

# A Multi-Model Ecosystem Simulator for Predicting the Effects of Multiple Stressors on Great Plains Ecosystems

*USEPA Western Ecology Division & Region 7*

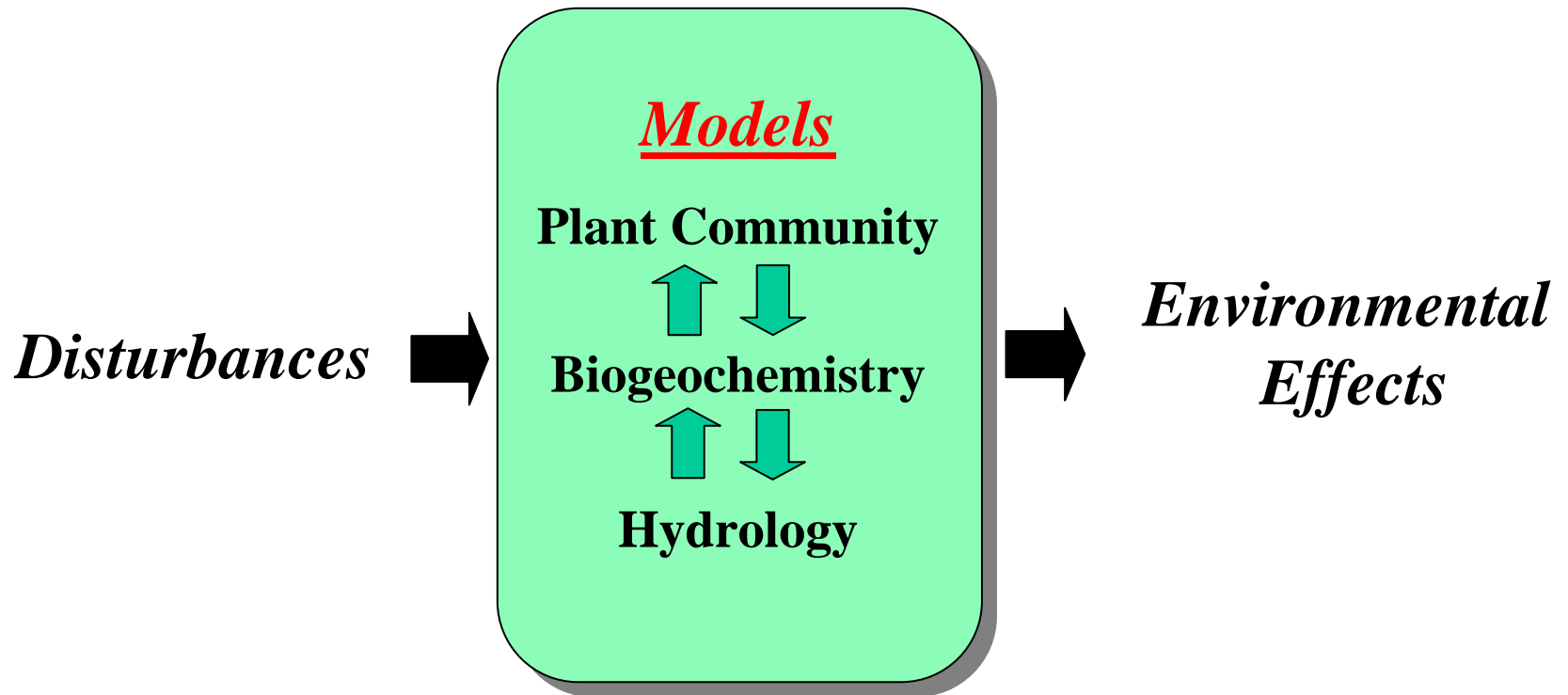
*Kansas State University, Georgia Institute of Technology, Marine Biological Laboratory*



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# *Modeling Framework & Goals*



# Modeling Framework & Goals

## Disturbances

- Vegetation change
- Climate variability
- Management
  - Fire frequency
  - Grazing intensity
  - Pesticides
  - Fertilizers



## Models

Plant Community



Biogeochemistry



Hydrology



## Terrestrial Effects

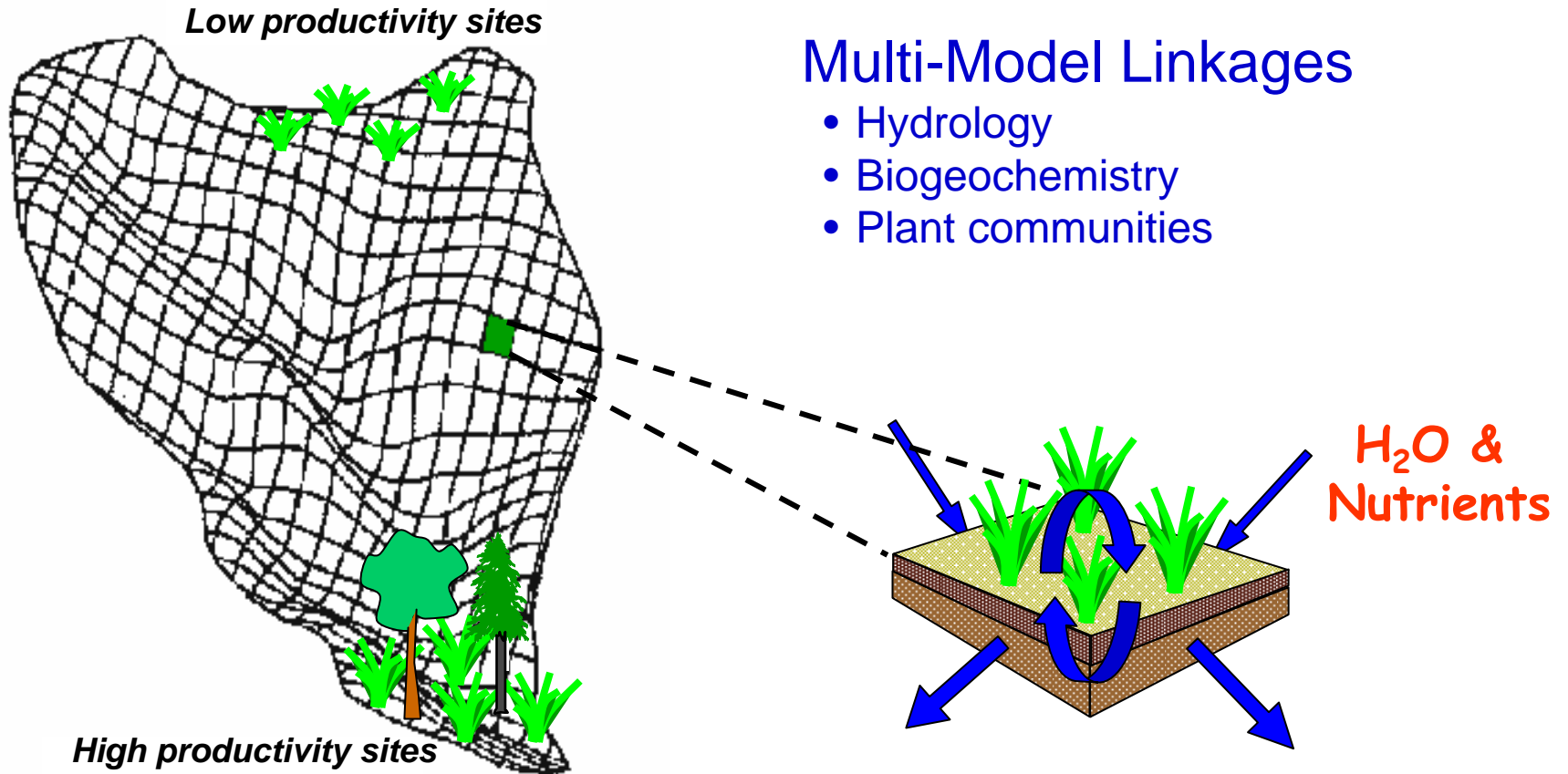
- Predict changes in vegetation type, productivity & carbon storage
- Predict fuel types & loads (input for fire & air quality models)

