LAND USE ALLOCATION MODEL: A TOOL FOR LINKING SCIENCE TO POLICY

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SYNOPSIS

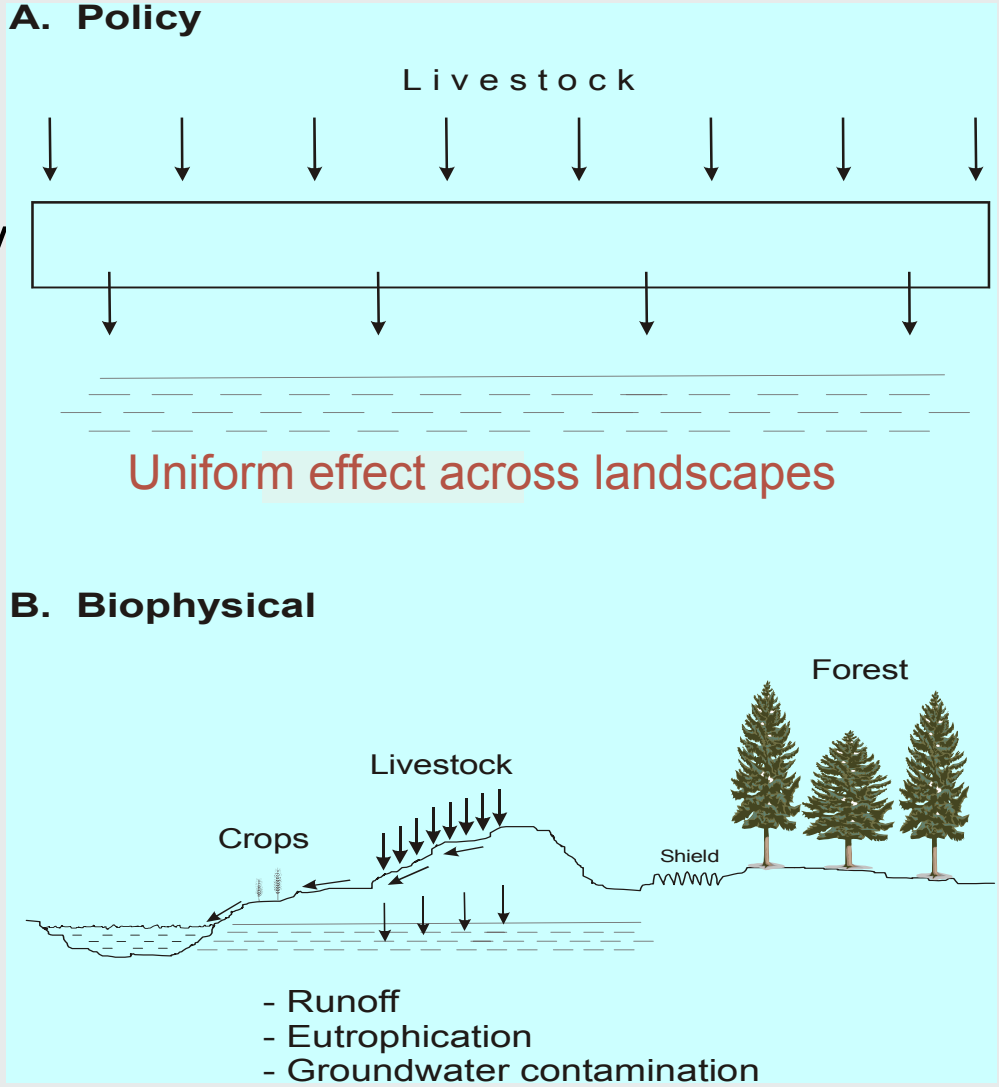
- INTRODUCTION
  - The Issue
  - Objectives
- POLICY/ECONOMIC PERSPECTIVE
- SCIENCE/BIOPHYSICAL PERSPECTIVE
- INTEGRATION APPROACH
  - The Integration Approach
  - The Land Use Allocation Model (LUAM)
  - The study area and data-rich pilot sites
- PRELIMINARY RESULTS
  - Agricultural trends in southern Ontario
  - Agricultural Land Use Change in southern Ontario
- SUMMARY AND NEXT STEPS

THE ISSUE

Economic & Policy models mainly function at macro-scale

L I N K

Biophysical models assess the impact of land use change (LUC) at the level of landscape



OBJECTIVES

- Conceptualize Integration of Economic and Biophysical models
- Construct a general framework for spatial modelling of this system
- Study drivers that cause Land Use Change
- Examine the socio-economic policy implications on the Environment using scenarios

POLICY/ECONOMIC PERSPECTIVE

- **Canadian Regional Agricultural Model (CRAM)**
  - A sector equilibrium model, Static in nature (*i.e. doesn't trace out time paths of changes*) for Canadian Agriculture
  - Administrative boundaries dictated by available economic data
  - Government policies are incorporated directly or indirectly
  - Non-linear mathematical programming model maximizing producer plus consumer surplus less transport costs
- **Objective**
  - Simulate regional producer decisions under changing economic conditions

