Climate change impacts on watershed hydrology, carbon and nutrient dynamics –– A case study in Missisquoi river watershed

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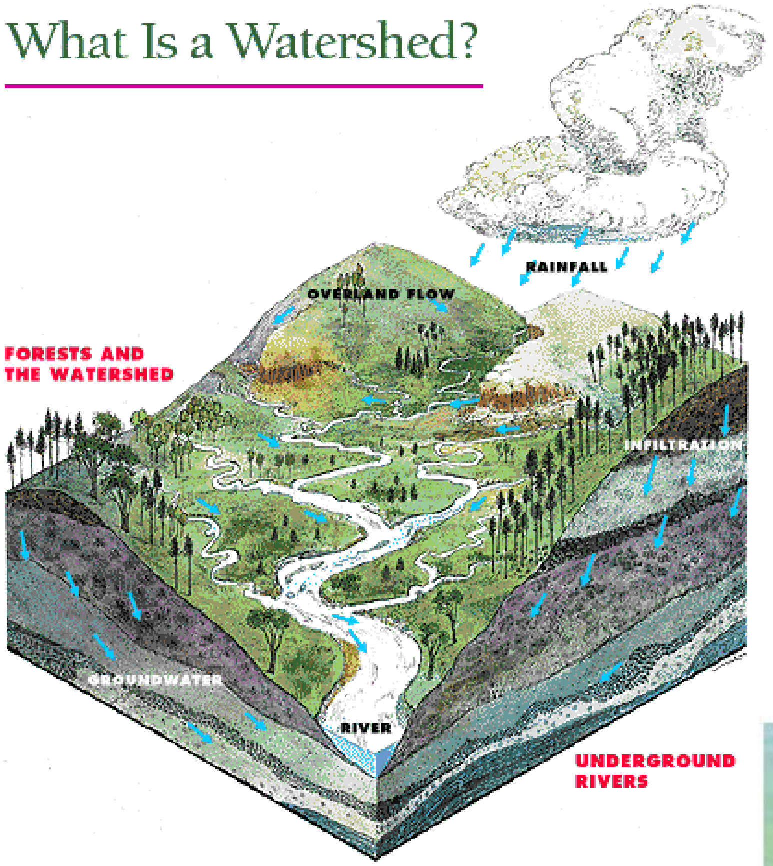
NEWRnet
Delaware • Rhode Island • Vermont
North East Water Resources Network
NSF
The University of Vermont
Vermont EPSCoR

