Modeling the dynamics of human activities, land, and water at cadastral scale

Yushiou Tsai

Scott Turnbull,
Asim Zia, Chris Koliba,
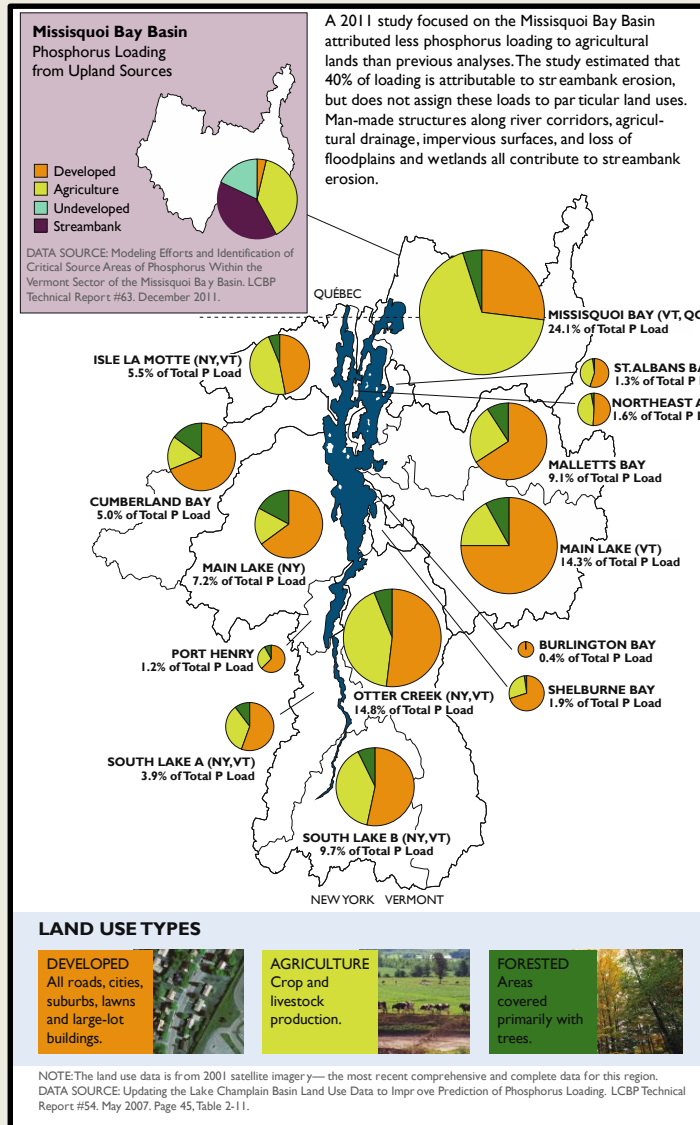Ibrahim N. Mohammond, Donna Rizzo, Brian Beckage
Morgan Rogers, Hope M. Zabronsky,, Gabriela Bucini, Peter Isles, Justin Guibert,
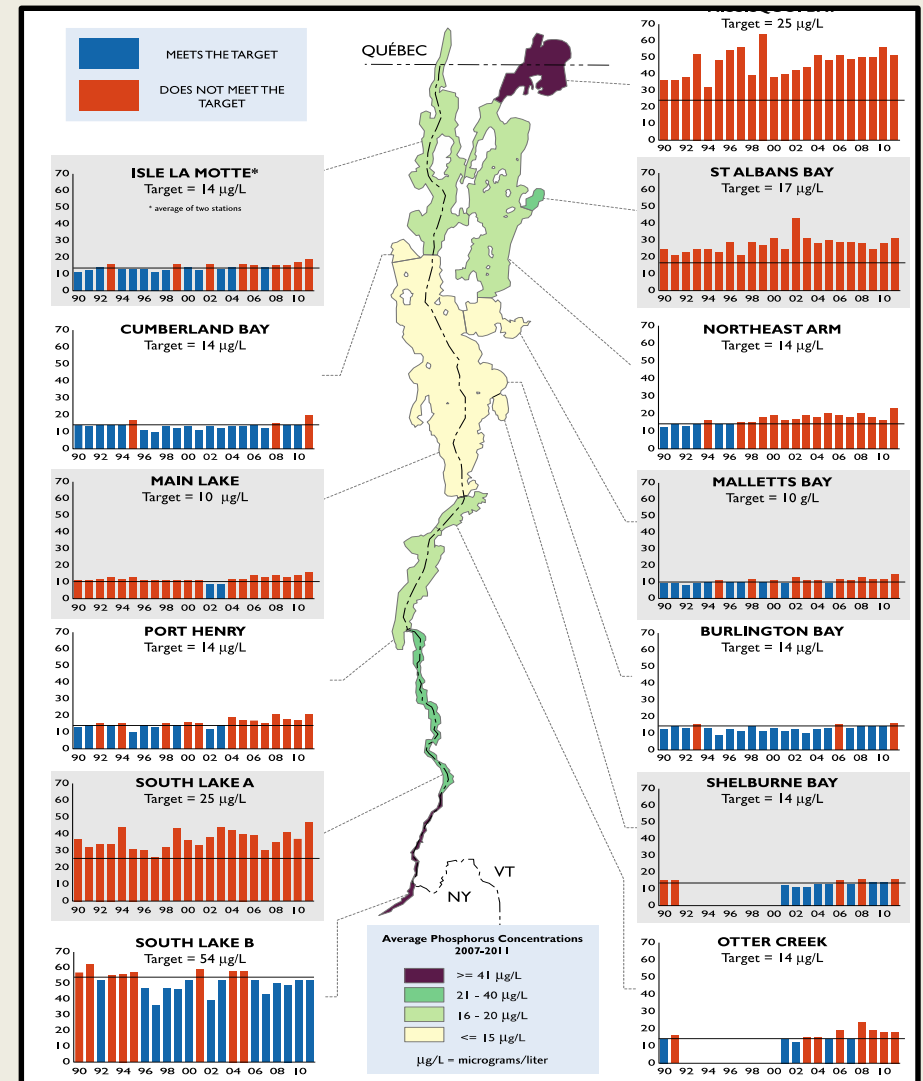Scott Hamshaw, Shad Mohamed Emam, Sarah Coleman, Steve R Scheinert, Scott Merill, Ahmed Hamed,
And ……………………………………………………………………….

