

Climate Impact on Land Use

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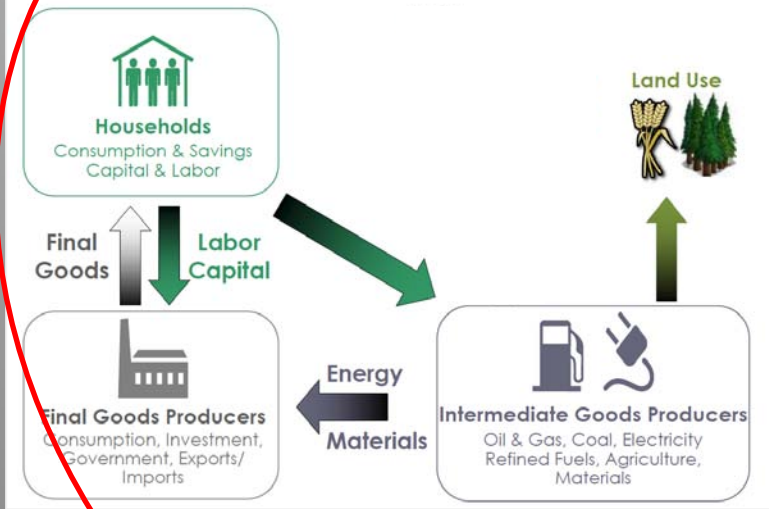
Motivation

- Interaction between land use and climate change
 - Land cover and land use change affect global and regional climate
 - Climate affects potential land productivities and thus land use
- To evaluate how climate affect the amount of land use by different sectors at regional level

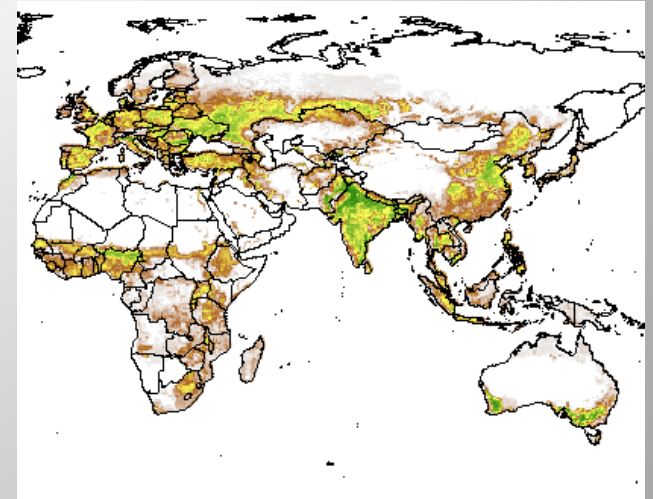
Toward IAM-Earth System Model Interactions