POLICY/ECONOMIC PERSPECTIVE *Cont.*

- ***Table 1*: Coverage of the CRAM Model**

Land Type	Field Crops (East/West)	Livestock (Bulk/Processed)	Economic Output (Crop/Livestock)
Cropland Hay land Pasture	Wheat Barley Soybeans Corn Canola Oats, Hay Other crops	Beef Hogs Dairy Poultry	Yields Prices Trade Food demand Feed demand Transportation cost Production cost

SCIENCE/BIOPHYSICAL PERSPECTIVE

- **In the framework of the National Agri-Environmental Health Analysis and Reporting Program (NAHARP), AAFC has defined different Agri-Environmental Indicators (AEIs) to:**
  - Assess the risk of water contamination
  - Estimate Green House Gas emissions
  - Assess the risk of soil degradation
  - Provide insight into trends in wildlife habitat
  - Promote better environmental practices
- **Objectives**
  - Assess environmental sustainability by combining scientific knowledge with information on agriculture
  - Translate scientific knowledge into a form that can be understood and used by citizens and decision makers

SCIENCE/BIOPHYSICAL PERSPECTIVE *Cont.*

- ***Table 2*: Canadian national AEIs**

Indicator Groups	Agri-Environmental Indicators
Soil Quality	Risk of: Water erosion, Wind erosion, Tillage erosion, Soil compaction, Soil salinization; Soil organic carbon
Water Quality	Risk of Water Contamination by Nitrogen, Phosphorus
Air Quality	Agricultural Greenhouse Gas Budget; Particulate matter
Biodiversity	Availability of Wildlife Habitat on Farmland
Environmental Farm Management	Soil cover by Crops and Residue; Nutrient and Pesticide Inputs
Production Intensity	Energy Use; Residual Nitrogen

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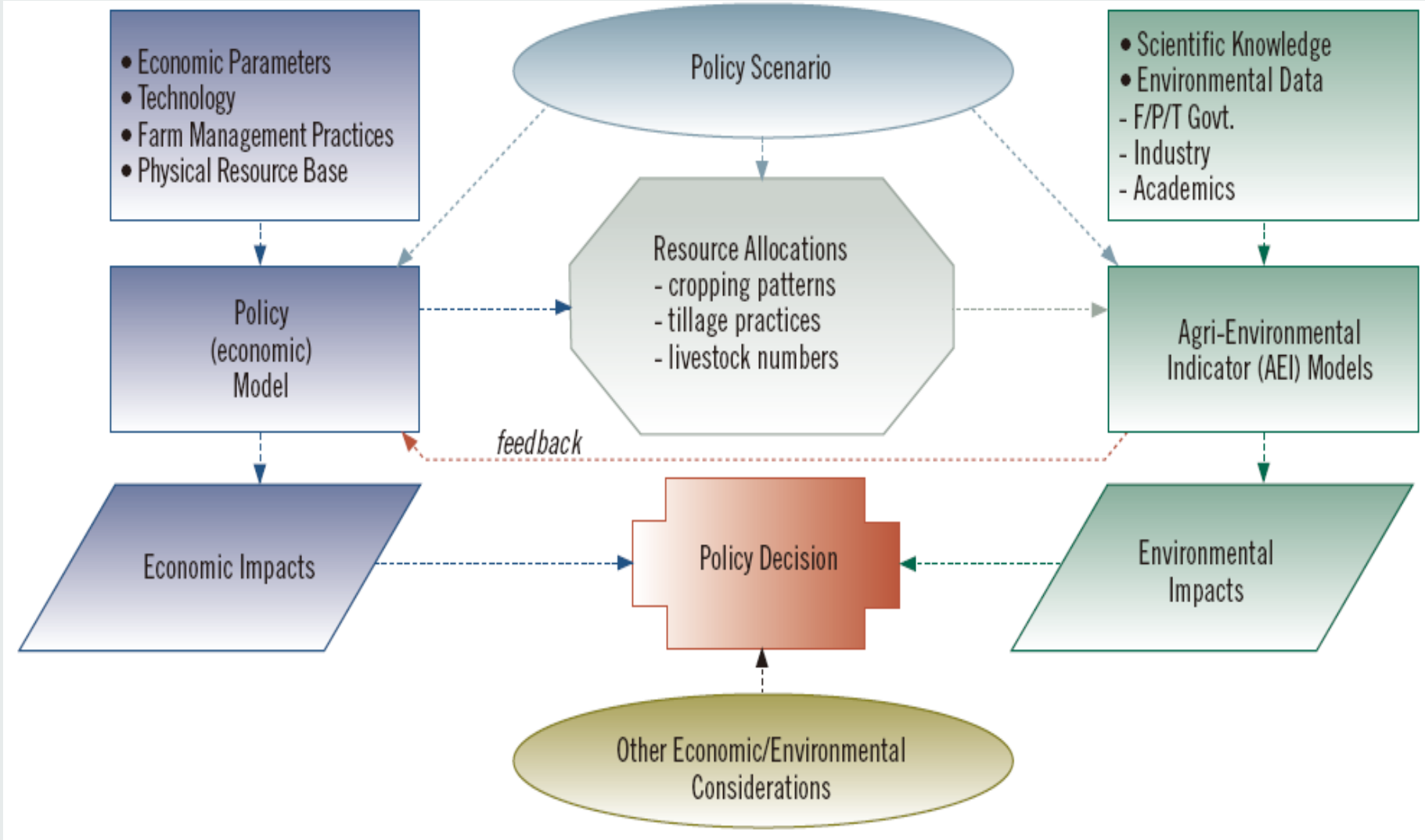
INTEGRATION APPROACH



