Modeling Social and Policy Dynamics in Lake Champlain Basin

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Adaptation Strategies

- **"Spontaneous" Versus "Planned" Adaptation**
- **"Planned" Adaptation Strategies in Agriculture**
  - **Technological Developments** (crop development, early warning systems, irrigation systems)
  - **Government Programs** (subsidy and grant programs, insurance programs, resource management)
  - **Farm production practices** (crop diversity, intensification level, cover cropping, buffers, BMPs)
  - **Farm financial management** (crop insurance, crop shares and futures, income stabilization programs, household income)

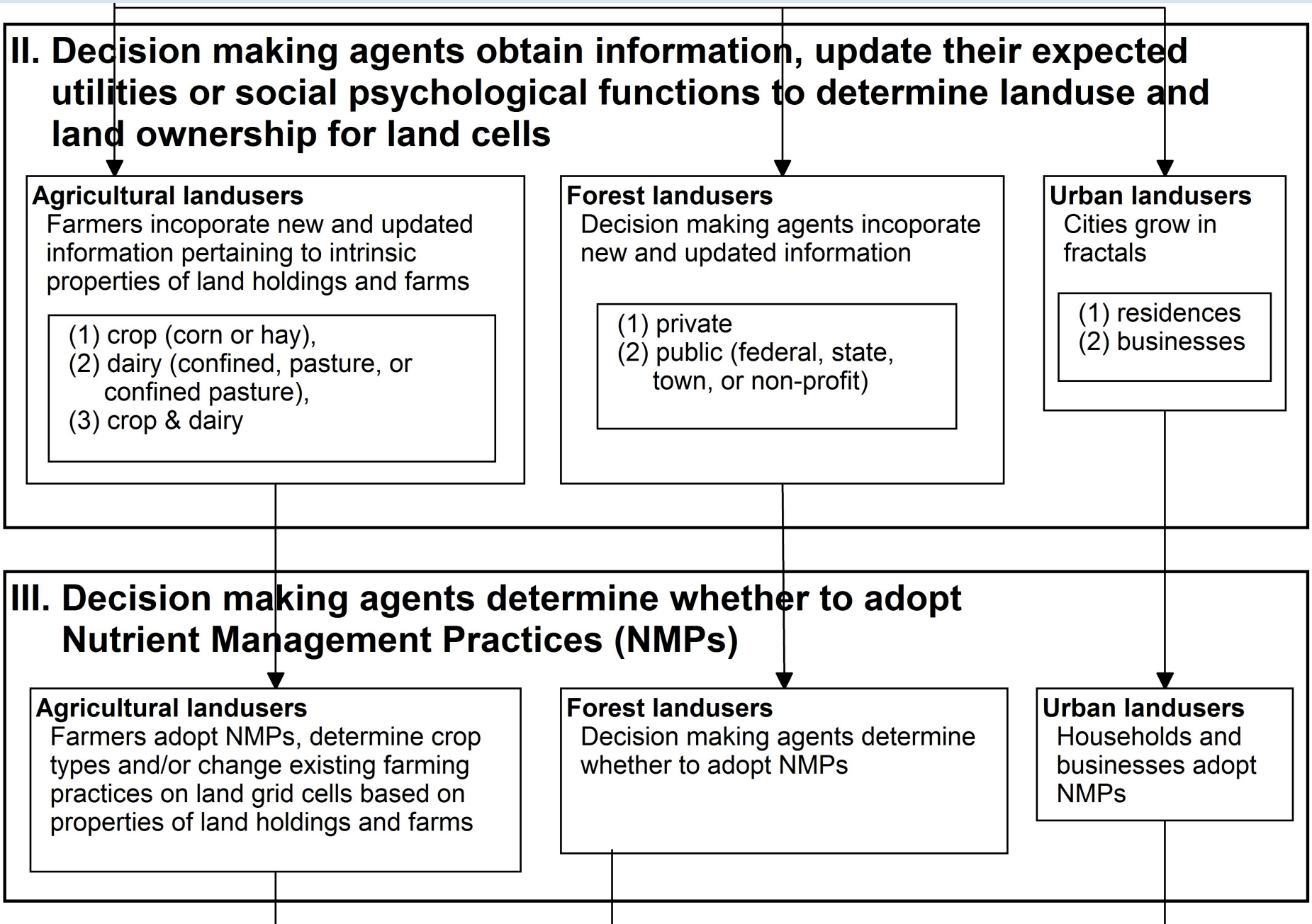
(Sources: Zia 2013 & Smit and Skinner 2002)

