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

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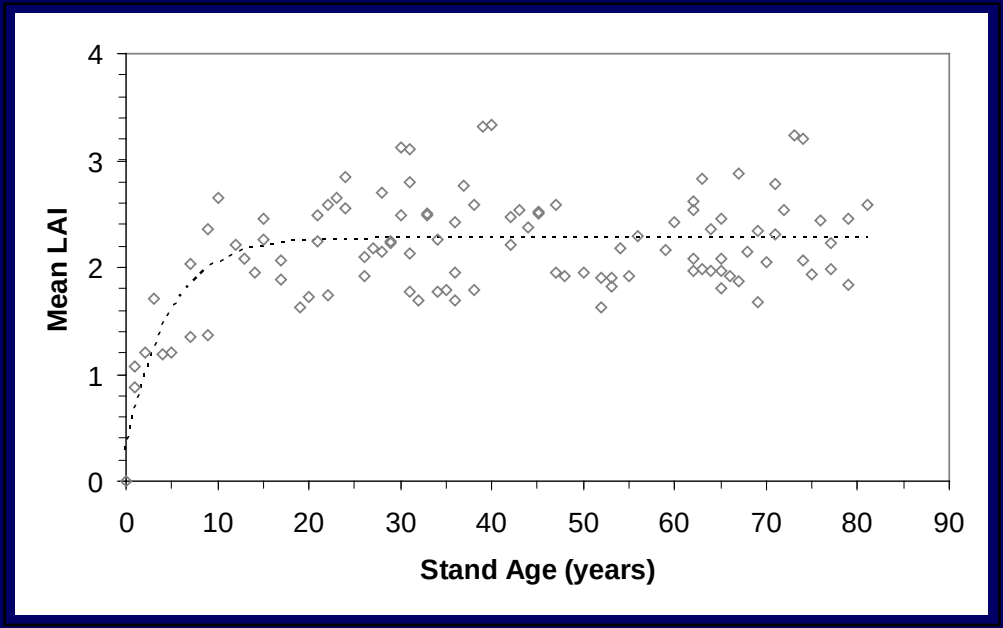
How do fire regimes and modifications to these regimes effect river flow characteristics in chaparral dominated ecosystems?

A goal is to investigate the interaction between climate change, fire regimes and river flow characteristics

CHAPARRAL POST FIRE LAI PATTERNS USING THEMATIC MAPPER NDVI DATA

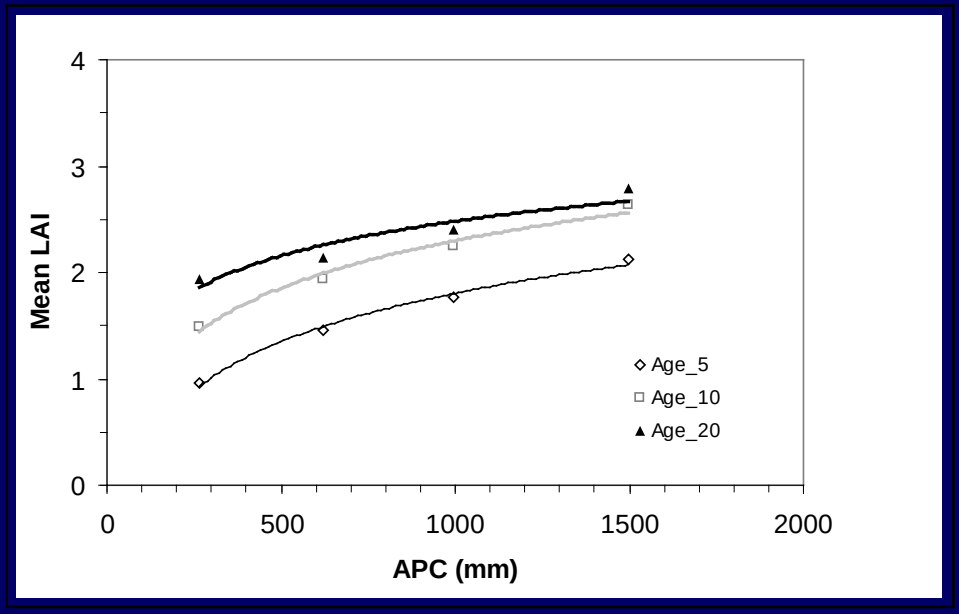
- A carefully intercalibrated time series of Thematic Mapper images (N=25) has been developed and used to derive post-fire LAI recovery trajectories. These trajectories have been shown to be suitable inputs for hydrologic models (e.g., MIKE-SHE) and for calibrating coupled carbon and hydrologic models (e.g., RHESSys).