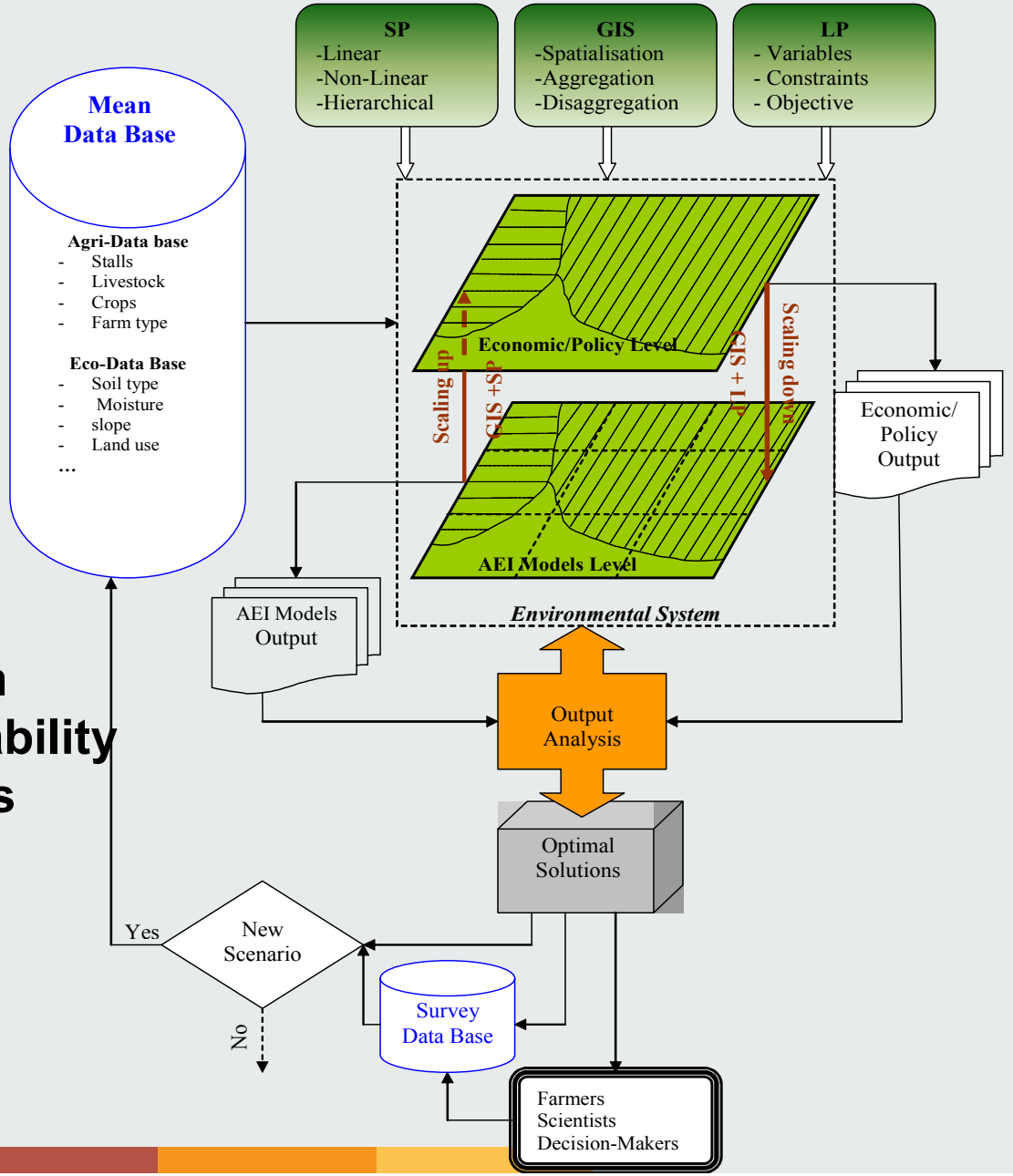
- *Figure 1*: Integrated Economic/Environmental Analysis