Integrated Assessment Model

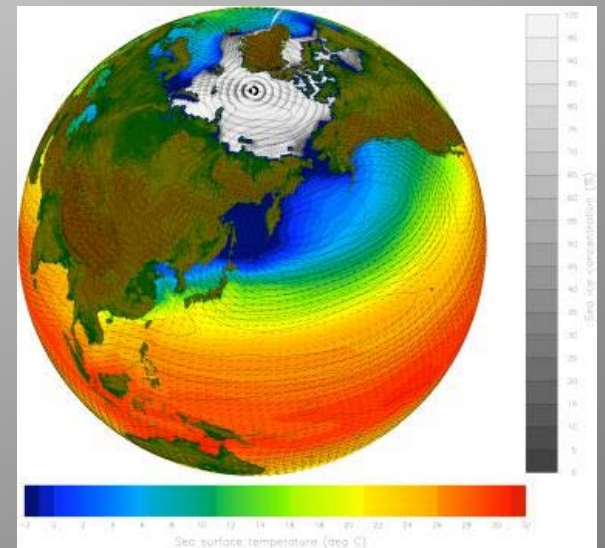
iPETS Model



Spatial
land use



Implement
in CLM/CESM



Feedback:
Land productivity
for agriculture



Modeling approach

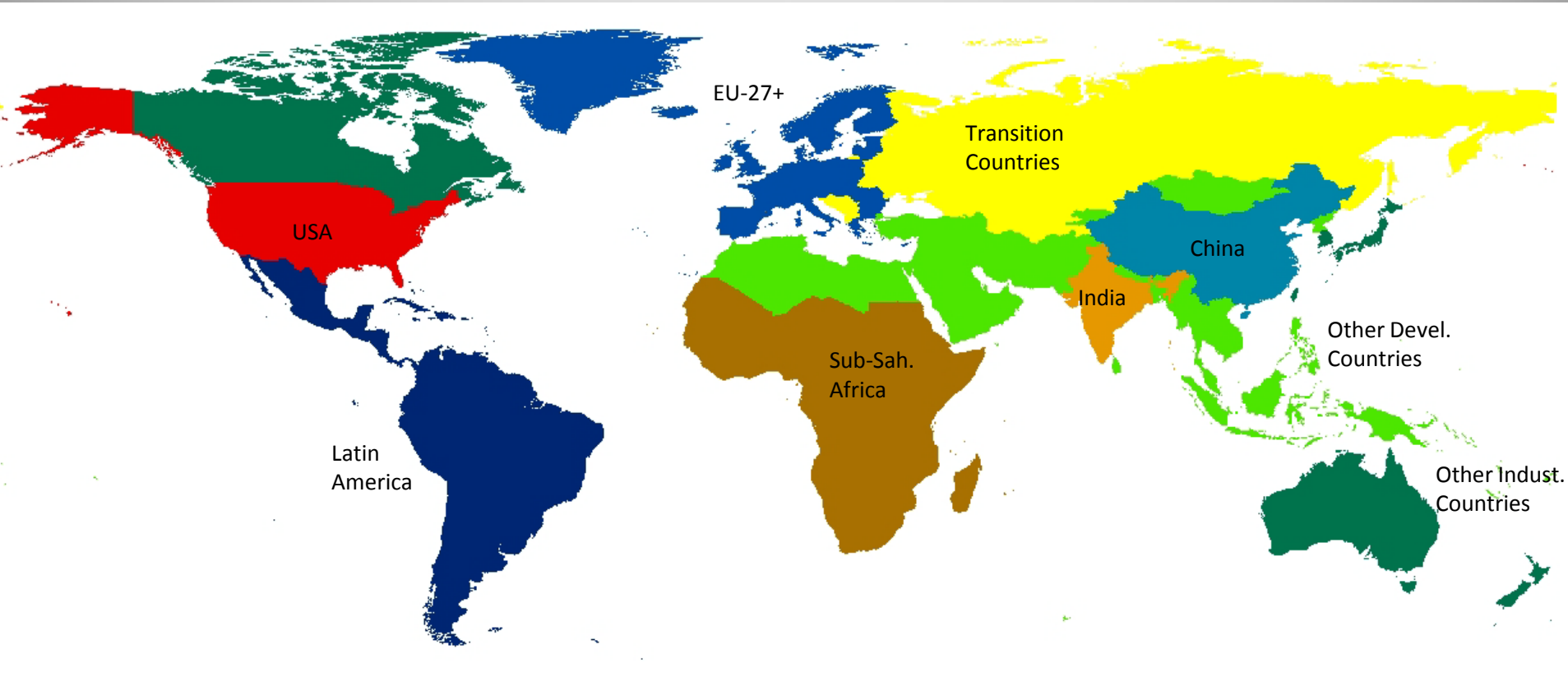
- Multiple types of land:
 - Two (physical) land types distinguished by Length of Growing Period: high productivity, low productivity
- Land competition
 - Three land-use sectors: crops, animal products and forestry
 - Different uses (cropland, pasture, forestland) imply different costs
- Explicit and endogenous
 - Model structure allows new land to be brought into production when necessary

Climate Impacts

- Total amount of land in each land type
 - Length of Growing Period: Number of days suitable for crop growth at each grid cell
 - Average daily temperature $> 5^{\circ}\text{C}$
 - Soil water balance
- Land Productivity Coefficient
 - Extreme events
 - Diseases/pests
 - CO_2 fertilization