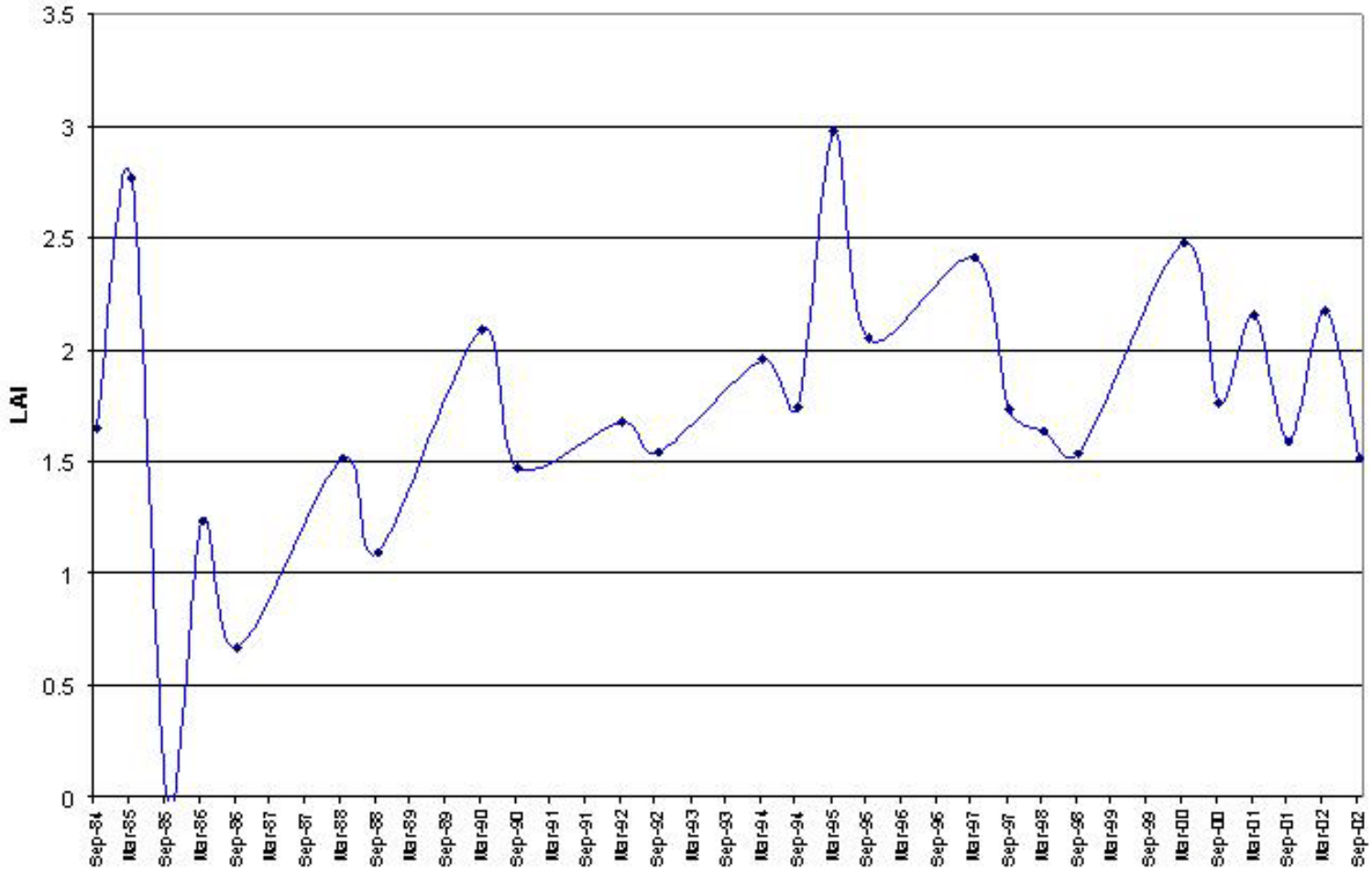
LAI Stand Age Relationship

Thematic Mapper Chronosequence Approach