Overview

- Behavioral Mechanisms in Land-Use Transition Agent Based Model (LUT ABM)

- Complex feedbacks among the coupled natural and human systems in LCB: A system dynamics modeling (SDM) approach

Behavioral Mechanisms in LUT ABM



Predicting Behaviors in Response to Policy Interventions

- Competing underlying theories to explain and predict behaviors in response to policy interventions

1. **Expected Utility Theory** (Rational and Bounded Rational Versions)

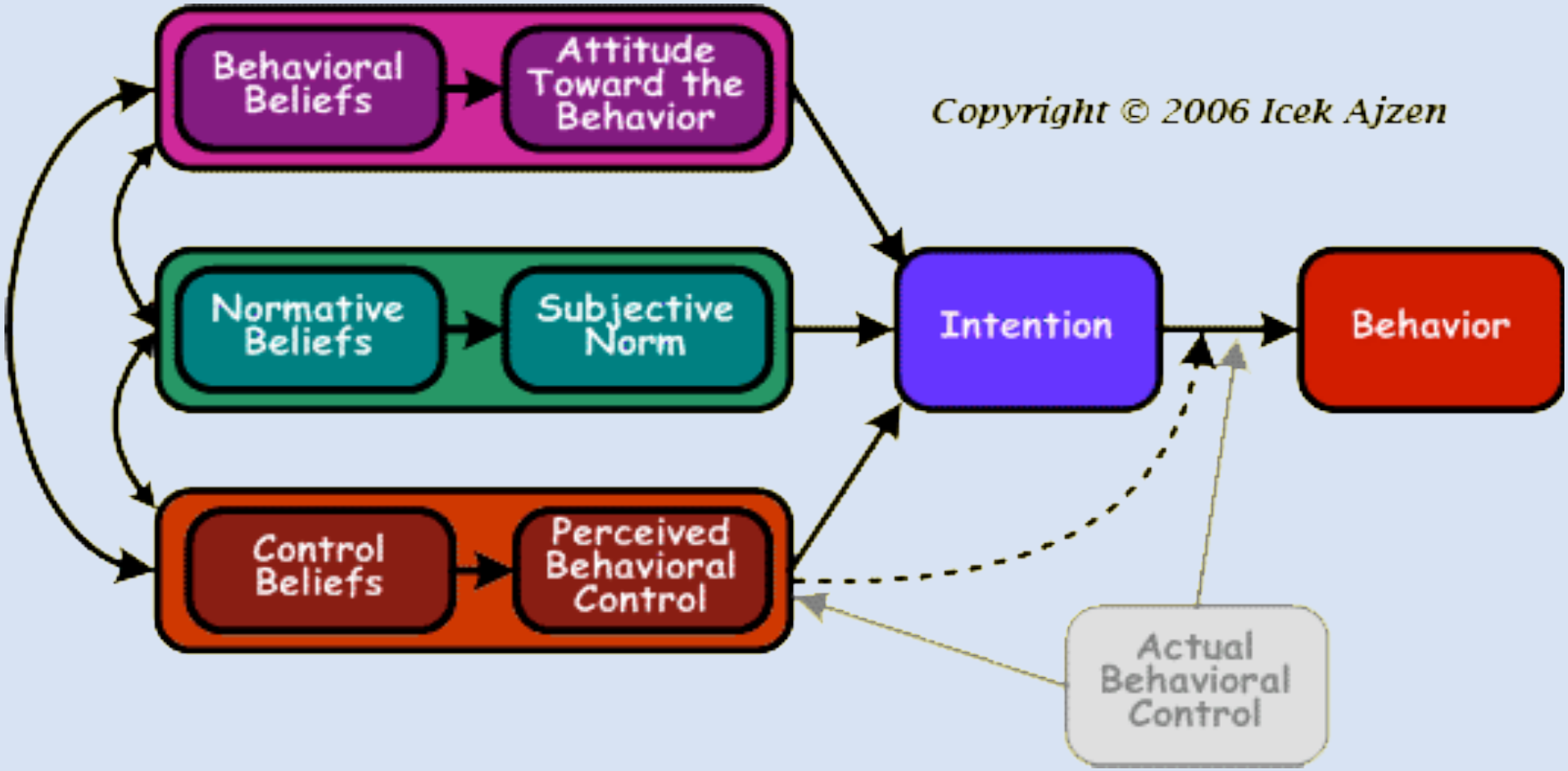
Maximize Expected Utility EU(X), where

$$EU(x_1, x_2, x_3) = k_1u(x_1) + k_2u(x_2) + k_3u(x_3) + k_4u(x_1)\,u(x_2) + k_5u(x_1)\,u(x_3) + k_6u(x_2)\,u(x_3) + k_7\,u(x_1)u(x_2)\,u(x_3)$$

For a decision making problem with three attributes x_1, x_2, x_3

2. **Theory of Planned Behavior**

Theory of Planned Behavior



[Updated Source: Fishbein and Ajzen (2010) *Predicting and Changing Behavior*]

Predicting NMP Adoption Under Alternate Policy and Behavioral Scenarios

- A pilot-tested 22-page 43-question survey instrument being implemented by NASS, USDA on a stratified random sample of Vermont farmers
- Bounded-rational (Conjoint Analysis) approach to estimate the likelihood of NMP adoption under alternate policy incentives and regulations
- Theory of Planned Behavior approach to estimate the likelihood of NMP adoption under different behavioral and social norm conditions

Conjoint Analysis Question Example

14. There are many different conservation practices that farmers use.

Suppose an agency offered to pay you to implement conservation practices on your farm for one year. Payments would be offered on a per acre basis. Conservation practices may be offered singly or in groups. Which combination of practices would you be mostly likely to implement?