THE LAND USE ALLOCATION MODEL (LUAM) 1

- **Spatial model to scale down economic model responses to biophysical level and scale up environmental impacts to policy model level in the following sequence:**
  - Identify the production responses to market conditions, agricultural policy and technological change
  - Determine locations on the landscape where the policy induced changes in production systems will take place
  - Determine the impacts of these changes on AEIs
  - Provide feedback of AEI responses to the CRAM level
- **Currently, LUAM is at its development stage and is designed to estimate environmental impacts of agricultural policies as well as the economic consequences**

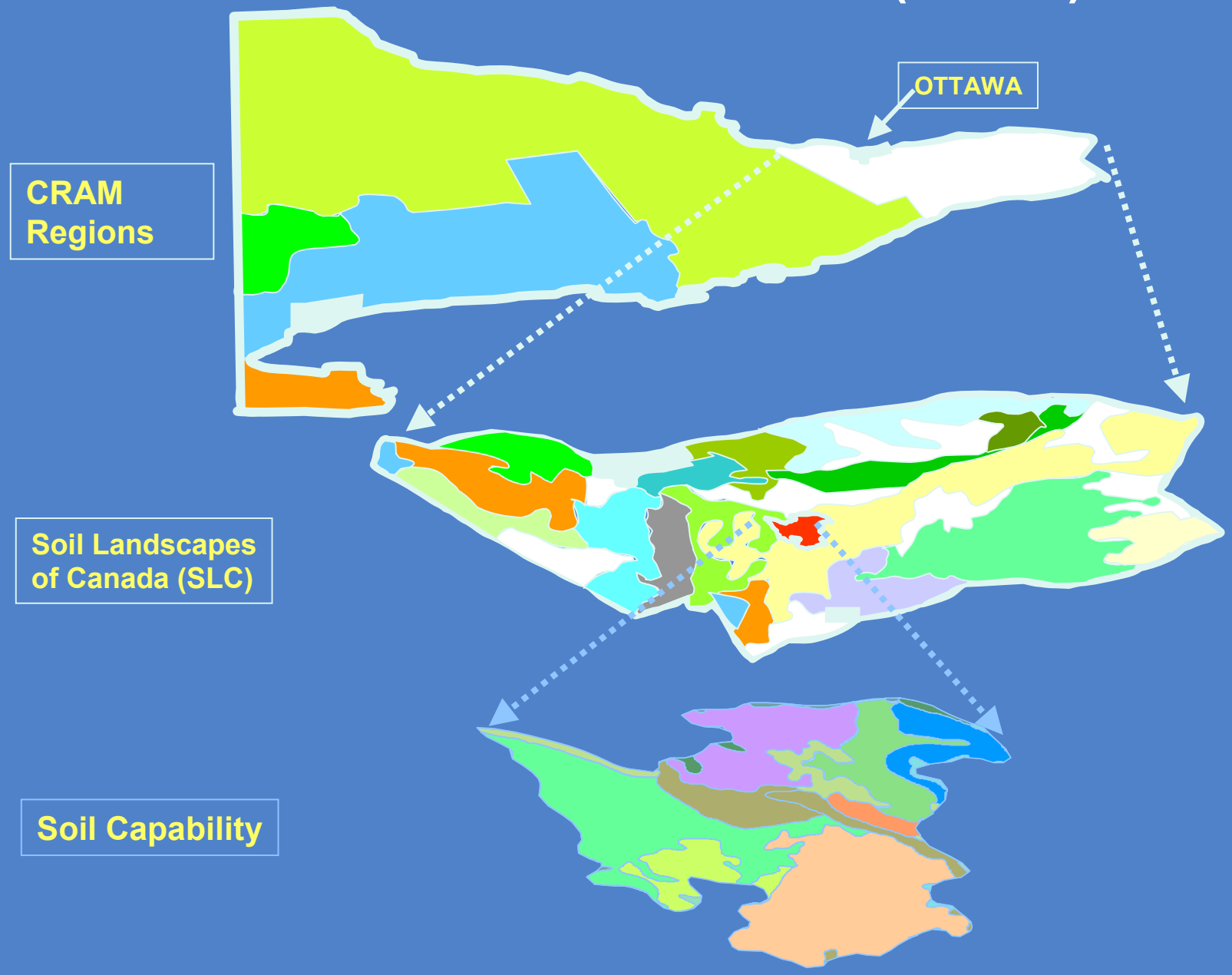
THE LAND USE ALLOCATION MODEL (LUAM) *Cont.*

Figure 2: Framework of the integrated LUAM system



Optimal solution = equilibrium system between economic viability and environmental constraints

THE LAND USE ALLOCATION MODEL (LUAM) *Cont.*



THE STUDY AREA AND DATA-RICH PILOT SITES

- **Study Area**:

Southern Ontario

- **Data-rich pilot sites**:

Census of Agricultural

Regions (CAR) 1 and 4

- **Data source**:

Census of Agriculture, Remote Sensing, Ground Truth data, CRAM Output, SLCs, CLI

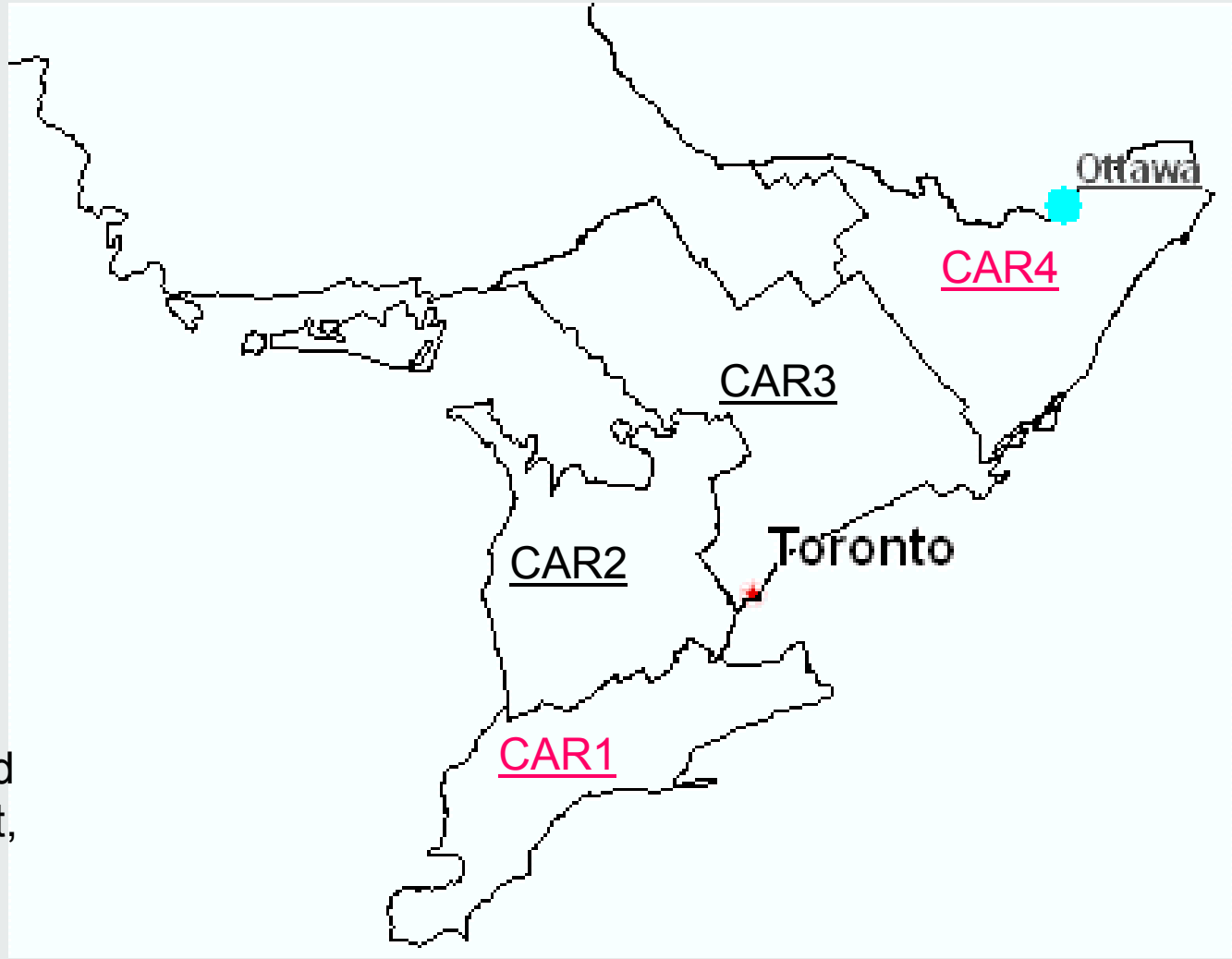


***Figure 3*: The Study area and data-rich pilot sites**

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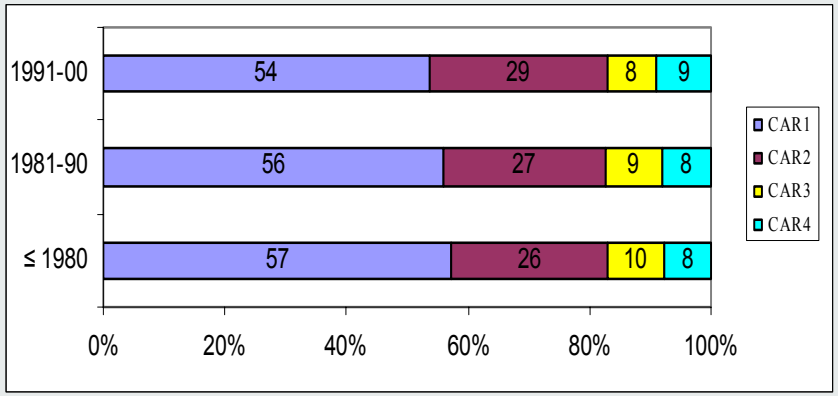
PRELIMINARY RESULTS 1