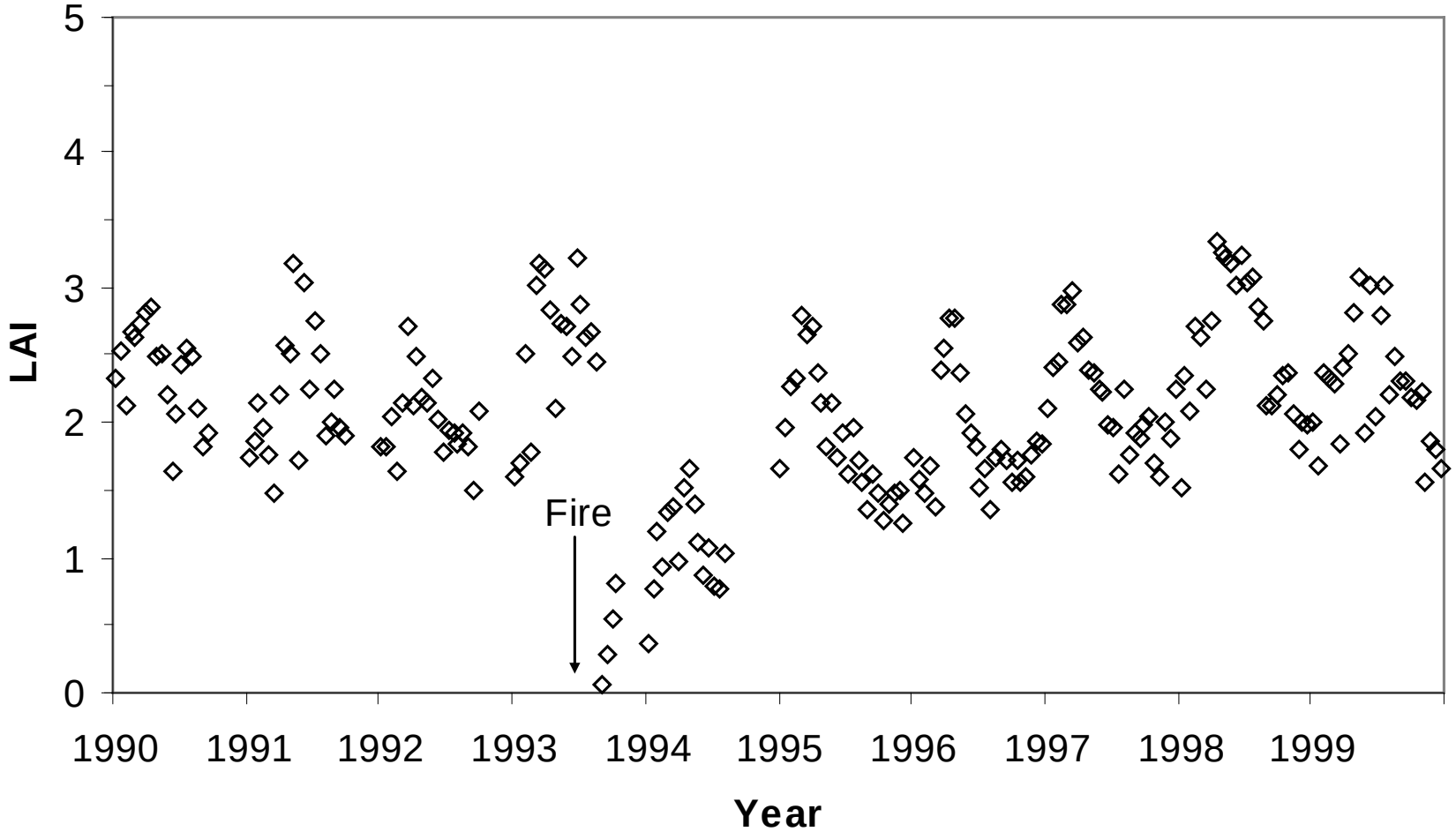
LAI Antecedent Precipitation Relationship