Consider each of the following combinations and rank them 1-7, with 1 being the one you are most likely to choose, and 7 being the one you are least likely to choose.

Please refer to the appendix for definitions of conservation practices if needed.

CONSERVATION PRACTICES	**RANK (1-7)**
You will be paid $30/acre to implement conservation tillage.	
You will be paid $90/acre to implement cover cropping.	
You will be paid $105/acre to implement conservation buffers.	
You will be paid $120/acre to implement conservation tillage and cover cropping.	
You will be paid $170/acre to implement conservation buffers and conservation tillage.	
You will be paid $175/acre to implement cover crops and conservation buffer strips.	
You will be paid $205/acre to implement cover crops, conservation buffers and conservation tillage.	

Theory of Planned Behavior Questions

32. How do you feel (very bad, neutral, or very good) about the adoption of the following (new or existing) nutrient management practices for your farming operation in the next one to three years? Please circle each practice on a scale from “very bad” (1) to “very good” (7):

Planned crop rotations	Very Bad			Neutral			Very good	N/A
	1	2	3	4	5	6	7	
Soil test at least once every 3 years	Very Bad			Neutral			Very good	N/A
	1	2	3	4	5	6	7	
Strip cropping	Very Bad			Neutral			Very good	N/A
	1	2	3	4	5	6	7	
N,P and K application at rates recommended by soil tests	Very Bad			Neutral			Very good	N/A
	1	2	3	4	5	6	7	
Buffers at edge of field	Very Bad			Neutral			Very good	N/A
	1	2	3	4	5	6	7	
Cover cropping	Very Bad			Neutral			Very good	N/A
	1	2	3	4	5	6	7	
Reduced tillage	Very Bad			Neutral			Very good	N/A
	1	2	3	4	5	6	7	

Theory of Planned Behavior Questions

33. The next question is designed to help us understand who (friends and/or family, neighbors, or other farmers) may most strongly influence your decision to adopt conservation practices.

