Are All Forest Fires Evil?

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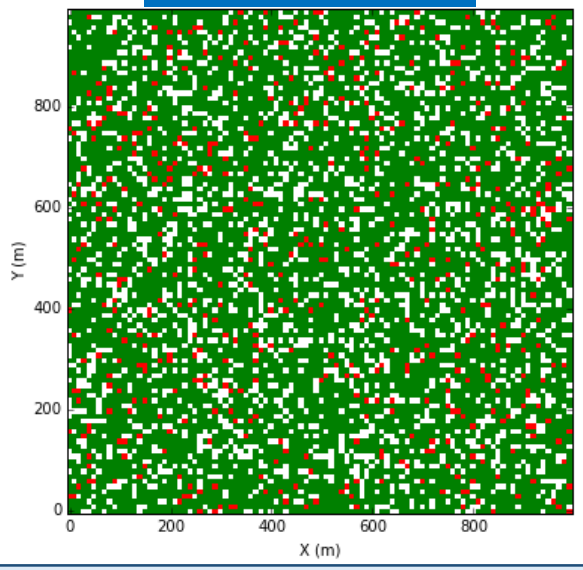
Let's look at model results

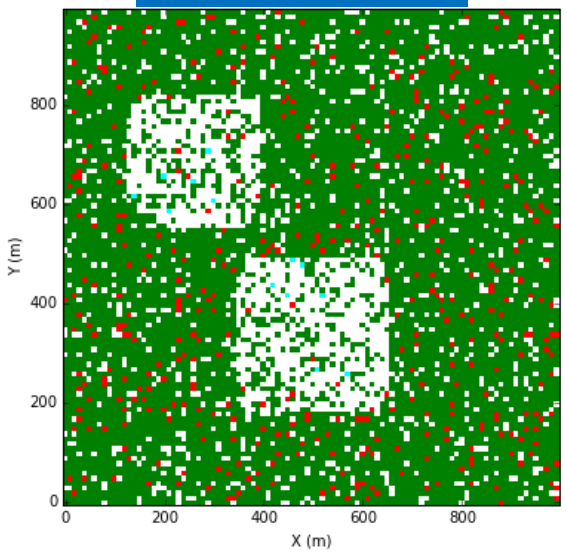
No Fires – Uncontrolled Grazing

Vegetation



Fires –Controlled Grazing

Vegetation



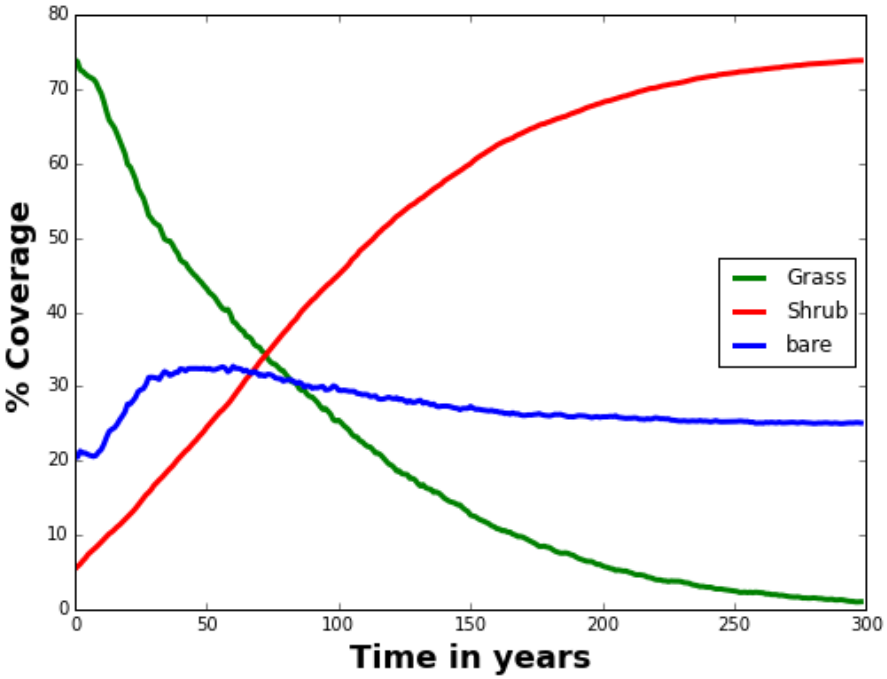
Shrubs | Grass | Bare | Burnt Shrubs | Burnt Grass

Game of Life type Cellular Automata Model

*Ravi, Sujith, and Paolo D'Odorico. "Post-fire resource redistribution and fertility island dynamics in shrub encroached desert grasslands: a modeling approach." *Landscape Ecology* 24, no. 3 (2009): 325-335.

