Climate change connotations of a suitability map for *Mimosa pigra* in Puerto Rico

M. Julio Barragán-Arce[1], Wilfredo Robles[2], Yetsabel Auccaille[3] and William Camacho-Aponte[3]

[1] *Department of Agricultural Economics and Rural Sociology,* [2] *Department of Crop and Environmental Sciences,*

[3] *Department of Mathematical Sciences, University of Puerto Rico at Mayagüez*

December 2, 2011

Content

Acknowledgements

- This material is based on research supported by USDA/NIFA Grant No. 2010-34135-21021 inTropical/ Subtropical Agriculture Research.
- USDA Forest Service personel based in Puerto Rico provided GIS layers for temperature and precipitation.

Introduction - Motivation

- Environment is an important determinant of survival
- If we can model this relationship we can:
  - use knowledge of the environment...
  - ... to predict survivability of a species
- This has many applications:
  - **Suitability maps.** Use environment over space to predict survivability over space
  - **Climate change impacts.** Use environment over time to predict survivability over time

Introduction - Objectives

- Estimate **correspondence** between environment and the survivability of *Mimosa pigra*
- Use this correspondence to:
  - build a **suitability map** for *Mimosa pigra* in PR
  - estimate **sensibility** of survivability of *Mimosa pigra* to climate change in PR

Data

Data types and sources

- A presence/absence vector layer data set for *Mimosa pigra* built by Robles and associate (2010).
- A complete temperature and precipitation GIS raster layer for Puerto Rico built by the USDA Forest Service personnel in Puerto Rico.

Methods

Logistic regression

The probability of presence p as a function of environmental variables X was estimated using the logistic function in opensource statistical software R:

$$p = \frac{1}{1 + e^{-\beta' X}}. \tag{1}$$

Maximum likelihood estimated parameters $\hat{\beta}$ were used to predict a suitability map for PR based on observed environmental data X.

Regression coefficients

Table: Estatistical analysis

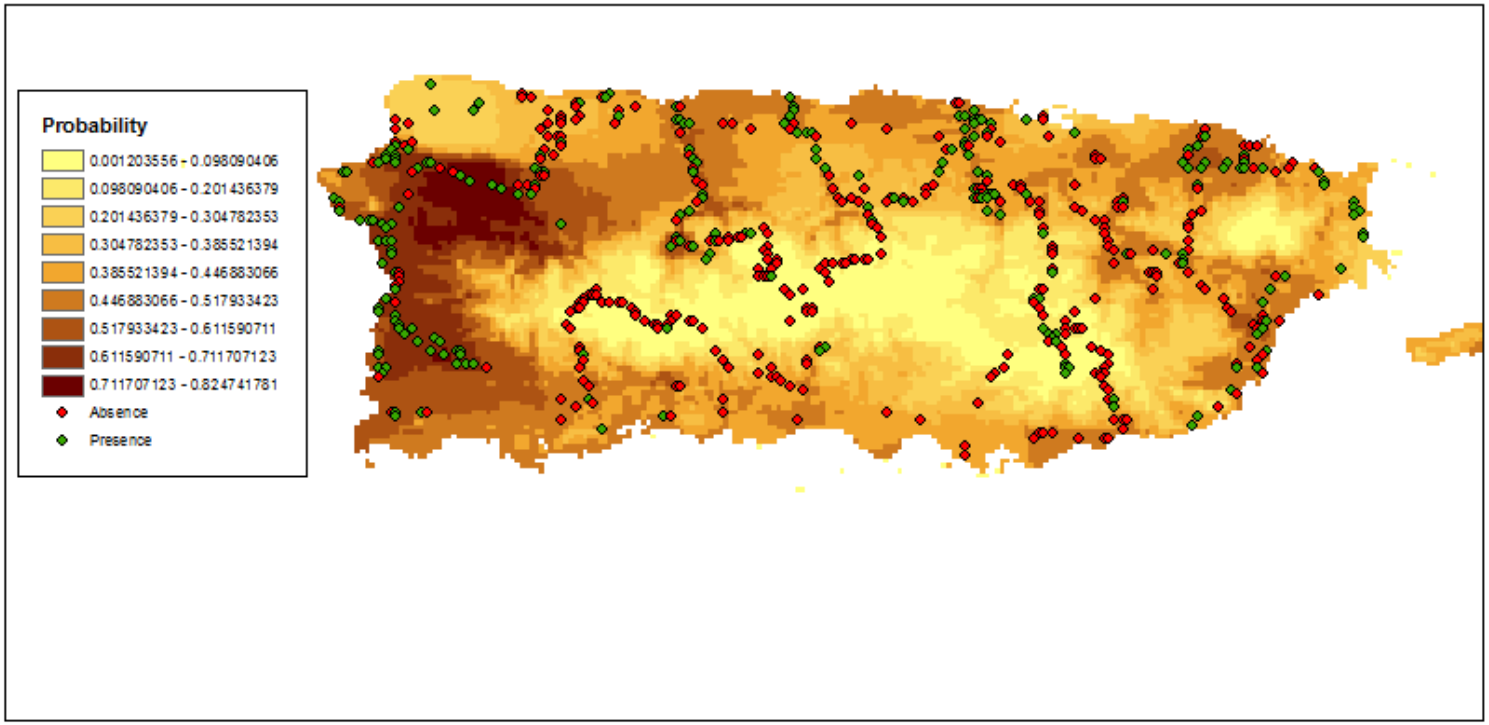
Coefficients	Estimate	Std. Error	z-value	P-value
Constant	-21.7500000	2.967000	-7.330	0.000***
Precipitation	0.0000076	0.000003	2.199	0.027*
Minimum temperature	-0.0002559	0.000747	-0.342	0.732
Maximum temperature	0.0068510	0.000956	7.162	0.000***