    Under each conservation practice, please tell us how strongly you agree or disagree that friends and family, neighbors, or other farmers think you should adopt that practice, if applicable.

    If not one influences your decisions, you can choose "not applicable" (N/A).

Planned crop rotations		
Your friends and/or family think you should adopt	Strongly agree 1 2 3 Neutral 4 5 6 7 Strongly disagree	N/A
Your neighbors think you should adopt	Strongly agree 1 2 3 Neutral 4 5 6 7 Strongly disagree	N/A
Other farmers think you should adopt	Strongly agree 1 2 3 Neutral 4 5 6 7 Strongly disagree	N/A
Soil tests at least once every 3 years		

Theory of Planned Behavior Questions

34. Are you confident that you can adopt/continue implementing the following Nutrient Management Practices? Please circle each practice on a scale from highly confident (1) to no confidence (7):

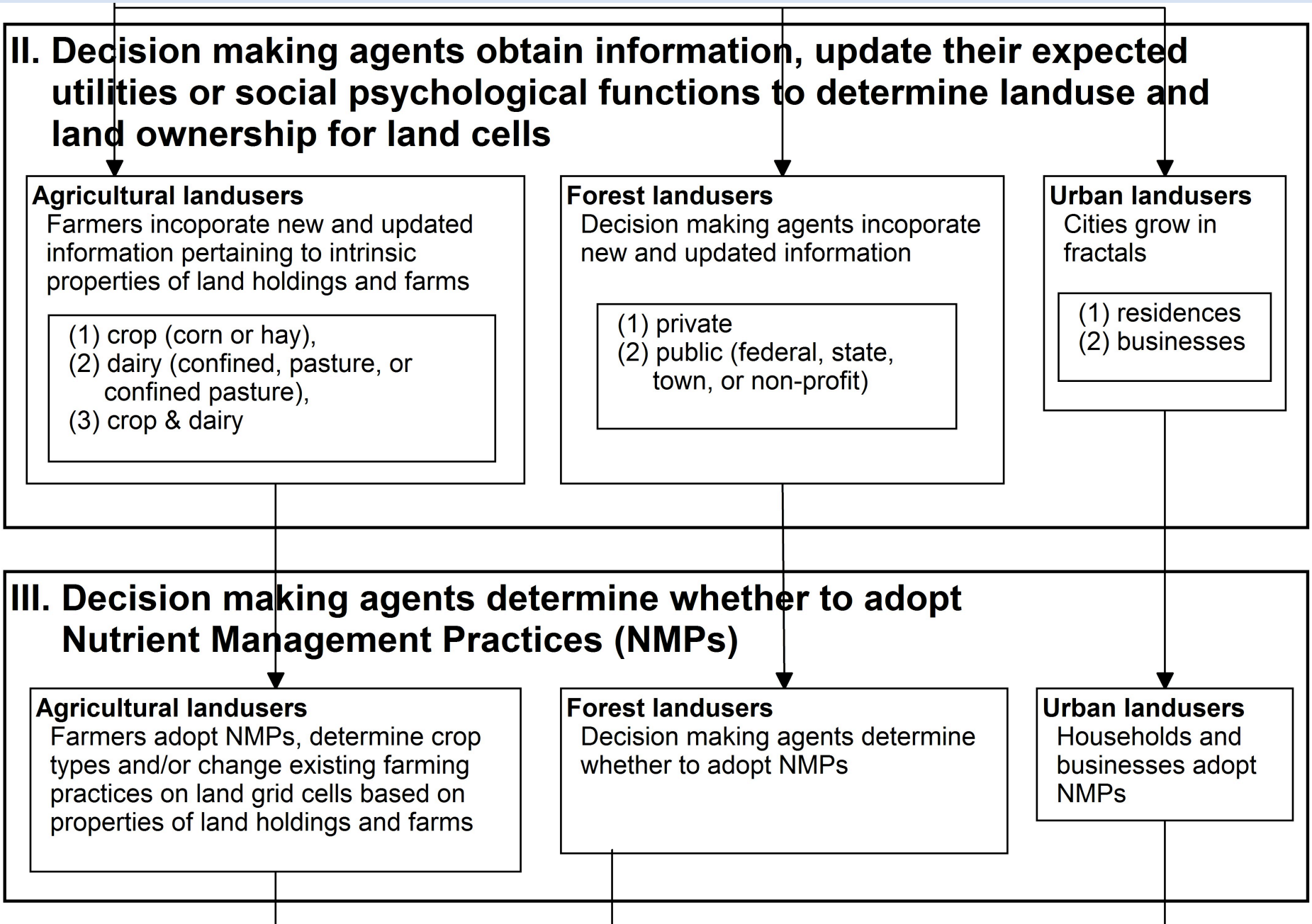
Planned crop rotations	Highly confident 1 2 3 4 5 6 7 No confidence	N/A
Soil test at least once every 3 years	Highly confident 1 2 3 4 5 6 7 No confidence	N/A
Strip cropping	Highly confident 1 2 3 4 5 6 7 No confidence	N/A
N,P and K application at rates recommended by soil tests	Highly confident 1 2 3 4 5 6 7 No confidence	N/A
Buffers at edge of field	Highly confident 1 2 3 4 5 6 7 No confidence	N/A
Cover cropping	Highly confident 1 2 3 4 5 6 7 No confidence	N/A