## Aquatic Effects

- Predict stream discharge & nutrient loads

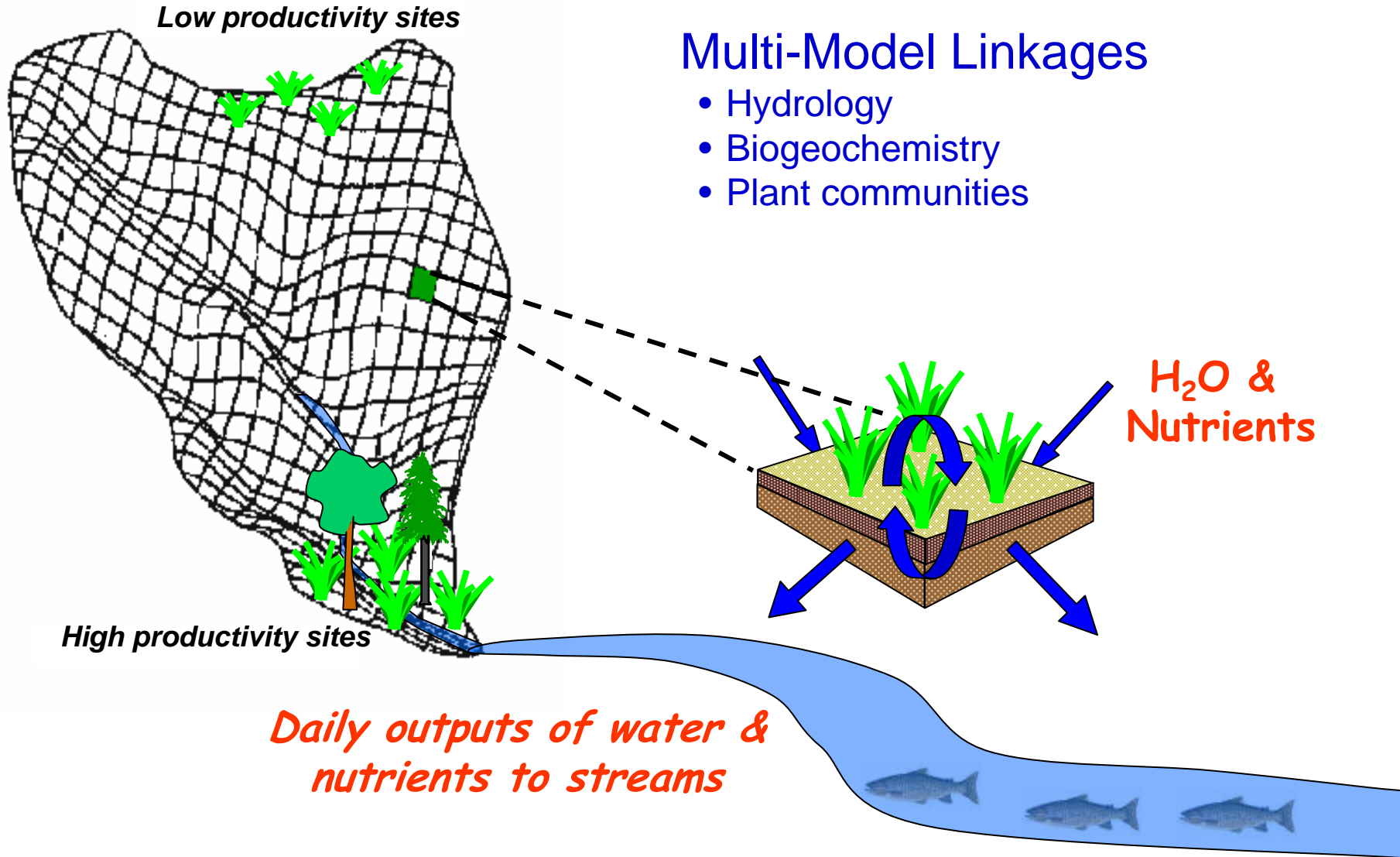
## Multi-Model Linkages

- Hydrology
- Biogeochemistry
- Plant communities



## Multi-Model Linkages

- Hydrology
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- Plant communities