Significance codes: $^{***} = 0$, $^{**} = 0.001$, $^{*} = 0.01$

'***': Highly significant, '**': Fairly significant, '*': Very little significant

Suitability map

Figure 1: Probability of presence



Sensibility to climate change

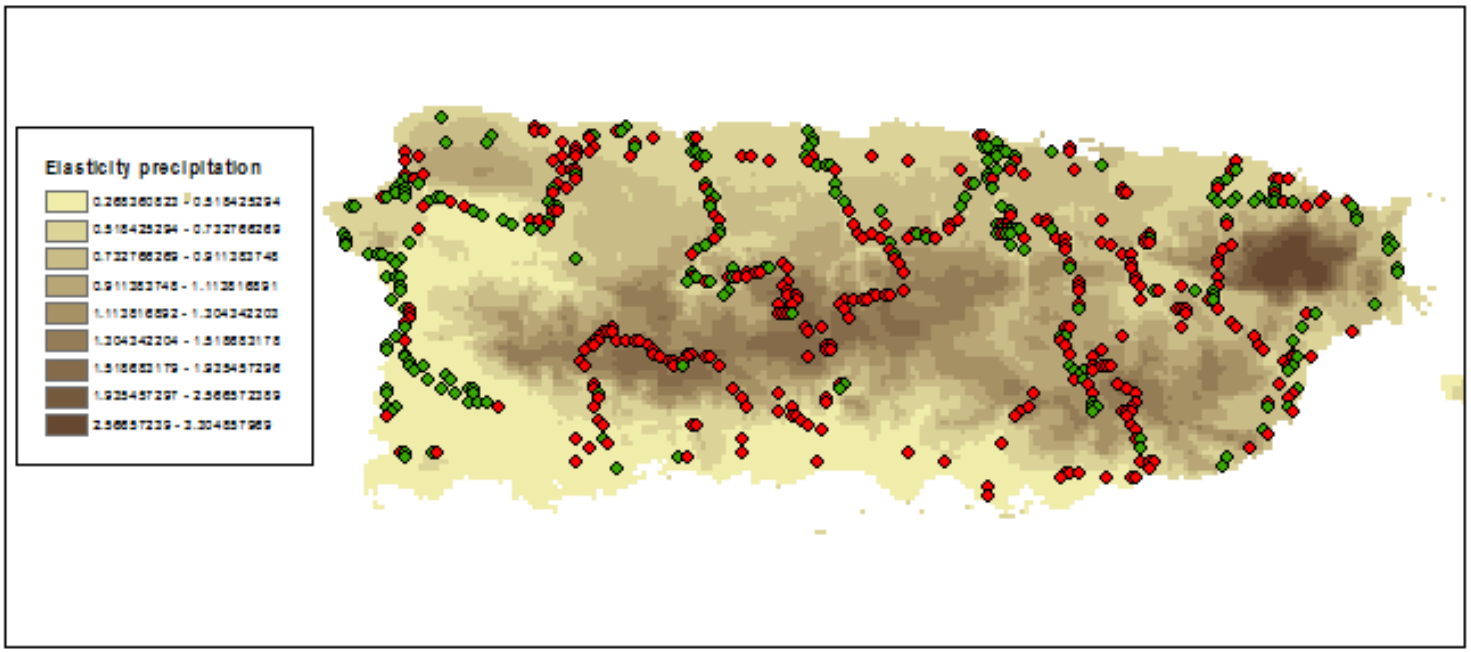
Elasticity

