Using Sensibility Analysis to Optimize the Calibration of Mathematical Models: An Aplication to the Study of the Spread of Mimosa Pigra in Puerto Rico

Julio Barragán-Arce[1] Iván Henríquez[2]

[1]Department of Agricultural Economics and Rural Sociology,
University of Puerto Rico, Mayagüez Campus

[2]Department of Mathematical Sciences,
University of Puerto Rico, Mayagüez Campus

December 2, 2011

Acknowledgements

We want to thank

- USDA/NIFA for its research support through Grant No. 2010-34135-21021, awarded through the Tropical/ Subtropical Agriculture Research program.
- Dr. Joel Pitt for his advise in the use of MDiG.
- USDA Forest Service in Puerto Rico provieded GIS layers for temperature and precipitation.

The statement of the problem...

Problem Statement

Modeling the spread of an invasive species in Puerto Rico through time.

We formulate the following questions:

- *How sensitive is our model to small changes in parameters?*
- *If we made an error in the measurement of the parameters, how large is the error in our results?*
- *What is the parameter that we must measure more accurately?*

About the model...

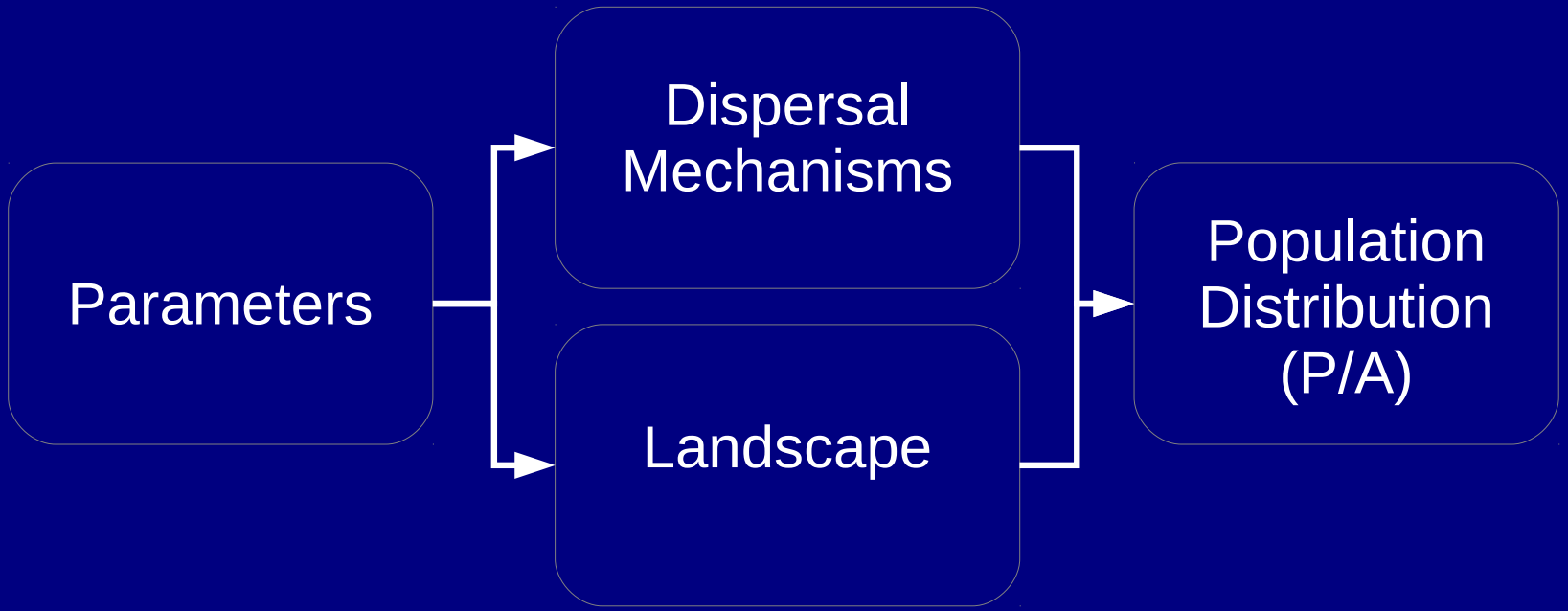


Figure: Main components of the model

About the model...