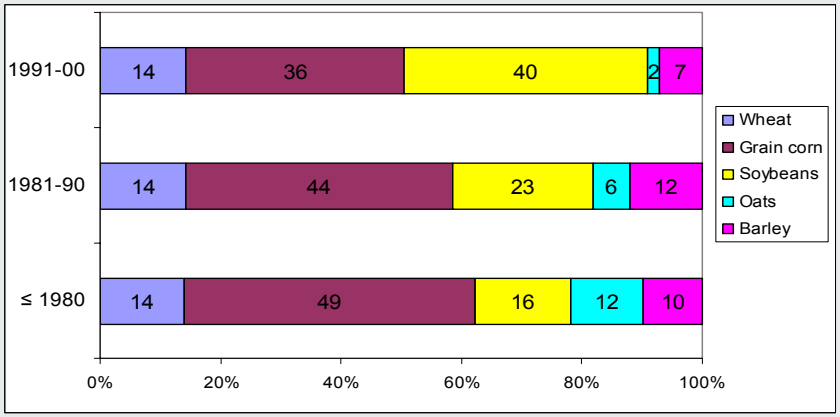
- Agricultural trends in Southern Ontario
  - Analysis of historic productivity trends for major crops was based on data provided by Statistics Canada
  - Crop yields and harvested area were considered from 1976 until 2002 over the four CAR regions
- Agricultural Land Use Change (LUC)
  - Rates, Characteristics and Trends of LUC were analysed at SLC and CAR level each 5 years from 1981 until 2001

PRELIMINARY RESULTS 2: Agricultural trends (1976-02)

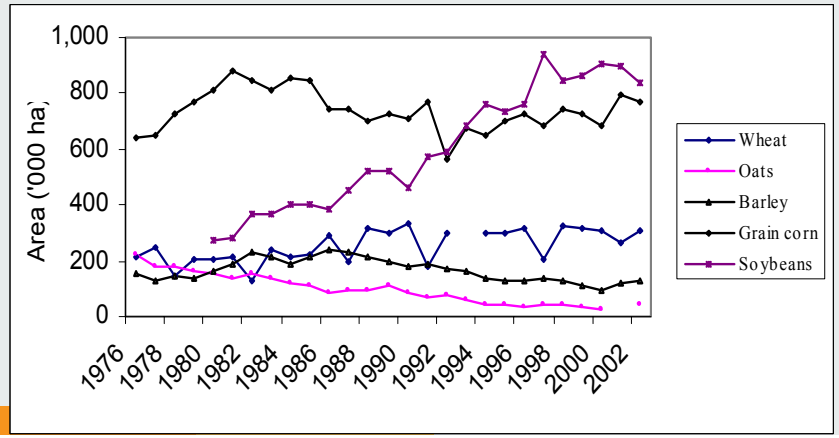
- The harvested area has remained stable in CAR4, slightly decreased in CAR 1 and CAR3 and increased in CAR 2



- 14% of the total harvested area was under wheat while areas under corn and oats have declined from 49% to 36% and 12% to 2% respectively