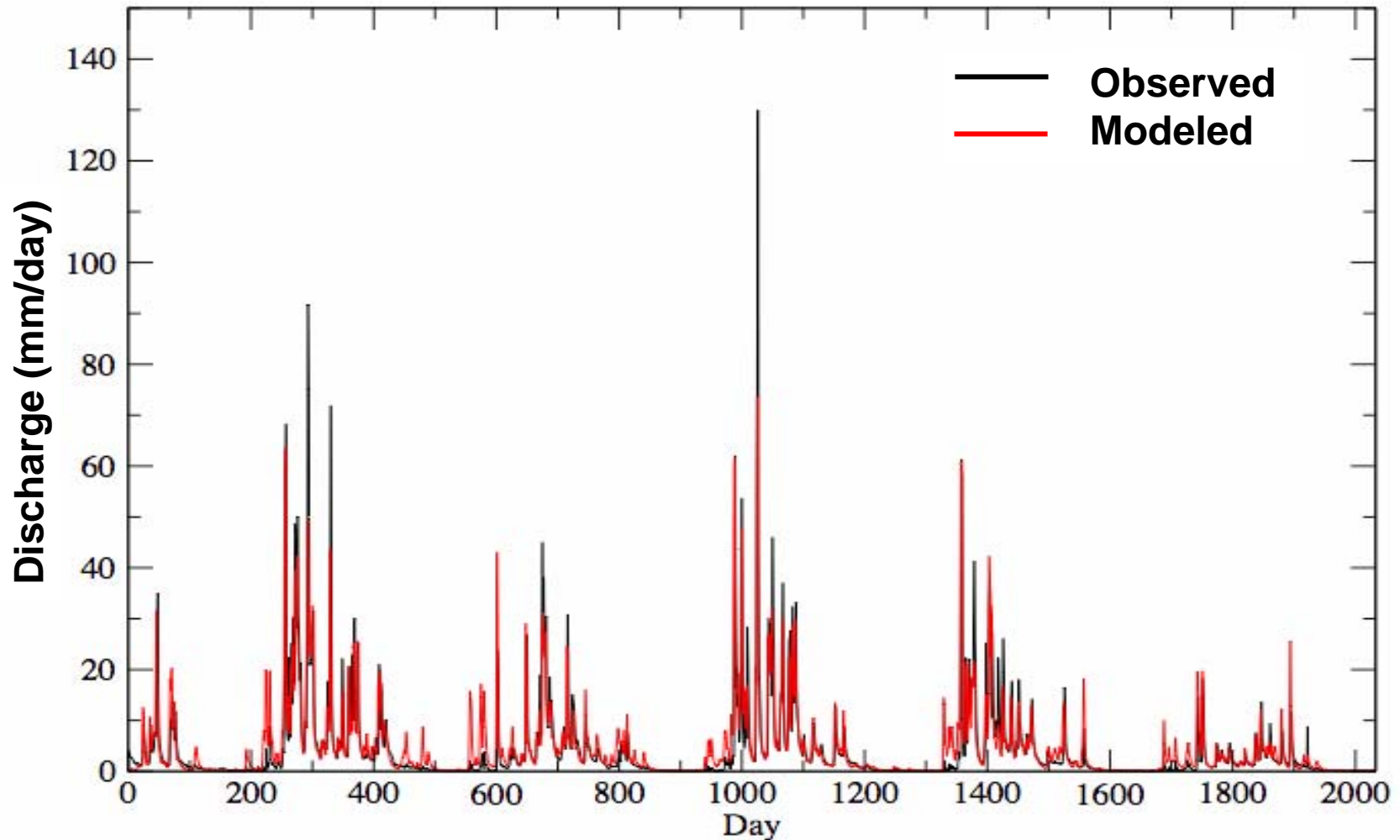


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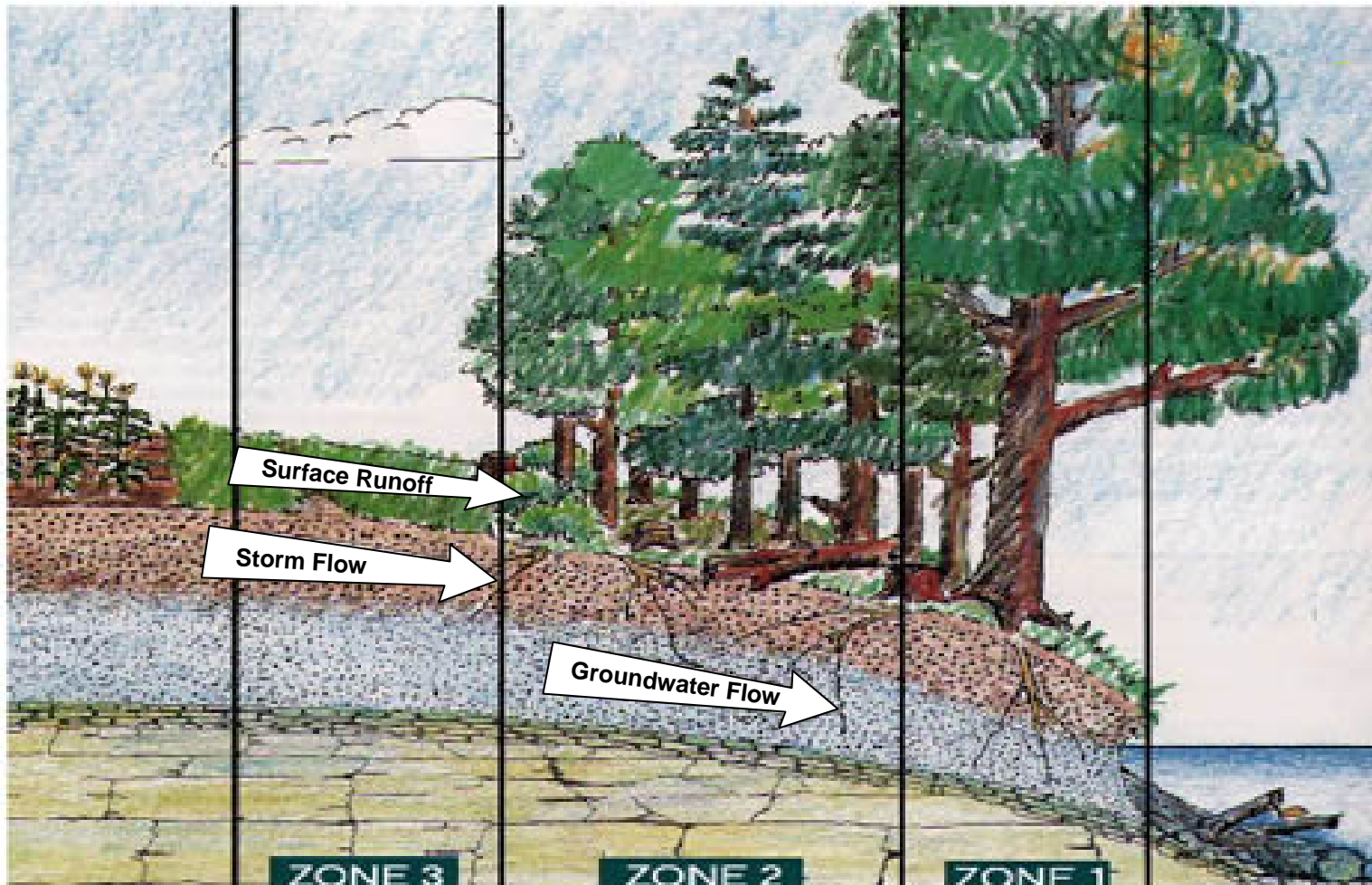
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# Stream Discharge