Theory of Planned Behavior Questions

35. If you do not already use the following practices, do you intend to adopt them in the next three years? Please circle for each practice on a scale from highly likely (1) to highly unlikely (7).

Practice	**I already use this practice (y/n)**	If No, please fill out this column
Planned crop rotations		Highly likely 1 2 3 4 5 6 Unlikely 7
Soil test at least once every 3 years		Highly likely 1 2 3 4 5 6 Unlikely 7
Strip cropping		Highly likely 1 2 3 4 5 6 Unlikely 7
N,P and K application at rates recommended by soil tests		Highly likely 1 2 3 4 5 6 Unlikely 7
Buffers at edge of field		Highly likely 1 2 3 4 5 6 Unlikely 7

Behavioral Mechanisms in LUT ABM



Complex Feedbacks

- SDM developed by Meals et al. (2008a, b)
- Improving this SDM and calibrating for Missisquoi and Winooski watersheds

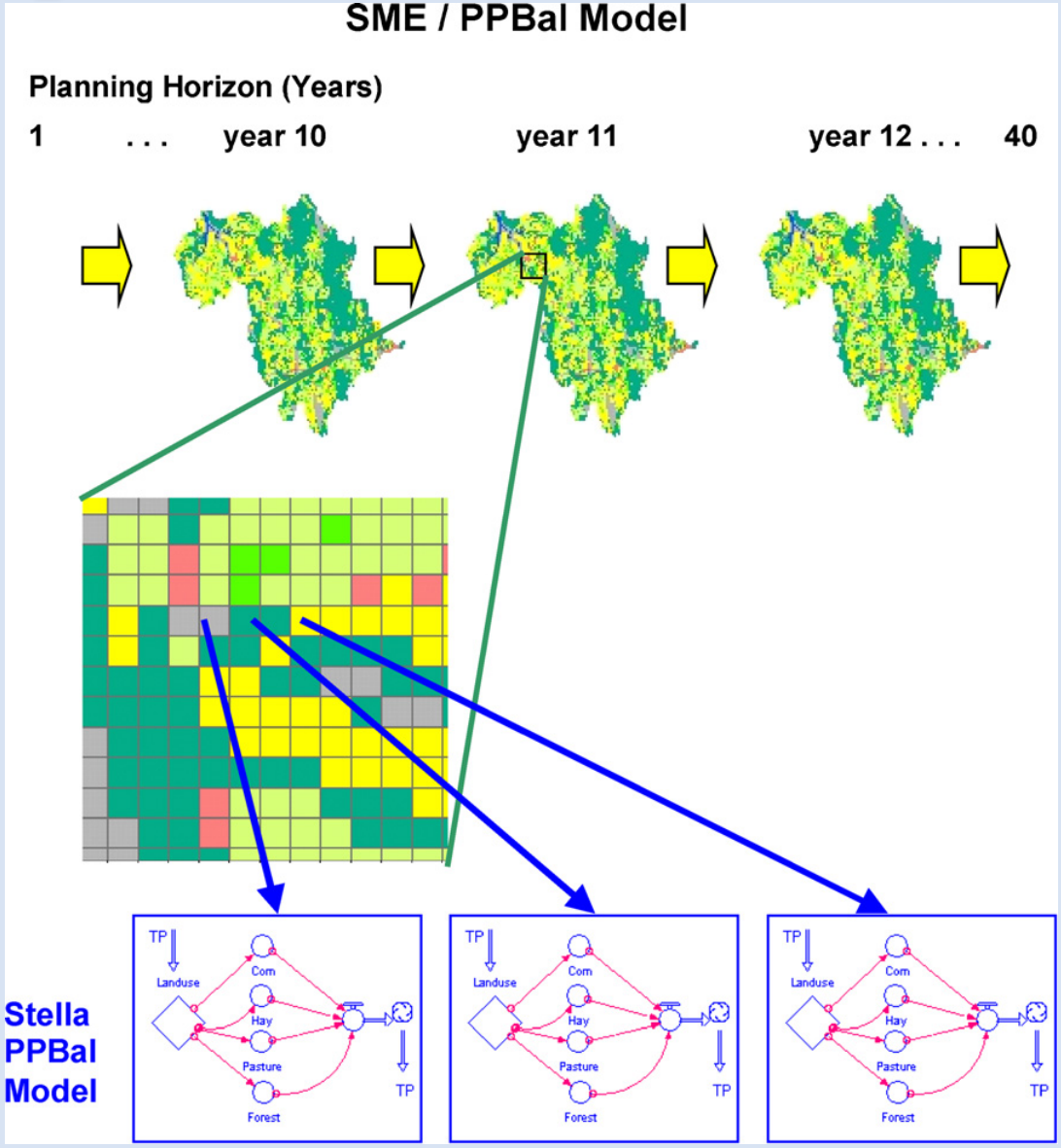


Fig. 2. Schematic diagram of the DISPLA approach based on the *Spatial Modeling Environment* (SME) and the *PPBalModel*.

