Human-Environment Interactions in a Changing Environment:

A Computational Model of Agropastoral Practices and Landscapes in Neolithic Spain

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The MedLand Project

- Develop an understanding of long-term environmental effects of human environment interaction in the Mediterranean
- We have developed multiple landscape and human decision making simulations which can be used individually or together to understand components of socio-ecologic system dynamics.

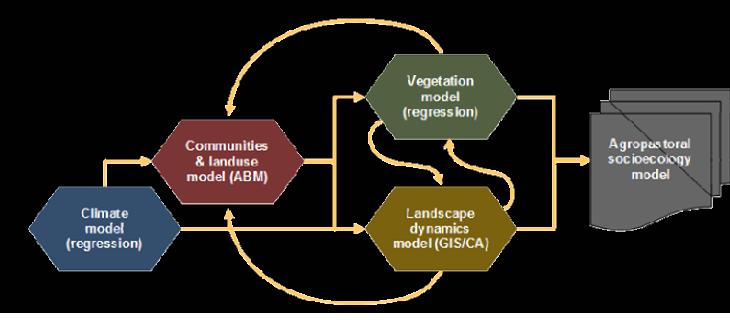
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Agent Environment Model Interaction Model System Settings	-Layers ⊡ Stars		AND STORES		
Villages Farming Households Wood Gathering Grazing	Sky				
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Meat & Milk required: 550000 kcal / capita / year	T Landcover Legend				
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Percent of population providing labor: (rounded up to whole person)		the second second	and the state of the		
Labor provided: 300 man-days / capta / year Yield Expectation Scalar: 75					
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Maximum distance cost to travel to farm: 10800		1 AMERICAN INC.			
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		Altitude 193 km Lat 38.3637"	Lon -0.4192°	Elev 16 meters	

Simulation GUI

Simulation Viewer using NASA WorldWind

AP-SIM and LandDyn

- The agent-based model component of our model, AP-Sim, emulates villages that practice non-irrigated wheat and barley farming as well as site-tethered mixed sheep and goat herds.
- Households make annual economic decisions about how much land to farm and how much land will be needed to feed their herds.
- LandDyn, is composed of GRASS GIS scripts including a land assessment model, a vegetation succession model, a soil fertility model, a catchment model and a surface process model.

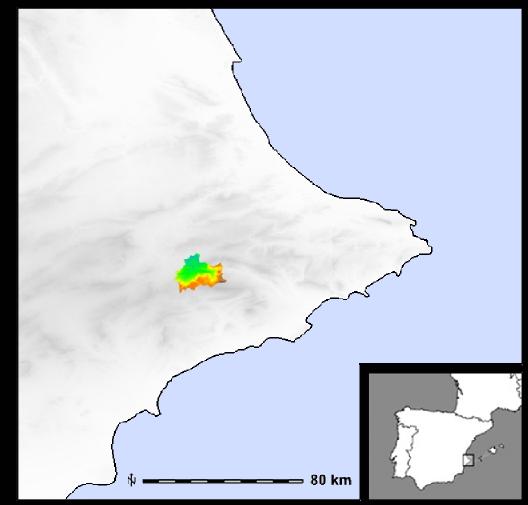


Experimental Study Area

During the Neolithic there is evidence of settlement reorganization and landuse

The Usual Suspects:

- Climatic Change
- Population Stress



Penaguila Valley, Spain

Expectations

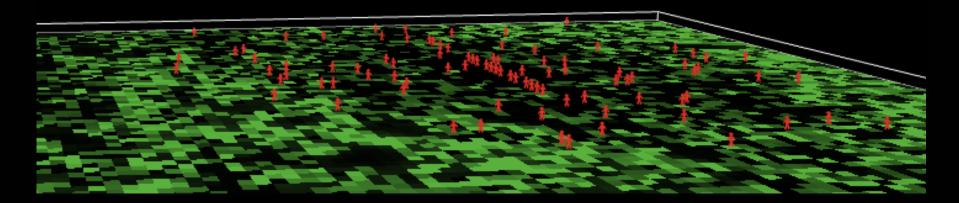
- High Population + Neolithic I Climate (Wetter) = Greatest Effect on Landscape
- Low Population + Neolithic IIb Climate (Drier) = Smallest Effect on Landscape