*HJ Andrews LTER, Oregon*



## Riparian buffer function for mitigating agricultural pollution



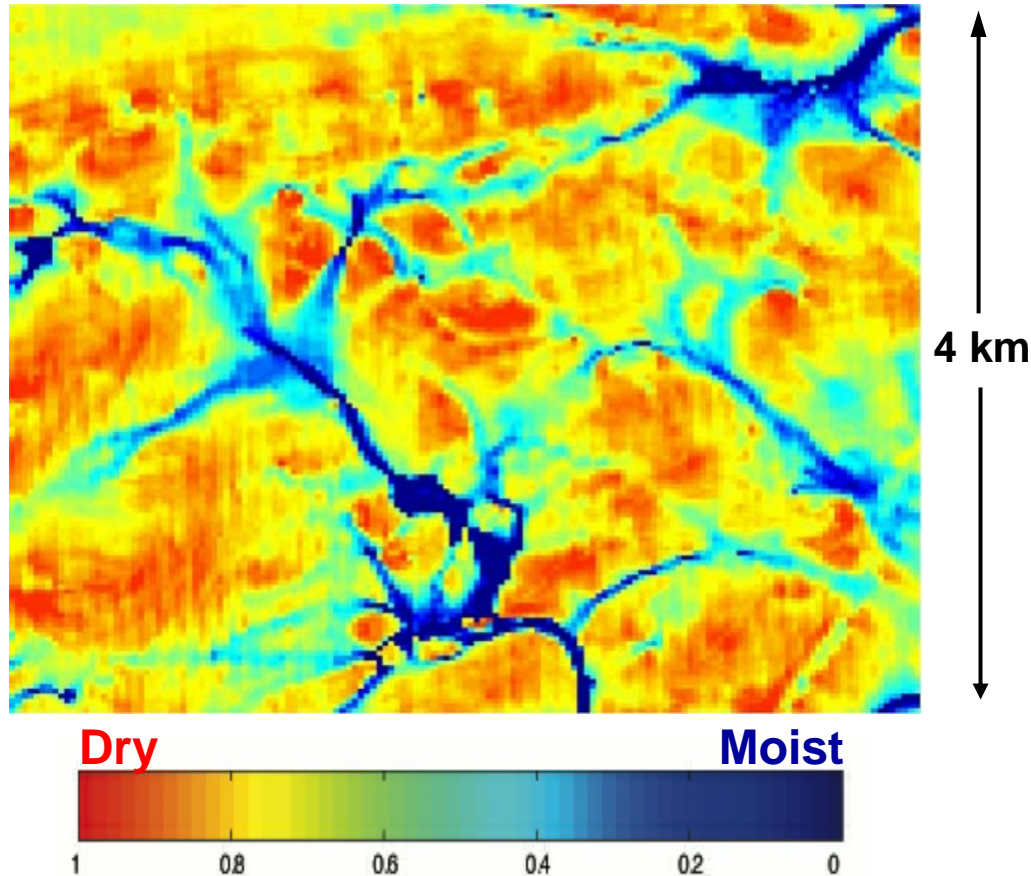
*Image credit: Chesapeake Bay Program*

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# Modeled Soil Moisture

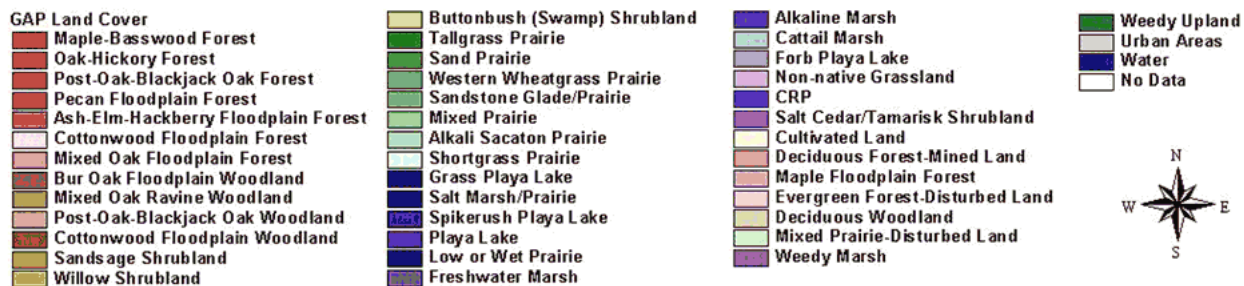