The elasticity is defined as the percent change in the predicted presence over the percent change in each variable. Elasticity of variable p with respect to variable x, denoted E_{px}, is defined as:

$$E_{px} = \frac{\partial p}{\partial x}\frac{x}{p}. \tag{2}$$

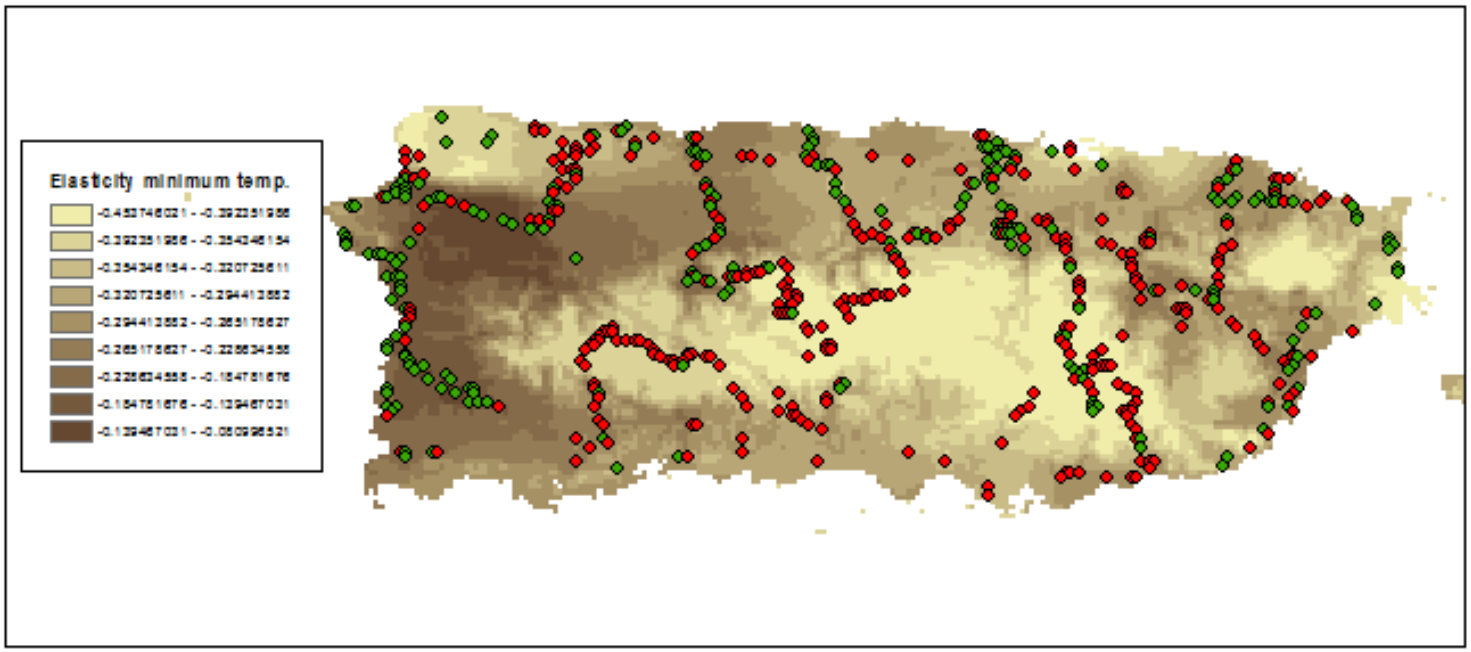
Sensibility to climate change - Precipitation