Population

- Prehistoric Population Rates are...?
- We use 6.6% as a birth rate for both simulations and vary the death rate as 5.2% and 5.7%
- Test two population growth rates: 0.05% and 0.1%
- Population Rates do vary in simulations from agropastoral returns



Neolithic Climate

Neolithic I: Wetter

Neolithic II: Drier Fewer Storms

More Storms



	Neolithic I	7550-6450 BP			
	Annual mm	R-factor	Storm mm	Storm #	
averages	515.2341261	4.537608	20.61391	24.98832	
stdevs	21.77078577	0.061896	0.18702	0.854224	



Neolithic II-b 5650-4250 BP							
	Annual mm	R-factor	Storm mm	Storm #			
averages	436.2173316	4.454338	19.16122	22.78008			
stdevs	22.73606926	0.017223	0.87561	1.090053			

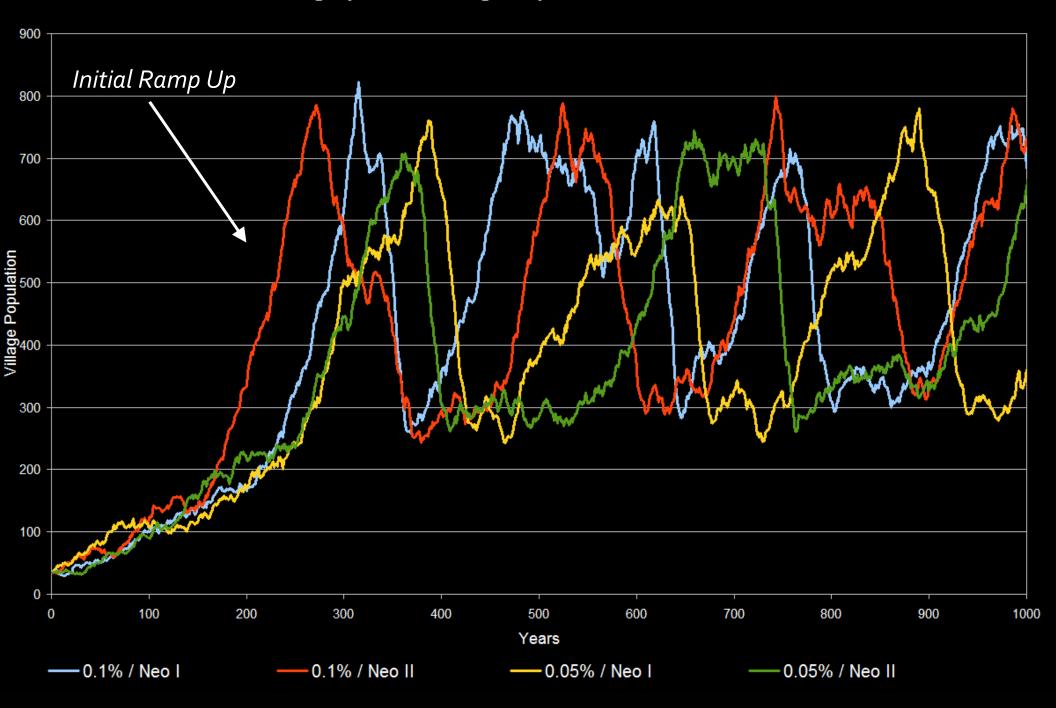
How do climate and population interact and result in stress on the landscape that may necessitate change in land-use strategies?