Jameson average LAI – from TM/ETM NDVI data



AVHRR

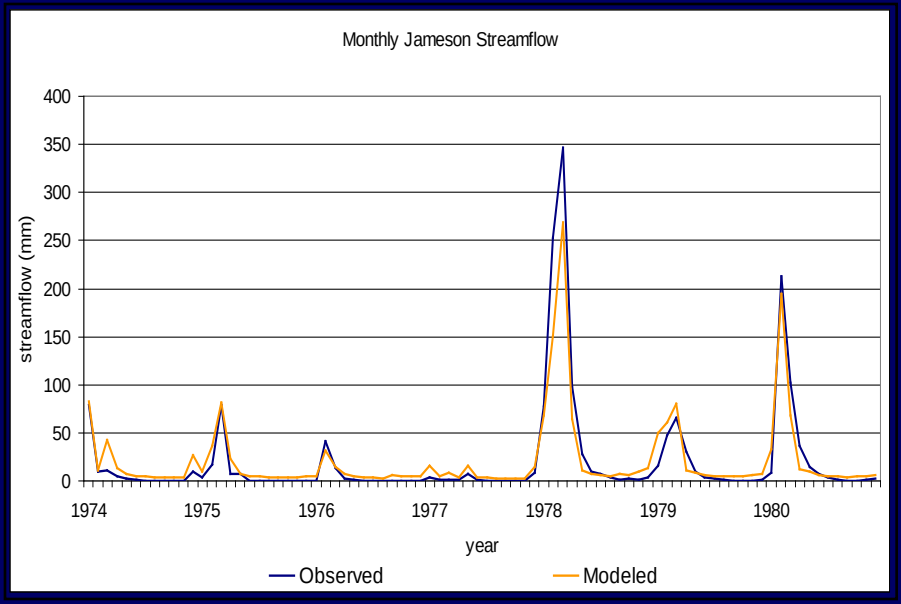

5
4
3
2
1
0
LAI
Fire
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Year

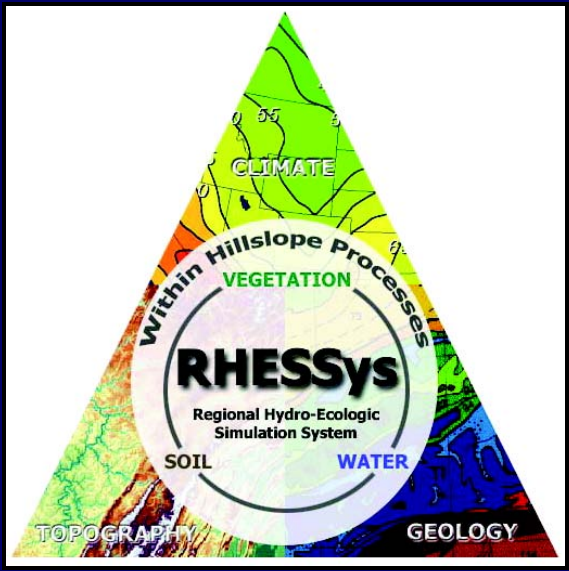
BI-VARIATE MODEL CALIBRATION

- Bi-variate calibration of RHESSys (gaged streamflow, satellite-derived LAI) has been successful following adaptations to the model and with a priori knowledge of vegetation type. Spatial patterns of LAI provided by Thematic Mapper data provides a means to validate modeled internal watershed conditions such as soil moisture and vegetation production.