Figure 2: Elasticity - Precipitation



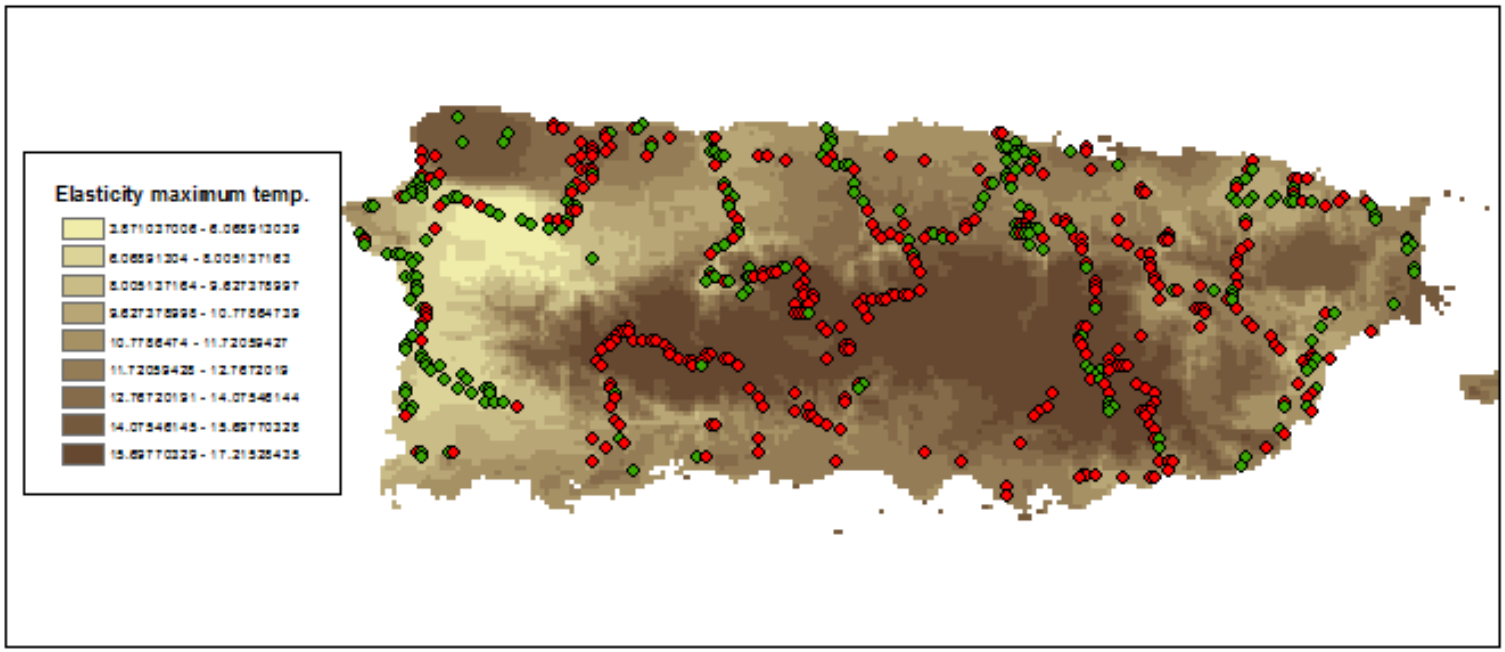
Sensibility to climate change - Minimum temperature