Foci & Importance

(SoL, LCBP, 2012, figure 7; page 9)

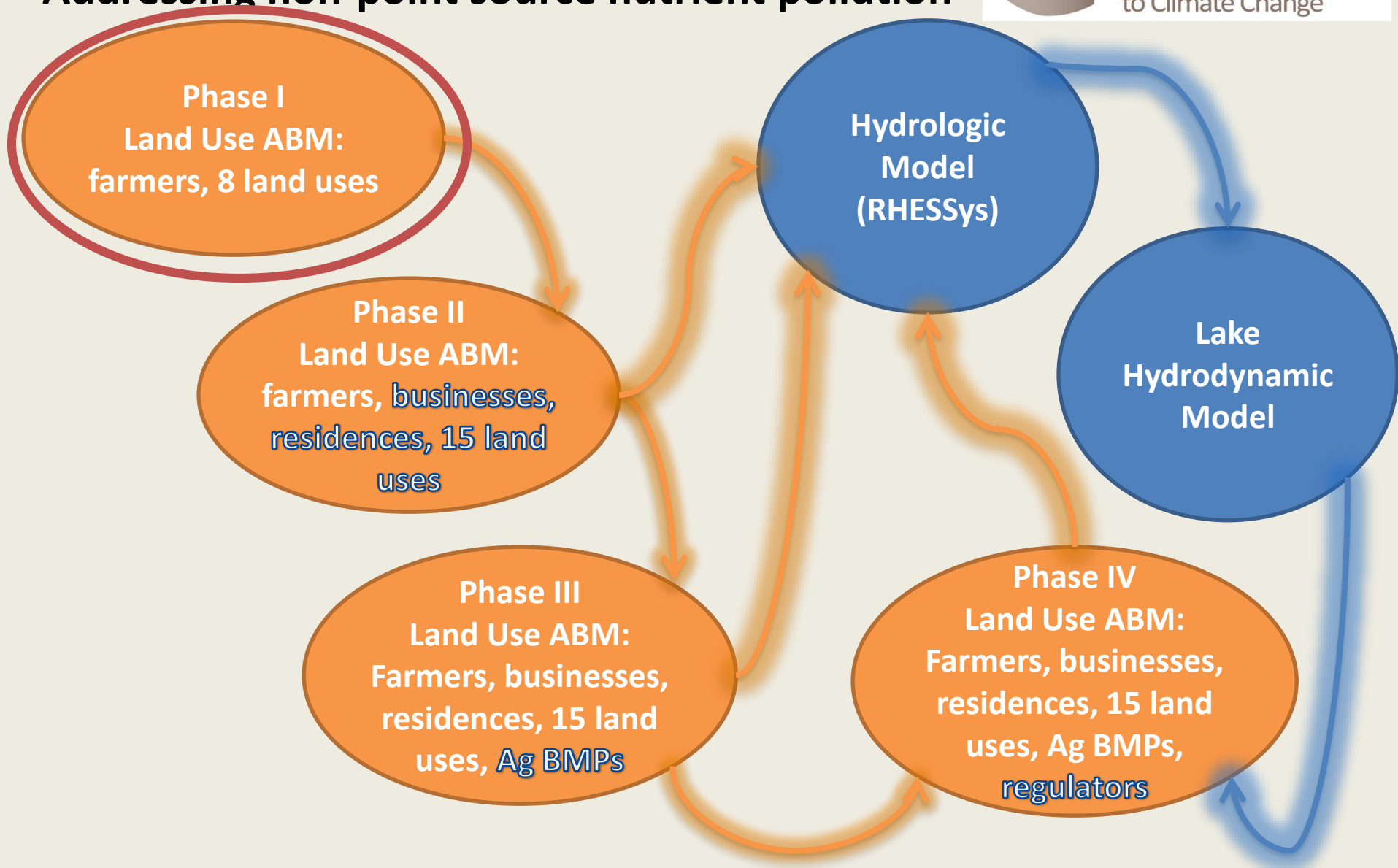

(SoL, LCBP, 2012, figure 3; page 6)

Foci & Importance

- Agent-Based modeling (ABM) for human activities at ~~c~~

- Int~~e~~ hy~~d~~

Parcels in Franklin County Vermont

St. Albans

Major Roads
Lakes & Rivers
Landowner Type
Farm
Urban Business
Urban Residence
Public Forest
Private Forest

0   4.75   9.5   19 Kilometers

Journey of Our Modeling Efforts
Addressing non-point source nutrient pollution

RACC
Research on Adaptation to Climate Change

Phase I
Land Use ABM:
farmers, 8 land uses

Phase II
Land Use ABM:
farmers, businesses, residences, 15 land uses

Hydrologic Model (RHESSys)