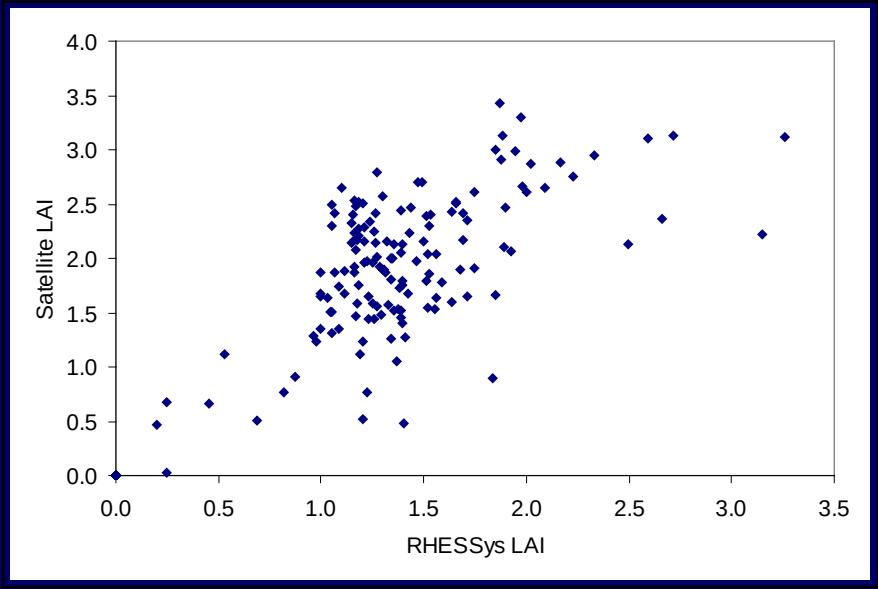
Bi-variate calibration

Monthly Streamflow





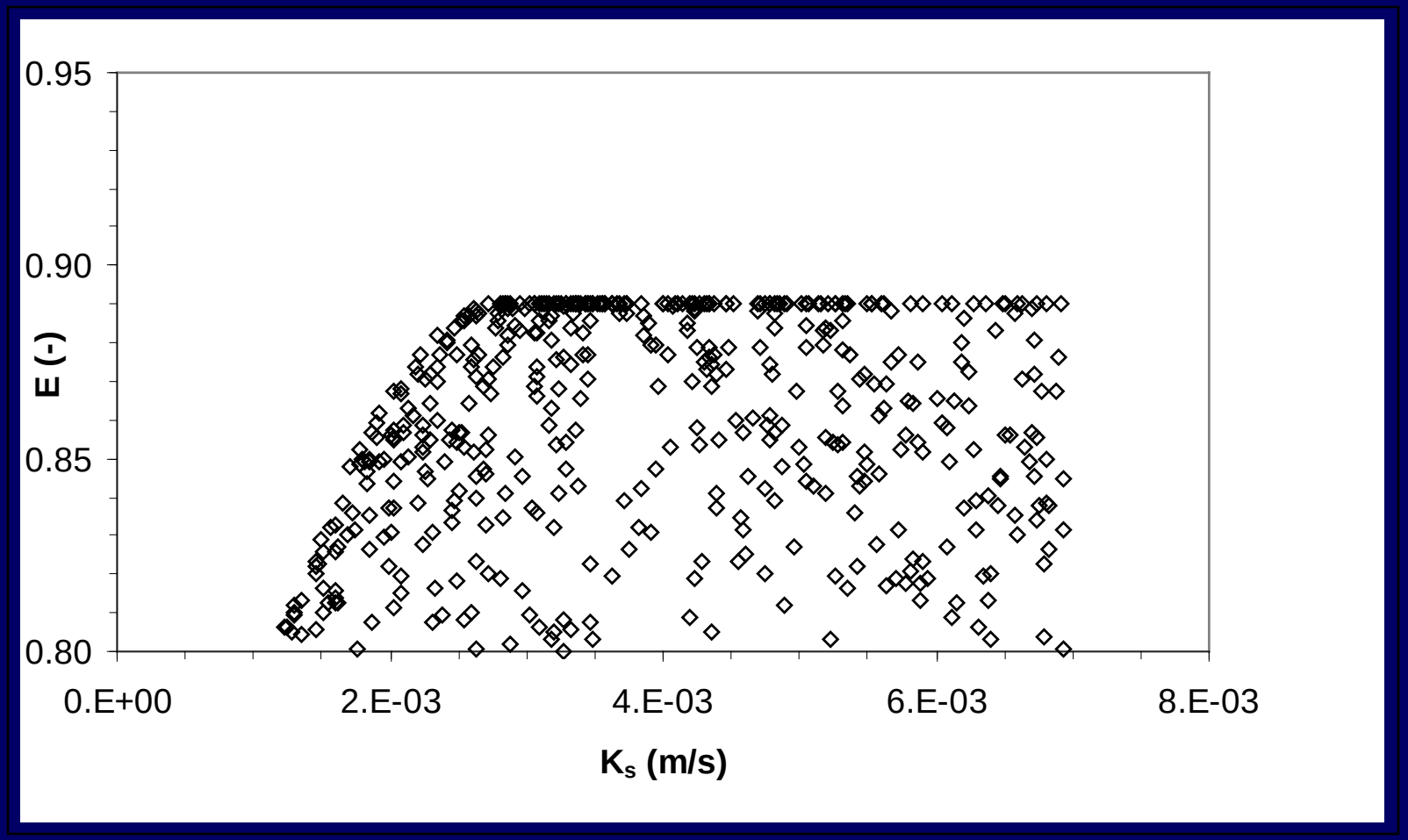
LAI
(540m resolution)