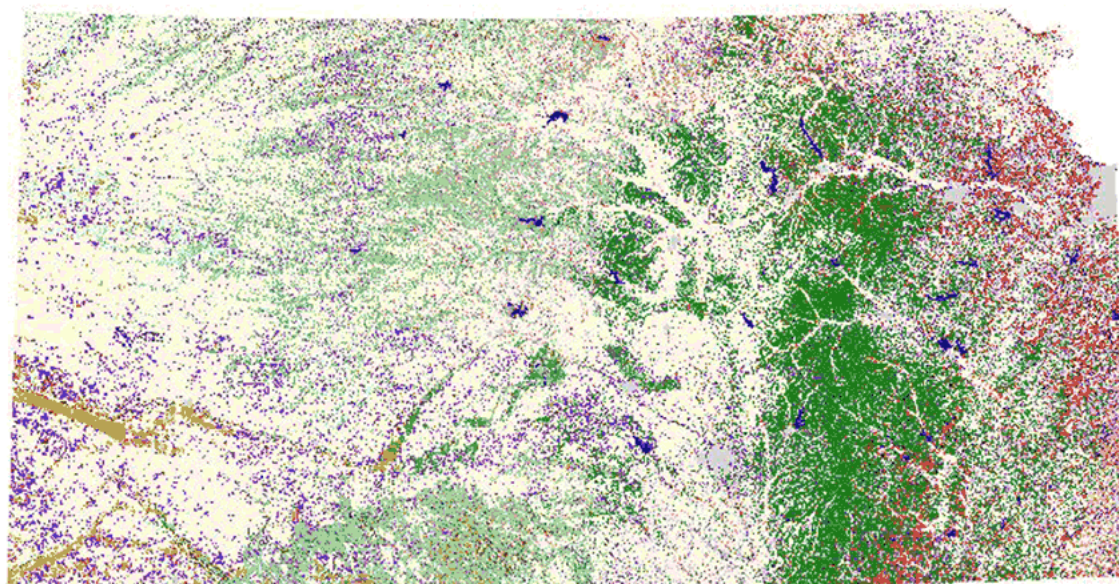
Black Rock Forest, NY



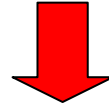
**Ridges are dry, riparian areas are moist**



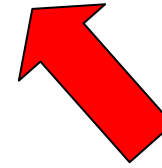
# Current Landcover of Kansas



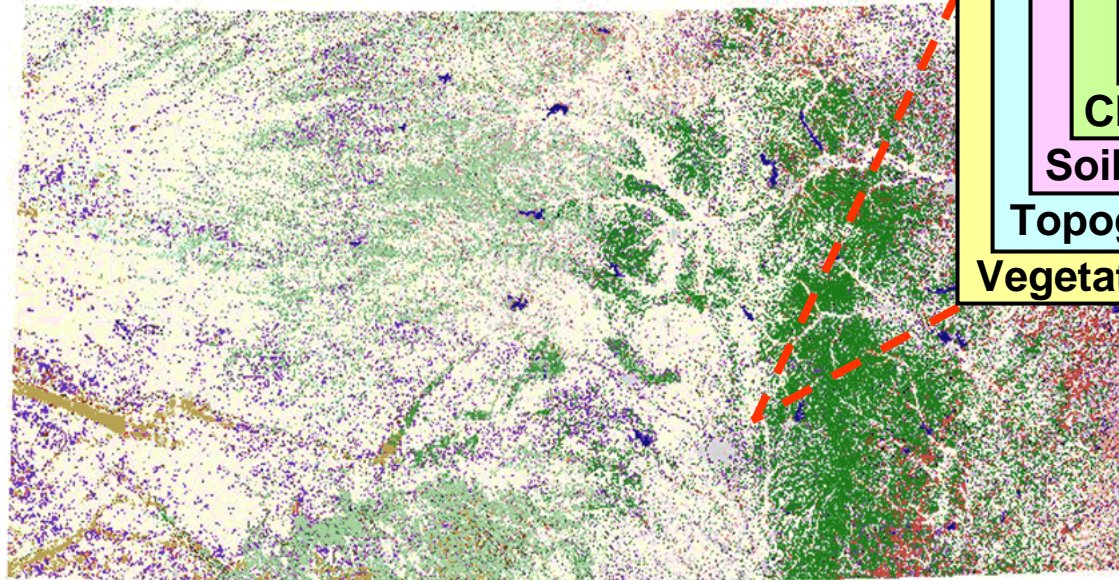
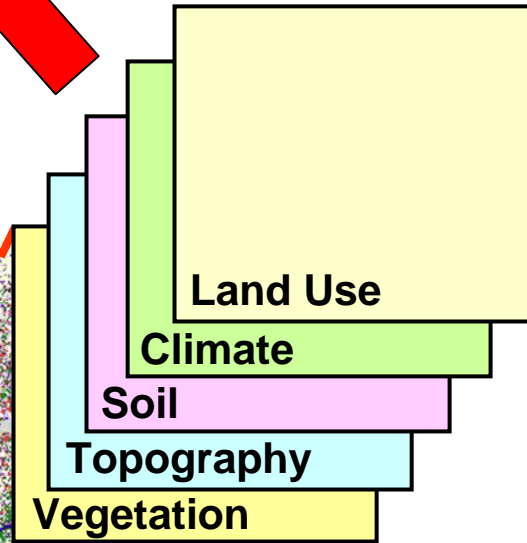
# Ecosystem Simulator