Water:
Flood, drought

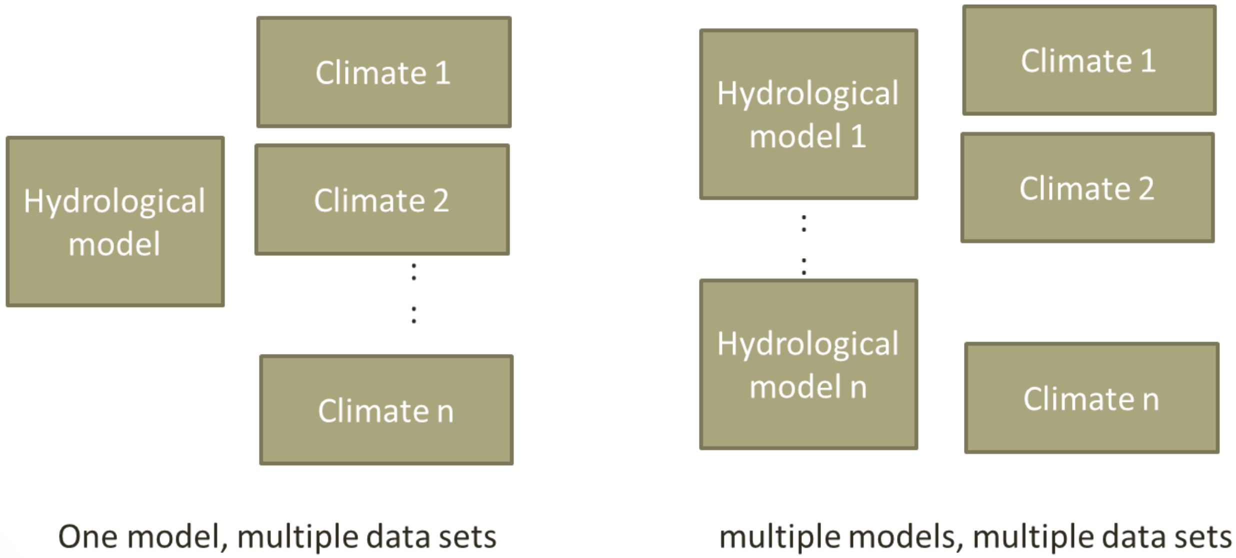


Carbon

Nutrient (nitrogen, phosphorus)

Climate change impacts

- Precipitation pattern (temporal and spatial) directly change water input
- Increased temperature
    1. Increase evapotranspiration
    2. Earlier snowmelt



