OPTIMAL TEMPORAL-SPATIAL CONTROL OF AN INVASIVE SPECIES OVER A HETEROGENEOUS LANDSCAPE: EXPLORATORY EXERCISES FOR THE CASE OF *MIMOSA PIGRA* IN PUERTO RICO

Iván Henríquez[1], Yetsabel Auccaille[2], M. Julio Barragán Arce[3], and Wilfredo Robles[4]

[1]Department of Mathematical Sciences
University of Puerto Rico at Mayagüez
[2]Department of Agricultural Economics and Rural Sociology
University of Puerto Rico at Mayagüez
[3]Corresponding author. Department of Agricultural Economics and Rural Sociology
University of Puerto Rico at Mayagüez
CALL Box 9000 Mayagüez PR 00681-9000
Email address: mariojulio.barragan@upr.edu
[4]Department of Crop and Agro-Environmental Sciences
University of Puerto Rico at Mayagüez

Most research on the optimal control of invasive species focuses on temporal and uncertainty issues and abstracts away from spatial considerations. However, the phenomenon of invasive species dispersal is inherently spatial in nontrivial ways. A proper understanding of how dispersal mechanisms interact with landscape heterogeneity to ultimately determine spatial dispersal patterns could play to the advantage of policy-makers aiming at controlling such invasions. This is particularly true in naturally isolated regions with considerable landscape heterogeneity such as Puerto Rico. Following some recent efforts to model optimal spatial control of invasive species, we adopt an integer programming approach to solve for a discrete space and multi-period invasion control policy that reduces the present value of the costs associated with (i) the implementation of control measures as well as with (ii) the damages brought about by the population not affected by the control measures. Control measures can be implemented at the pixel level in two alternative ways: (i) containing the movement of the invasive species from one cell to another; and (ii) eradicating the invasive species from the pixel. A cellular automaton is defined over a two dimensional grid and is programmed to model an uncertainty-free dispersal process. The invasive species is only allowed to spread over landscape that is suitable to its survival. This suitable landscape is derived from a suitability map estimated statistically using a spatial logistic regression of presence/absence as a function of climatic variables (temperature and precipitation). A threshold value between zero and one is defined above which the survival probability of each pixel is changed to a 1 (suitable) and below which it is changed to a 0 (unsuitable). The resulting map gives a suitable region in a shape that roughly resembles that of a picture frame. The frame is delimited on the outside by the sea, and on the inside by mountains, both of which are unsuitable for the invasive species. Simulations were made for several alternative locations of the initial invasion (e.g., bordering the sea along a long side, in between the sea and the mountains, on a corner, etc.). Optimal control policies take into considerations the location of the invasive species as well as the shape of the suitable and unsuitable landscape to help contain the invading species.