Figure 3: Elasticity - Minimum temperature



Sensibility to climate change - Maximum temperature

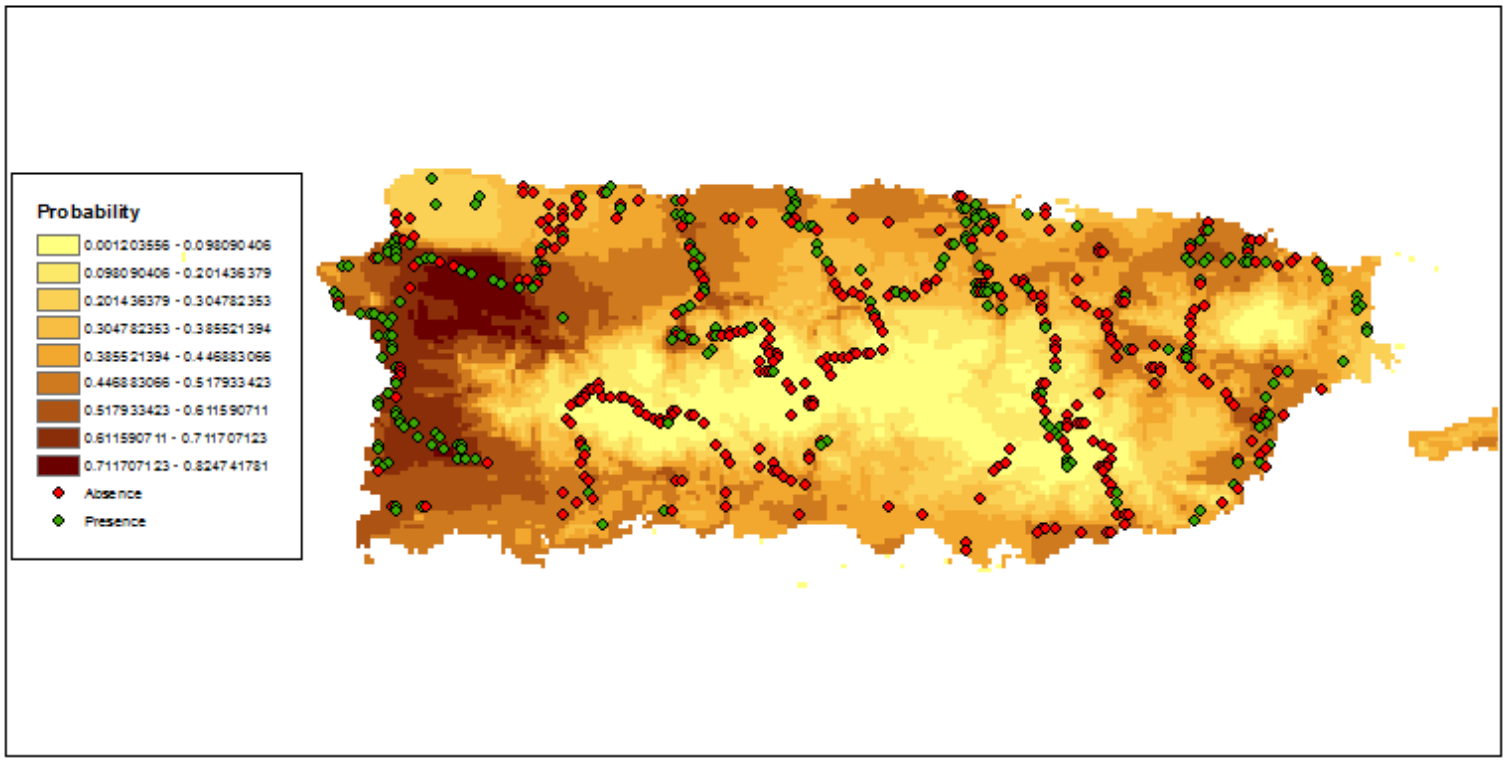
Figure 4: Elasticity - Maximum temperature



How does climate change impact suitability?

What is the impact of a 1% increase in maximum temperature?