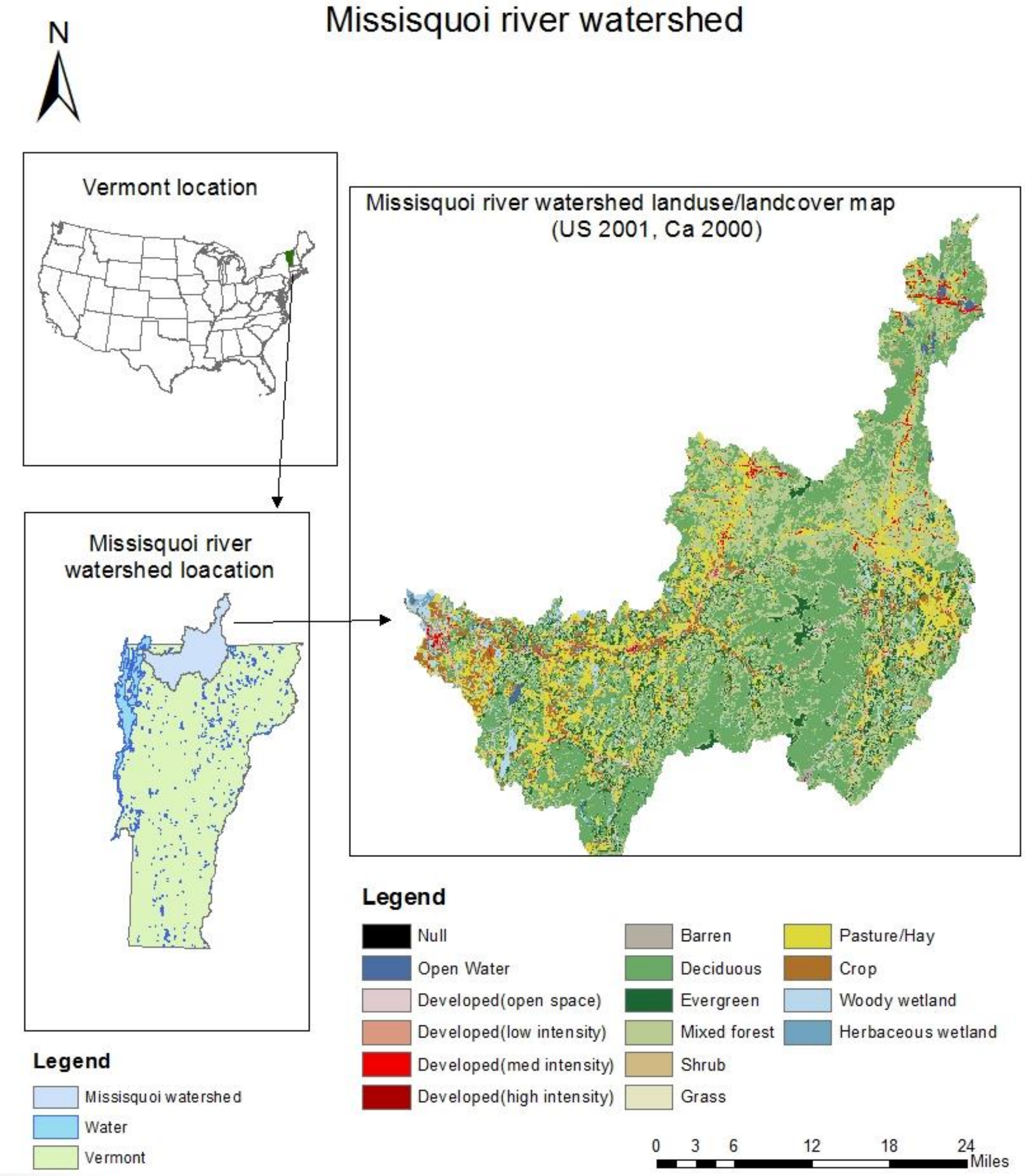
Integrating phenology change

- Phenology change
  - Earlier leaf on in Spring and later leaf off in Fall
  - In US, the average growing season length increased about 9.4 days from 1982 to 2008 (*Jeong et al.*, 2011) , mainly due to later leaf fall
- Quantify climate change impacts on hydrology, carbon and nitrogen with RHESSys model

1980-2002: historical study, growing season extension (later fall)
2016-2035: Using future projection climate data

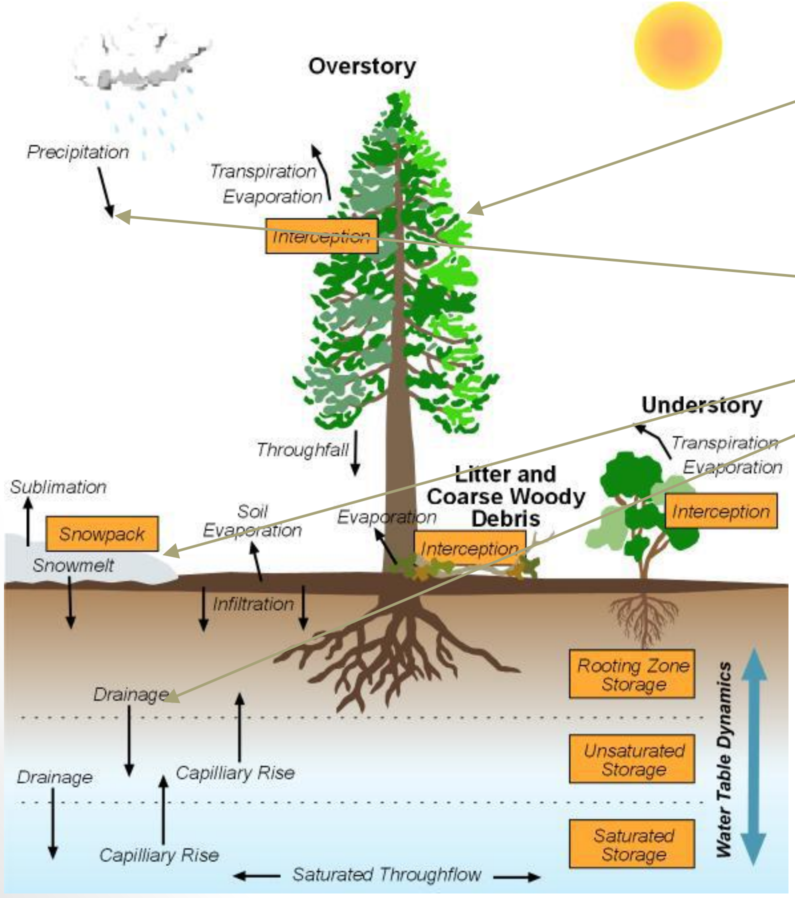
Scenarios	Control	A	B	C	D
Leaf fall date change	0 d/year	0.2d/yr	0.25 d/yr	0.33 d/yr	0.5 d/yr
Leaf fall date change(RHESSys)	0	1 d/ 5yrs	1 d/4yrs	1 d/ 3yrs	1 d/2yrs

Experiment design for 5 leaf fall scenarios


Missisquoi river watershed
N
Vermont location
Missisquoi river watershed loacation
Missisquoi river watershed landuse/landcover map
(US 2001, Ca 2000)
Legend
Missisquoi watershed
Water
Vermont
Legend
Null
Open Water
Developed(open space)
Developed(low intensity)
Developed(med intensity)
Developed(high intensity)
Barren
Deciduous
Evergreen
Mixed forest
Shrub
Grass
Pasture/Hay
Crop
Woody wetland
Herbaceous wetland
0 3 6 12 18 24
Miles