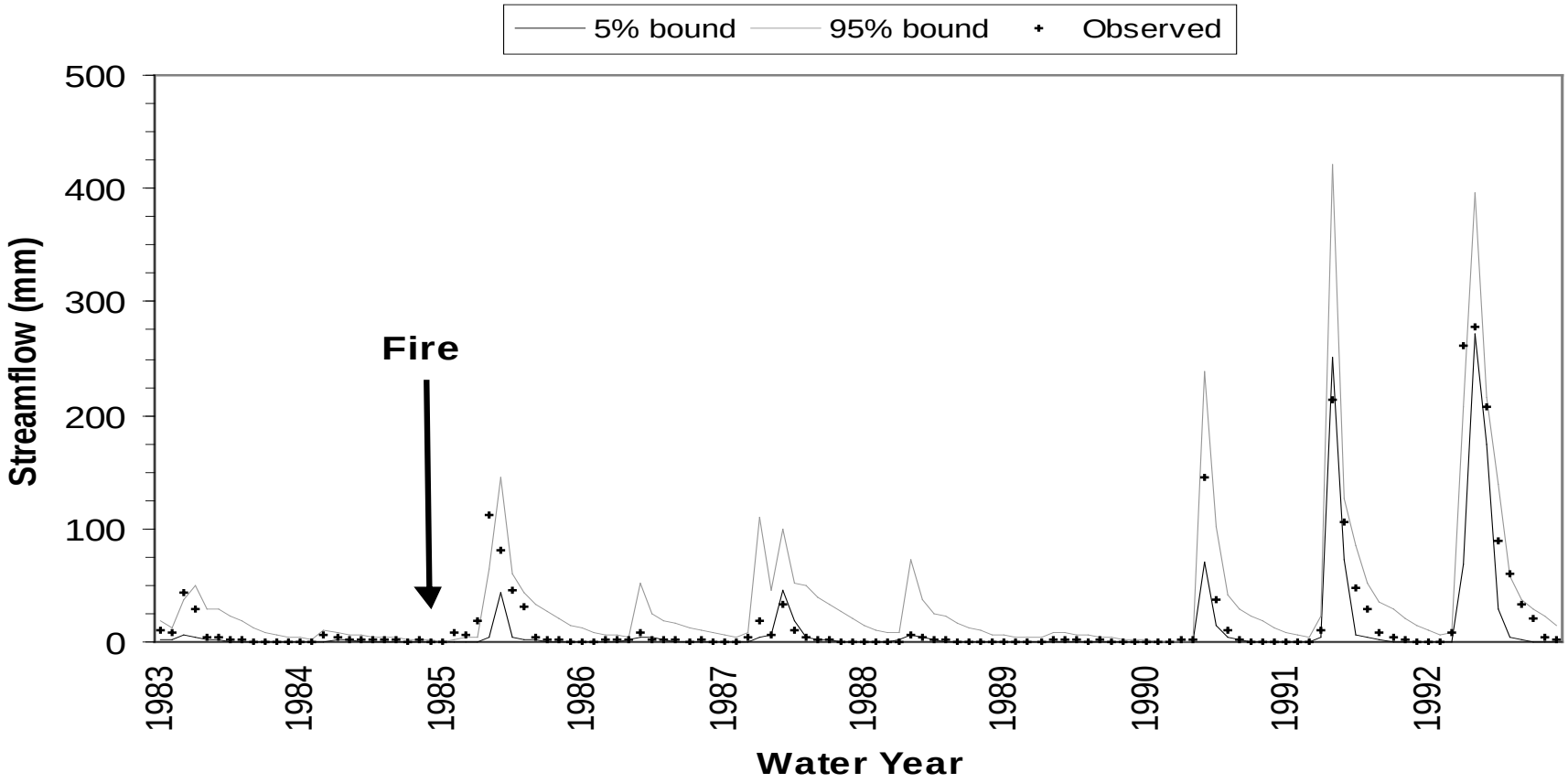
MODEL UNCERTAINTY

- Parameter equifinality gives rise to uncertainty in hydrologic and coupled carbon-hydrologic models and can be addressed using the Generalized Likelihood Uncertainty Estimator (GLUE) methodology. Spatial heterogeneity in land cover type is the primary source of uncertainty in modelled LAI.

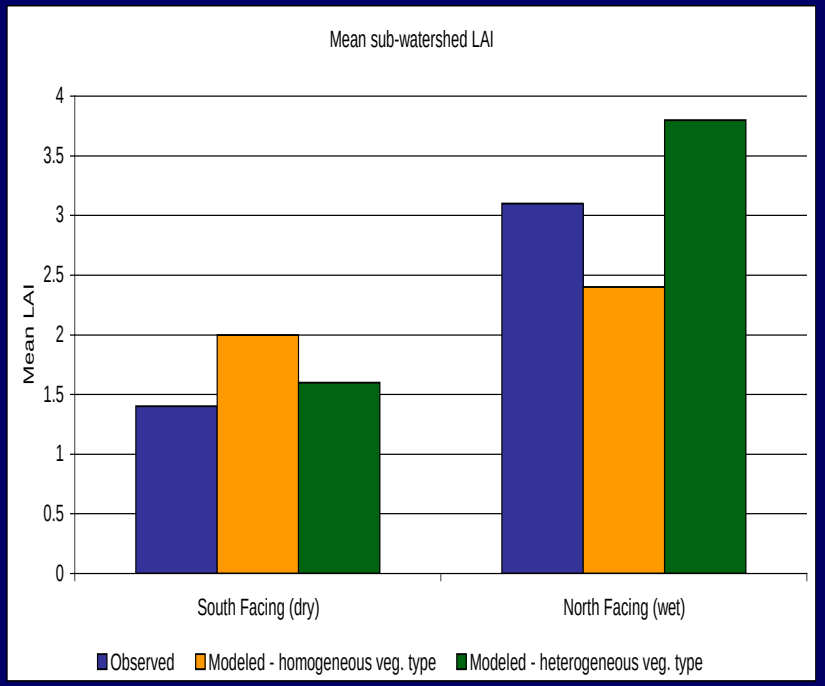
Coefficient of efficiency (observed vs. modeled streamflow) for range of RHESSys saturated hydraulic conductivity



