegetation. They compete with native species for nutrients and other resources, alter ecological conditions, transmit diseases to native species, interbreed with them, and hinder their reproduction by causing repeated succession of plants (Flory and Lockwood, 2020.). Consequently, IAS have a direct impact on biodiversity, the environment, and entire ecologies (Novak, 2018.). In addition to their impact on local flora, IAS can also have direct and indirect effects on human health. Various respiratory or skin allergic reactions, such as pollen-induced allergies or dermatitis triggered by phytotoxic plant sap, are considered direct impacts (MINGOR, 2022.).

In addition to environmental and health concerns, IAS also have negative economic consequences. They cause significant economic damage by reducing crop yields in agriculture, forestry, and fisheries, and it is expensive to stop their spread. Especially considering that the majority of economic, agricultural, and recreational activities depend on a healthy environment (Novak and Kravrščan, 2011.). Loss of agricultural production due to overgrowth of pastures with inedible grasses, costs of chemicals and machinery required to control IAS, the health problem caused by pathogenic and toxic alien species leading to loss of social productivity due to illness or death of affected people, and loss of tourism revenue due to disease epidemics are just some of the direct costs that affect society and the economy as a whole. Indirect costs include contamination around dams and rivers due to increased soil erosion, reduction in property values due to ecosystem alteration, damage to infrastructure due to ecosystem alteration, increased frequency of fires, floods, or landslides, and the costs of condition monitoring, surveillance, education, remediation, and control of the above activities (Charles and Dukes, 2008.). IAS also pose an indirect threat. IAS can alter the food web of an ecosystem by destroying or displacing native food sources. In addition, they may provide little or no nutritional value in the form of food for wildlife and affect the number or diversity of species important to wildlife habitat. Aggressive plant species can quickly turn a diverse environment into a monoculture, while others can alter ecosystem conditions such as soil chemistry or wildfire intensity (Edward, 2003.).

Assessments and research findings on alien IAS are critical, especially for countries at higher risk of invasion, to guide efforts to prevent the introduction and spread of alien species. In this way, it is possible to help protect human health, the economy, infrastructure, native species, and associated ecological values (Njoki, 2017.) IAS often cannot be eradicated from their native habitats except on smaller islands and other limited sites. Therefore, preventive measures through legal restrictions on the introduction of alien species into the natural environment, early detection of potentially IAS, and implementation of immediate steps to control their spread and eradication are critical. The most successful methods against IAS are the implementation of prevention and control measures at the earliest stage of invasion. According to the European Commission in 2014, Europe spends about 4.5 billion euros each year to mitigate the harmful effects of IAS, and this is only from the perspective of agriculture and human health. It is estimated that the annual damage in Europe exceeds 12.5 billion euros, while estimates in the United States are as high as 90 billion euros (Sundseth, 2014). The consequences of the spread of IAS include negative impacts on biodiversity, human life and health, disruption of ecosystem functioning, significant economic losses and damage to economic development (ecological, pedological, climatological, botanical, zoological; health impacts in the form of allergies, poisoning and diseases; economic, agricultural, forestry, tourism, infrastructure impacts, etc.). An increasing number of research is addressing the characteristics of IAS and the characteristics of communities that are sensitive to invasions and have significant impacts on the ecosystem and human well-being (Vila et al, 2011.; Moravcova et al., 2015.).

Potential benefits

Unfortunately, the strict focus on reducing the impact of IAS leads to ignoring their potential use as biomass source. IAS are not considered a nuisance and waste, but can have ecological benefits. For example, they can be used for the production of various products such as honey. Unlike other plant species, they can provide pollen and nectar to bees and insects during climatically difficult seasons because they are highly resilient to adverse environmental conditions (Aniko et al., 2022.). They can also serve as a natural source of specialized metabolites and other chemicals with antioxidant and antibacterial activity, or as an ingredient for the production of pharmaceuticals. In addition, they can be used as a raw material for firewood, biofuel, biogas, etc., and contribute to the reduction of greenhouse gas emissions, unlike fossil fuels. In addition, certain non-native plants provide ecological benefits, such as shelter and food resources for native species or timber production (Hanley and Roberts, 2019.). Although their spread and the amount of biomass they produce are among the greatest risks to biodiversity, their availability in large quantities can be beneficial in creating novel, cost-effective, and environmentally friendly solutions to future challenges (Van Meerbeek et al., 2015). Contrary to popular belief, alien IAS could be considered as ecological, economic, or even social change agents that require extensive research, continuous adaptation, and improvement of existing systems for control and management.

Conclusions

In just a few years, the claim that IAS are one of the leading drivers of biodiversity loss around the world has become the most cited source in several publications and studies dealing with biodiversity or IAS. However, in reality, IAS are mostly associated with waste and huge amounts of biomass, as well as with a problem for which there is no viable solution. In Croatia, the European Union and the rest of the world, there is insufficient research on IAS, especially plant species and biodiversity. There is a legal framework for IAS, but the implementation of agreements, policies and guidelines requires a much stronger commitment from individuals and local communities, especially from the government and legislative bodies of the Republic of Croatia, the EU and the whole world. In such a disorganized environment, it is extremely difficult to monitor IS, let alone prevent its spread. Moreover, every year the EU and the rest of the world invest more time and money to remove them from the nature and take care of them, but these are obviously only temporary measures, because it is impossible to eradicate the mentioned species permanently.

More consideration should be given to the potential use of their biomass. Just as IAS have adapted to a variety of environmental situations, we also need innovation and flexibility to effectively deal with coming disasters.

There are few IAS whose risk is recognized on a global scale. Their influence and impact will soon be felt across a wide range of sectors, including agriculture, business, and the economy. Estimates put global losses in the billions of dollars, while there is no adequate monitoring system for IAS. Therefore, it is essential to take adequate precautions and focus on the problem of IAS, as well as to find a solution that will not only keep IAS under control, but also provide a solution in the form of their further use and serve as an example of a circular economy.

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Utjecaji, prijetnje i potencijalne koristi od invazivnih biljnih vrsta

Sažetak

Masovne migracije uzrokovale su prva kretanja biljaka i životinja iz jedne regije u drugu, zajedno sa sjemenjem prehrambenih usjeva i stoke. Većina ovih vrsta, posebice invazivnih, ima značajne izravne i neizravne gospodarske, poljoprivredne i zdravstvene posljedice. Procjenjuje se da praćenje i kontrola invazivnih stranih vrsta stoji milijarde dolara diljem svijeta godišnje. Nakon uništavanja staništa, klimatskih promjena i onečišćenja, invazivne strane vrste jedna su od najvećih prijetnji bioraznolikosti. Dio novca potrošenog na praćenje, kontrolu i iskorjenjivanje stranih vrsta mogao bi se nadoknaditi integracijom tih vrsta u kružno gospodarstvo, stvaranjem proizvoda ili energije s dodanom vrijednošću i ekstrakcijom specijaliziranih metabolita visoke vrijednosti.

Ključne riječi: strane invazivne vrste, biomasa, energetska kriza, kružno gospodarstvo