Modeling the geographic spread and proliferation of invasive alien plants (IAPs) into new ecosystems using multi-source data and multiple predictive models in the Heuningnes catchment, South Africa

Bhongolethu Mtengwana,Timothy Dube,Bester Tawona Muderer &Cletah Shoko

Abstract

The geographic spread and proliferation of Invasive Alien Plants (IAPs) into new ecosystems requires accurate, constant, and frequent monitoring particularly under the changing climate to ensure the integrity and resilience of affected as well as vulnerable ecosystems. This study thus aimed to understand the distribution and shifts of IAPs and the factors influencing such distribution at the catchment scale to minimize their risks and impacts through effective management. Three machine learning Species Distribution Modeling (SDM) techniques, namely, Random Forest (RF), Maximum Entropy (MaxEnt), Boosted Regression Trees (BRT) and their respective ensemble model were used to predict the potential distribution of IAPs within the catchment. The current and future bioclimatic variables, environmental and Sentinel-2 Multispectral Instrument satellite data were used to fit the models to predict areas at risk of IAPs invasions in the Heuningnes catchment, South Africa. The present and two future climatic scenarios from the Community Climate System Model (CCSM4) were considered in modeling the potential distribution of these species. The two future scenarios represented the minimum and maximum atmospheric carbon Representative Concentration Pathways (RCP) 2.6 and 8.5 for 2050 (average for 2041–2060). The results show that IAPs are predicted to expand under the influence of climate change in the catchment. Concurrently, riparian zones, bare areas, and the native vegetation which is rich in biodiversity will greatly be affected. The mean diurnal range (Bio2), warmest quarter maximum temperature (Bio5), and the warmest quarter precipitation (Bio18) were the most important bioclimatic variables in modeling the spatial distribution of IAPs in the catchment. Comparatively, all the models were successful in predicting the potential distribution of IAPs for all the scenarios. The BRT, MaxEnt, and RF predicted the spatial distribution of IAPs with an Area Under Curve (AUC) of 0.89, 0.92, and 0.94, respectively. The study highlighted the importance of multi-source data and multiple predictive models in predicting the current and potential future IAP distribution. The results from this study provide baseline information for effective land management, planning, and continuous monitoring of the further spread of IAPs within the Heuningnes catchment.