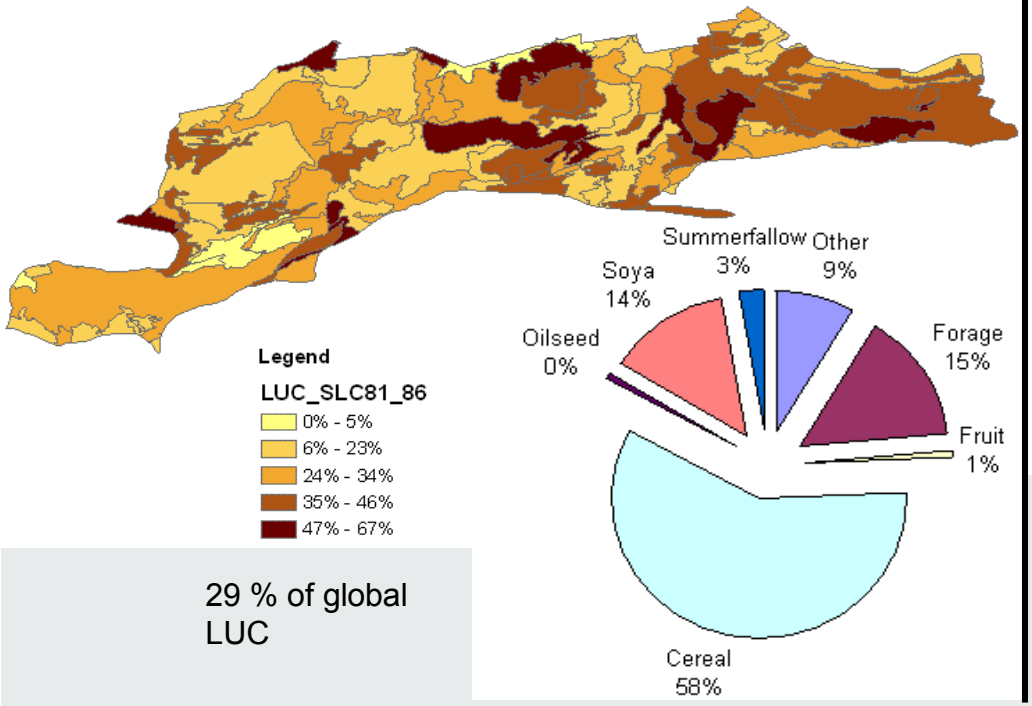


- The area under soybeans has dramatically increased, surging from 16% to 40% of total harvested area



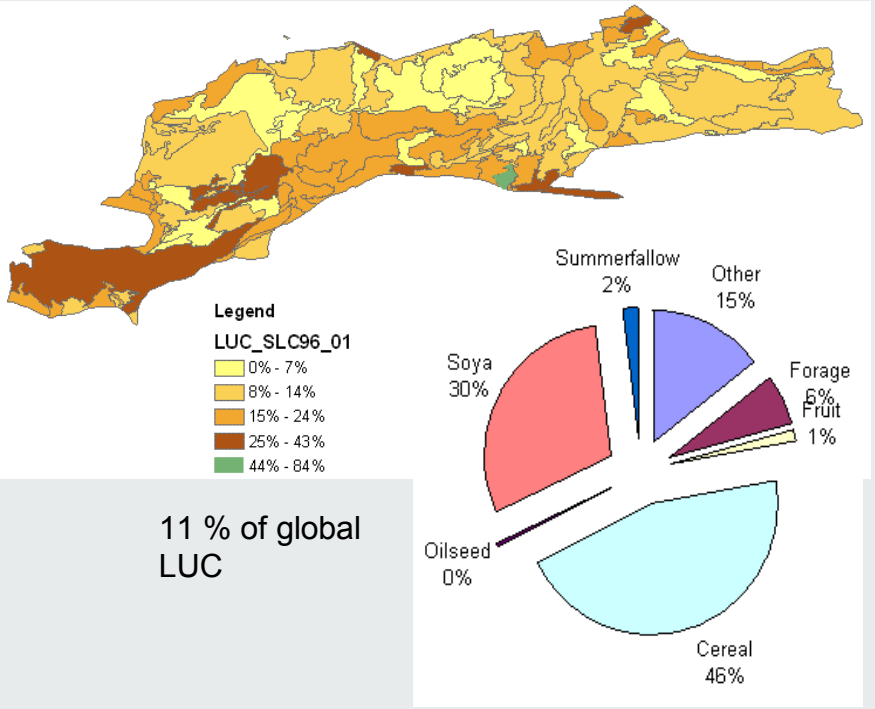
PRELIMINARY RESULTS 3: Land Use Change in CAR1