1000 Meters

4 Parameter Sets:

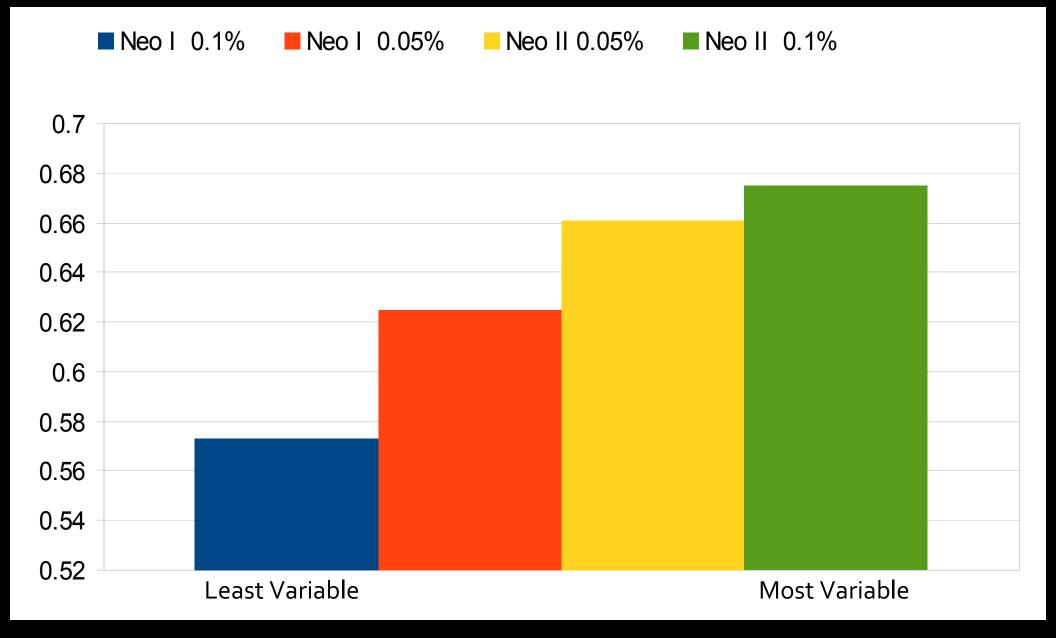
- High Population Rate, Low Rainfall
- Low Population Rate, Low Rainfall
- High Population Rate, High Rainfall
- Low Population Rate, High Rainfall

Modeled Area of Penaguila Valley Agent Impacts, 750 Years **Agropastoral Village Populations for 1000 Years**



