Chapter 7
Plant Invasions as a Symptom and Driver of Degradation



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Abstract Alien plant invasions are a crucial yet often underestimated component of desertification processes in Spain. Their ecological and socio-economic impacts are increasingly evident, involving both species with a long history of introduction (e.g., *Arundo donax*) and those more recently introduced (e.g., *Cenchrus setaceus*). For example, invasive alien plants threaten native biodiversity, reduce the productivity of agricultural and grazing lands, and alter key ecosystem processes such as water availability, soil stability, and fire regimes. In Spain's arid and semi-arid landscapes, where natural resilience is already compromised, the invasion of alien plants can accelerate land degradation and exacerbate desertification. Furthermore, their interaction with other global change factors can create feedback loops that further destabilize these fragile ecosystems. Integrating the management of invasive alien plants into broader environmental and restoration programs is essential to prevent further degradation and to maintain ecosystem services and supporting local communities dependent on these vulnerable drylands. Effective management can thus play a pivotal role in mitigating desertification and fostering long-term ecological sustainability in Spain.

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Introduction to Alien Plant Invasion

For centuries, humans have introduced plant species to areas beyond their natural ranges, both intentionally (e.g., for ornamental, agricultural, or forestry purposes) and unintentionally (e.g., through the transport of goods, such as seeds in commercial soil; or via tourism, such as seeds attached to hiking boots; Hulme 2009). These species movements have intensified in recent decades due to globalization, and as a result, many plant species have reached new regions of the world where they did not previously occur (Seebens et al. 2021).

Only a portion of all introduced species establish self-sustaining populations in their new environments. Some also exhibit a strong capacity to spread, colonizing large areas and causing negative environmental and socio-economic impacts. The latter are known as invasive alien plants: a subset of introduced alien plants that became established and spread in the introduced regions, causing negative impacts on nature and often also on people (Roy et al. 2024).

It is estimated that 6% of all introduced plant species become invasive. The impacts of invasive plants include native biodiversity loss, alteration of biogeochemical cycles and ecological processes such as fire regimes or water cycles, as well as detrimental effects on economic sectors (e.g., on agriculture, tourism, or water management) and on human well-being (Roy et al. 2024). Furthermore, the management of alien plant invasions generate high economic costs for public administrations and society at large (Novoa et al. 2024).

In particularly fragile ecosystems, such as the arid and semi-arid environments of southern Europe, invasive alien plants pose an even greater threat, as they can undermine ecosystem resilience to other drivers of change traditionally associated with desertification processes. These ecosystems are already highly vulnerable to climate change, resource overexploitation, and land degradation. Plant invasions can amplify these pressures, acting synergistically with them and driving profound ecological transformations. In some cases, plant invasions may even act as triggers of desertification processes, accelerating the loss of key ecosystem services and threatening the ecological and socio-economic sustainability of affected regions (Ravi et al. 2009).

Plant Invasions and Desertification

Invasive alien plants can cause or accelerate the degradation of land in arid and semiarid ecosystems through various mechanisms. For example, some species have high transpiration rates and rapid growth, consuming large amounts of water. This is the

case of the giant reed (*Arundo donax*), native to riparian zones in East Asia and invasive in Spain (Fig. 7.1), which can consume up to 2000 l of water per square meter. This reduces water availability for native species and can alter local hydrological regimes (Jiménez-Ruiz et al. 2021). In addition, giant reed invasions reduce the water flow capacity of riverbeds, causing major impacts (Box 7.1).



Fig. 7.1 Invasion of giant read (*Arundo donax*) in Cabo de Gata, Almería. Photo by Ana Novoa

Box 7.1: Media Interest in the Invasion of *Arundo donax* Following DANA Episodes in the Valencian Community

The invasion of the giant reed (*Arundo donax*) in riverbeds and agricultural fields across the Valencian Community has attracted the attention of various media outlets, especially after the episodes of heavy rainfall associated with the DANA in 2024. The invasion of the giant reed worsened the effects of the DANA-related flooding, negatively impacting local agriculture. Some examples of this media coverage include:

Una caña invasora arrastrada por la DANA coloniza el campo valenciano: "Superan la altura de árboles" (*An invasive reed dragged by the DANA colonizes the Valencian countryside: "They grow taller than trees")* – Europa Press, May 6, 2025.

Una especie invasora se dispara tras la DANA y amenaza el campo valenciano: "Se extiende como la pólvora" (*An invasive species surges after the DANA and threatens the Valencian countryside: "It spreads like wildfire")* – 20minutos, May 4, 2025.

La "Arundo donax," la caña invasora que agravó la riada de Valencia: "Quitar un kilómetro cuesta un millón" (*"Arundo donax," the invasive reed that worsened the Valencia flood: "Removing one kilometer costs a million"*) – El Español, Novembeer 11, 2024.