MIKE-SHE streamflow simulation with GLUE uncertainty bounds

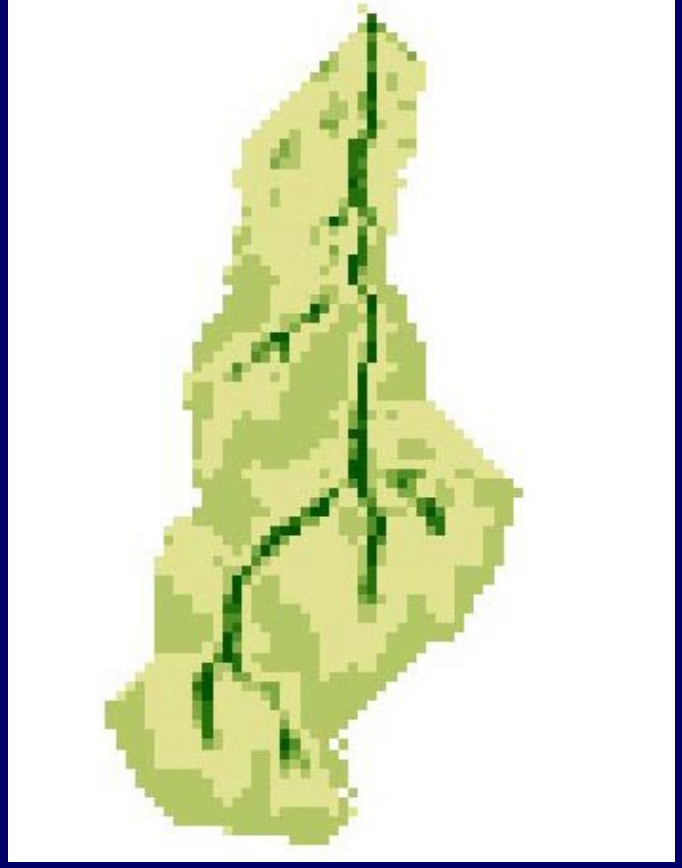


Implications of heterogeneity within Northern Mixed Chaparral - the presence of riparian oaks is significant for simulating river flows and LAI



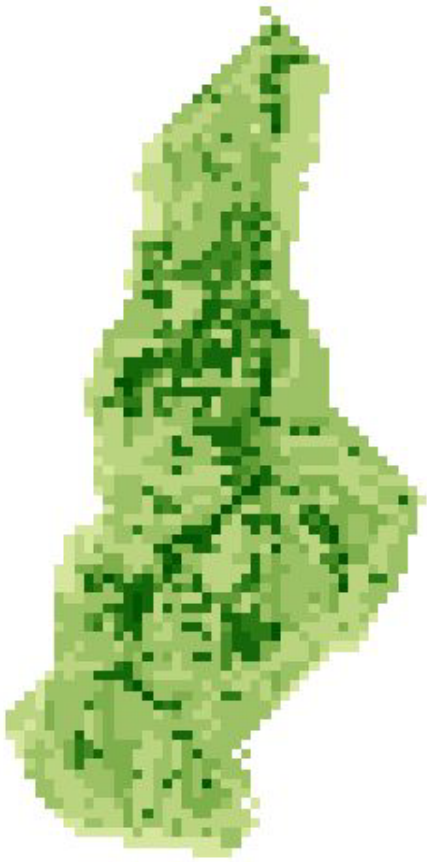
LAI - Thematic Mapper

0 - 1.0
1.1 - 1.7
1.8 - 2.4
2.5 - 2.9
3.0 - 3.4
3.5 - 4.1
4.2 - 4.9
5.0 - 6.1
6.2 - 10.4



