Fire, Land Cover and Climate Change: Impacts on River Flows in Semiarid Shrubland Watersheds

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Introduction

- Fire in Mediterranean-Type Ecosystems (MTEs) dramatically alters watershed land cover conditions and initiates vegetation recovery sequences (pyric succession) that span many decades

- Complexity and uncertainty around vegetation long-term recovery rates presents a major challenge to modeling the current and future response of river flows to different fire regimes

- Hydrologic uncertainties are amplified by potential changes in future climatic conditions

- Increased ignition sources associated with growing human population and expected changes in climatic conditions are likely to increase fire frequencies in shrubland watersheds, typical of MTEs

Hypothesis

Changes in the fire regime and climate will alter aggregate ecosystem conditions giving rise to modified long-term river flow characteristics

Study Site

Santa Cruz

- Area: 192 km^2
- MAP: 496 mm
- MAQ: 1.7 * 10^7 m^3
- Mean elevation: 1027 m
- Mean slope: 43%

Gibraltar

- Area: 559 km^2
- MAP: 680 mm
- MAQ: 6.0 * 10^7 m^3
- Mean elevation: 1035 m
- Mean slope: 44%

Methods

Anticipated Results

- An improved understanding and quantification of the hydrologic consequences of land cover and climate change associated with different fire regimes in MTE semiarid shrubland watersheds

- Improved hydroecological modeling algorithms for semiarid shrubland watersheds

- Improved satellite-based models for deriving leaf area index (LAI) in these ecosystems

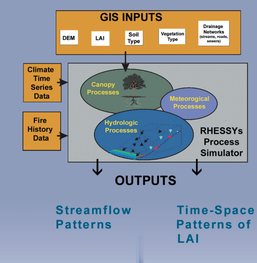
- A time-series of regional LAI maps that will be available for other investigators and for comparison with other LAI products (e.g., MODIS standard products)

- An integrated fire regime, climate and hydroecological modeling system that can incorporate improved sub-models for future research in MTE landscapes

Methods

RHESSYs

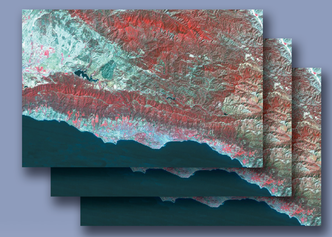
Regional Hydro-ecologic Simulation System (RHESSYs)



Streamflow Patterns

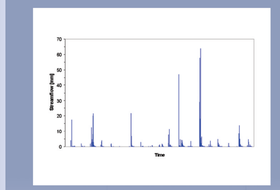
Time-Space Patterns of LAI

Remote Sensing Time Series
(Landsat Thematic Mapper Imagery)



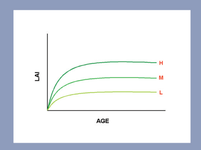
- Transform using spectral vegetation indices / spectral mixture analysis
- Convertion of indices / green vegetation fraction to LAI

Bivariate Calibration and Verification
(Streamflow and LAI)



Observed Daily Streamflow

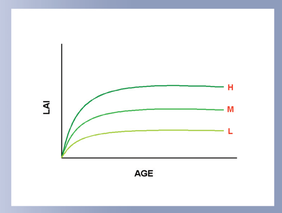
RHESSys calibrated using daily streamflow verification based on tgemporal streamflow and spatial variation in LAI and post-fire LAI recovery trajectories



Post-fire LAI Dynamic

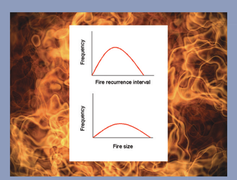
Spatial LAI Patterns

LAI Chronosequence



- LAI chronosequence derived from TM data and fire history
- Chronosequences derived for different landscape productivity units (high, medium, low)

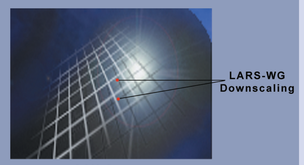
Fire Simulator



Hypothesis Testing

Simulation	Fire Regime		Climate Regime
Baseline (current) Scenarios	Observed (fire history maps)		Observed (climate stations)
	Synthetic fire regimes at current freq. (40-60 yrs) and current distribution		Synthetic LARS-WG climate based on current climate means and variability
Projected Future (Altered) Scenarios	20% increase	current size smaller fire size larger fire size	Synthetic LARS-WG climate based on GCM derived climate means and variability
	40% increase	current size smaller fire size larger fire size	
	80% increase	current size smaller fire size larger fire size	

Climate Simulator



GCM Output (VEMAP)

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