Mediterranean Landscape Dynamics Project

- The Medland project aims to understand the long-term effects of ancient landuse practices on the environment.
- GIS-based surface process simulation coupled with semi-dynamic stochastic landuse models (eventually with Agent-Based landuse model)
- Track the effects of landuse on landcover and subsequently on the spatial extent and severity of erosion and deposition through time
Modeling Ancient Human Impacts

• What affect, if any did ancient human landuse have on the environment?
  – Little direct archaeological evidence of human impacts on the environment
  – Even less direct evidence of the processes that created anthropogenic landscapes

• We must simulate ancient landuse through spatially explicit process-based models
  – Human processes (farming, herding, deforestation)
  – Natural processes (climate, vegetation, geological)
1. **Potential landscape model**
   (natural processes only—no human impacts!)

2. **Reference landscape time series**
   (Paleolandscape reconstruction, archaeological data, paleoenvironmental data)

3. **Agropastoral socioecology model**
   (Semi-Stochastic and Agent-based human landuse models coupled with natural process models)
Topography

- Stereo aerial photos
- Point elevation extraction
- High-resolution (5m) DEM interpolation
- Study areas defined as watersheds using hydrologic modeling
Terrace Mapping

- Geomorphic mapping
- Terrace sequence identification
- Field ground truthing
- OSL dating of sediments
Topography: Paleolandscape reconstruction

- Keep older surface remnants
- Remove all younger surfaces
- Interpolate elevations in removed areas from elevations of adjacent paleosurfaces
Paleoclimatological Modeling

- Weather station data retrodicted for 14ky at 200 yr intervals to produce sequences for annual and monthly precipitation, temperature (mean, days >40°, days <0°), and storms.
- Monthly and annual climate sequence models interpolated to create paleoprecipitation surfaces using multiple regression (topography, distance from sea, latitude, etc).
• Potential natural vegetation model based on phytogeography (climatic/topographic variables)
• Human Landuse affects natural vegetation by reduction (grazing, burning) or replacement (farming)
• Vegetation regrowth models incorporate successional dynamics
Human Landuse Modeling

Catchment modeling
Stochastic Landuse models
Multi-agent Simulation

Agent Impacts
- cleared
- cultivated
- Village

Landcover

Cumulative Net Elevation Change

Legend:
- Bare
- Grasses
- Shrubs
- Woodland

Color scale:
- 2
- 0
- -2
Resultant Vegetation Profiles

- Grass
- Shrubs/Maquis
- Woodland
### Erosion/Deposition Modeling

#### Options
- r: Calculate for predominantly rill erosion instead of sheet erosion
- n: Output a map of the net erosion deposition as well
- k: Keep all intermediate files as well
- z: Keep region zoomed to output maps

#### Input elevation map (DEM):
- Select the input elevation map.

#### Prefix for all output maps:
- usped

#### Rainfall (P factor) map prefix (leave off years):
- Select the rainfall (P factor) map prefix.

#### Soil erodibility index (K factor) map or constant:
- Select the soil erodibility index (K factor) map or constant.
- 0.32

#### Landcover index (C factor) map prefixes (leave off years):
- Select the landcover index (C factor) map prefixes.

#### Band-pass filter neighborhood size:
- Select the band-pass filter neighborhood size.
- 3

#### Band-pass filter threshold value, sigma (meters):
- Select the band-pass filter threshold value, sigma.
- 0.10

#### Neighborhood smoothing method:
- Select the neighborhood smoothing method.
- median

#### Iteration Time Step (integer years):
- Select the iteration time step.
- 200

#### Maximum Time Step (oldest year):
- Select the maximum time step.
- 14000

#### Minimum Time Step (youngest year):
- Select the minimum time step.
- 0

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**Example Command**

```
run = usped.iltr.devl.prefix=usped K=0.32 nbhood=3 sigma=0.10 method=median number=200 maxyrs=14000 minyrs=0
```
Model the effect of the resulting landcover on erosion

40 years of fallow agriculture with grazing

Control Model (no landuse)
Risk assessment

Erosion-prone areas

Stable areas
3-D results with human landuse

Reality Check. There IS a deep canyon in this location!!!