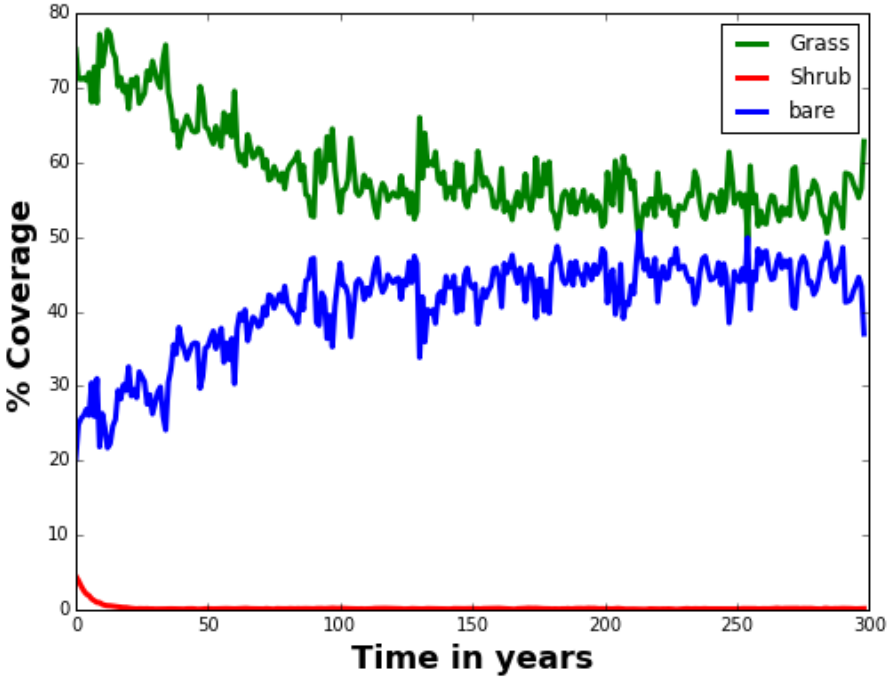
I am a Scientist – I Love Plots!

No Fires – Uncontrolled Grazing



- Implies shrub encroachment into grassland

Fires –Controlled Grazing

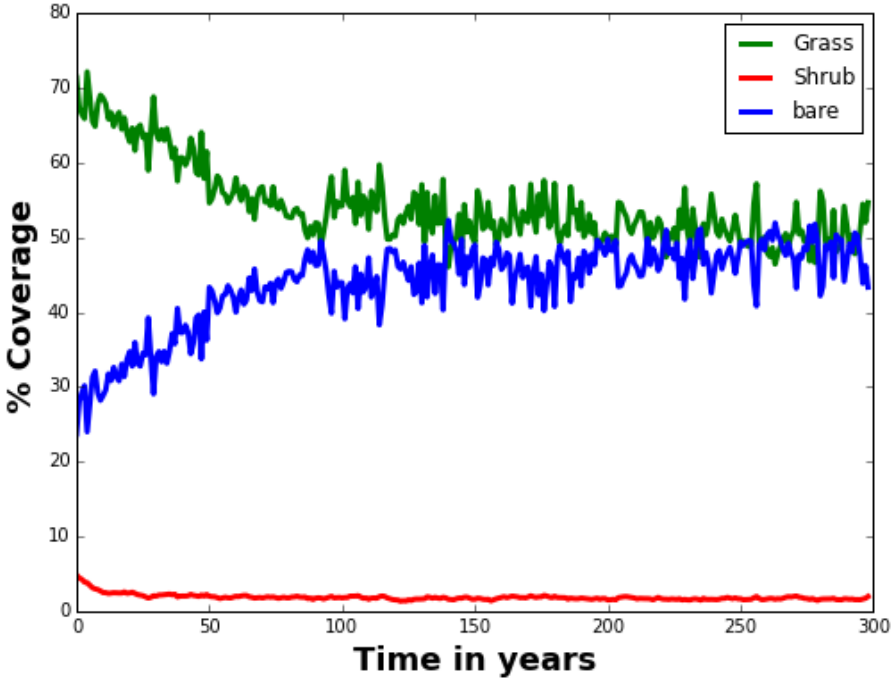


- Implies grasslands are healthy

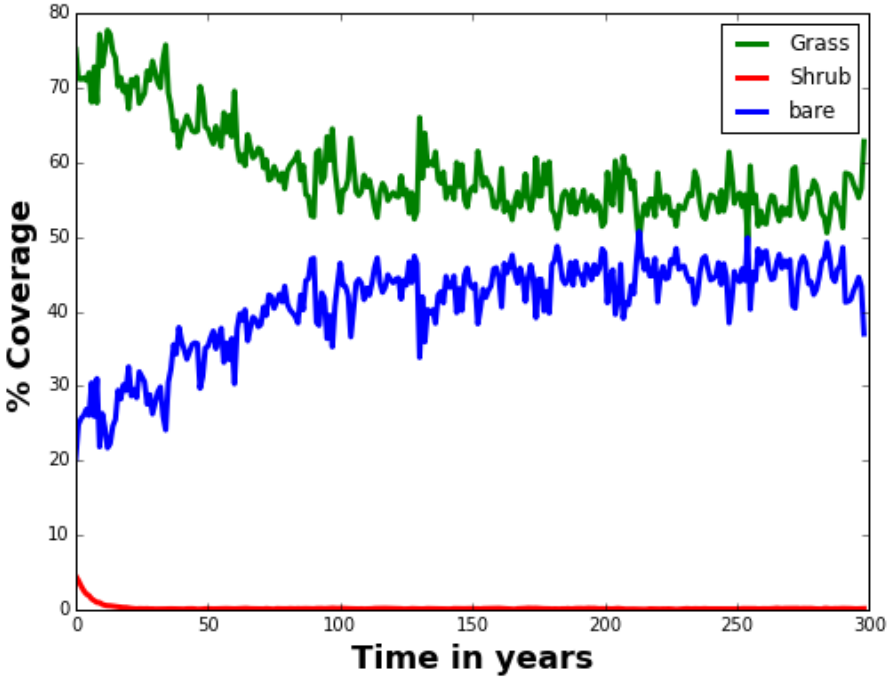
Shrub encroachment => land degradation with implications on ecosystem structure & function

Wait!!! Was Grazing the Culprit??