Lake Hydrodynamic Model

Phase III
Land Use ABM:
Farmers, businesses, residences, 15 land uses, Ag BMPs

Phase IV
Land Use ABM:
Farmers, businesses, residences, 15 land uses, Ag BMPs, regulators

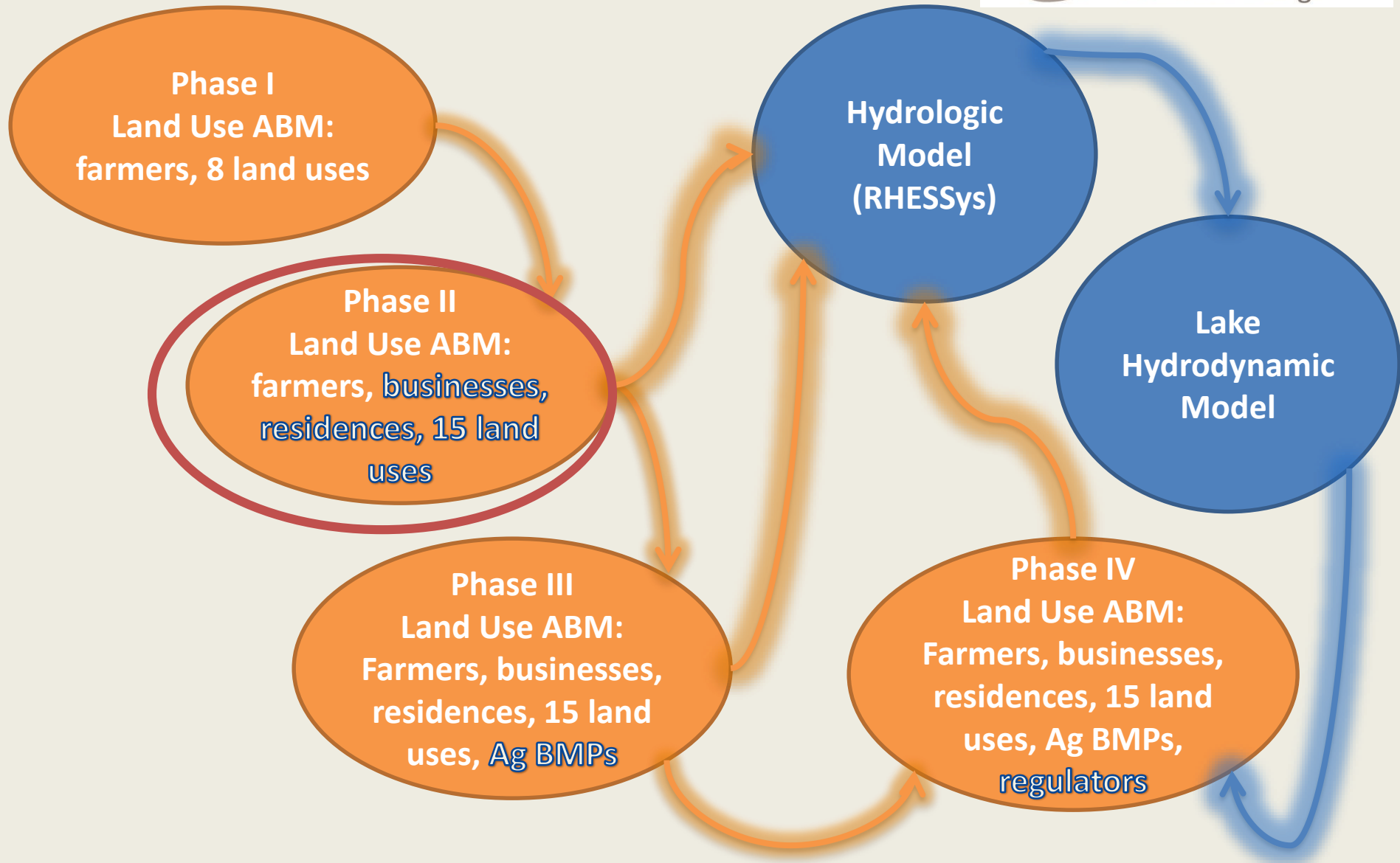# Forest Regrowth (Transition) in Missisiquoi Watershed?

- Tsai et al. (2015) published in Land Use Policy

Farmers' Economic Condition
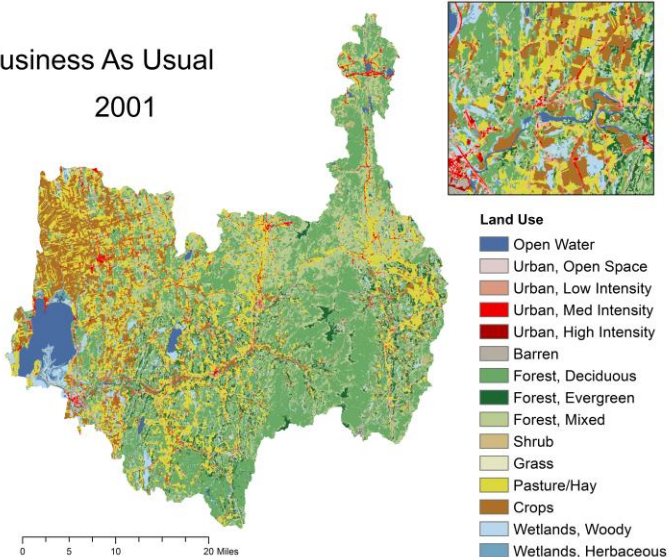
Farmers' Value of Food Production
- Low
- Medium
- High