LAI - homogeneous

2.1- 2.2
2.3- 2.6
2.7- 3.0
3.1 - 3.5
3.6 - 4.0
4.1 - 4.7



LAI - heterogeneous

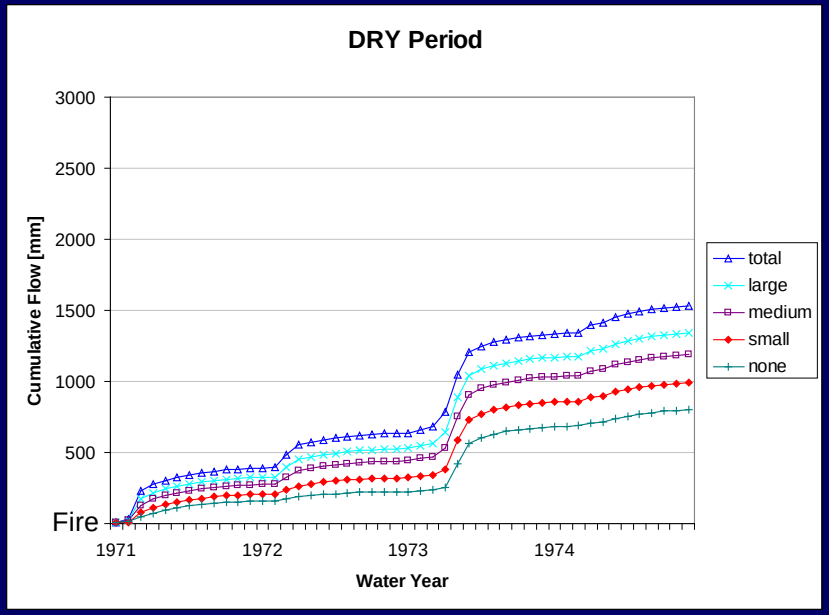
0 - 1.0
1.1 - 2.2
2.3 - 2.7
2.8 - 4.0
4.1 - 8.4
8.5 - 9.0
9.1 - 9.4
9.5 - 9.8
9.9 - 10.8

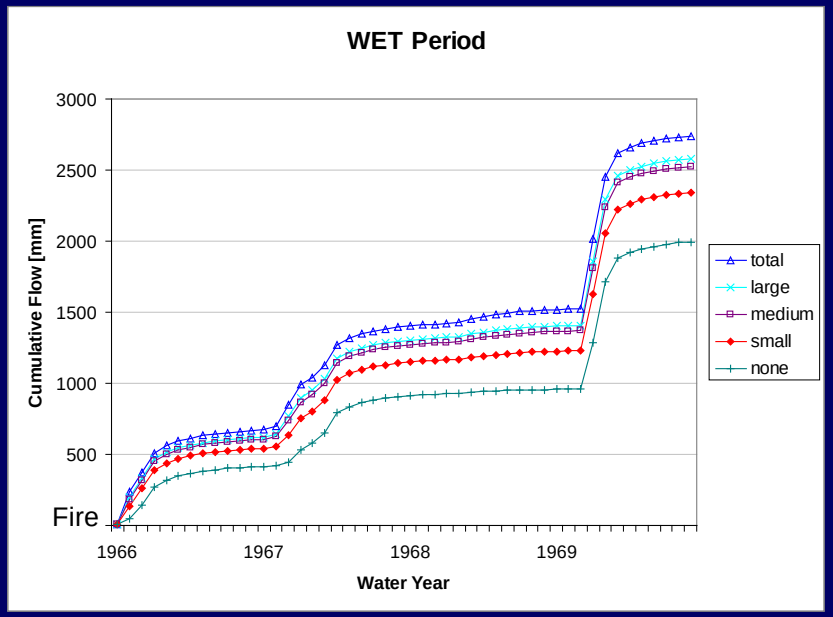
HYDROLOGIC RESPONSE TO FIRE

- Results based on the calibrated MIKE-SHE model indicate that there is a systematic relationship between the area burnt in a watershed and the resulting increase in river flow in the first 4 – 5 years after fires. The absolute change in river flow is similar for wet and dry periods, but represents a larger fraction in the dry period flows.

MIKE-SHE simulated streamflow following fire

(for range of fire sizes)





Methodological Outcome

Robust research methodology for application in other watersheds/regions and for land use/land cover change/climate change scenarios:

- Thematic Mapper NDVI-LAI approach.
- Model calibration based on river hydrograph and satellite-derived LAI.

Formally address parameter equifinality.