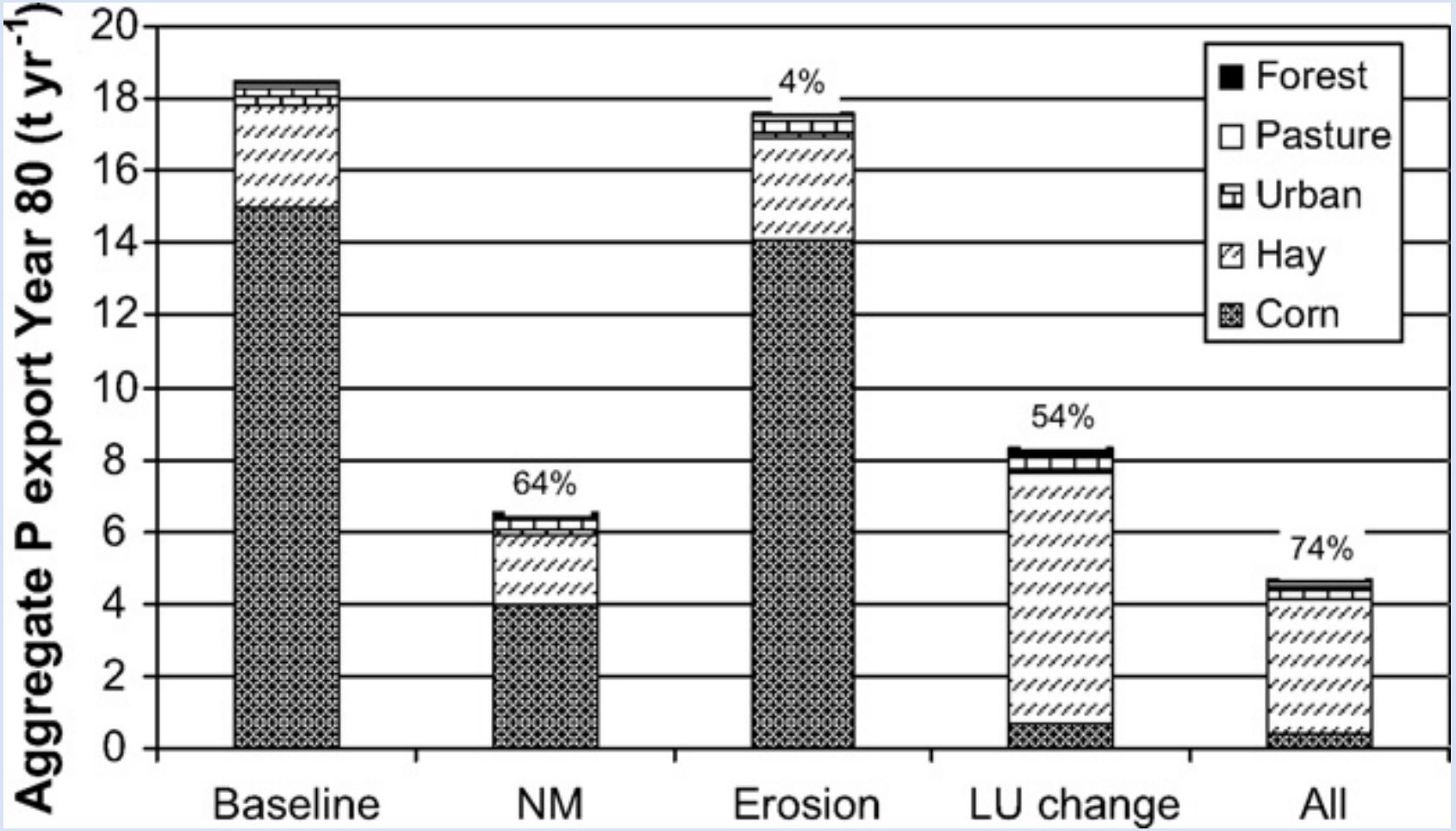