Fires – Uncontrolled Grazing



Fires –Controlled Grazing

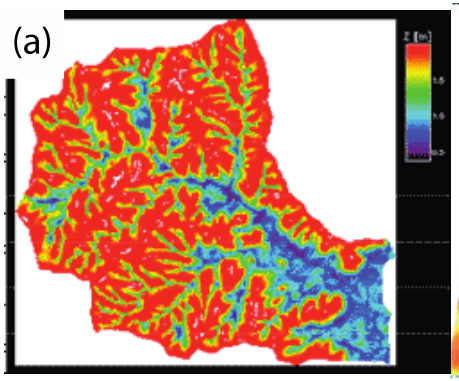


Nah!!! I don't think so!

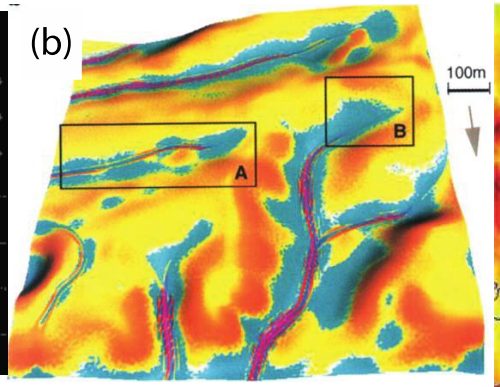
Did you change your mind?

Numerical Modeling as a Powerful Tool

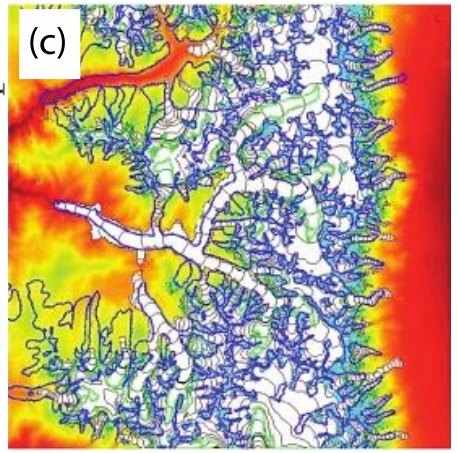
CATCHMENT HYDROLOGY
(Ivanov et al., 2004)

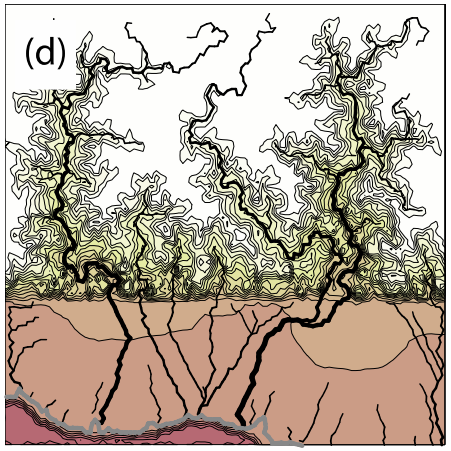


SOIL EROSION
(Mitas and Mitasova, 1998)

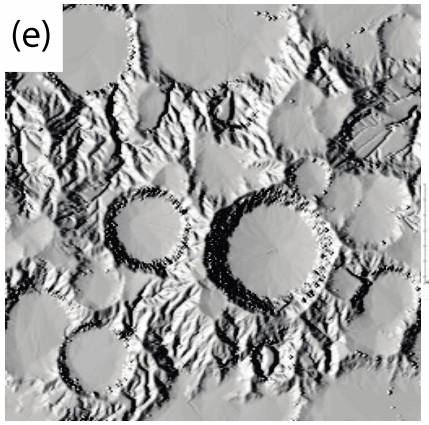


GLACIER DYNAMICS
(Kessler et al., 2006)

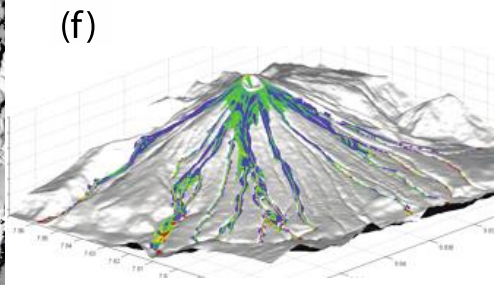




LANDSCAPE EVOLUTION
(Tucker and Hancock, 2010)