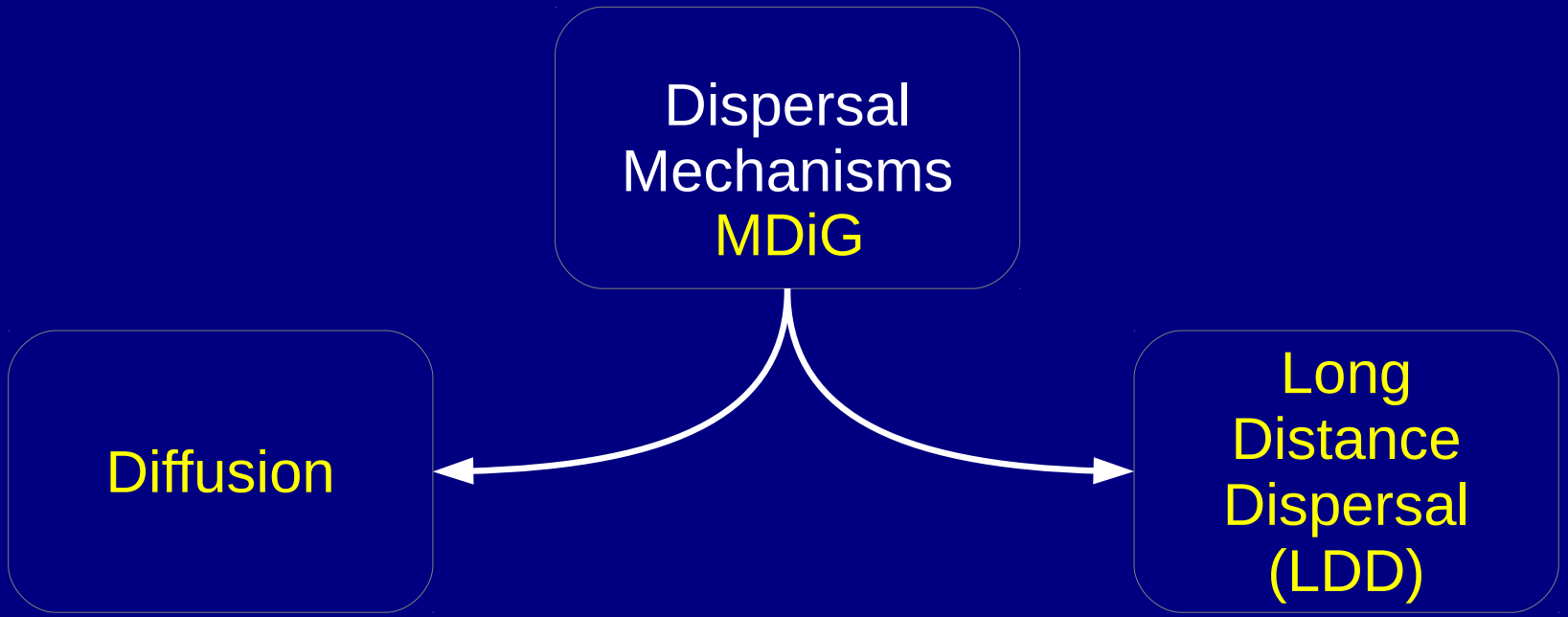


Figure: Two ways of spreading

About the model...

PARAMETERS

1. Dispersal Rate
2. Shape
3. Neighbors

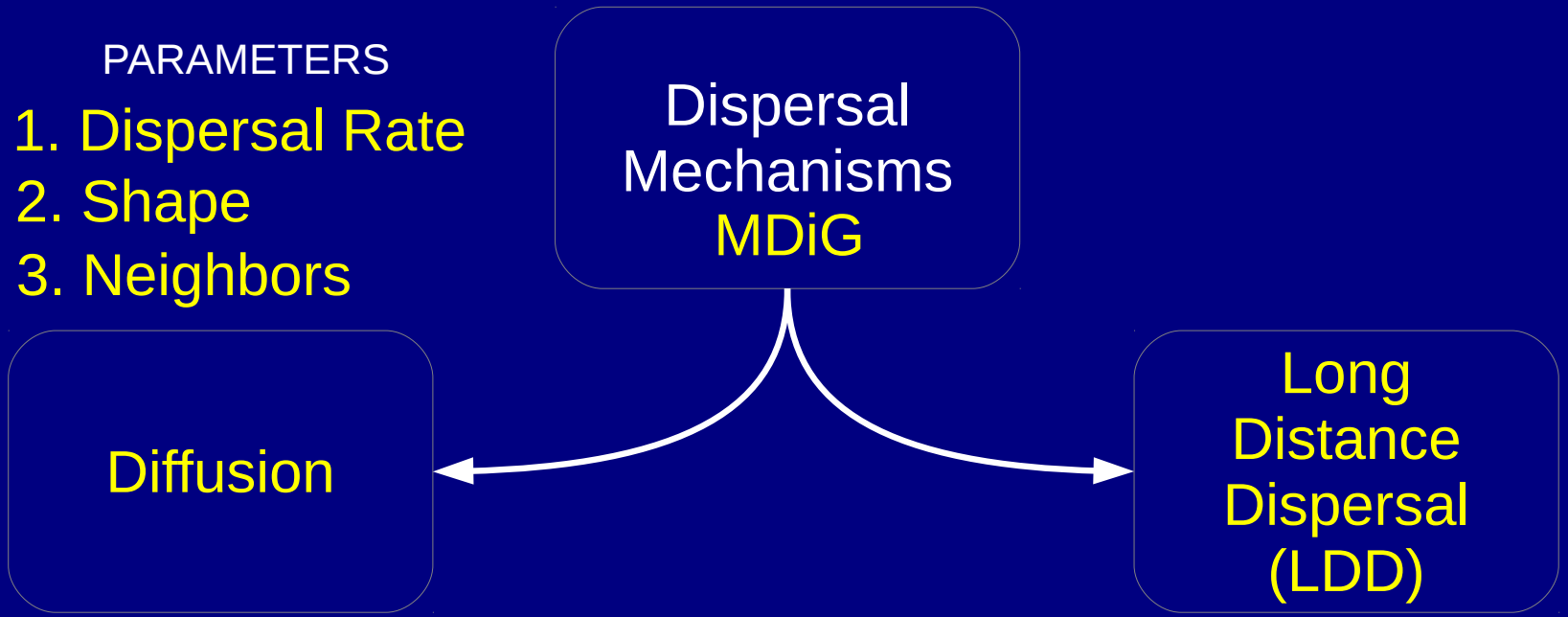


Figure: Diffusion parameters

About the model...