## Future Land Cover Maps *Alternative Futures?*



### GIS Data Layers



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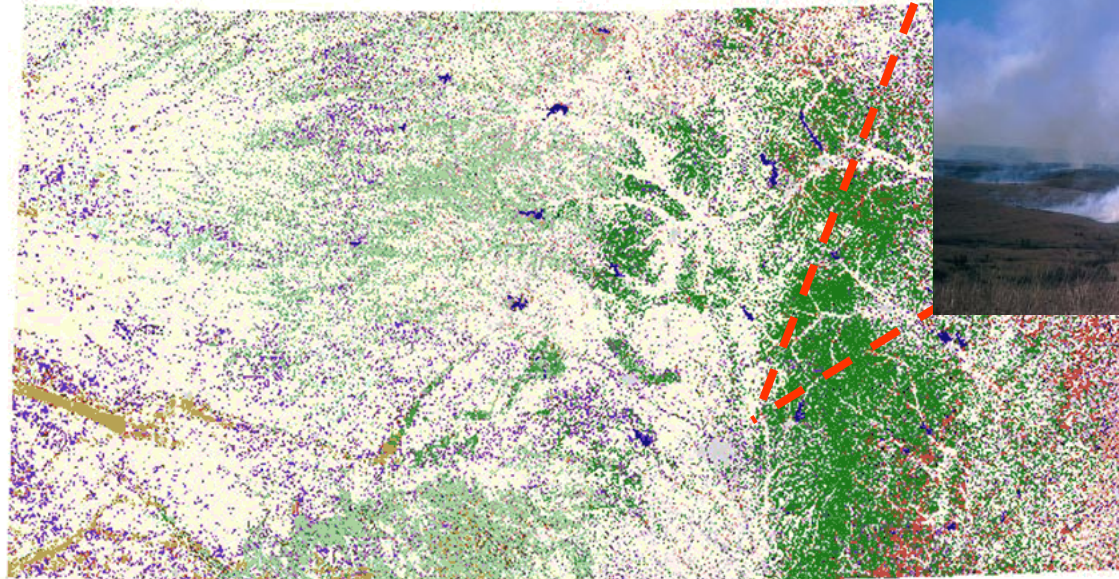
# Ecosystem Simulator



## Future Land Cover Maps *Alternative Futures?*

Links to air quality models

<http://www.blueskyrains.org/animation.html>



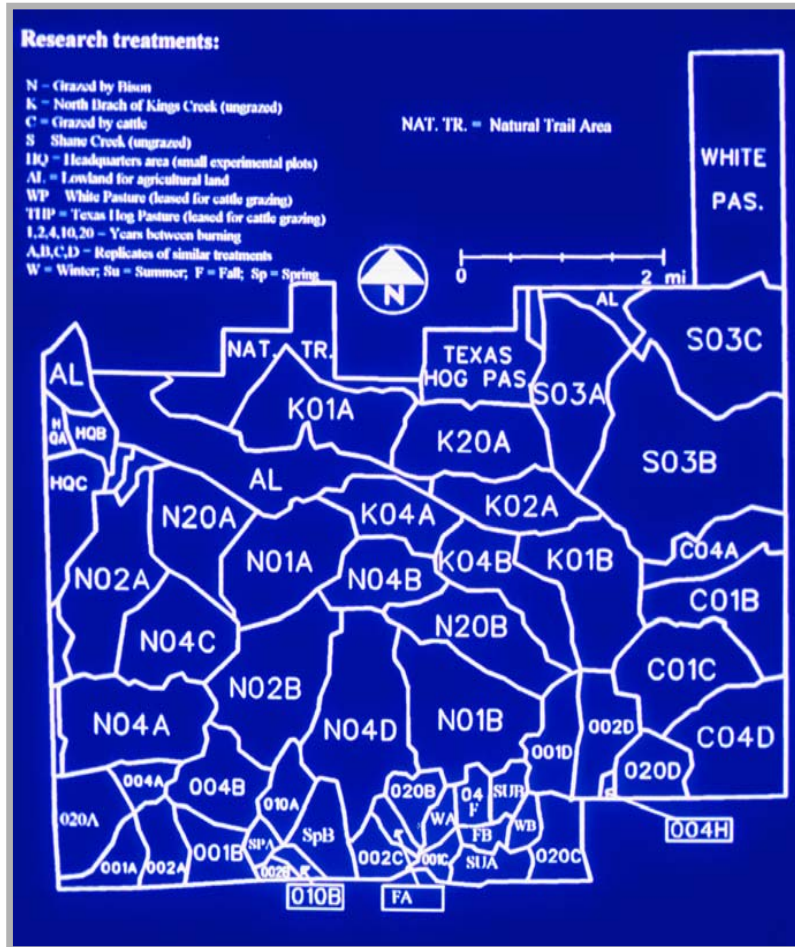
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# Work Plan

2006-2007

Konza Prairie Biological Station



2007-2008

E. Kansas / Flint Hills Region



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# ***Contributors***

## **Konza Prairie LTER & NASA Landcover Projects:**

John Blair, Loretta Johnson, Jay Ham, Shawn Hutchinson – KSU

Kevin Price, U of KS

John Briggs, AZ State

Alan Knapp, CO State

## **EPA Region 7**

Brenda Groskinsky

Mike Davis

## **Modeling**

Bob McKane, USEPA

Marc Stieglitz, GA Tech

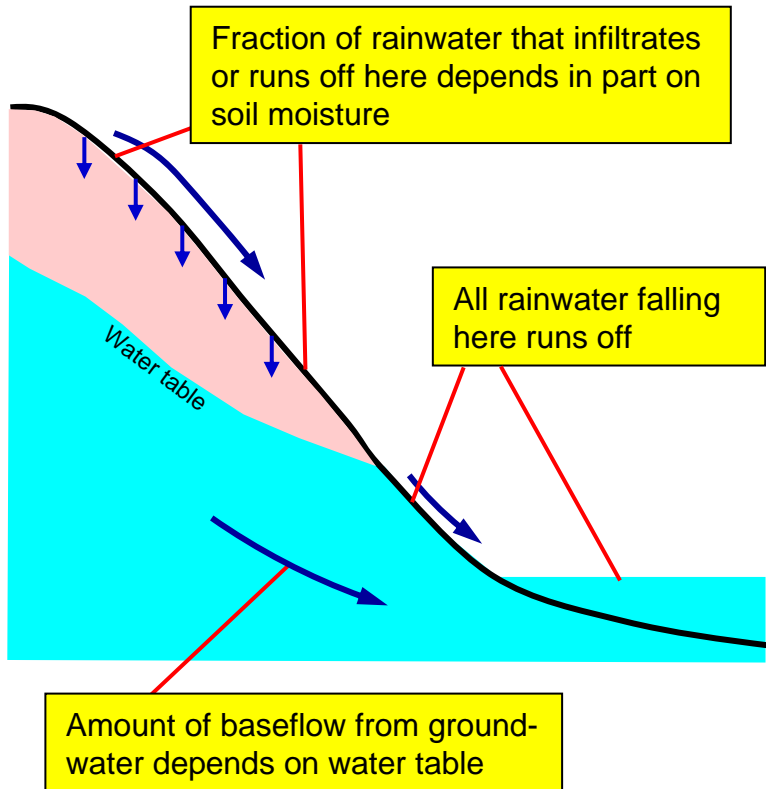
Ed Rastetter, Bonnie Kwiatkowski, MBL

Adam Skibbe, USEPA contractor

# End of 7/6/06 KSU presentation

(additional slides follow with more info on models, etc )