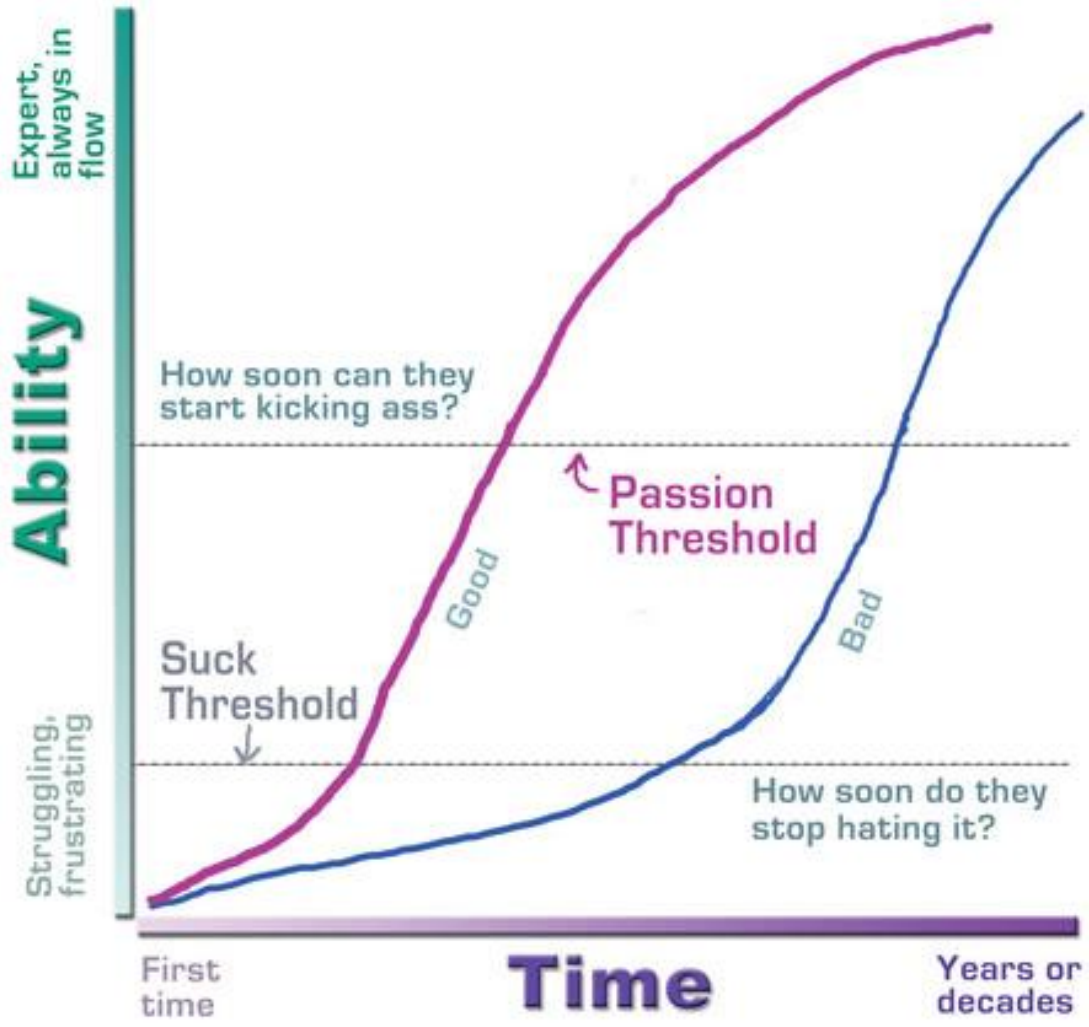
IMPACT CRATERING AND DEGRADATION
(Howard, 2007)



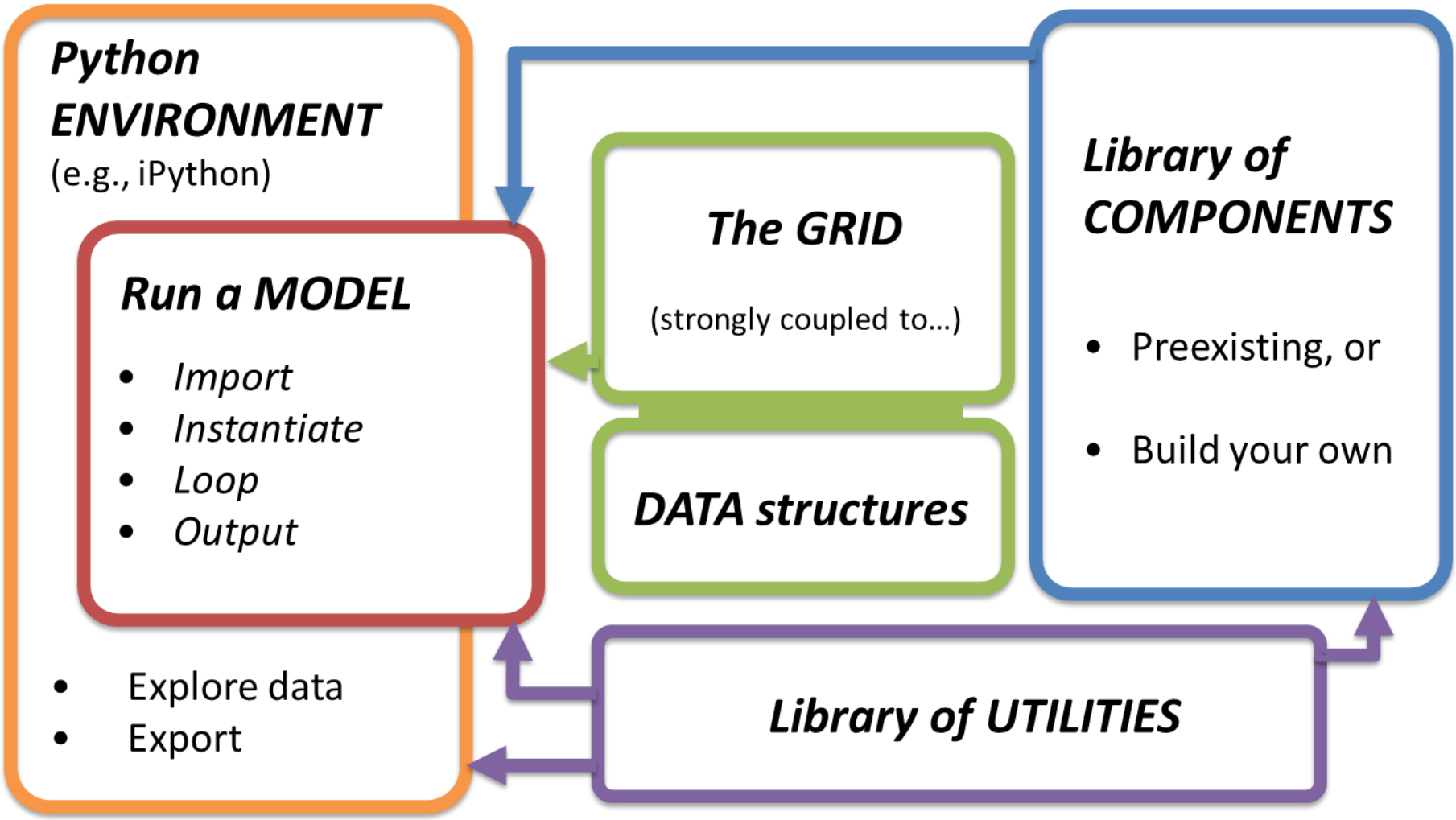
LAVA FLOWS
(Kelfoun et al., 2009)