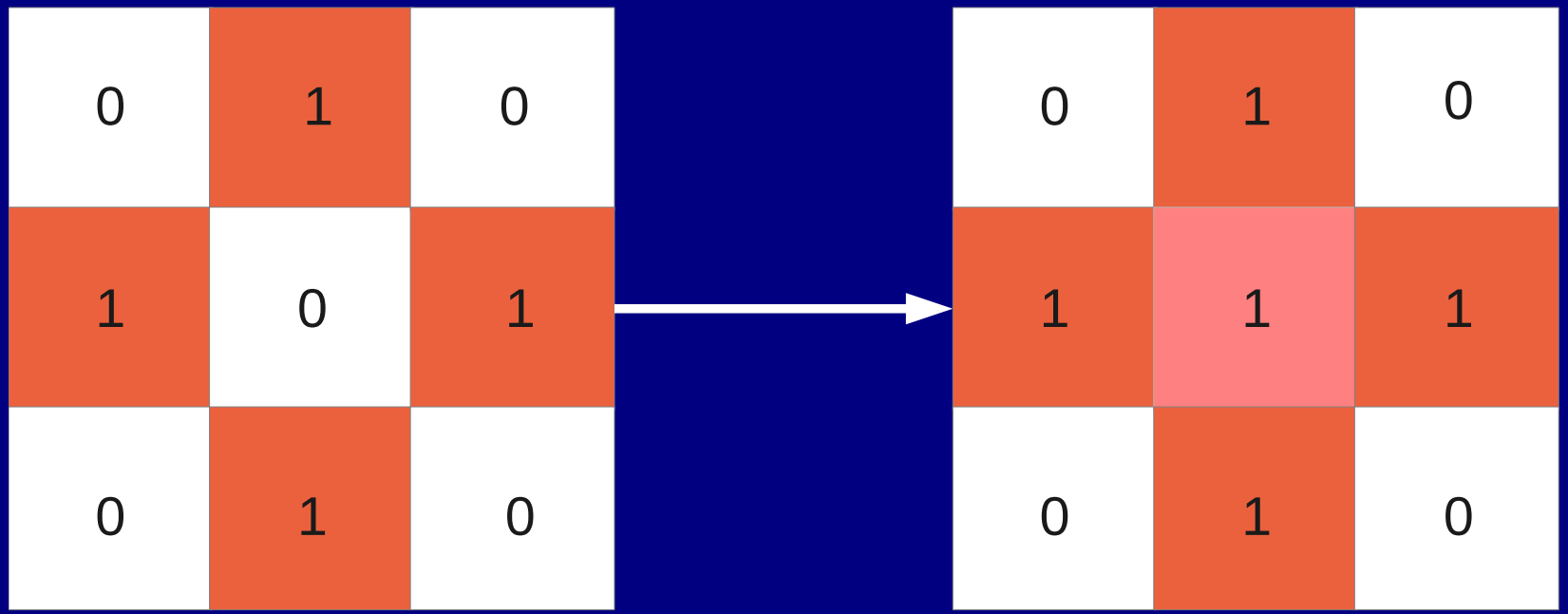


Figure: Diffusion

About the model...

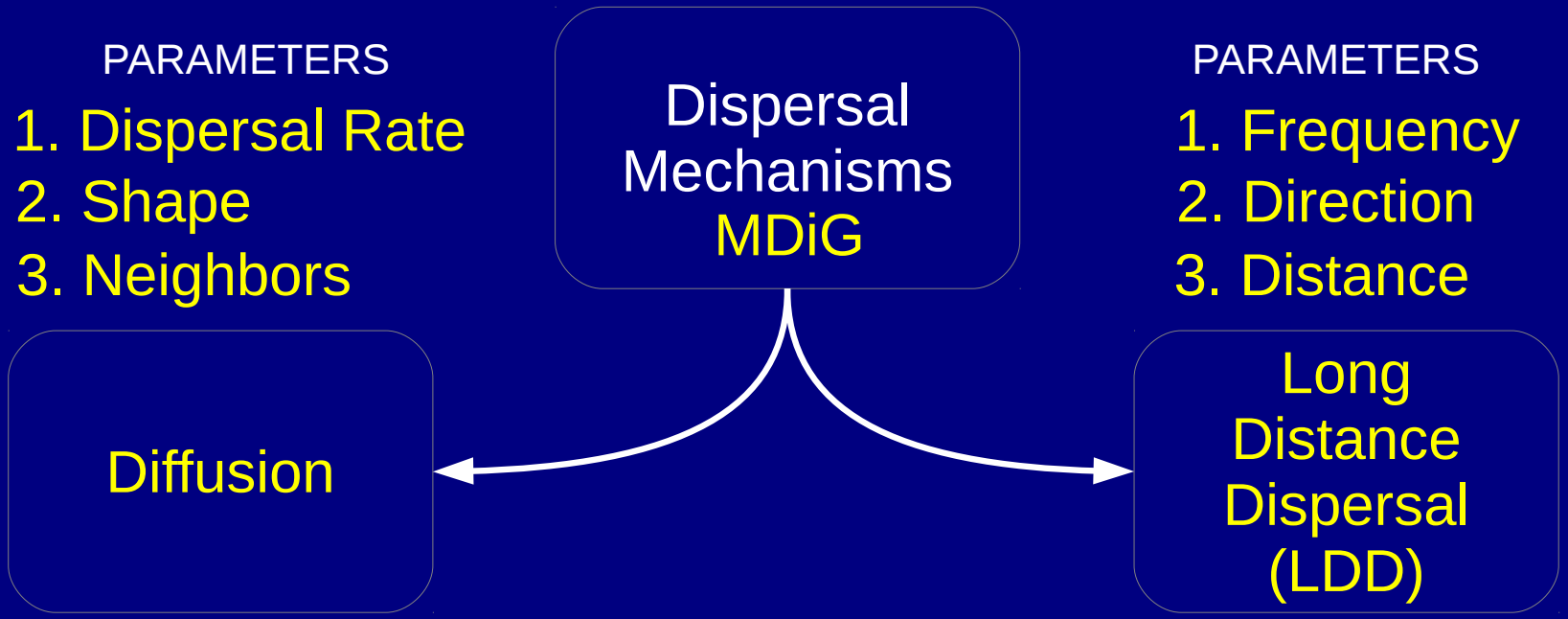


Figure: Diffussion parameters and Long distance dispersal (LDD)

About the model...