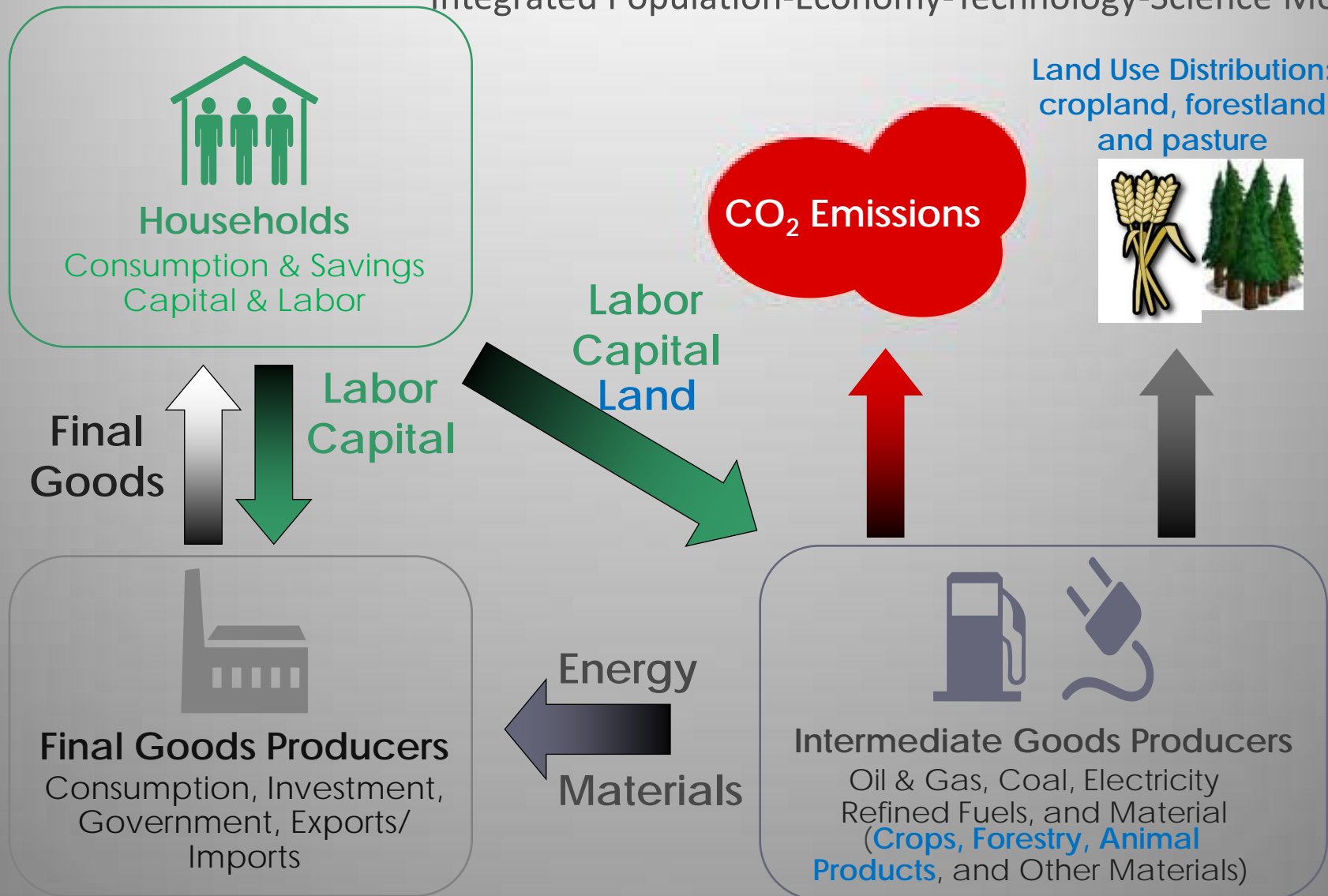
iPETS: 9-Region “CGE” Model, with Trade

(CGE = Computable General Equilibrium)