Una caña invasora arrastrada por la DANA coloniza el campo valenciano (*An invasive reed dragged by the DANA colonizes the Valencian countryside*) – Telecinco, May 6, 2025.

These reports reflect growing social and political concern about the impact of the giant reed in the region, as well as the urgent need to implement management and control measures to mitigate its effects.

Invasive plants can also increase fuel biomass, leading to more frequent and intense wildfires (Brooks et al. 2004; Chap. 6). This shift in fire regimes can hinder ecosystem recovery by limiting secondary succession and accelerating land degradation. In Spain, several invasive plants, such as *Arundo donax* and *Ampelodesmos mauritanica*, contribute to changes in wildfire regimes by increasing both the quantity and continuity of fuel, both vertically and horizontally, thereby facilitating the rapid spread of intense wildfires (Vilà et al. 2001; Coffman et al. 2010).

Moreover, invasive alien plants often displace native species, reducing biodiversity and compromising the provision of key ecosystem services—such as soil stabilization and the maintenance of biogeochemical cycles—which in turn weakens ecosystem resilience to extreme events (Vilà et al. 2024). Invasive plants usually form dense and monospecific stands that limit light and water availability for native species, a particularly critical issue in arid and semiarid ecosystems. Notable examples include *Carpobrotus* spp. and *Arundo donax*, whose dominance can significantly alter native

plant communities, and even affect other taxa, such as invertebrates (Campoy et al. 2018; Jiménez-Ruiz et al. 2021).

Alien plant invasions also pose a significant threat to human well-being. On one hand, they cause exorbitant economic losses. For example, in Spain, the cost of alien plant invasions has amounted to at least over 140 million euros since 1997 (Novoa et al. 2024). The costliest species is the water hyacinth (*Eichhornia crassipes*), an aquatic plant that invades lakes and rivers, producing large amounts of biomass. Its rapid proliferation drastically reduces the amount of light penetrating the water and limits gas exchange between the atmosphere and the aquatic environment. In addition, due to its high evapotranspiration rate, it decreases the availability of water, which affects supply for irrigation, human consumption, and other uses. The water hyacinth also clogs navigation and irrigation channels, hinders economic and recreational activities, and creates ideal conditions for mosquito proliferation. Currently, the recorded costs of water hyacinth in Spain exceed 53 million euros (Novoa et al. 2024). In other parts of the world, such as Lake Victoria (Mujingni Epse Cho 2012), the invasion of water hyacinth has even forced communities to abandon their livelihoods.

Other examples of alien invasive plants causing major economic losses in Spain include eucalyptus (*Eucalyptus* spp.), with losses of up to 41 million euros, the giant reed (*Arundo donax*), with losses of over 11 million euros, and fountaingrass (*Cenchrus setaceus*, Fig. 7.2), with losses exceeding 8 million euros (Novoa et al. 2024).

In arid regions, certain types of exotic plants tend to show a higher propensity to invade than others. For instance, it has been observed that a large number of plants exhibiting Crassulacean Acid Metabolism (CAM), once introduced into arid areas outside their native range, have managed to spread and invade (Yu et al. 2024). This is likely due to their physiological adaptations, which give them advantages in environments characterized by water scarcity, high temperatures, and poor soils—conditions that may facilitate their success as invasive species in arid ecosystems. For example, several species from the cactus family (Cactaceae), especially those in the *Opuntia*, *Austrocylindropuntia,* and *Cylindropuntia* genera, are invading arid areas of Africa, Australia, the United States, and Europe (Novoa et al. 2015, Fig. 7.3), causing a wide range of negative ecological and socioeconomic impacts (Novoa et al. 2016).

Alien plant invasions interact with other global change drivers such as climate change, overexploitation of natural resources, land-use changes, and pollution, creating complex scenarios that worsen the loss of ecosystem functionality and resilience (Roy et al. 2024). For example, the overexploitation of aquifers reduces the resilience of native vegetation, facilitating invasions by alien plant species that access groundwater more efficiently (Dudley et al. 2014). Similarly, the combination of recurring fires and prolonged droughts creates a hostile environment for native species, favoring the invasion of fire-adapted alien species (Le Maitre et al. 2023). These interactions generate feedback loops that can accelerate the processes of invasion and desertification (Ravi et al. 2009).