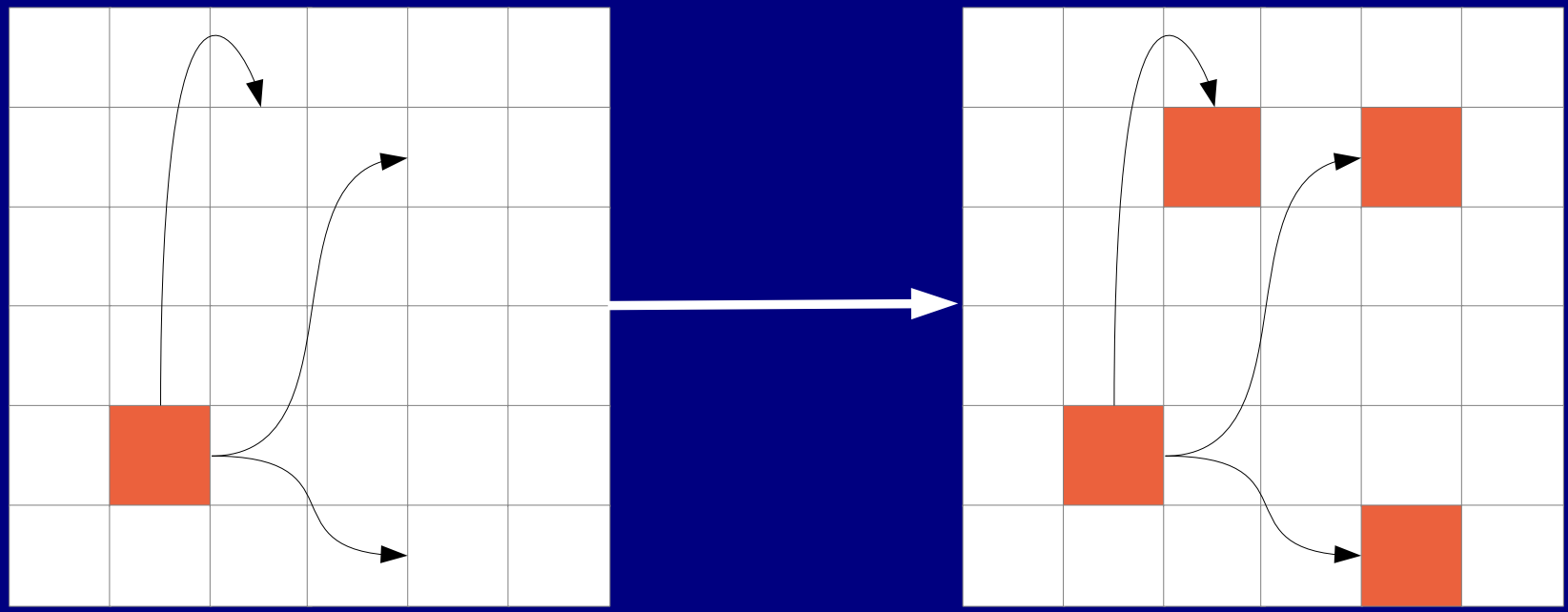


Figure: Long distance dispersal (LDD)

About the model...

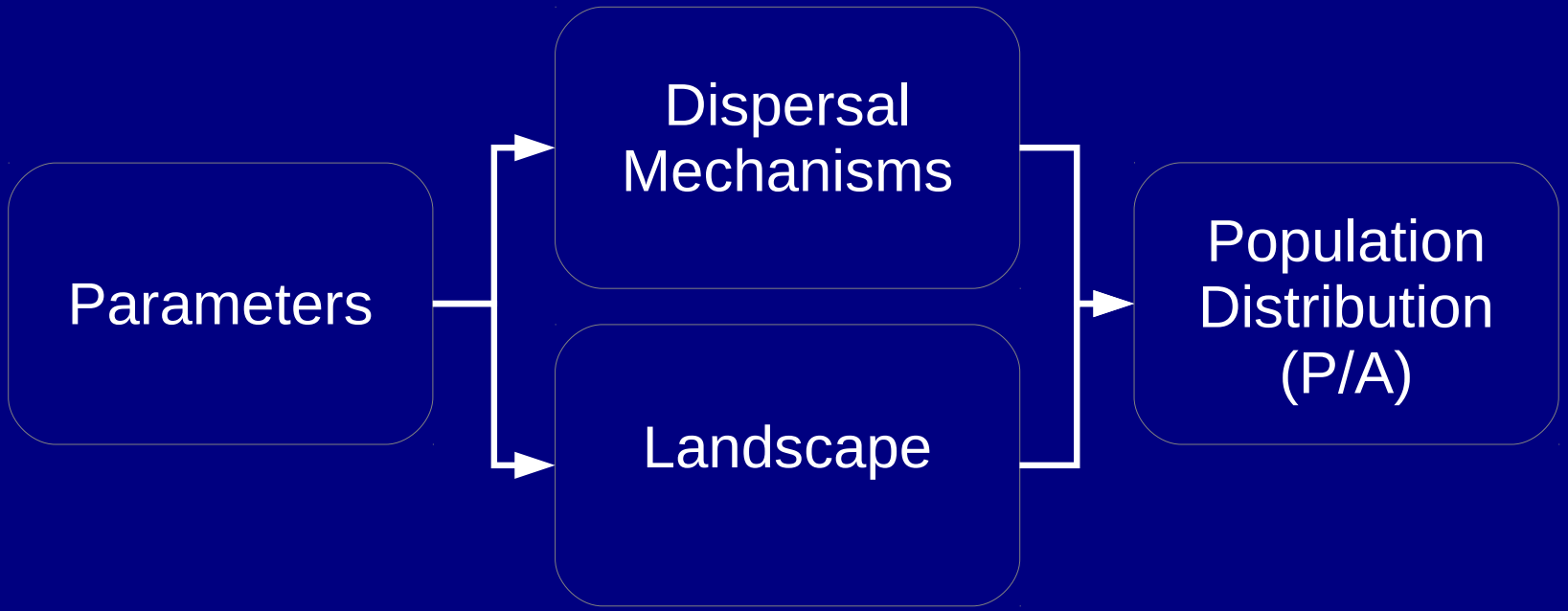


Figure: Main components of the model

About the model...