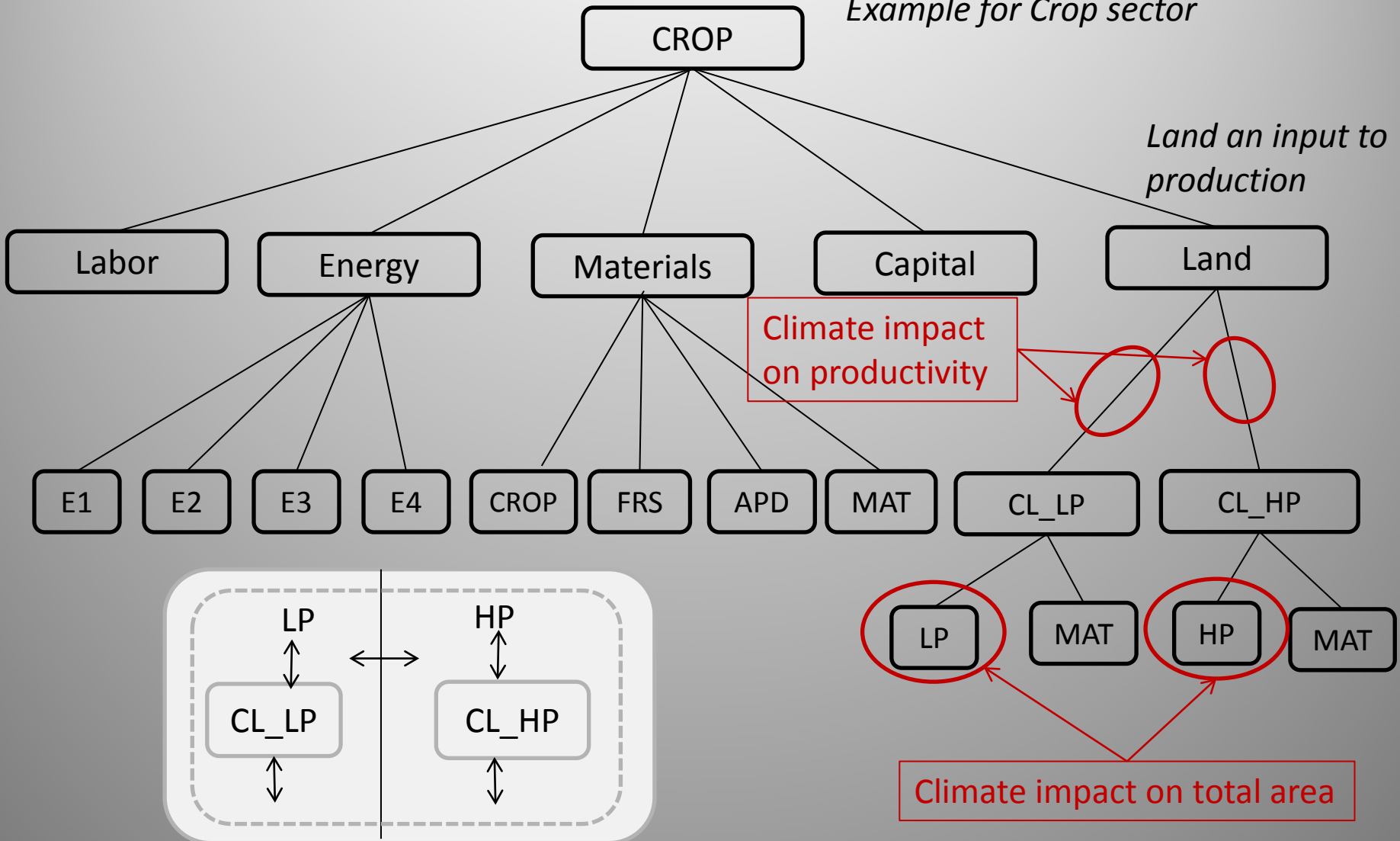
iPETS Model

Integrated Population-Economy-Technology-Science Model



Production Tree

Example for Crop sector



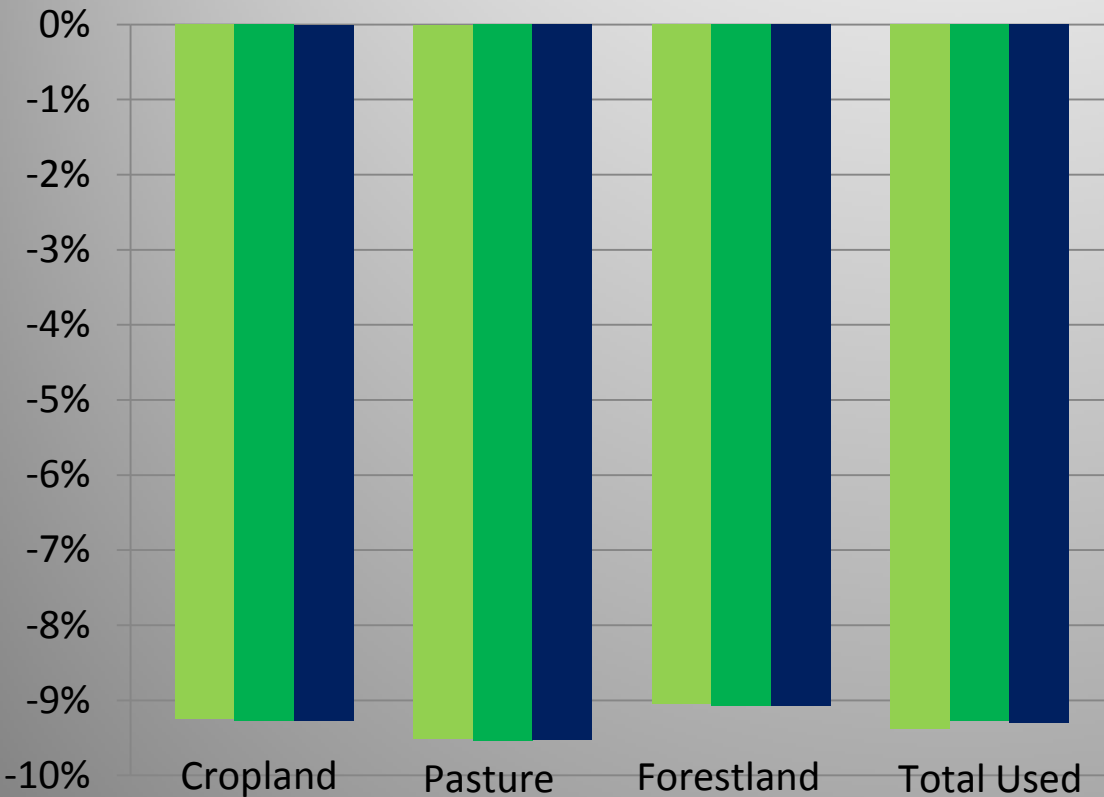
Scenarios: Latin America

- Baseline: RCP 8.5
- Alternative scenarios
 - S1: Reduction of total available land
 - Areas for both land types reduce 10% at 2100
 - S2: Reduction of high productive land and increase of low productive land with total fixed
 - 10% of high productive land converts to low productive land at 2100
 - S3: 20% reduction of productivity coefficient for both types of land in all sectors
 - S4: 20% reduction of productivity coefficient for high productive land in all sectors
 - S5: 20% reduction of productivity coefficient for cropland for both types