Many Commonalities!

!!! The **Kick Ass** Curve !!!



A Python Toolkit for Modeling Earth-Surface Processes



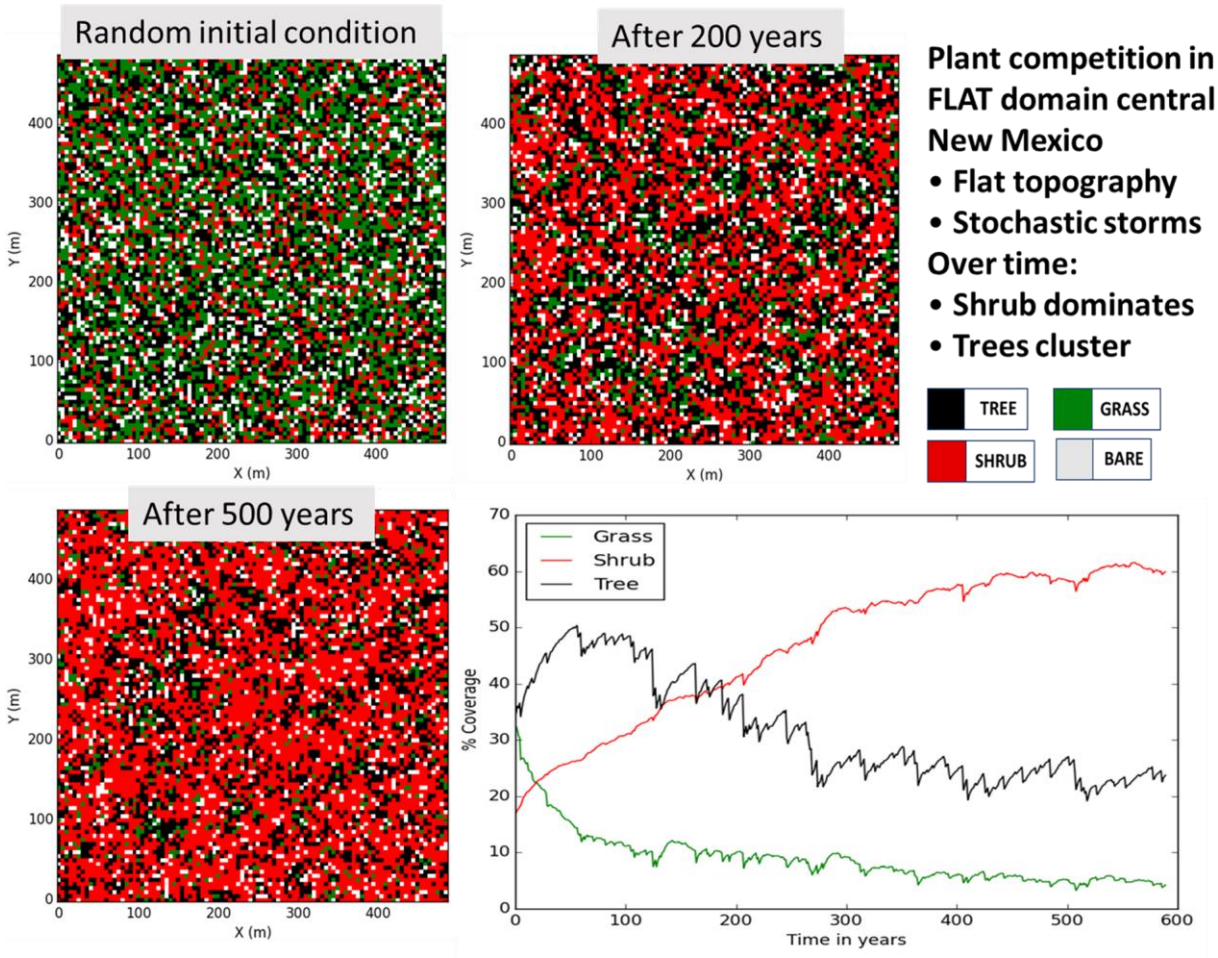
Thanks For Listening!!!