Village Populations Begin With 36 People and reach a maximum size of 800 people

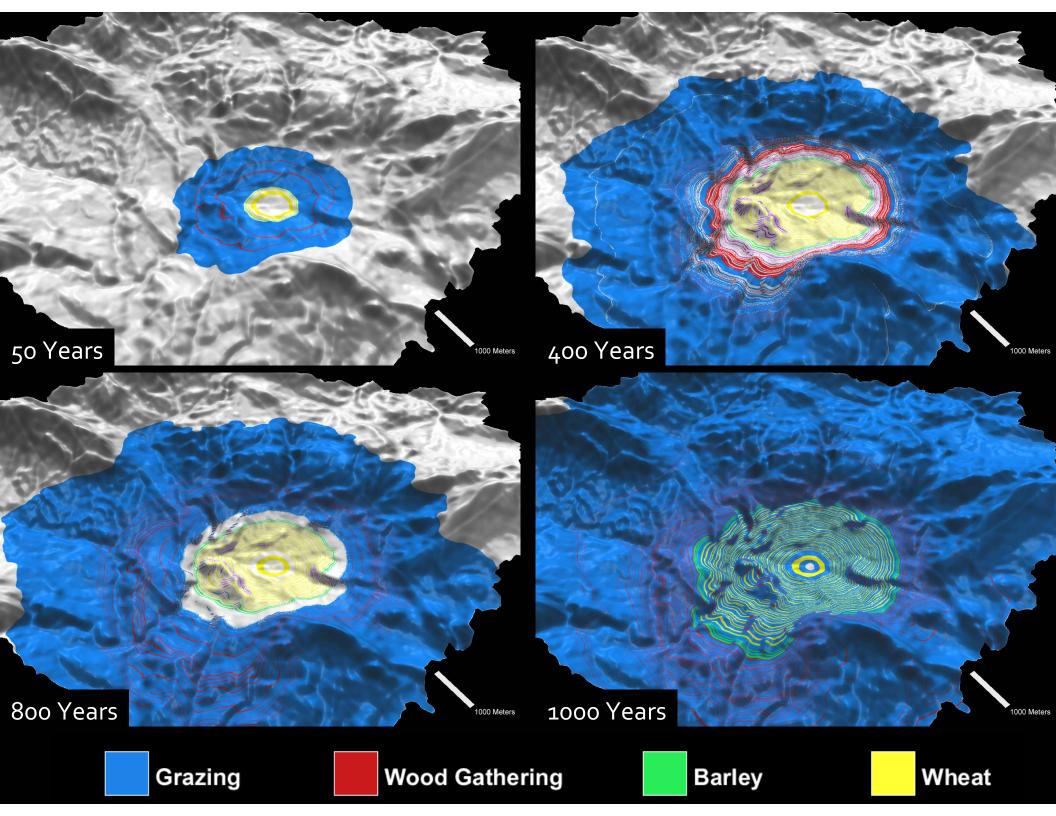
Population Variation

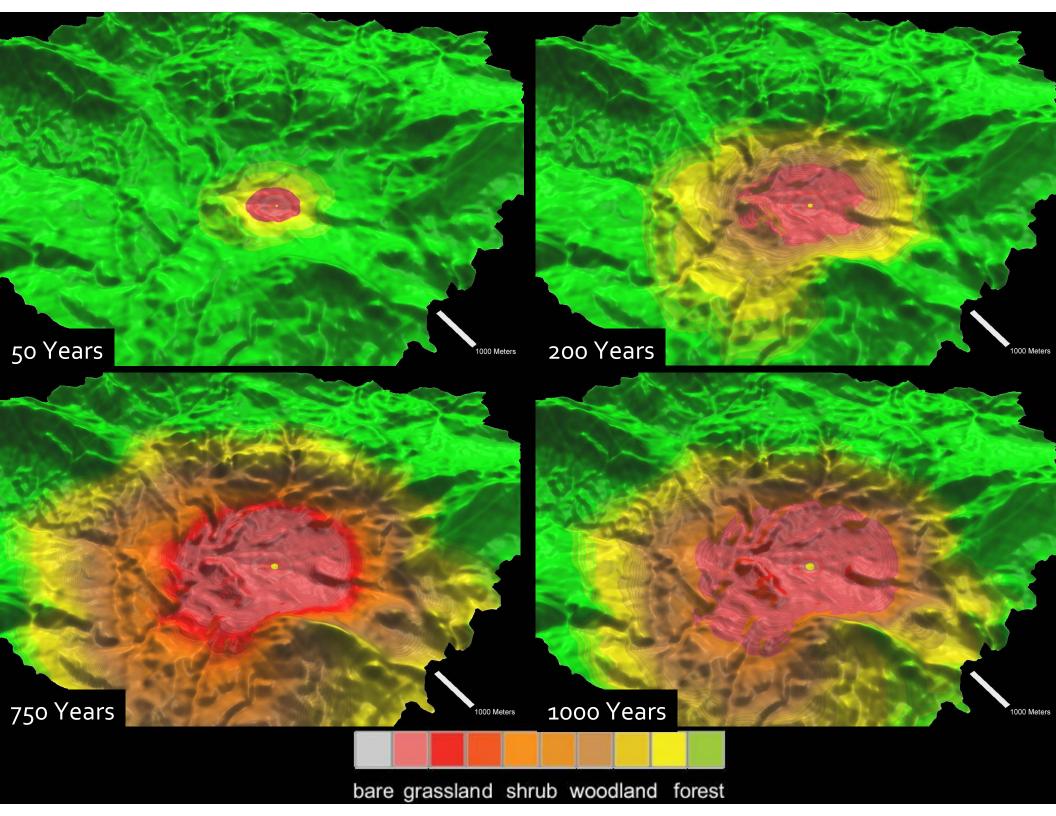


Village Population Years -0.1% / Neo II 0.1% / Neo I 0.05% / Neo I 0.05% / Neo II .