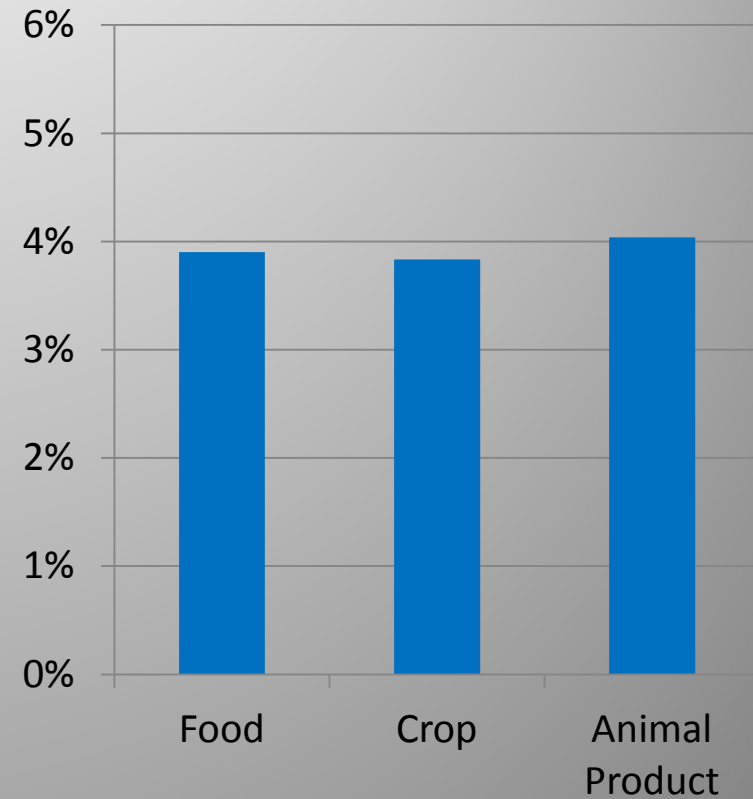
Land Use in 2100: S1

Constraint: 10% reduction in total available land

Results: % change in land use



Results: % change in prices

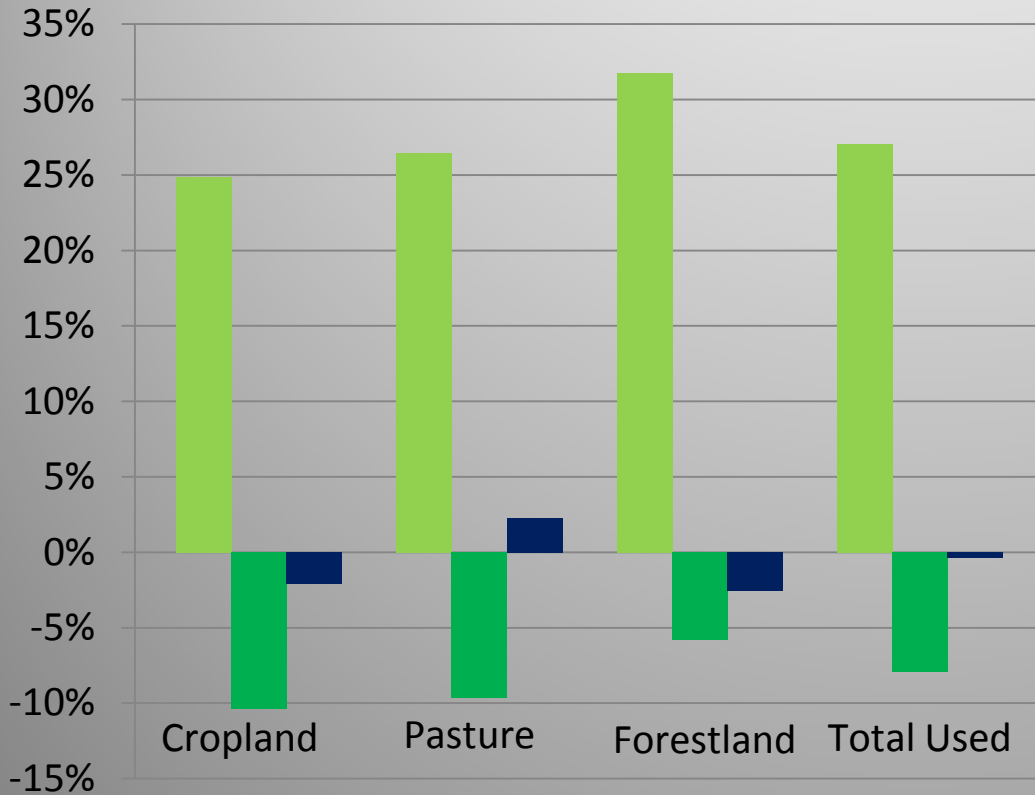


Low productive land High productive land Total land in production

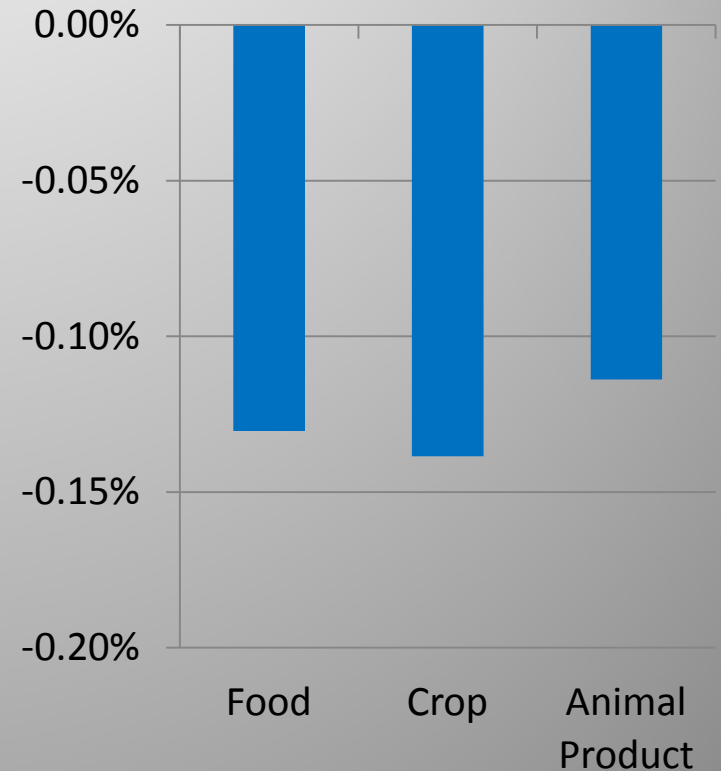
Land Use in 2100: S2

Constraint: 10% high productive land -> low productive

Results: % change in land use



Results: % change in prices

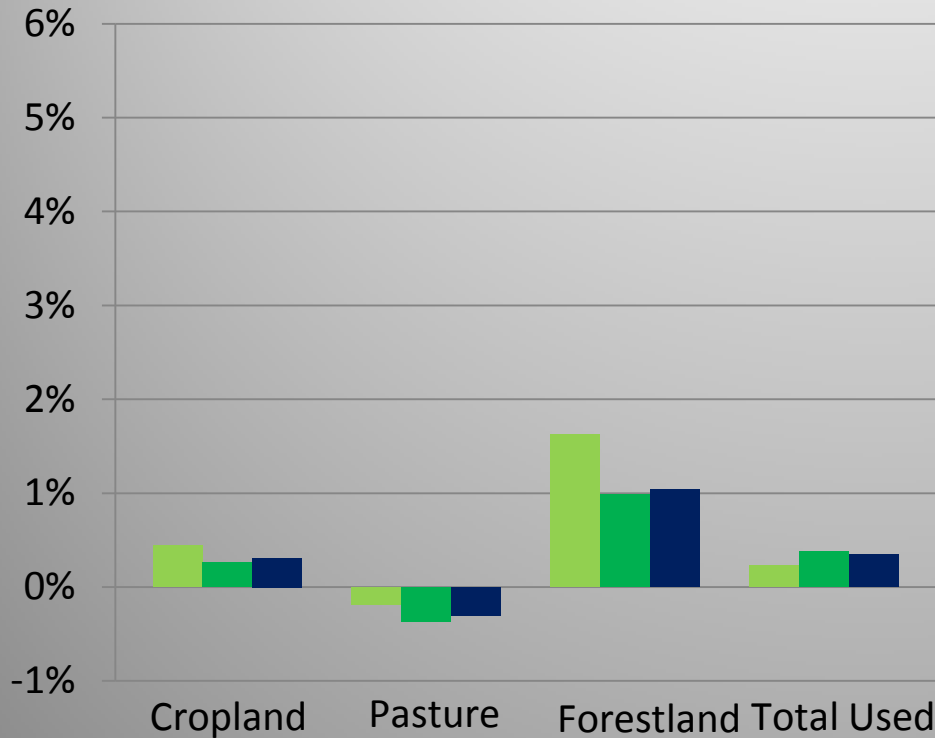