MDWR: Moderate Downward Wealth Redistribution
LDWR: Large Downward Wealth Redistribution
IP: Increase Poverty
IED: Increase Economic Disparity
MAP: Moderately Alleviated Poverty
LAP: Largely Alleviated Poverty

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Land Use Scenarios
Inputs for Hydrologic Model
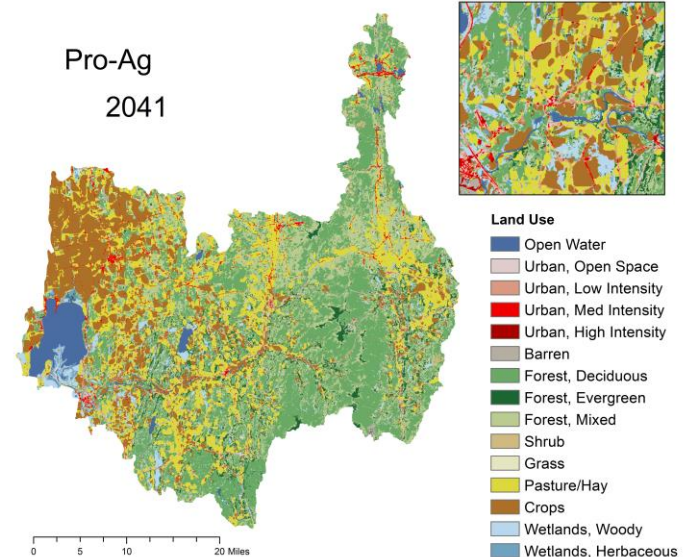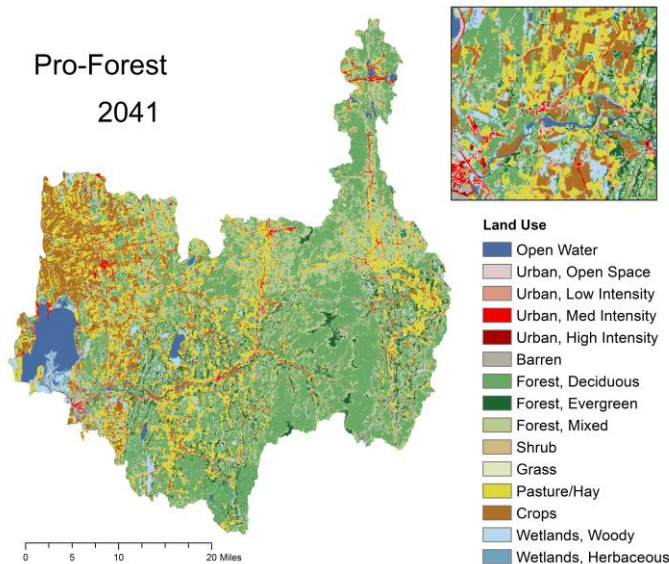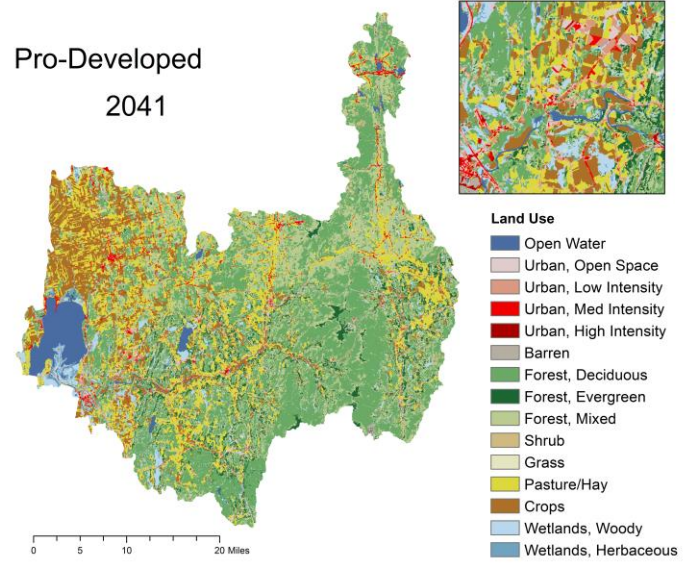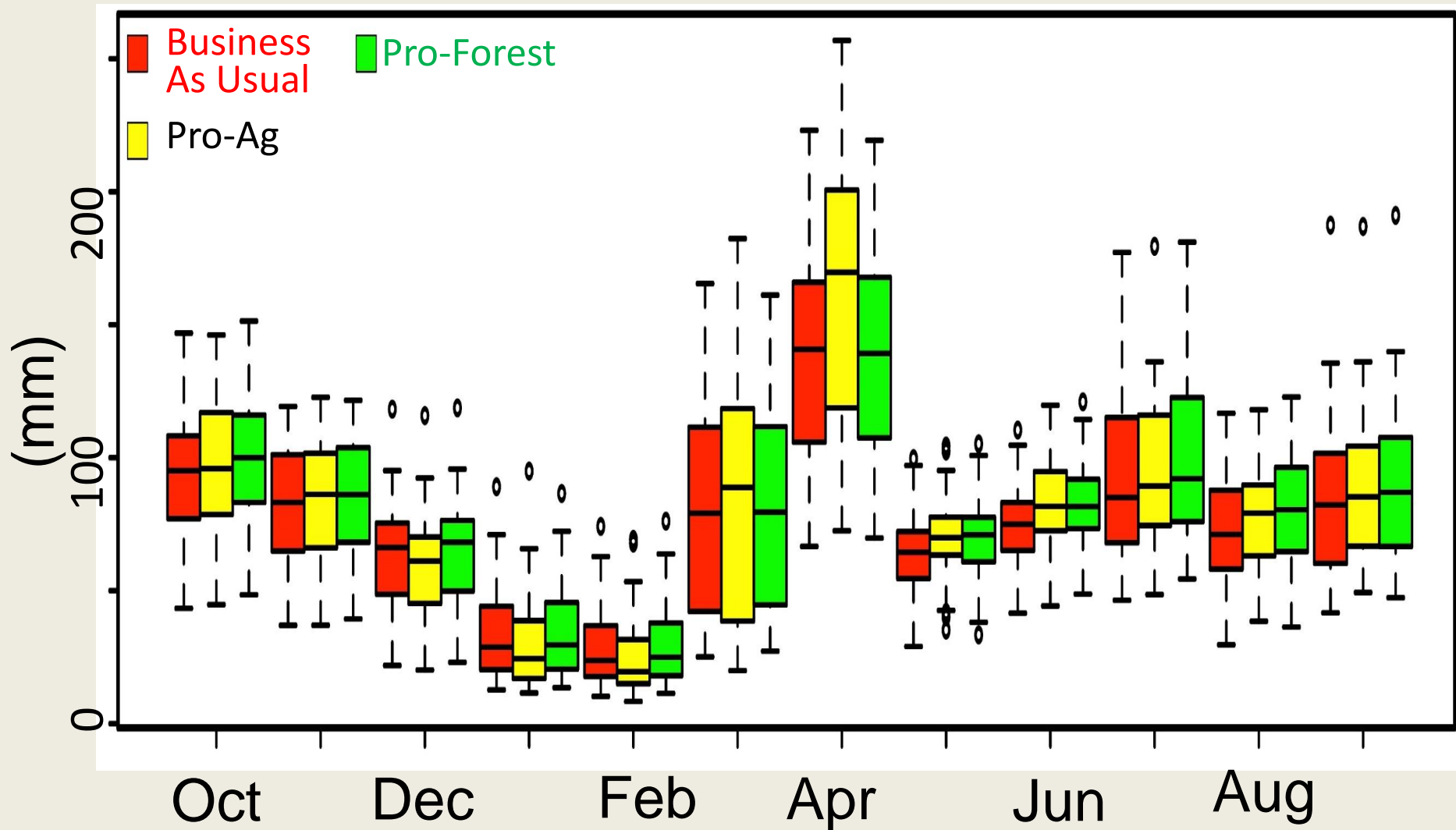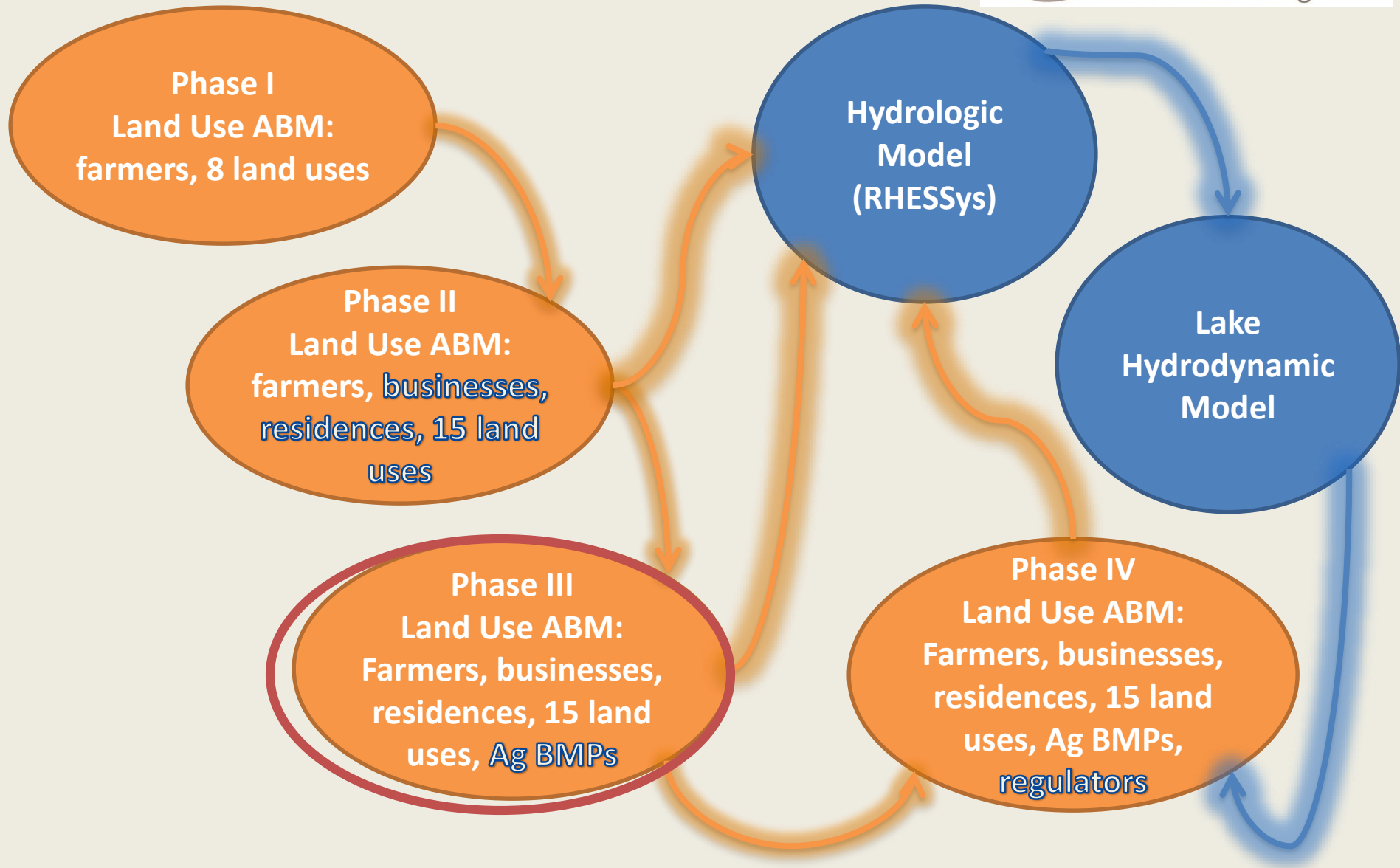
Preliminary Results:
Runoff to Missisquoi Bay