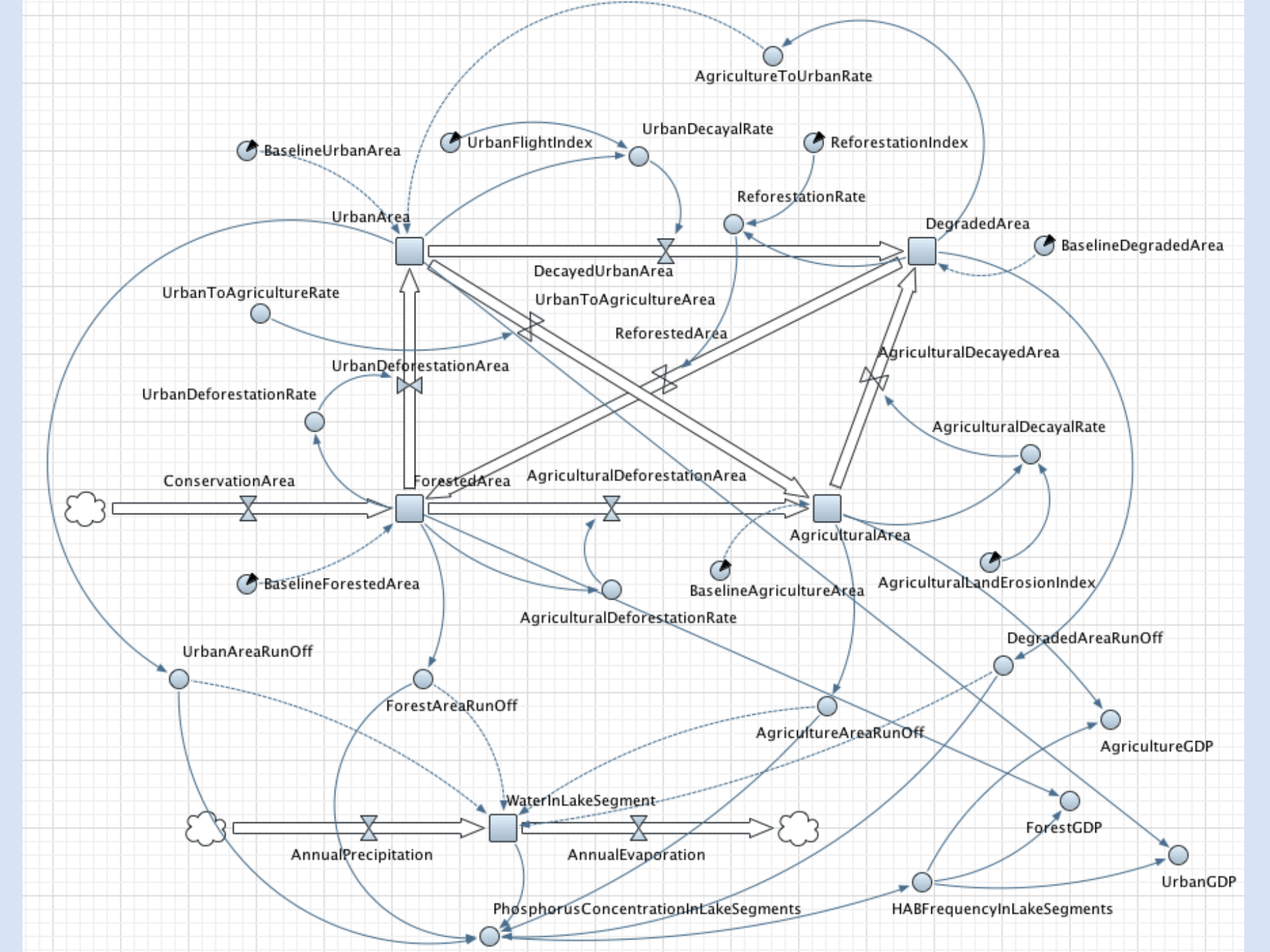