Low productive land **High productive land** **Total land in production**

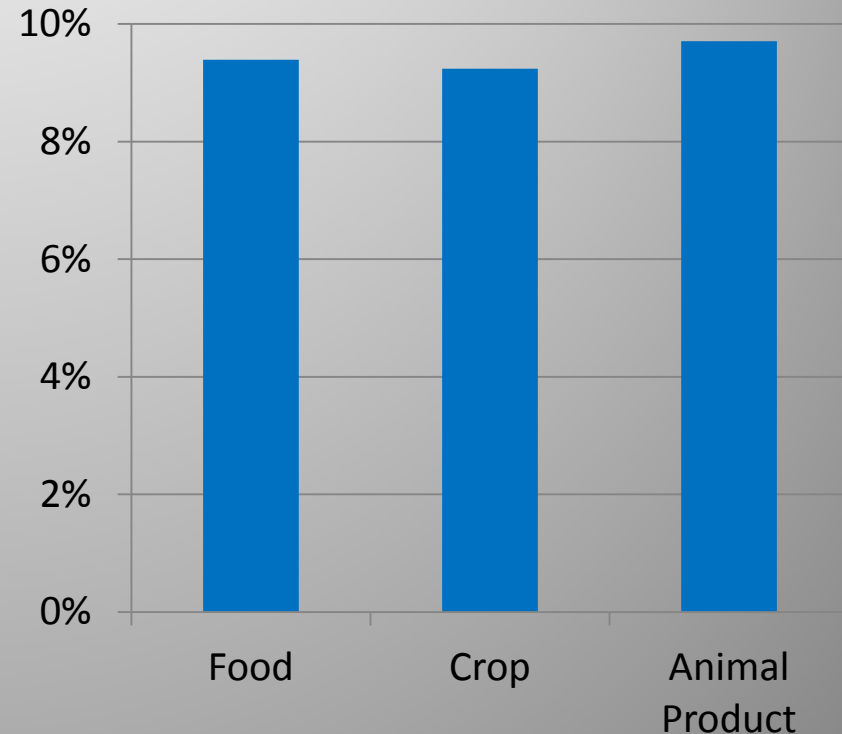
Land Use in 2100: S3

Constraint: land productivity coefficients for both types in all sectors: ↓ 20%

Results: % change in land use



Results: % change in prices

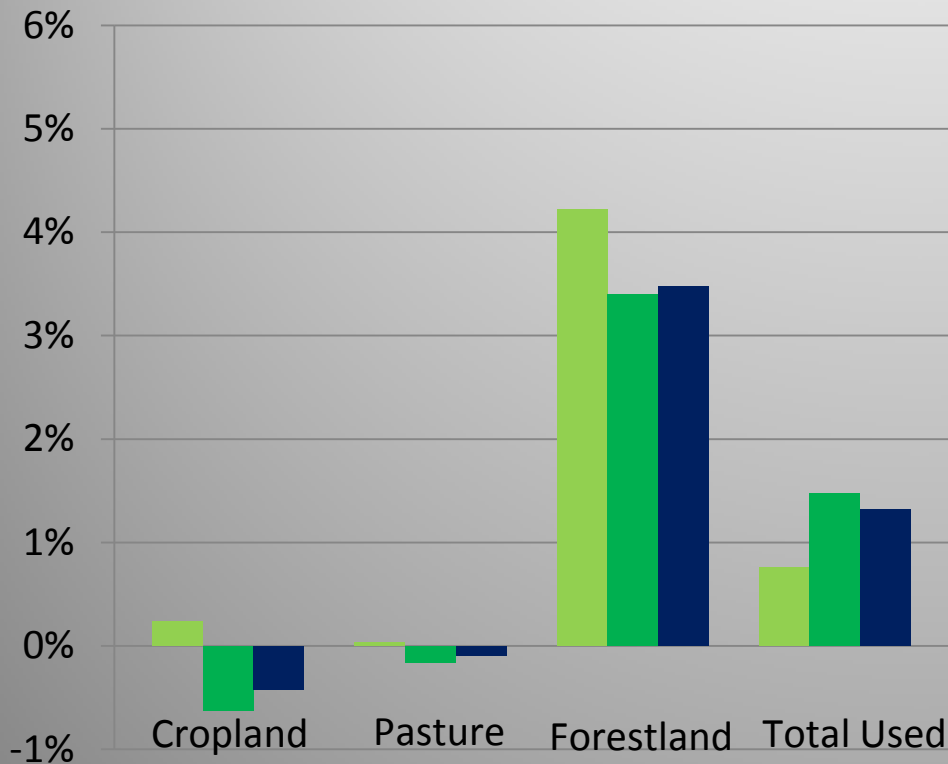


Low productive land **High productive land** **Total land in production**

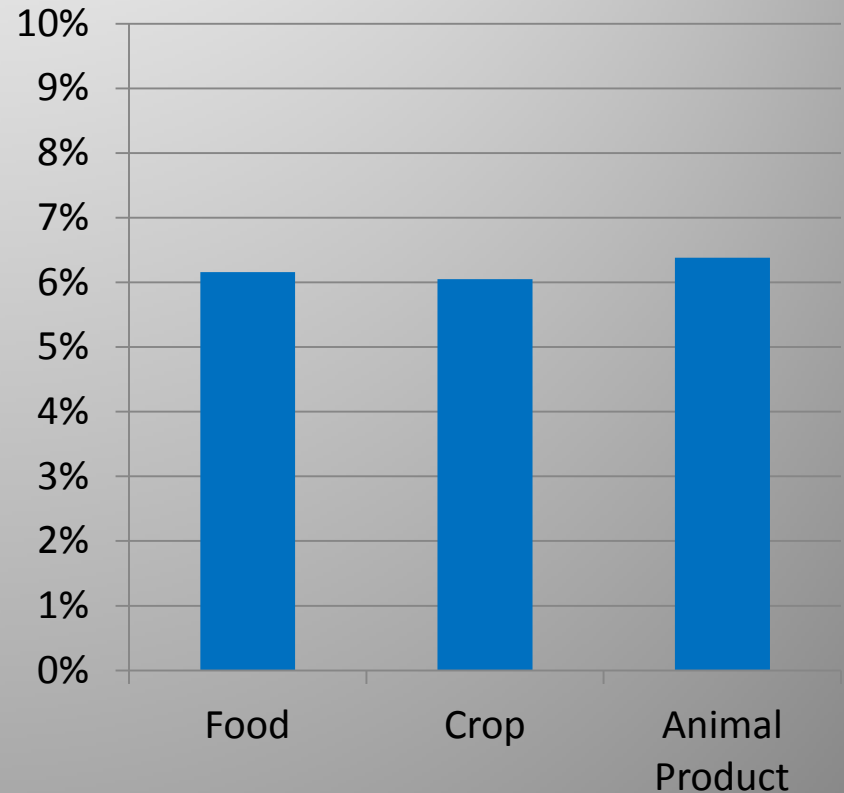
Land Use in 2100: S4

Constraint: land productivity coefficients for high productive land: ↓ 20%

Results: % change in land use