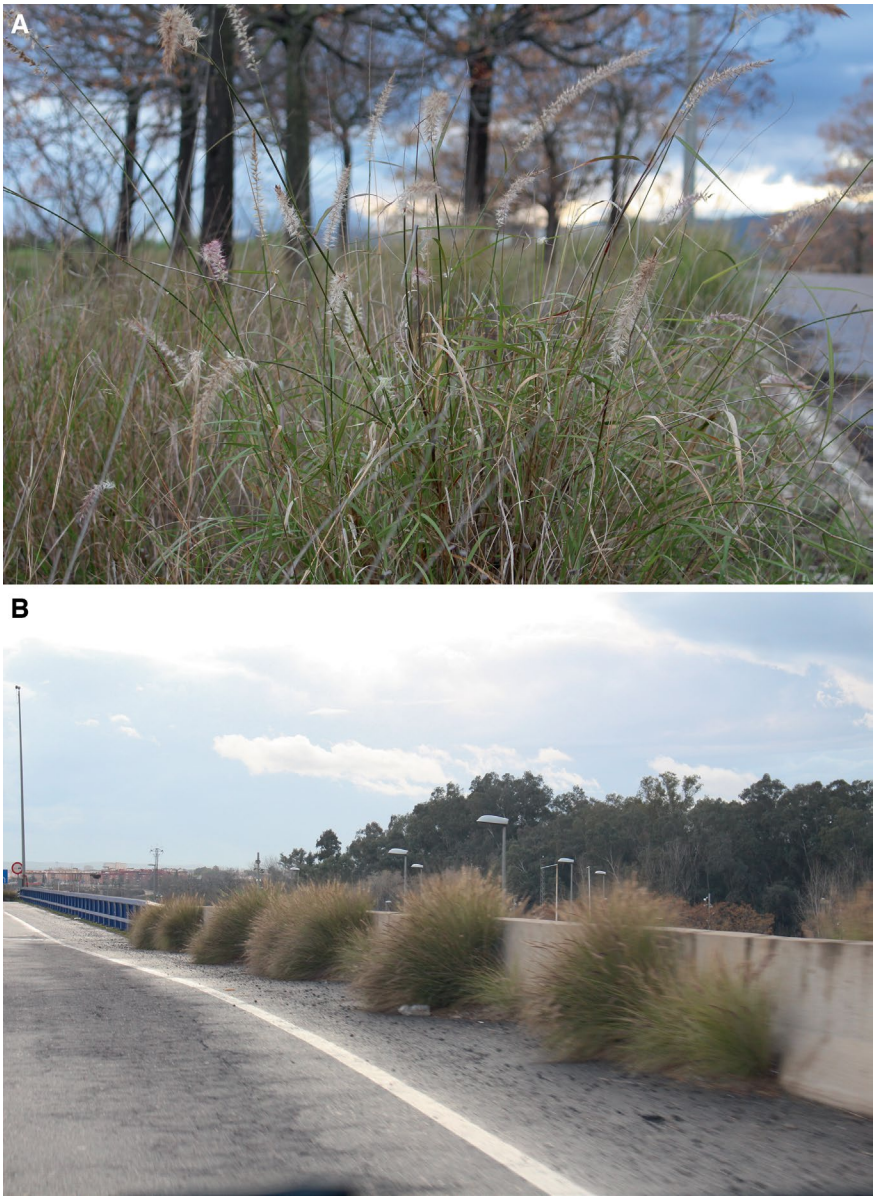


Fig. 7.2 Invasion of crimson fountaingrass (*Cenchrus setaceus*) in Córdoba, Southern Spain. Photos by Pablo González



Fig. 7.3 Invasion of *Austrocylindropuntia subulata* in Cabo de Gata, Almería. Photo by Ana Novoa

Addressing Plant Invasions

The most cost-effective way to address alien plant invasions is to prevent the introduction of new potentially invasive alien plants (Roy et al. 2024). This requires predicting which species could become invasive if introduced, and regulating their introduction. It is also essential to have clear and effective protocols for the early detection of and rapid response to new invasions.

Since 2007, Spain has had a specific legal framework to address invasive alien species through the Spanish Catalog of Invasive Exotic Species. Established under the Law on Natural Heritage and Biodiversity and developed through Royal Decree 630/2013, the catalog prohibits the possession, transport, and trade of listed species, and mandates their control or eradication. Inclusion in the catalog is based on scientific evidence regarding human-mediated introduction and the species' potential threat to biodiversity, agriculture, or the economy. Currently, the catalog includes 199 taxa, 85 of which are plants.

Despite these legal restrictions, enforcement remains challenging, particularly in private land, which undermines the long-term effectiveness of control and restoration efforts. In addition to the catalog, a list of 3,500 potentially invasive alien taxa hosted on the website of MITECO (Ministry for the Ecological Transition and the Demographic Challenge). Royal Decree 570/2020 (16 June) establishes that importing any of these taxa from outside the European Union for the first time requires prior environmental authorization from MITECO.

Finally, since 2014, there has been an EU regulation (No. 1143/2014, on the prevention and management of the introduction and spread of invasive alien species), which includes a list of invasive alien species of Union concern and introduces restrictions similar to those in the Spanish legislation (Castro Díez et al. in press).

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