Check out Landlab @ landlab.github.io

Landlab: Modeling Framework

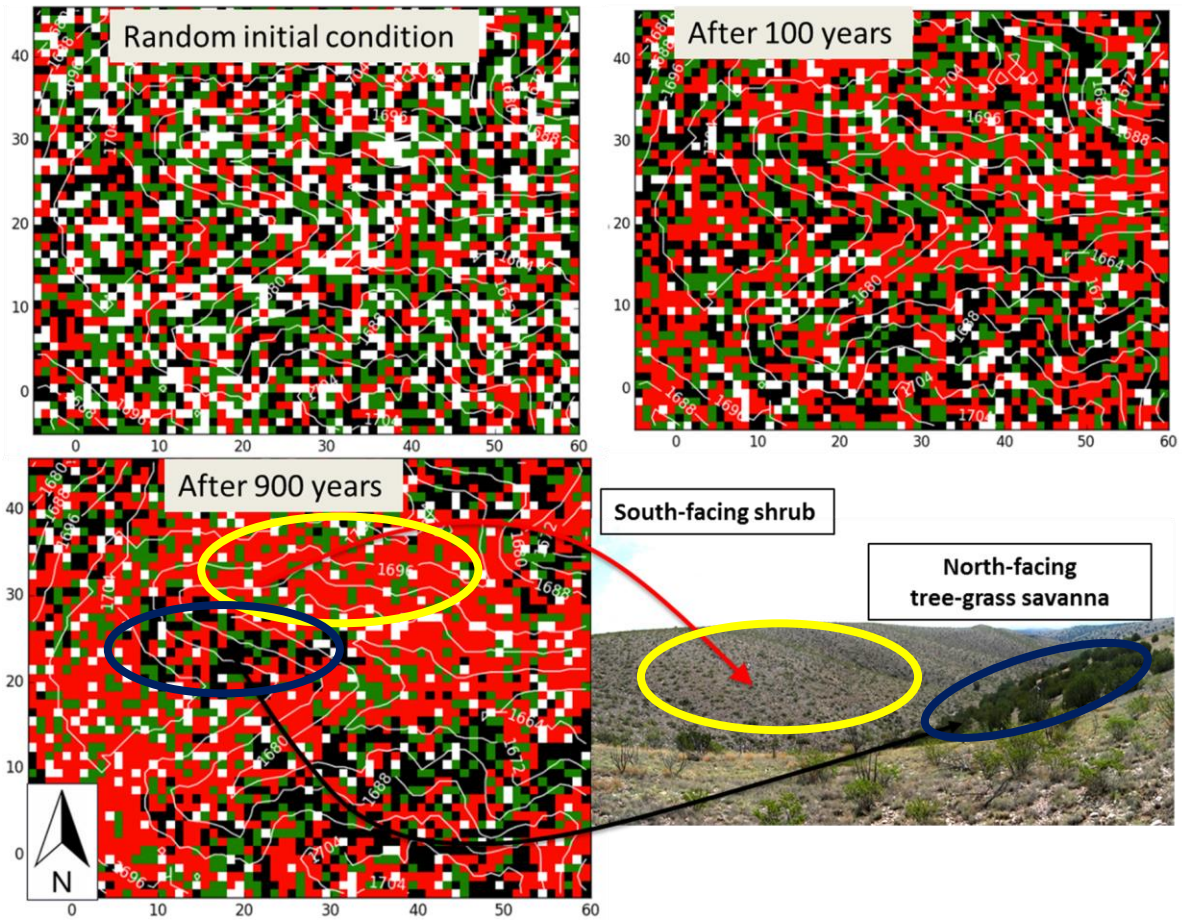
- creates an environment for building numerical models of earth-surface dynamics
  - e.g., flow of mass/sediment
- can use existing infrastructure
  - building blocks such as grid with inbuilt data structures
  - library of components
- models can be built by combining components
- facilitates undivided attention towards model(s) of interest