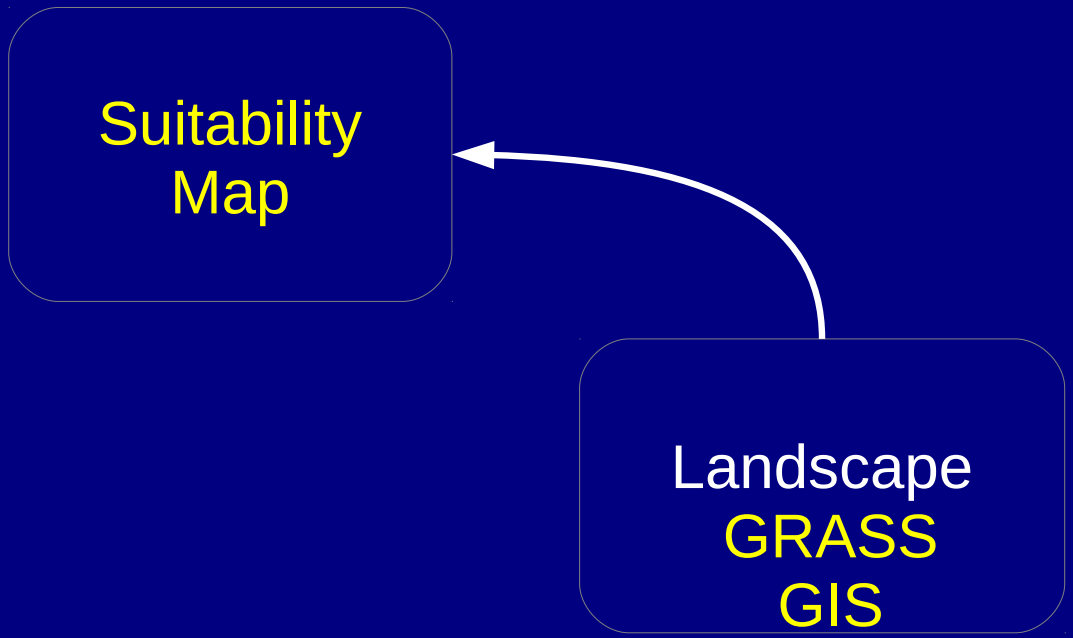


Figure: Heterogeneity of the environment

About the model...

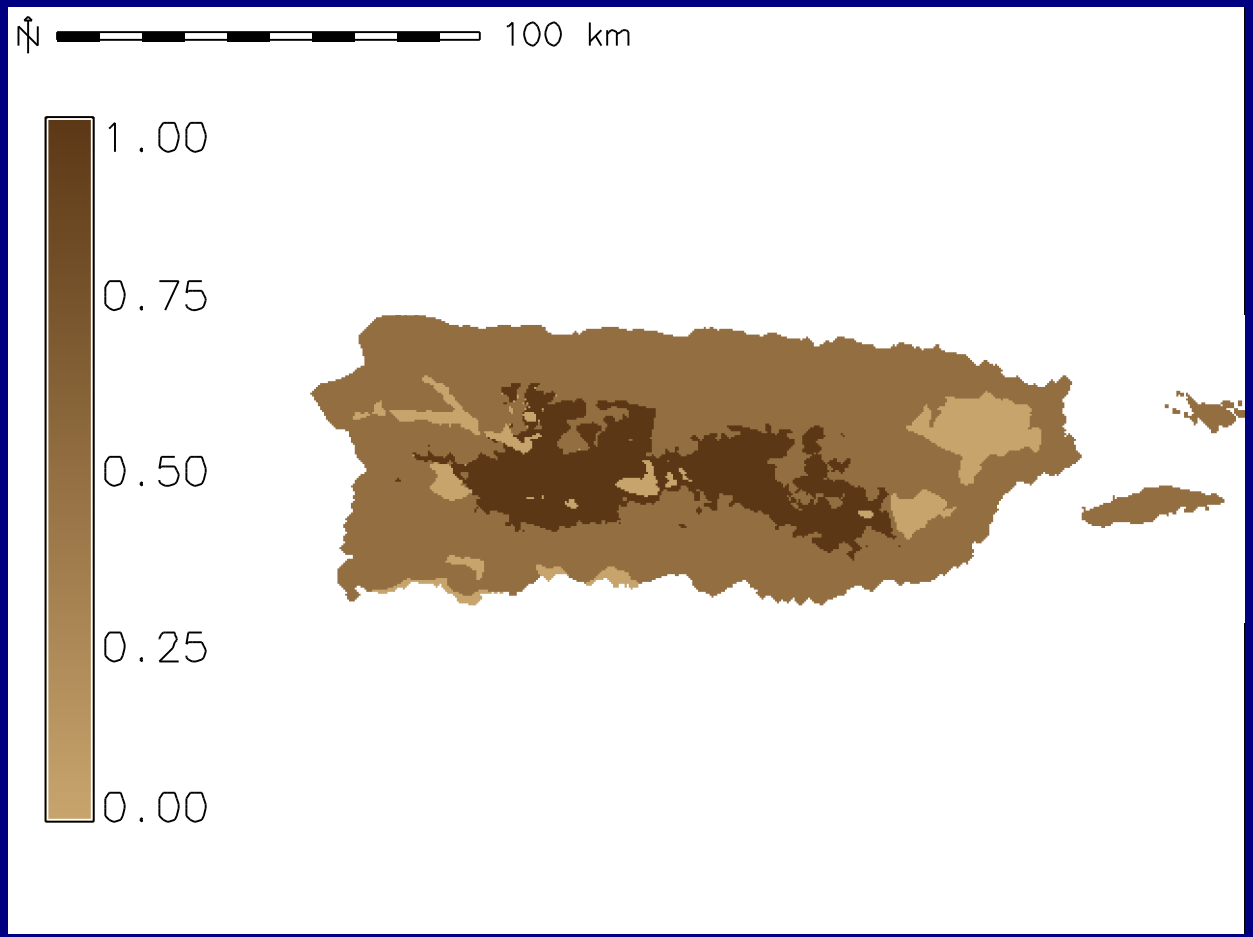


Figure: An index-based suitability map for *Mimosa pigra*

About the model...