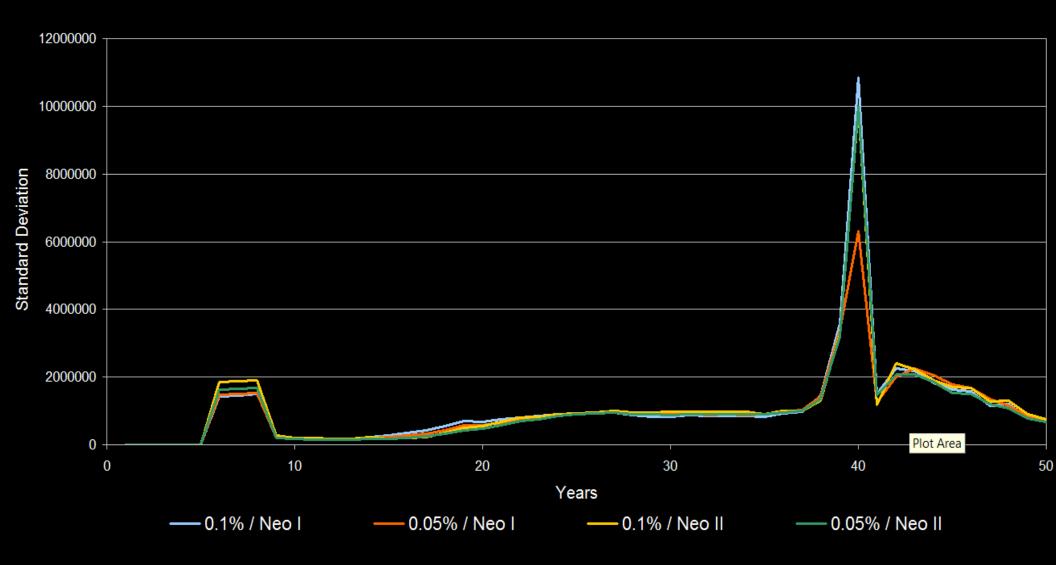
Average Village Populations After 500 Years

High Population Rate and Drier Climate Results In An Earlier Ramp Up Period





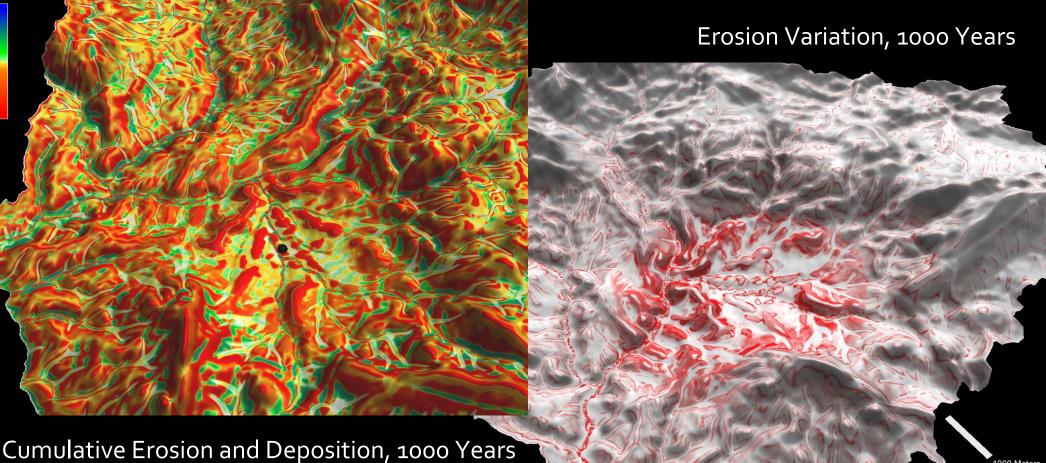
Landcover Variation After 1000 Years of Agropastoral Landuse