Integrate dissolved phosphorus module into RHESSys

- Lack phosphorus module

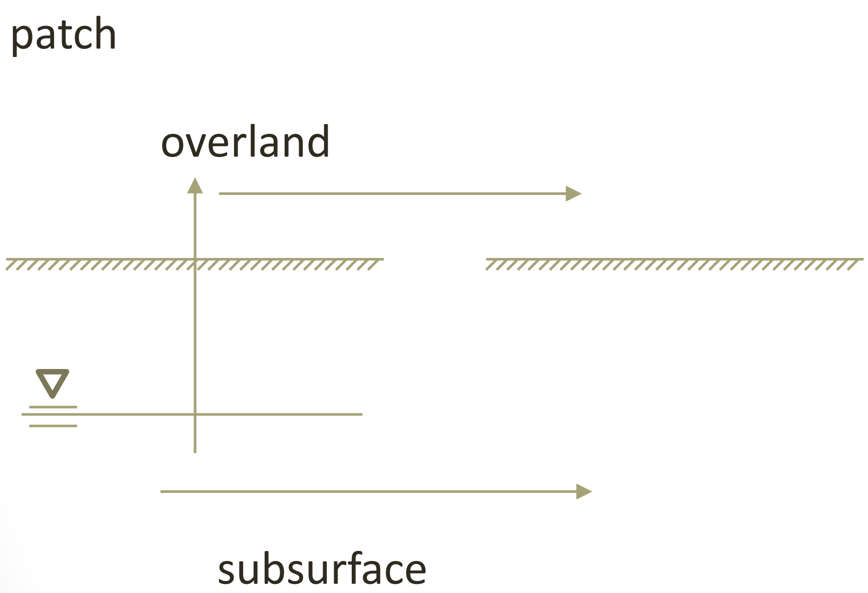


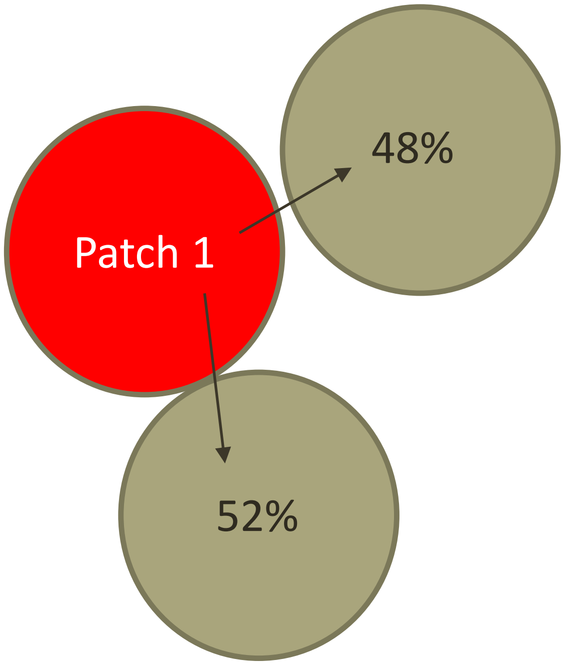
canopy processes:
ET, photosynthesis,
plant growth, mortality

Patch processes: water, fertilizer,
Nitrification, denitrification,
carbon

Adding mineral phosphorus soil
pools

Routing dissolved phosphorus





Using current routing method in RHESSys to transport dissolved phosphorus over land

Expected publications

- Climate change impacts on Missisquoi Waterhsed hydrology in Lake Chaplain Basin—implications of growing season length extension for watershed hydrology.
- Construct carbon budget in the past decades in Missisquoi watershed – integrating growing season length extension impacts
- Nitrogen export characteristics in a mixed land use watershed: past and future
- Integrating a dissolved phosphorus module in a distributed hydro-ecological model-- Regional Hydro-Ecologic Simulation System (RHESSys)