(AGU 2014: Mohammed et al., 2014; Tsai et al., 2014)
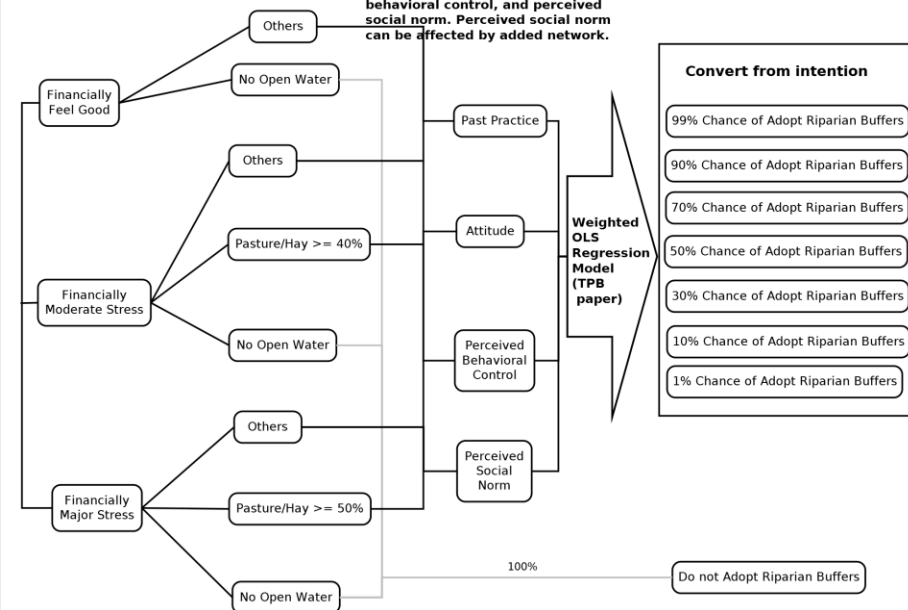
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Hydrologic Model (RHESSys)

Lake Hydrodynamic Model

Farmers' Adoption of
Best Management Practices (BMPs)

- Probability of adopting BMPs
  – Economic condition
  – Social condition
    - Past Practice
    - Attitude
    - Perceived social norm
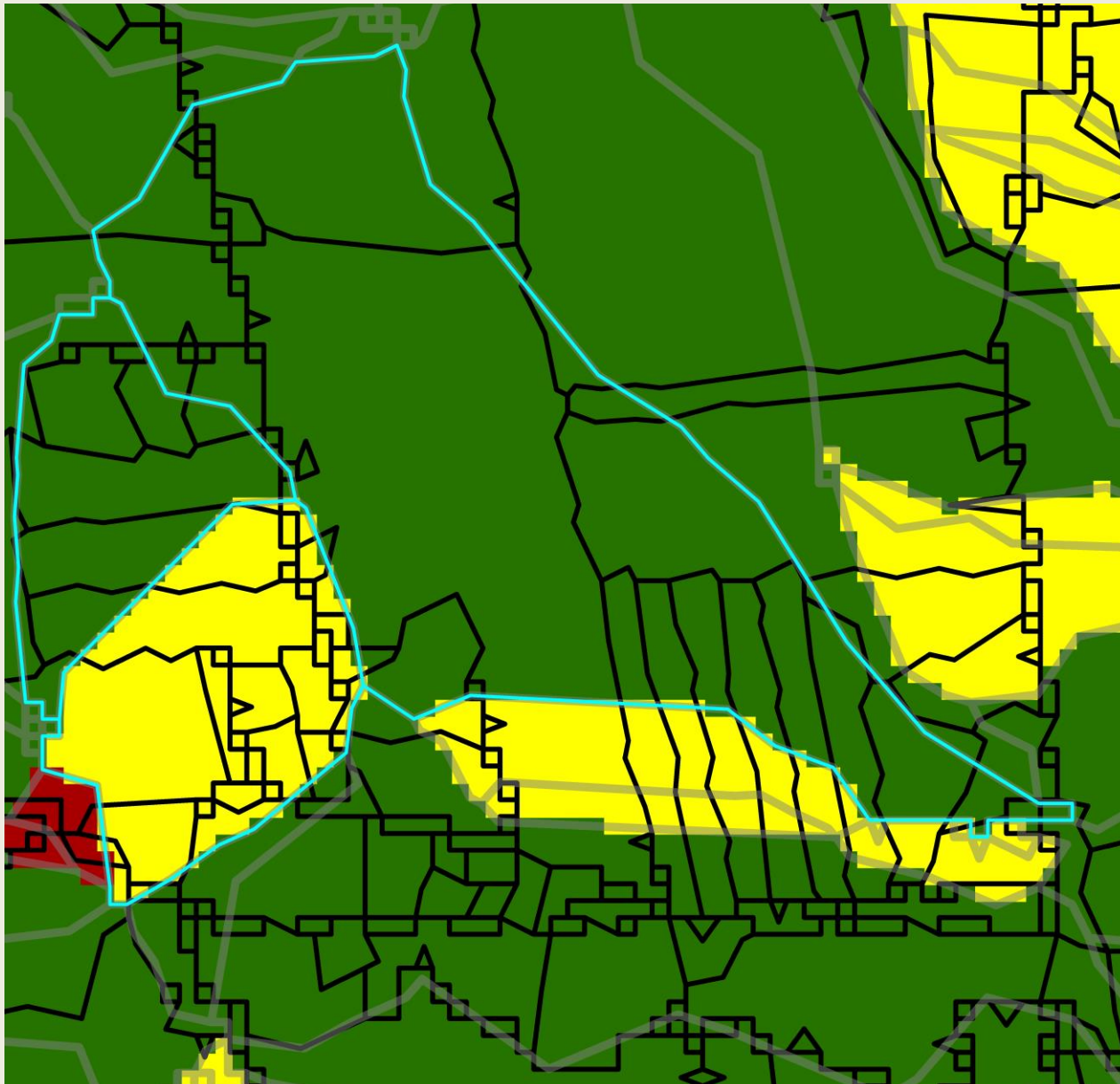   - Perceived control behaviors
  – Land use