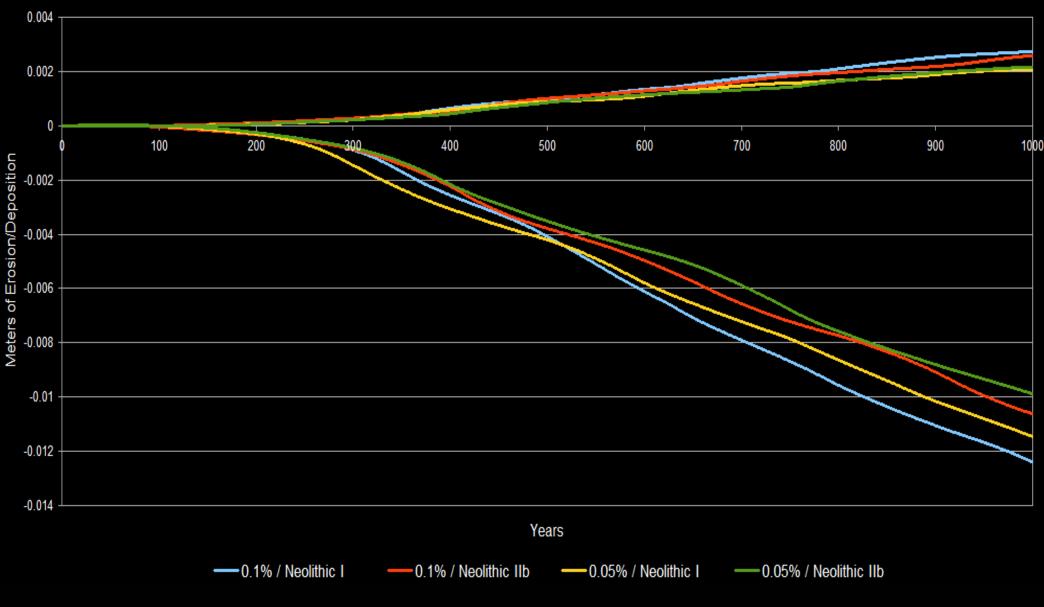
Low Population and Wetter Climate is Less Variable

Erosion & Deposition

- We compare control models of E & D to our simulations to determine the human contribution
- Which is the larger factor, Climate or Humans?



Median Cumulative Erosion and Deposition for all models

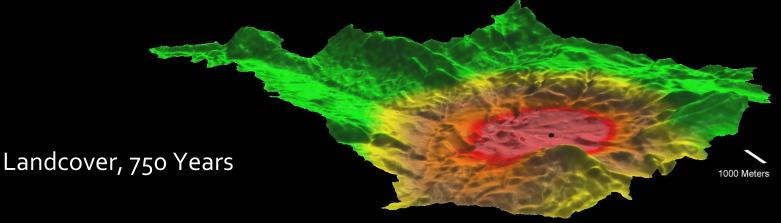


-Little Difference In Deposition

-A Wetter Environment Results in the Most Erosion, Population Is Still A Factor

Preliminary Conclusions

- None of the Parameter Combinations we used are inherently unstable and must lead to a re-organization of landuse
- The combination of a High Population Rate and Neolithic I climate results in the most variable population and the most erosion
- Village Populations reach a maximum size that is not well understood
- It is unclear why a high population rate and drier climate results in a faster ramp up period
- Importance of climate underscores the importance of adding climatic variation during simulations



Acknowledgements

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