Land use change 1981-1986



29 % of global LUC

Land use change 1996-2001

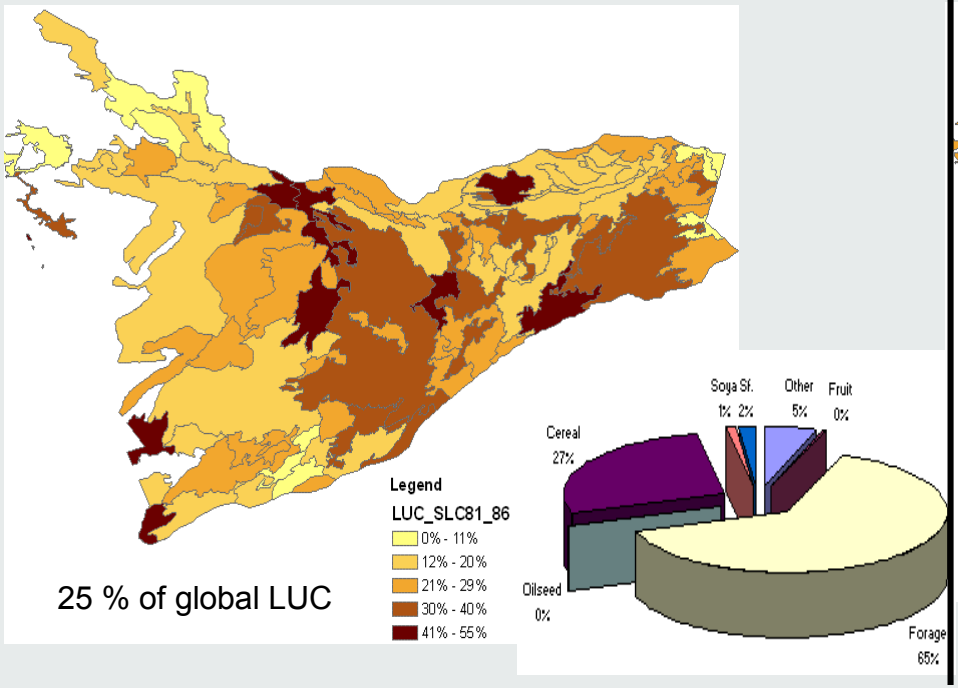


11 % of global LUC

- **The color of each SLC indicates the rate of change, while pie charts indicate the type of change in CAR1:**
  - There was 29% of global LUC in 1981-86 mainly due to Cereal crops (58%)
  - There was 11% of global LUC in 1996-01 mainly due to Cereal (46%) and Soybeans (30%)

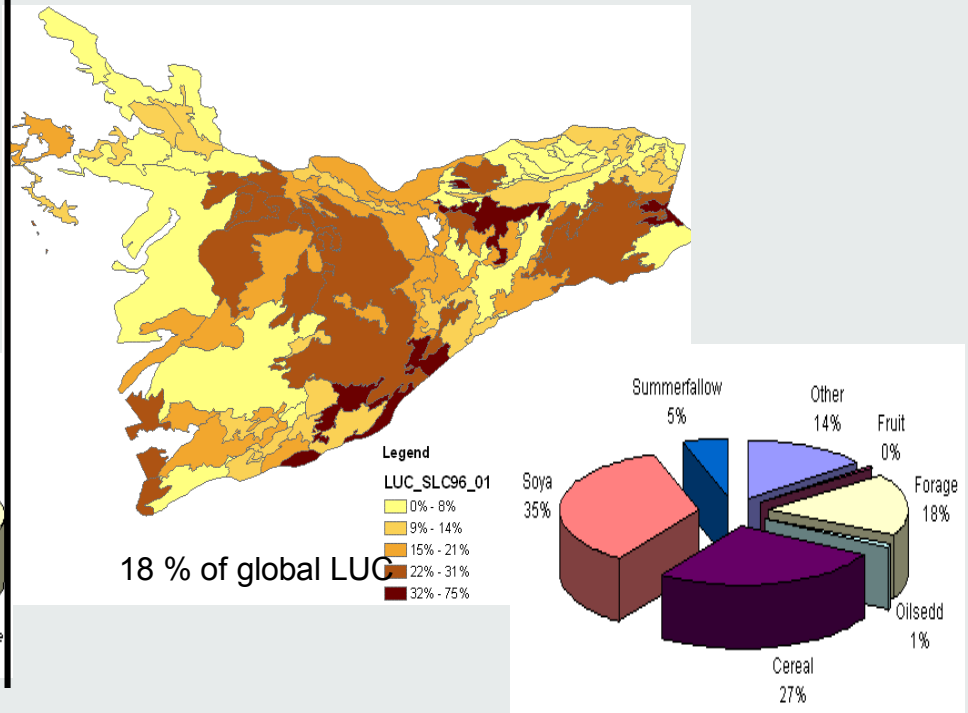
PRELIMINARY RESULTS 4: Land Use Change in CAR4

Land use change 1981-1986



25 % of global LUC

Land use change 1996-2001



18 % of global LUC

- **The color of each SLC indicates the rate of change, while pie charts indicate the type of change in CAR4:**
  - There was 25% of global LUC in 1981-86 mainly due to Forage (65%) and Cereal (27%)
  - There was 18% of global LUC in 1996-01 mainly due to Soybeans (35%) Cereal (27%) and Forage (18%)

SUMMARY

- ✓Integrating policy models with biophysical models and assessing their impacts is a complex task that must and can be based on a comprehensive analysis

- ✓The LUAM Model is built to address this challenge

- ✓The advantages of LUAM can be summarized as follows:
  - Both policy models and biophysical models can operate at their scale of functionality
  - It serves as a bridge for “translating” information across different scales
  - It tests several agri-environmental scenarios
  - And defines the best equilibrium system between economic viability and environmental constraints

- ✓The first results provide evidence of distinctive regional variation in the rates and characteristics of Land Use Changes

NEXT STEPS - CONCLUSION

- ✓The next steps of LUAM development can be summarized as follows:
  - Determine policy, market, technological and biophysical driving forces that might cause LUC
  - Identify what attributes of land or production systems make them more apt to change
  - Develop mathematical relationships or algorithms linking change drivers with landscape properties
  - Develop a strategy for testing algorithms across agricultural regions in Ontario
- ✓When the LUAM model is tested and validated in Ontario, it will be adapted to prairie regions
- ✓This model will provide AAFC a lead in bridging policy models and biophysical indicators for a better understanding of economic and environmental issues.

THANK YOU – MERCI !

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