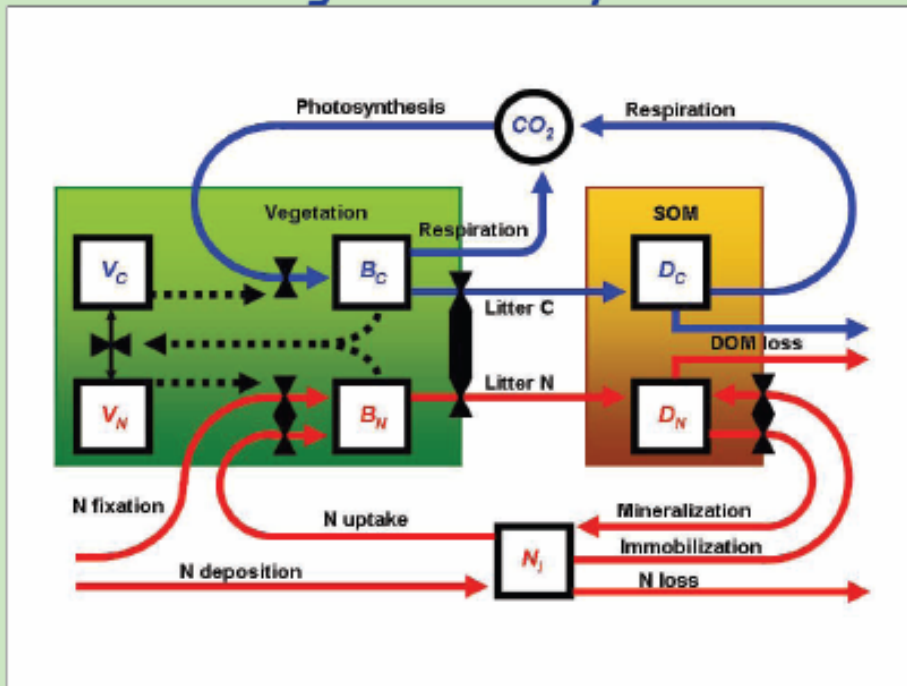
# Georgia Tech Hydrology Model



## Key Features:

- Explicitly accounts for topographic controls on soil moisture, based on contributing upslope area and the local slope angle.
- Predicts 3 components of discharge to streams: surface runoff, stormflow (unsaturated zone) & baseflow (saturated zone).
- Predicts spatial distribution of soil moisture (vertical & horizontal) within watersheds.

## MEL Biogeochemistry Model



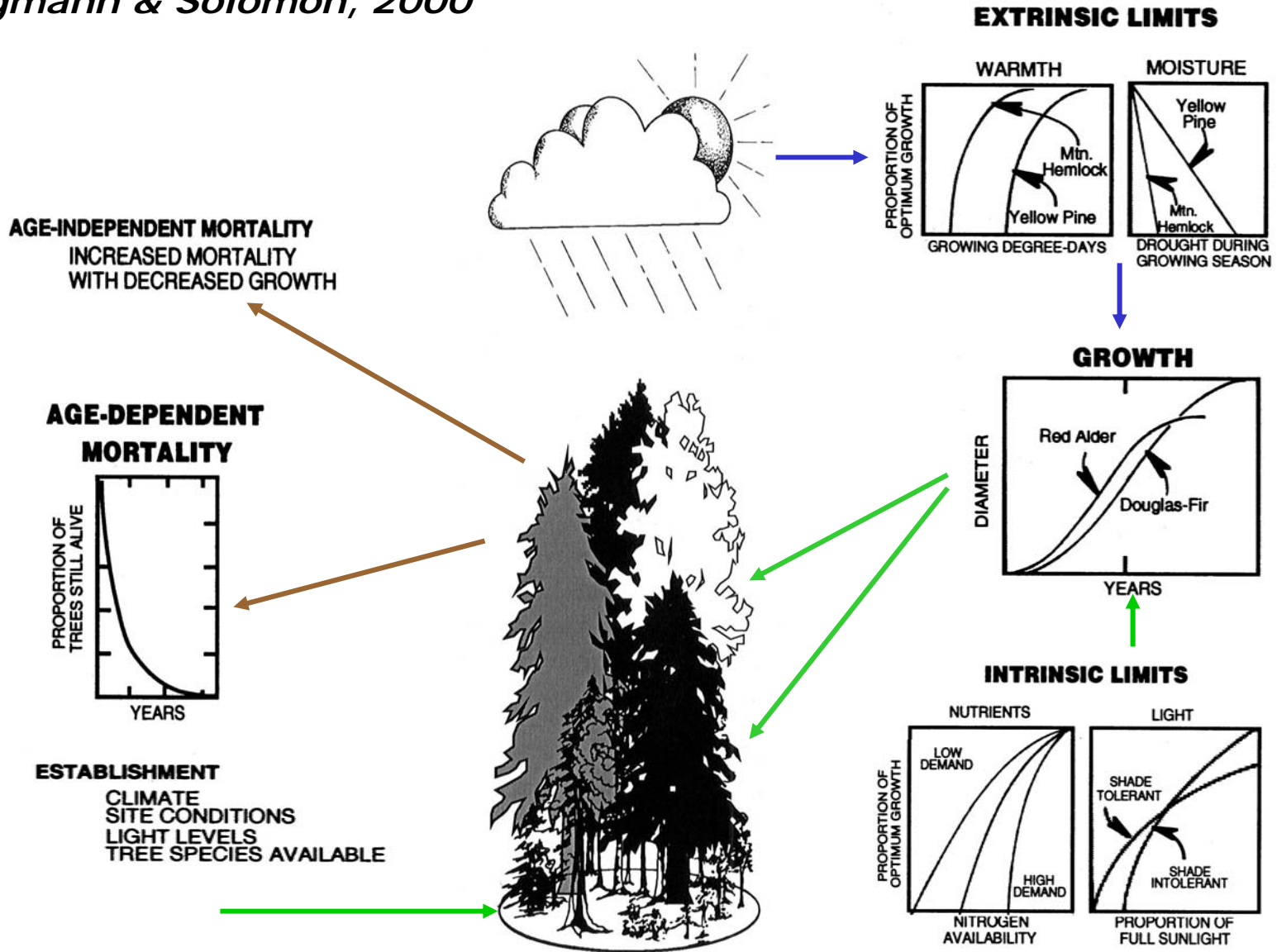
### Key Features:

- Cycles simulated: C, N, P, & H<sub>2</sub>O
- Resources simulated: H<sub>2</sub>O, PO<sub>4</sub>, NH<sub>4</sub>, NO<sub>3</sub>, N fixation, DON, CO<sub>2</sub>, light
- Predict effects of land use, climate, chemicals & air pollutants on plants & soils
- Simulate daily to century-scale responses to multiple stressors
- Applicable to any terrestrial ecosystem: grasslands, forests, tundra, ag systems...



# FORCLIM PLANT COMMUNITY MODEL

*Bugmann & Solomon, 2000*



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# **NASA Land Cover Change Project**

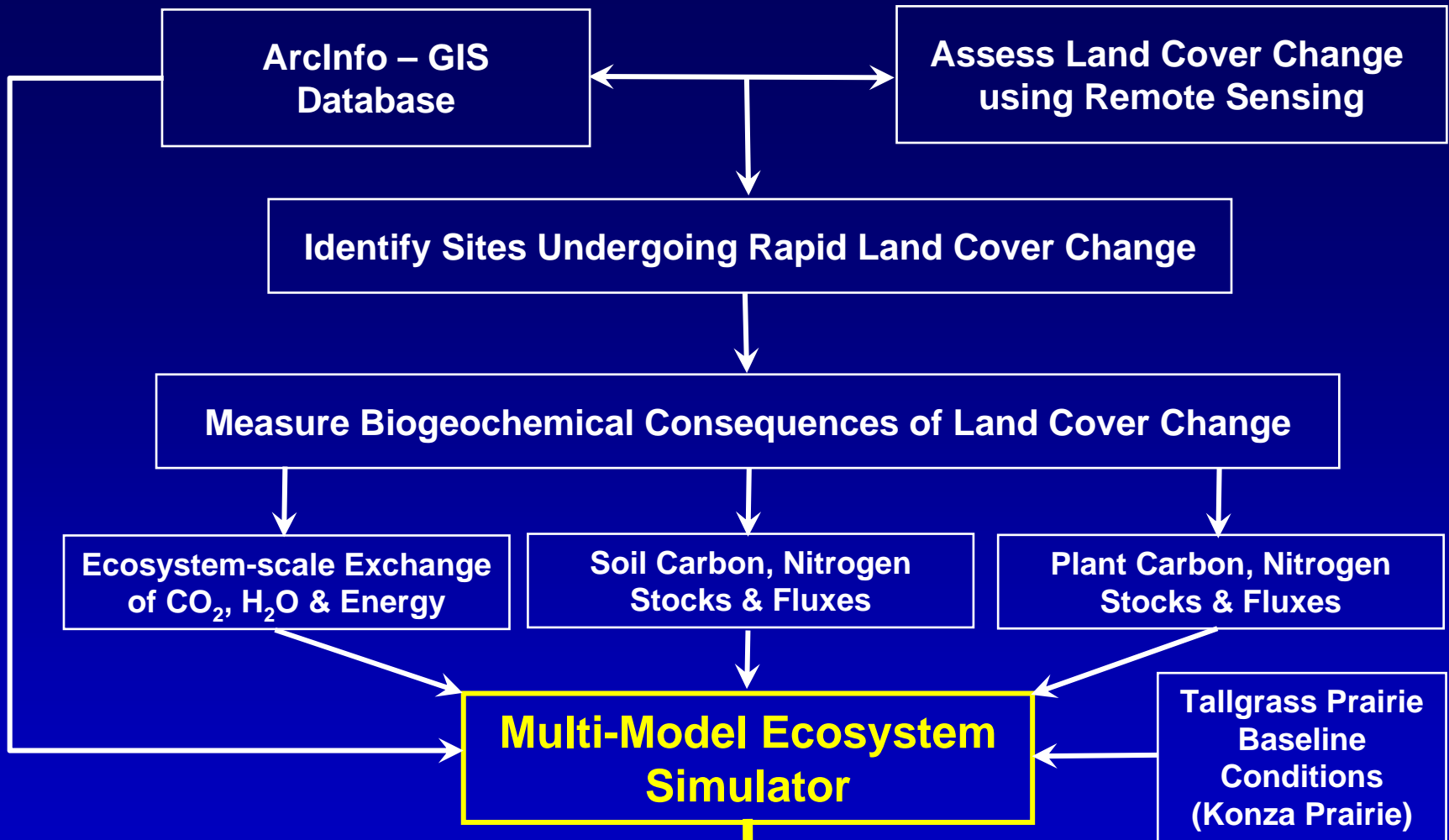
*Project leader: Dr. Loretta Johnson, KSU*

- 1. Determine historical rates and patterns of woody encroachment in the Great Plains.**
- 2. Quantify consequent changes in ecosystem carbon, nitrogen & water cycles.**
- 3. Develop models to forecast & diagnose regional patterns of woody encroachment and its effect on land, air & water resources.**



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***Forecast and Diagnose Effects of Land Cover Change on Regional Land, Air & Water Resources***

# ***EPA Program Office Clients***

## **OPPTS (pesticides & toxics)**

- Improve habitat & wildlife modeling

## **OW & OWOW (water quality)**

- Improve watershed & water quality modeling
- Assess BMP strategies for achieving TMDL criteria

## **OSWER (solid waste)**

- Improve diagnostics for contaminated sites
- Improve predictions for clean-up & restoration

## **OAR (air quality)**

- Improve models for assessing effects of atmospheric nitrogen deposition on watersheds.
- Link biomass, fire & air quality models?