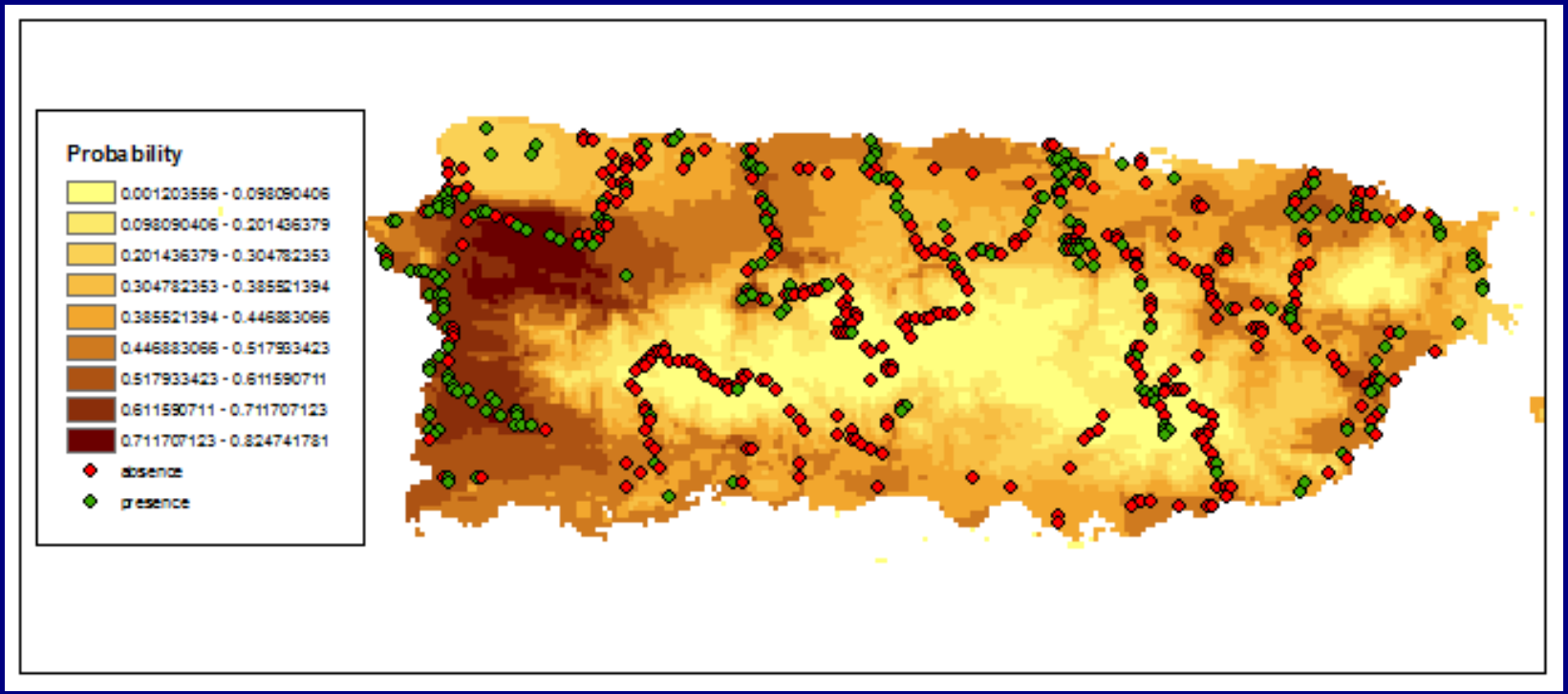


Figure: A statistical-based suitability map for *Mimosa pigra*

About the model...

