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Short Communication

Mapping risk: Priorities to prevent the establishment of invasive Salt Cedar (*Tamarix spp*.)

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ABOUT THE STUDY

Invasive alien species are one of the most severe threats to the conservation of biodiversity and a significant cause of socioeconomic losses; they also affect human health and welfare. In addition to this, current climate change accelerates the advance of this threat, generating conditions either for the expansion of established species or for the introduction of new species in the natural environments (Natale et al., 2008). From the arrival of a new species to its establishment and dispersal, the consequences of invasions increase over time; hence, prevention and contention actions are always the most efficient measures. Furthermore, if the species is detected while populations are still relatively small and restricted in space, the chances of controlling its expansion are significantly higher. Salt cedar is an aggressive invader of arid environments from the USA, Mexico, and Australia, where its presence causes profound changes in natural communities and ecosystem processes. In 2010, studies were published that confirmed that it was also widely distributed in Argentina, from northern Patagonia to the northwest of the country, and the presence of four species of *Tamarix* was confirmed: *T. gallica*, *T. ramosissima*, *T. chinensis*, and *T. parviflora*. *T. gallica* showed the widest distribution although *T. ramosissima* appeared to be more invasive. The genus seems to have the ability to invade a wide region of Argentina, mainly concentrated in the central-west area including more than three quarters of the total arid and semiarid area vulnerable to invasion. It was also observed that the dispersion of *Tamarix* is related to water flows, roads, and human-induced disturbances. Many high biodiversity value sites are under actual or potential threat of invasion by salt cedar. Furthermore, salt cedar species also affect social and economical values invading both, high productive value lands and subsistence agriculture lands. At this moment, the results obtained indicate that the salt cedar invasion process in Argentina would be in an earlier phase than the reported cases of the USA, Mexico, and Australia. This might be explained by a lower propagule pressure and/or a lower density of dispersion roads in the country. This situation highlights the importance of developing prevention and contention strategies, as the best alternative considering both environmental and economical aspects. In this sense, early detection and rapid intervention are among the preferred actions to achieve successful results in the management plans for invasive alien species (Robertson et al., 2020). The identification of areas where probabilities of establishment and invasion by an alien species are high can reduce logistic and economic costs. Therefore, risk assessment based on information about the alien species and the invaded environment has become a widely-accepted tool to estimate the likelihood and magnitude of the threat (Mc Kay et al., 2017). Considering the above, the objective of this work was to develop an invasion risk index that can be modeled within a Geographic Information System (GIS) environment, combining information on the current and potential distribution of the salt cedar, the analysis of dispersion routes and the potential impact on environmental and socioeconomic values (Natale et al., 2012). To build the risk index, a cartographic information search was carried out about the different variables that were to be used. The values of the variables were translated into numerical data, then the variables were related through mathematical algorithms to build a global index that would identify situations in which the presence of *Tamarix* implies high, medium, or low environmental and socioeconomic risks. Thereby, from the sum of the natural and socio-economic values, a sensitivity index was obtained, understood as the degree of fragility of the system against the establishment and invasion of tamaricks (Natale et al., 2018). As a second instance, a vulnerability index was generated, defined as the probability that the system is affected by the invasion, considering 1) Its impact sensitivity (previously calculated), 2) Accessibility for the species, considering the vectors and dispersal routes, and 3) The aptitude of the environment to be colonized. Vectors

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and dispersal routes and habitat variables were related to each other through the arithmetic mean reflecting a compensatory relationship. Then, the sensitivity index was related to the dispersal routes through a summation that reflects the greater possibilities of the arrival of the genus in the cases of presence of dispersal routes (exposure), without ruling out the possibility that tamaricks may disperse naturally through wind and water or deliberately introduced by humans. The result of this summation was related to habitat variables through a product, so that sites with low or no aptitude for the presence of the genus receive low or no vulnerability values. Finally, to obtain the risk index, the vulnerability index was combined with the potential distribution map of *Tamarix*, understood as the probability of the presence of the genus. The algorithm used was the product so that the sites that presented a value of 0 for any of the components also had a null value in the final risk index. In other words, only vulnerable areas where the genus is likely to develop are considered in the invasion risk analysis. All the variables were translated into layers of information within a geographic information system platform. The vector layers were interpolated to raster format to standardize the information. The spatial analysis extension of the Arcgis 9.10 software (ESRI, Redlands, CA, USA) was used to relate the information layers through the selected mathematical algorithms and obtain the final risk map. The risk map obtained for Salt cedar in Argentina managed to discriminate between high, medium, and low-risk areas within the area of presence probability of the genus. For example, in the east of Buenos Aires and in the north of La Pampa we find areas of a high risk of invasion, surrounded by medium risk sectors, while the low-risk areas were mainly circumscribed to the west of San Juan and La Rioja. High-risk areas were also identified in the province of Córdoba, associated mainly with productive values; and high-risk areas in the province of Mendoza given by a combination of productive and conservation values.

CONCLUSION

Finally, this model generates a quantitative valuation of the territory and divides it into a set of small subunits, such that each unit can be rated by the possibility that the invasive species will establish itself there and cause a measurable impact. This differentiates it from other risk assessments that are based on decision trees, climatic models of species distribution, or semi quantitative models and/or scoring systems. Other relevance of the developed index is that it might be extended and applied to different invasive species, regions, and working scales, whenever the information to feed the model is available.

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