Landlab Ecohydrology: simulation on flat topography



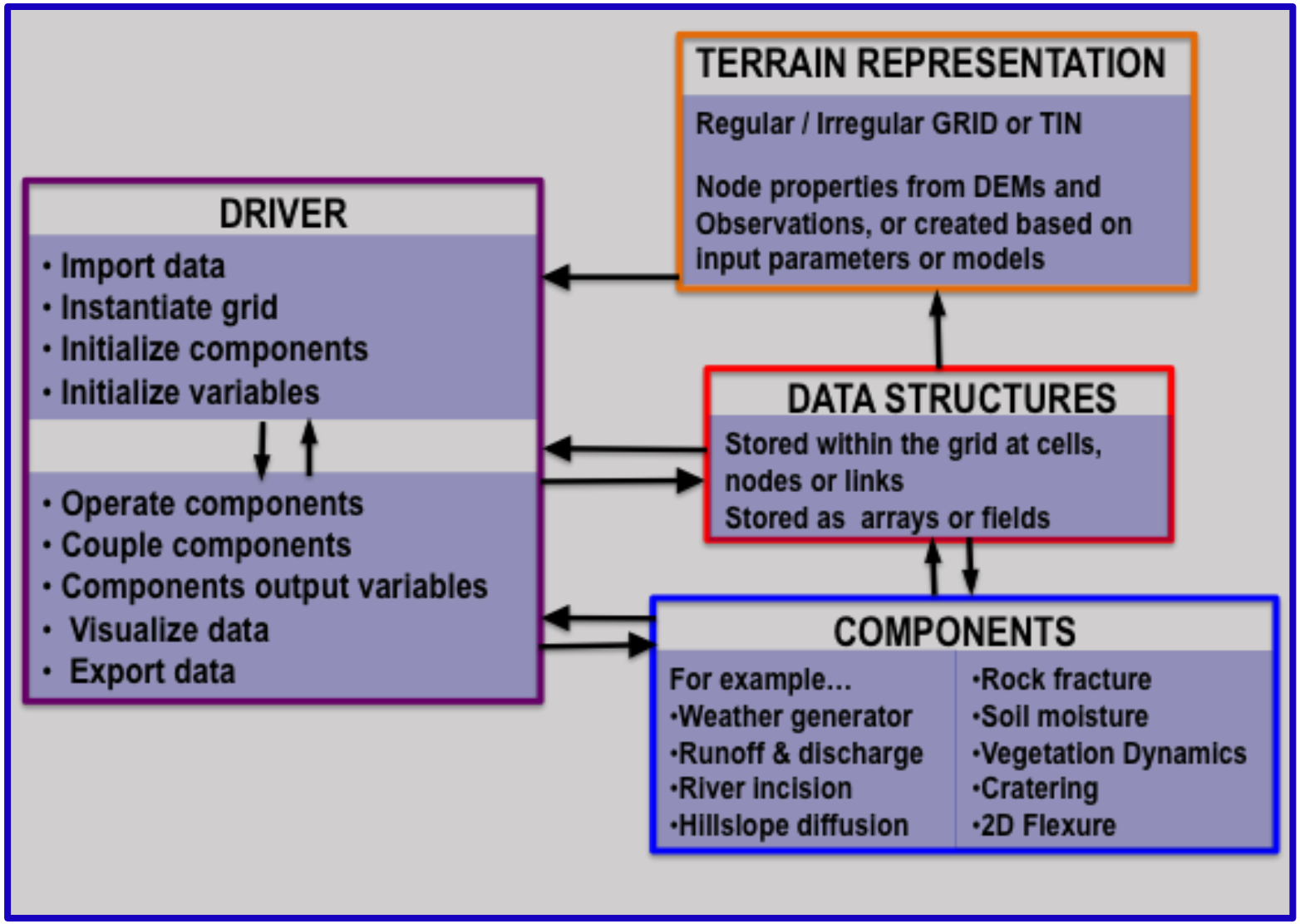
This figure shows time slices of cellular automaton plant competition model coupled to vegetation model output for simulation of vegetation organization on a flat topography

Landlab Ecohydrology: simulation on actual topography



This figure shows time slices of cellular automaton plant competition model coupled to vegetation model output for simulation of vegetation organization on actual topography in Sevilleta, Central New Mexico

Landlab: Modeling Framework



Landlab Ecohydrology

Inter-storm Vegetation Dynamics:

Storm Generator:

- generates rectangular Poisson distributed storms

Radiation (RAD):

- calculates daily spatially-distributed solar radiation

Potential Evapotranspiration (PET):

- uses solar radiation fields and weather variables to calculate PET

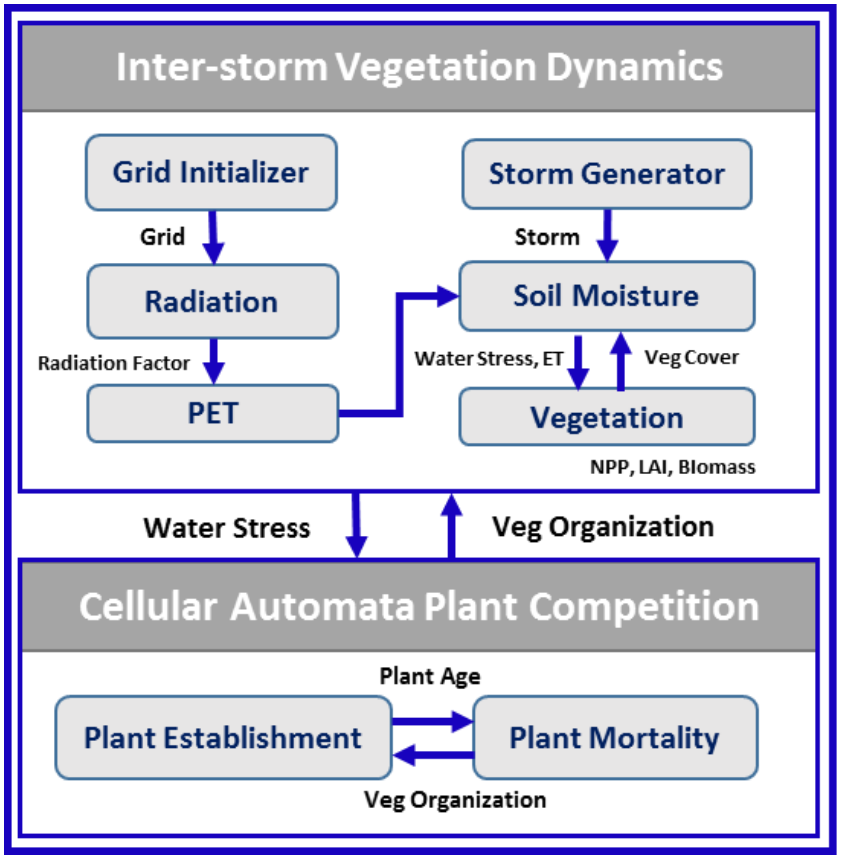
Soil Moisture:

- solves root zone water balance between two storms given PET and rainfall fields

- returns actual evapotranspiration (AET) and soil moisture

Single Species Vegetation:

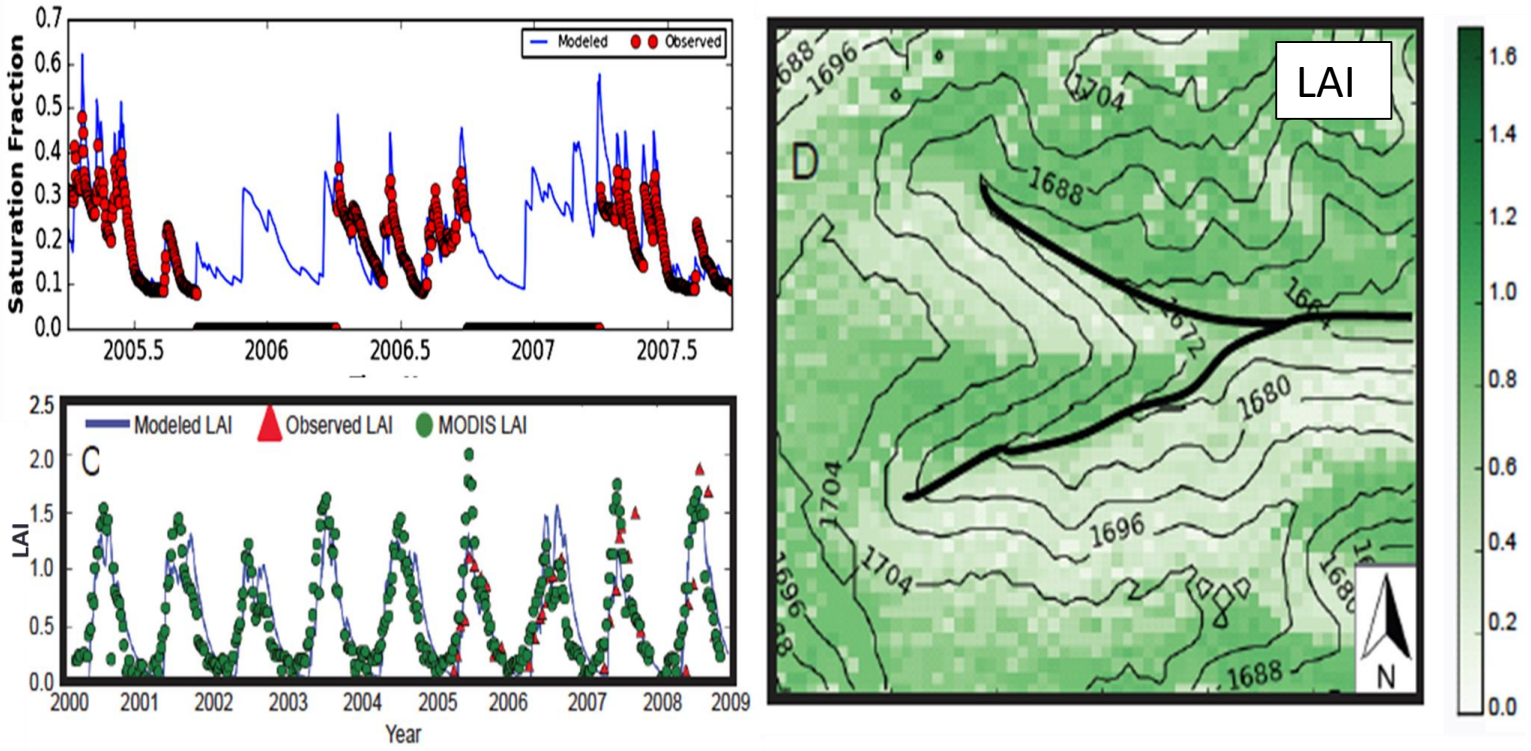
- computes net primary productivity based on AET and calculates leaf area index and biomass



Plant Competition:

- uses cellular automata model to simulate inter-species plant competition
- based on user defined rules

Validation of Vegetation Model at Nebraska Sand Hills



Left: These pictures compare the model outputs of vegetation model applied at a point with observations at Nebraska Sand Hills, NE.

Right: This picture shows a spatial pattern of Leaf Area Index (LAI) at an instant of time for a basin in Nebraska.