Fig. 13. Plot showing the sum of P export from modeled pixels in the test watershed at the end of 80-year DISPLA simulations. Numbers above bars represent reductions relative to baseline scenario.

Source: Meals et al. (2008b: 232) *Agriculture, Ecosystems and Environment*


AgricultureToUrbanRate
BaselineUrbanArea
UrbanFlightIndex
UrbanDecayalRate
ReforestationIndex
ReforestationRate
UrbanArea
DegradedArea
BaselineDegradedArea
DecayedUrbanArea
UrbanToAgricultureRate
UrbanToAgricultureArea
ReforestedArea
AgriculturalDecayedArea
UrbanDeforestationArea
UrbanDeforestationRate
AgriculturalDecayalRate
ConservationArea
ForestedArea
AgriculturalDeforestationArea
AgriculturalArea
BaselineForestedArea
BaselineAgricultureArea
AgriculturalLandErosionIndex
AgriculturalDeforestationRate
DegradedAreaRunOff
UrbanAreaRunOff
ForestAreaRunOff
AgricultureAreaRunOff
AgricultureGDP
WaterInLakeSegment
ForestGDP
AnnualPrecipitation
AnnualEvaporation
UrbanGDP
PhosphorusConcentrationInLakeSegments
HABFrequencyInLakeSegments

Complex Feedbacks: Unresolved Issues

- Identifying precipitation and extreme event variability impacts on land-use transitions and NMP adoptions in LCB
  - Focus groups, interviews, data mining in progress
- Predicting conditions for the emergence of alternate stable states in the terrestrial and lake systems
  - Deepening collaboration with Q2 and Q1 modeling teams
- Predicting the economic, social and ecological impacts of deteriorating water quality scenarios in Lake Champlain
  - A PhD student expected to investigate this in collaboration with ANR. Public opinion surveys already in progress
- Representing and communicating uncertainty across natural and human system models
  - Collaboration with Q1, Q2 and IAM teams. IAM workshop in September 2013.