- Effectiveness of riparian buffers on reducing Phosphorous (Tsai et al., 2016, Journal of Environmental Quality, under revision)
  – Buffer width, slope
  – Soil, vegetation, hydrologic conditions, P levels in the fields

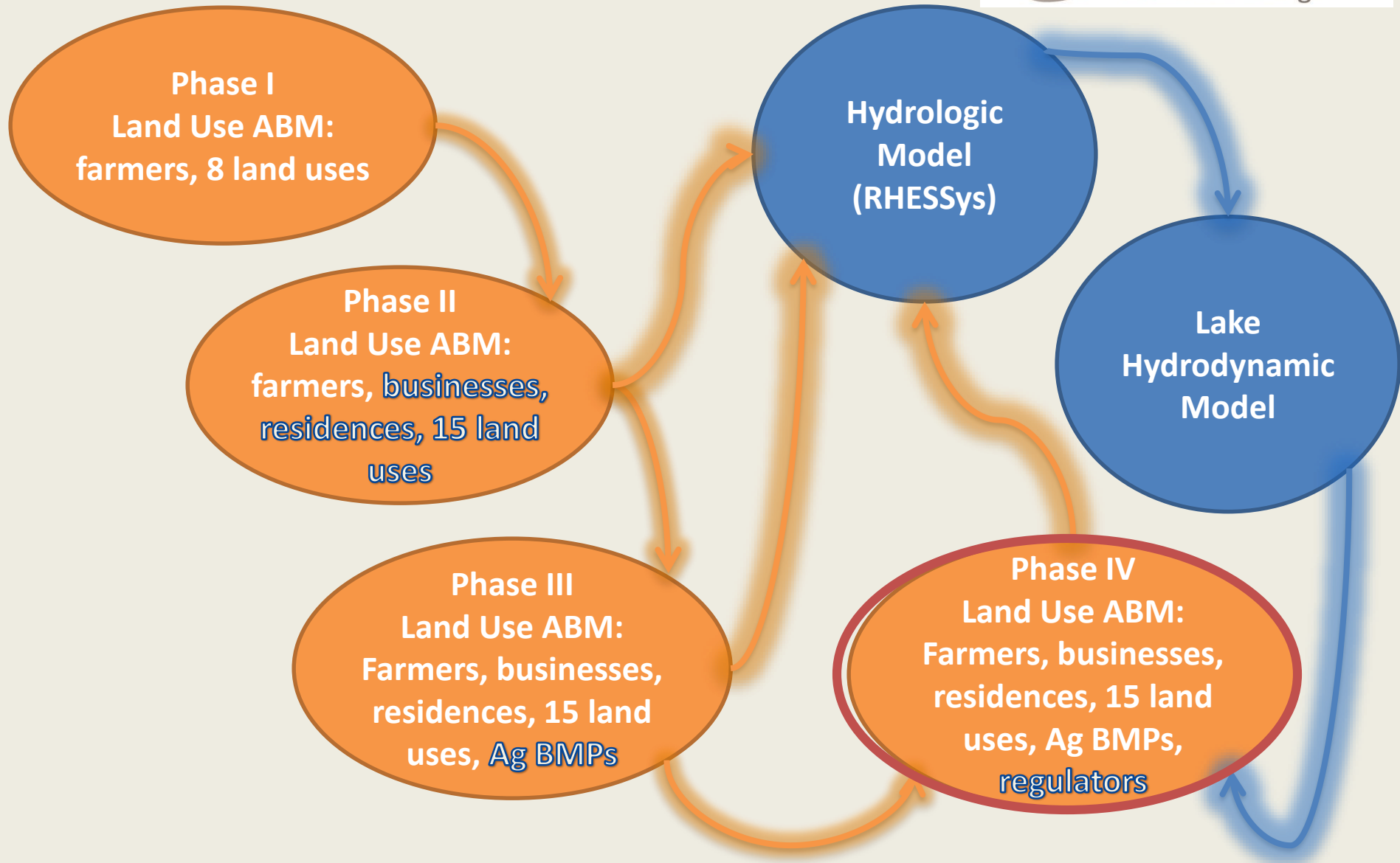# BMPs Integration Between
Land Use & Hydrologic Models