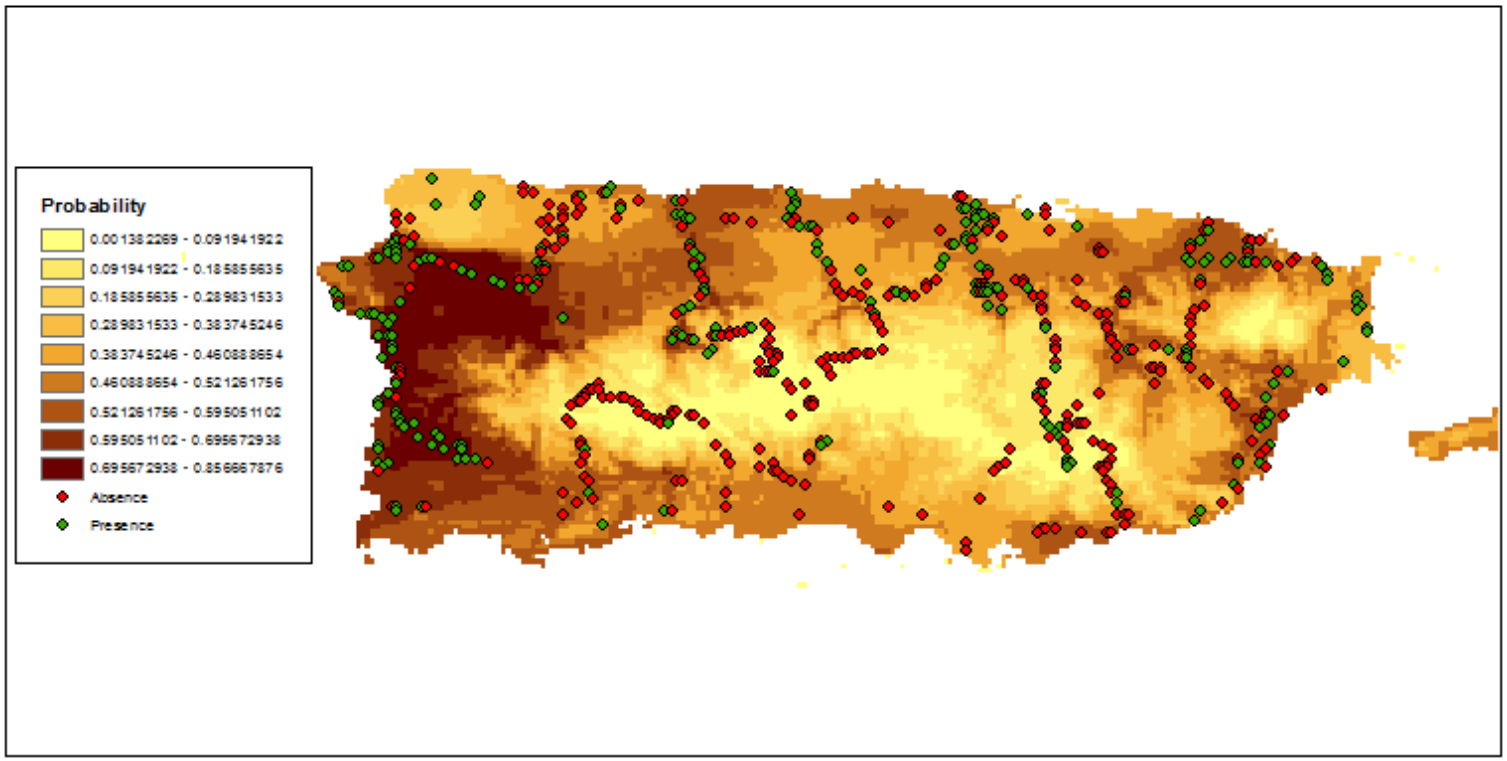
Fig. 5: Suitability with present-day data



How does climate change impact suitability?

What is the impact of a 1% increase in maximum temperature?

Fig. 6: Suitability with a 1% increase in Max. Temp.



Conclusions

- The western lowlands and the central highlands tend to be, respectively, the most and least suitable region for the establishment of *Mimosa pigra*.
- Elaticities evaluated at Island-level averages indicate that suitability is most affected by changes in maximum temperature and in precipitation.
- Global warming could thus increase suitability of PR environments to *Mimosa pigra*.