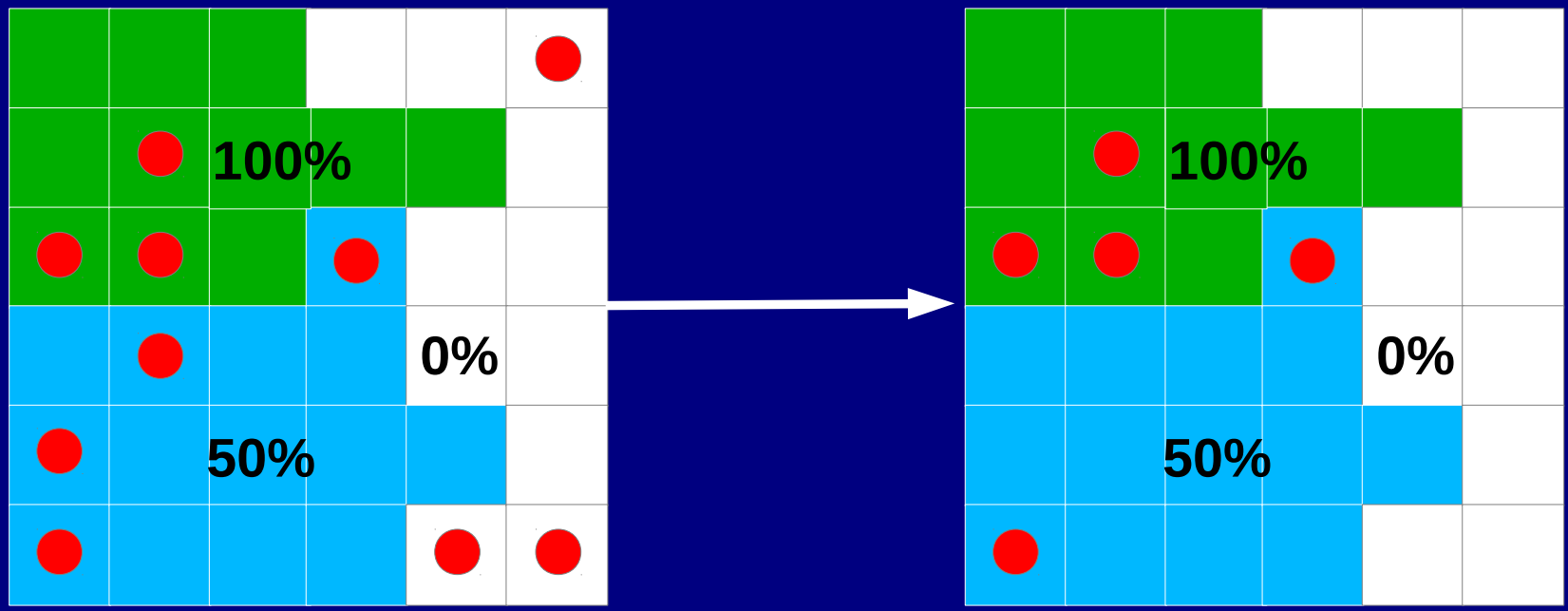
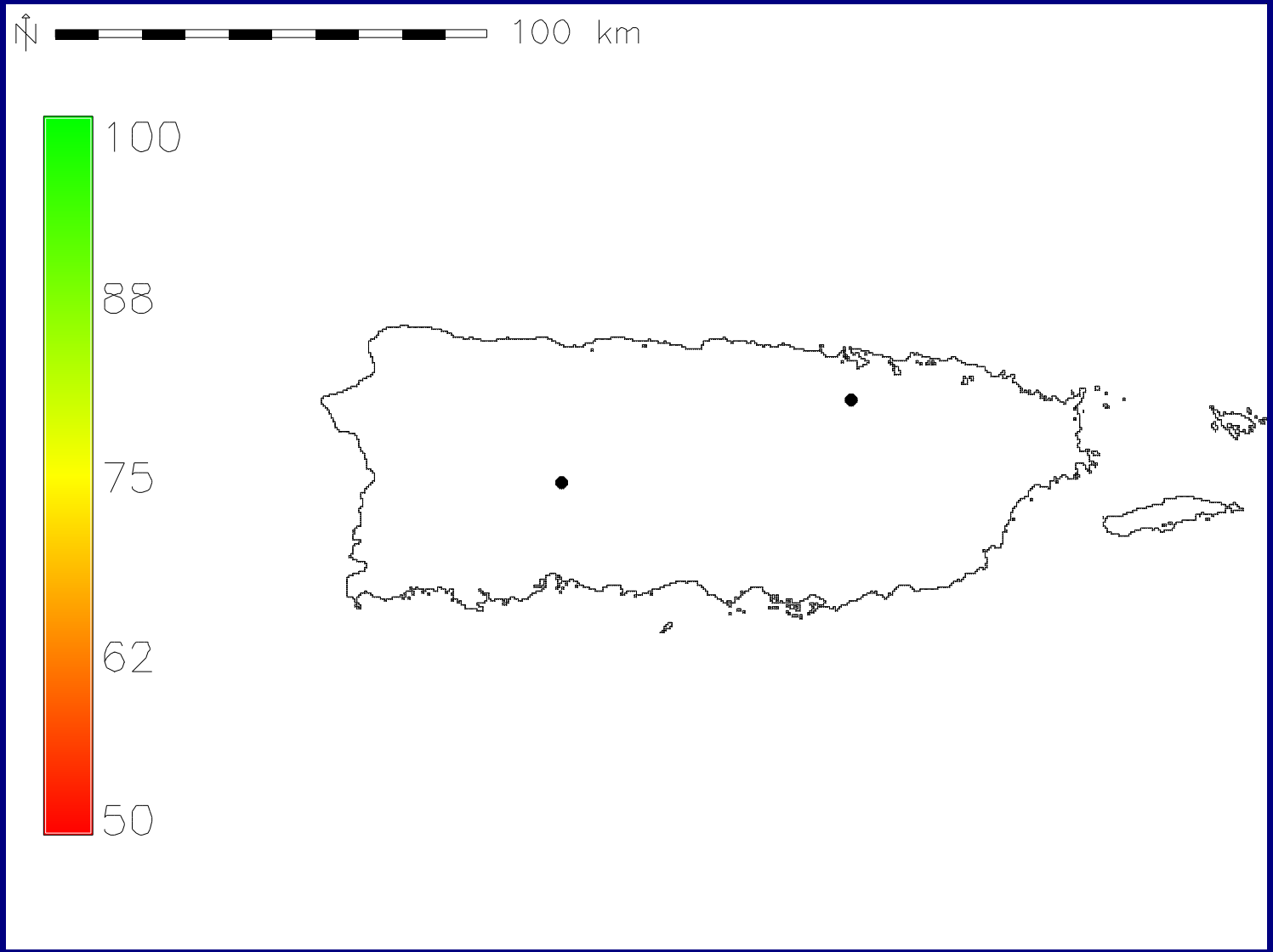


Figure: We can determine if individuals will survive the next period

A Simulation!



Sensibility of parameters...

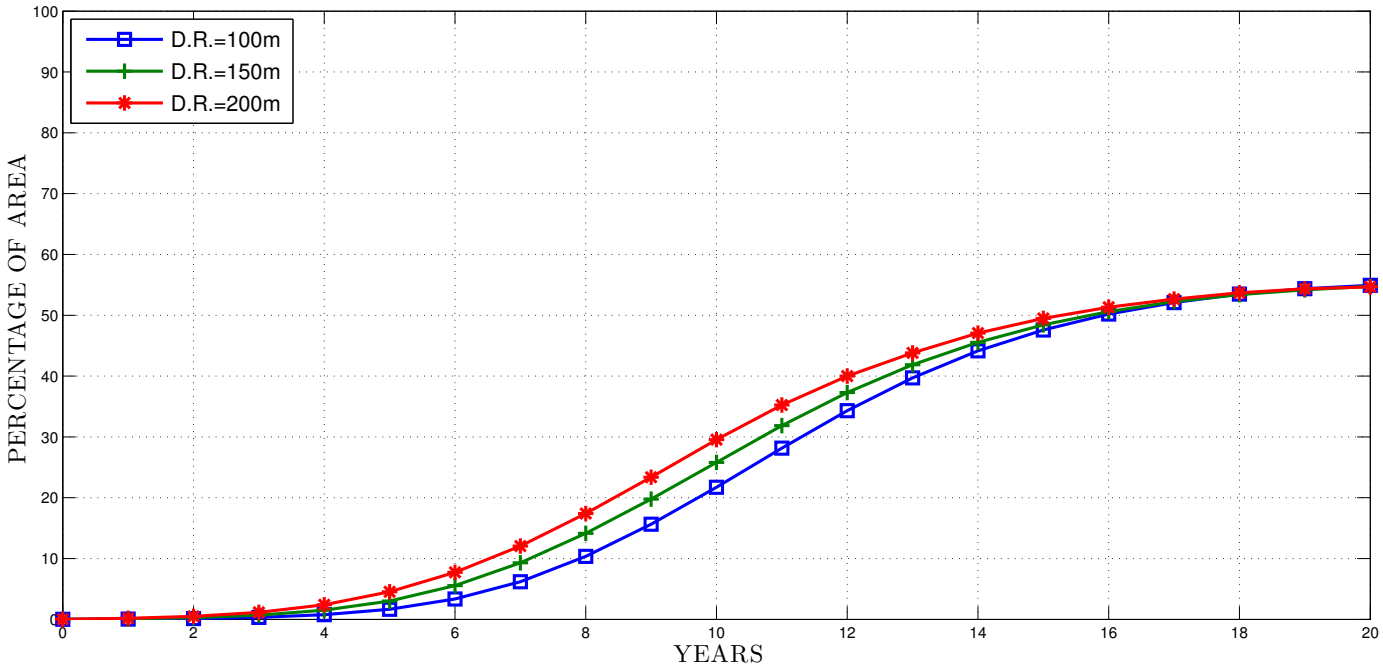


Figure: Elasticity for Dispersal Rate = 0.004
Distance = 10kms
Frecuency = 0.2

Sensibility of parameters...