Results: % change in prices

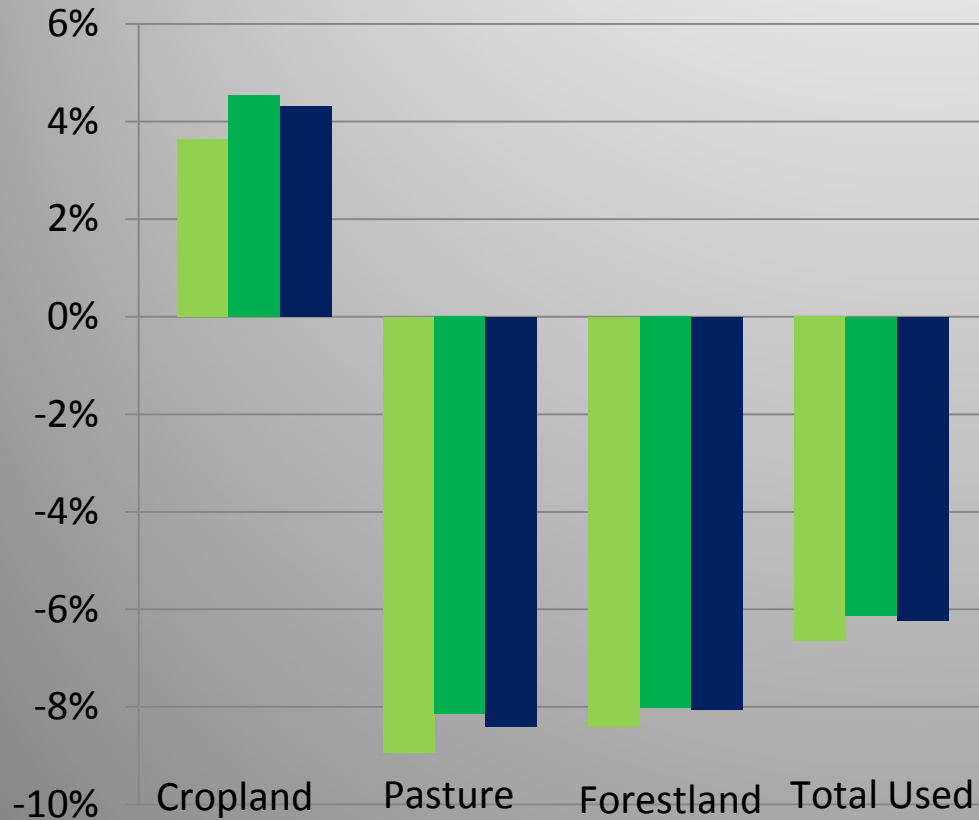


Low productive land High productive land Total land in production

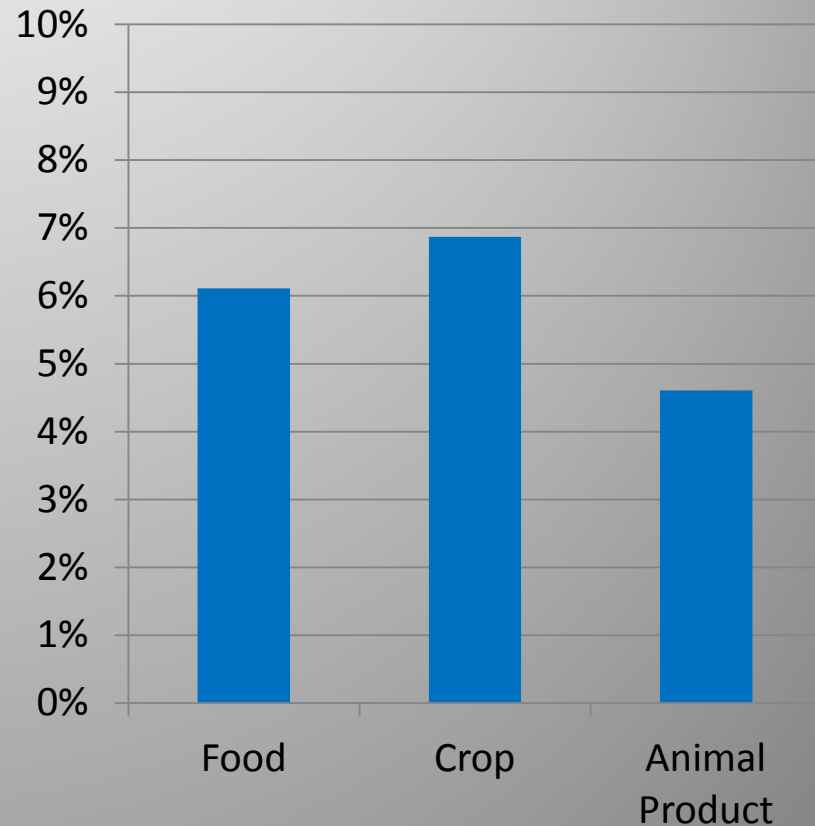
Land Use in 2100: S5

Constraint: crop land productivity coefficients for both types: ↓ 20%

Results: % change in land use



Results: % change in prices



Low productive land High productive land Total land in production

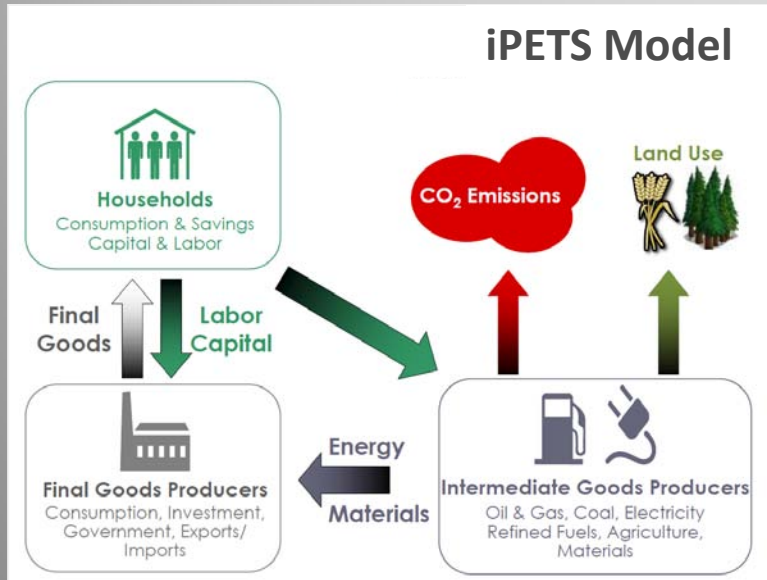
Conclusions

- Productivity changes potentially driven by climate change affect land use in multiple ways
