Modeling Impacts of Landuse Practices on Mediterranean Landscapes

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MEDITERRANEAN LANDSCAPE DYNAMICS PROJECT

- NSF ERE Biocomplexity in the Environment Program, grant BCS-0410269
- Develop a modeling laboratory for the long-term recursive dynamics of agropastoral landuse and landscape change

Map of the Mediterranean region & high resolution study area.
Modeling Laboratory

- 3 interlinked modeling environments
  - Potential landscape model
  - Reference landscape chronosequence
  - Agropastoral socioecology model

- Initial state
- Initial state & validation at various stages

- Climate model
- Terrain modeling: multi-yr. steps
- Vegetation modeling: multi-yr. steps
- Potential landscape model
- Reference landscape chronoseq.

- Paleo-vegetation
- Paleo-terrains (DEM's)
- Reference landscape model

- Modern DEM
- Geological data
- Archeological data
- Vegetation edaphic parameters

- Paleo-botanical data
- Agent Modeling
- Settlement & landuse modeling
- Climate model
- Settlement & landuse modeling
- Terrain modeling: multi-yr. steps
- Vegetation modeling: multi-yr. steps
- Agropastoral socioecology model

- Archeological data
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- Modern DEM
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- Climate model
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- Terrain modeling: multi-yr. steps
- Vegetation modeling: multi-yr. steps
- Agropastoral socioecology model
Surface Process Dynamics

- Landcover
- Topography
- Soils
- Climate
- Landuse
Modeling Overview

- Modeling environment built in GRASS
  - Geographic Resource Analysis Support System
- USPED
  - Unit Stream Power Erosion/Deposition
  - \( ED = \frac{d(T \times \cos a)}{dx} + \frac{d(T \times \sin a)}{dy} \)
    - \( ED \) is net erosion or deposition of sediment
    - \( a \) is topographic aspect
    - \( T \) (sediment transport) is RUSLE value
    - \( T = R \times K \times LS \times C \times P \)
  - where ...
    - \( R \) is the rainfall intensity factor,
    - \( K \) is the soil factor,
    - \( LS \) is the topographic (length-slope) factor,
    - \( C \) is the vegetation/landcover factor
    - \( P \) is the prevention practices factor.
Modeling Inputs

- Human landuse
- Topography
- Rainfall intensity (R-Factor)
- Landcover and erodability (C-Factor)
- Soil and erodability (K-Factor)
Landuse Modeling

✧ Model components
  ✧ Growing agricultural catchments
  ✧ Shifting and non-shifting cultivation
  ✧ Grazing catchment
  ✧ USPED calculation
  ✧ Iterated to simulate cumulative change

✧ Multi-agent simulation (near future)
Landuse Modeling
Topography

- Terra ASTER DEM
- Re-interpolated to 15m resolution
- Ultra-high resolution topography from aerial photograph stereo pairs (near future)
- Study areas defined as watersheds using hydrologic modeling
Rainfall Intensity

- 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).
- Transformation to R-Factor surface

![Graph showing annual precipitation over time with station data points.]
Landcover

- Simple estimate of paleovegetation
- Community models based on climate and topography (near future)
- Patch models incorporating successional dynamics (eventually)
- Using NDVI regression to scale vegetation to C-Factor
Soil

- Simple constant currently
- Using remote sensing to calculate K-Factor (near future)
- Dynamically modeling changing soil thickness and erodability (near future)
Surface Process Models

- Intensive horiculture (red cultivated)
- Site-tethered grazing
- Extensive forest grazing

 대하여 Intensive horiculture (red cultivated)
Surface Process Models

- Shifting cultivation (red cultivated, brown fallowed, green forest)
- Site-tethered grazing
- Extensive forest grazing

✧ Shifting cultivation (red cultivated, brown fallowed, green forest)