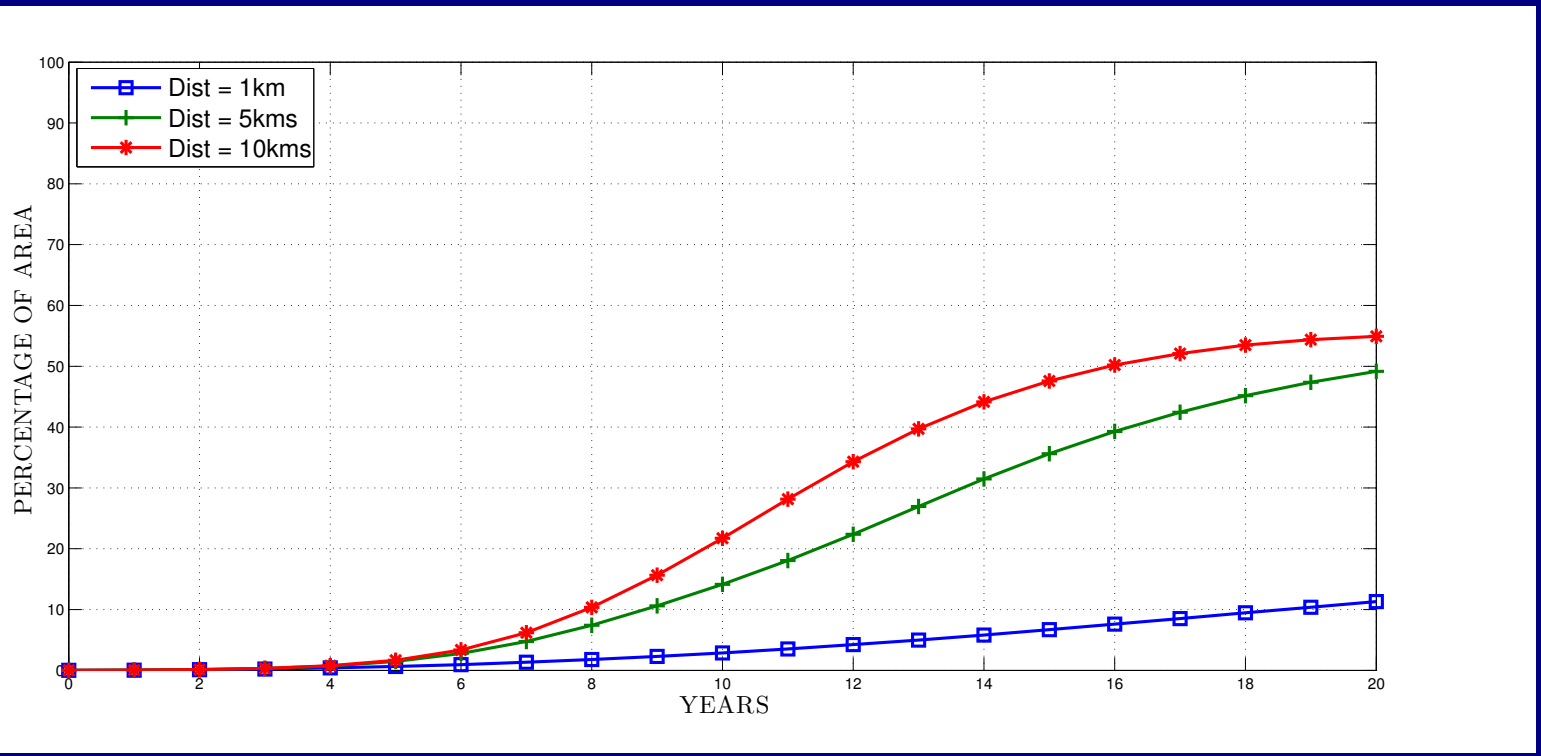


Figure: Elasticity for Distance = 0.836
D.R. = 100m/y
Frecuency = 0.2

Elasticity of Parameters

Definition

The elasticity of a variable A respect a parameter x is

$$E = \frac{\frac{\Delta A}{A}}{\frac{\Delta x}{x}}$$

- A: Infested area
- x: Parameter varying

Elasticity of Parameters

Elasticity for DISTANCE for LDD.

		Frequency					
		0.05		0.1		0.2	
D.R.	50m/y	0.183	0.352	0.285	0.252	0.342	0.111
	150m/y	0.302	0.475	0.465	0.308	0.553	0.120
	200m/y	0.510	0.545	0.774	0.345	0.836	0.117

Elasticity for DISPERSAL RATE.

		Frequency					
		0.05		0.1		0.2	
Dist	1km	1.259	1.462	1.007	1.263	0.688	1.097
	5kms	0.367	0.503	0.099	0.189	0.012	0.020
	10kms	0.260	0.213	0.040	0.053	0.006	0.004

Conclusions

When we change parameter values we find that some have a greater impact on the model predictions than others. The following list orders the parameters in according to their degree of influence on the model results, starting with the most sensitive parameter:

- Distance (magnitude of the jump)
- Frequency (Number of jumps)
- Dispersal rate

References

- Pitt JPW, Worner SP and Suarez A (2009) Predicting Argentine ant spread over the heterogeneous landscape using a spatially-explicit stochastic model. Ecological Applications 19: 1176-1186
- GRASS Development Team, 2010. Geographic Resources Analysis Support System (GRASS) Software, Version 6.4.0. Open Source Geospatial Foundation. http://grass.osgeo.org

THANKS!

ANY QUESTIONS?