USING SENSIBILITY ANALYSIS TO OPTIMIZE THE CALIBRATION OF MATHEMATICAL MODELS: AN APPLICATION TO THE STUDY OF THE SPREAD OF MIMOSA PIGRA IN PUERTO RICO

M. JulioBarragán-Arce1, Iván Henríquez-Rivera2
1Department of Agricultural Economics and Rural Sociology, University of Puerto Rico, Mayagüez, 2Department of Mathematical Sciences, University of Puerto Rico, Mayagüez

In mathematical models, the better the estimates of parameter values, the better the calibration of the model to real world phenomena. However, it usually pays-off to be more precise in the measurement of some parameters and less precise in the measurement of others. One would want to improve measurements of those parameters whose measurement errors create the greatest fluctuations in the predictions of the model. We apply this reasoning to a model of the spread of Mimosa pigra in Puerto Rico. The model takes explicit account of dispersal mechanisms of the invasive species as well as landscape heterogeneity. It consists of a computational framework (MDiG) that uses cellular automata to simulate short distance dispersion and draws from several probability distributions to simulate long distance dispersion. The impact of the environment on the survival of the invasive species is modeled with the use of a suitability map. Both modeling components are set up in a GIS framework. We chose plausible dispersion parameter values from the literature and took the survival probabilities to be the predicted suitability index estimated by Barragán, et al. (2011). We assumed an initial spatial distribution of the species and ran the model for 20 successive periods computing the infested area after each period. We repeated this procedure 100 times and computed, for each period, the average infested area. We then changed the parameter values, one at a time. For each change in the value of a parameter, we repeated the above procedure. We then computed elasticities for each parameter as percent change in infested area over percent change in parameter value. We found that model predictions are most affected by changes in the long distance parameters, making their proper estimation particularly valuable. Precision in the diffusion parameter was found to be of marginal importance.

Key Words: dispersal, simulation, invasive species, Mimosa pigra, MDiG, calibration