 - Effects differ across land types and land use sectors
- ↓ (↑) in land supply in certain type
 - Amount of land used of that particular type in production ↓ (↑)
 - Drives food price ↑ (↓)
- ↓ in land productivity
 - Food prices ↑
 - Amount of land use can go ↑ or ↓
 - Additional investigation of productivity effects on land use is needed

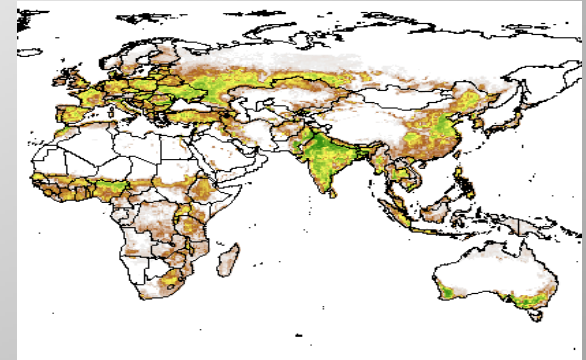
Next Step

- Global model: Inter-regional effects

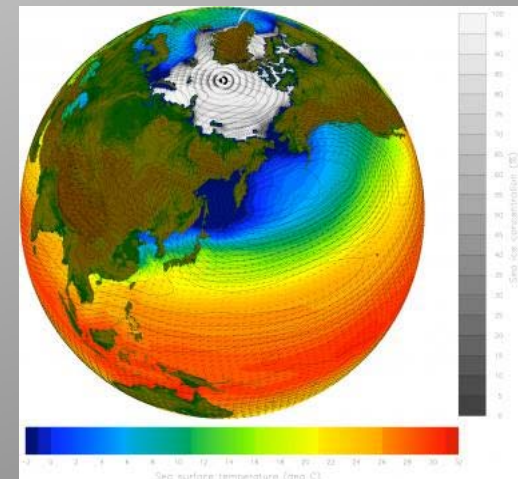
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