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Hydrologic Model (RHESSys)

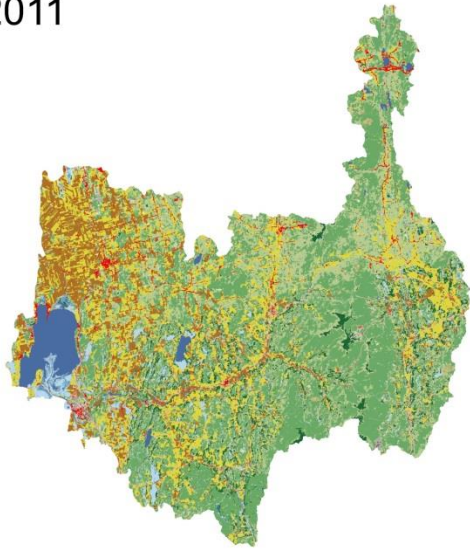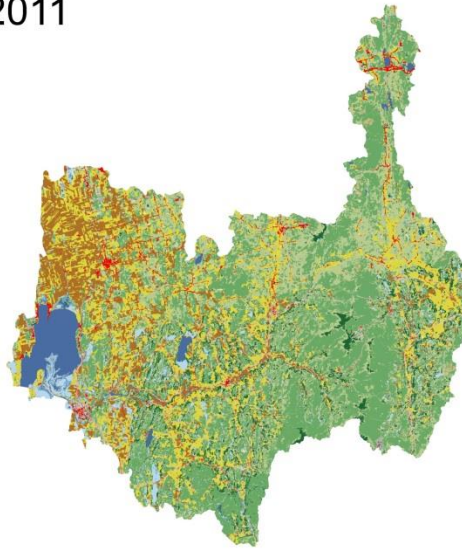**Lake Hydrodynamic Model**

Regulator Agents

- Regulators response to water quality in the lake
  - Total Phosphorous
  - Chlorophyll
- Regulators act on worsening water quality
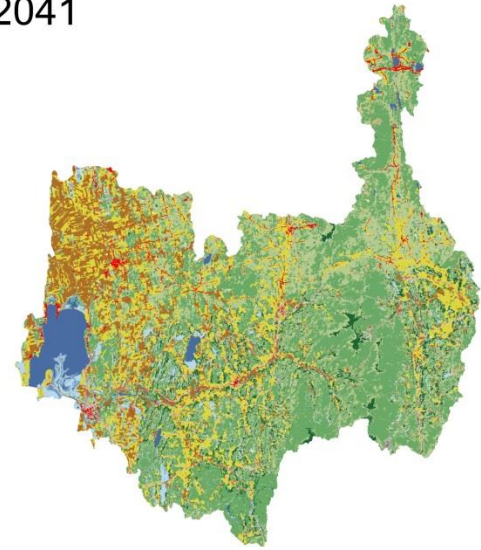 - Policy scenarios

- Thank You

Observed Land Use 2011
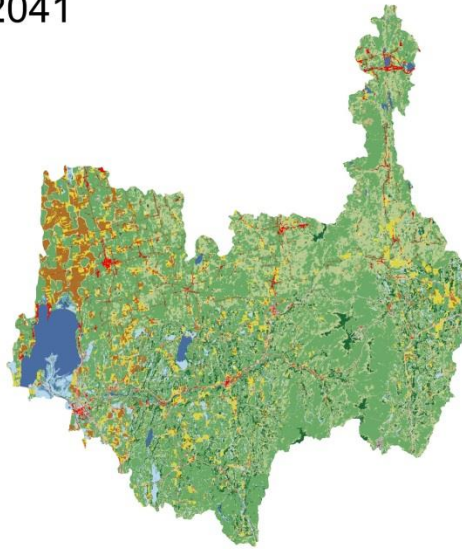
Business as Usual 2011

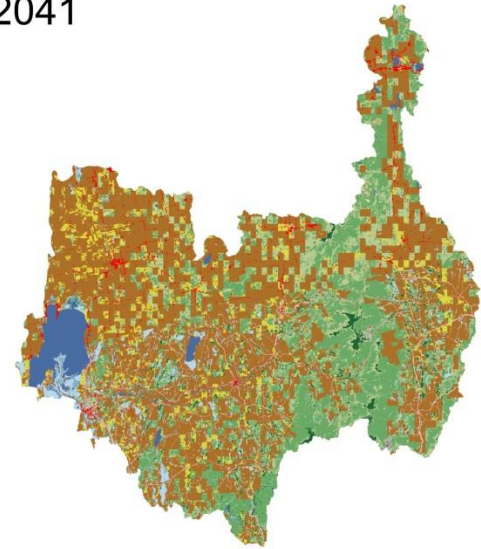Business as Usual 2041

Pro-Forest 2041

Pro-Ag 2041

NLCD Land Cover Classification

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren (Rock/Sand/Clay)
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Crops
- Woody Wetlands
- Herbaceous Wetlands

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