Integrating Forest Sector Models that investigate GHGs with Computable General Equilibrium Models

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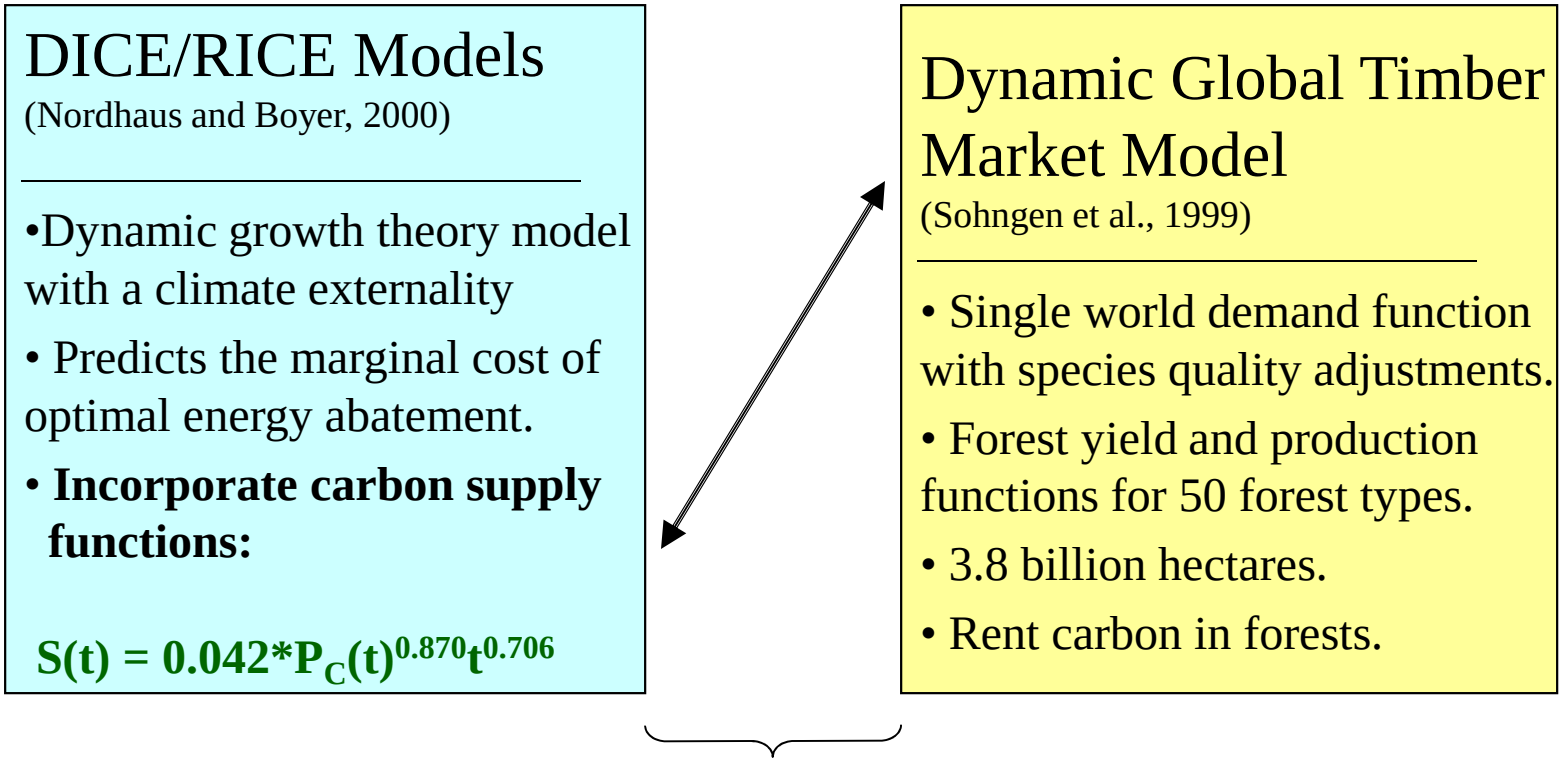
Overview of presentation

- Dynamic global timber supply model
  - Overview
  - Simulations
  - Lessons learnt (Sohngen and Sedjo)
- Dynamic global computable general equilibrium model
  - Overview
  - Simulations
  - Lessons learnt (Wong and Alavalapati)
- Opportunities for integration

1. Dynamic Forestry Model

- 50 Ecosystem and Management Classes:
  - *Temperate forests*
  - *Subtropical Plantation*
  - *Low-mid latitude temperate and subtropical*
  - *Northern Inaccessible*
  - *Tropical Inaccessible*
- Economic Data:
  - Yield functions; forestland area; harvesting, transportation, and land cost functions; demand etc. from Sohngen et al. (1999).
- Carbon parameters from Sohngen and Sedjo (2000).
- Rent Carbon
  - Explore different carbon paths depending on policies.

Integrating Forestry and Energy



Policy Analysis

(1) "Optimal" Forest Policy

(2) Potential for forestry under Kyoto

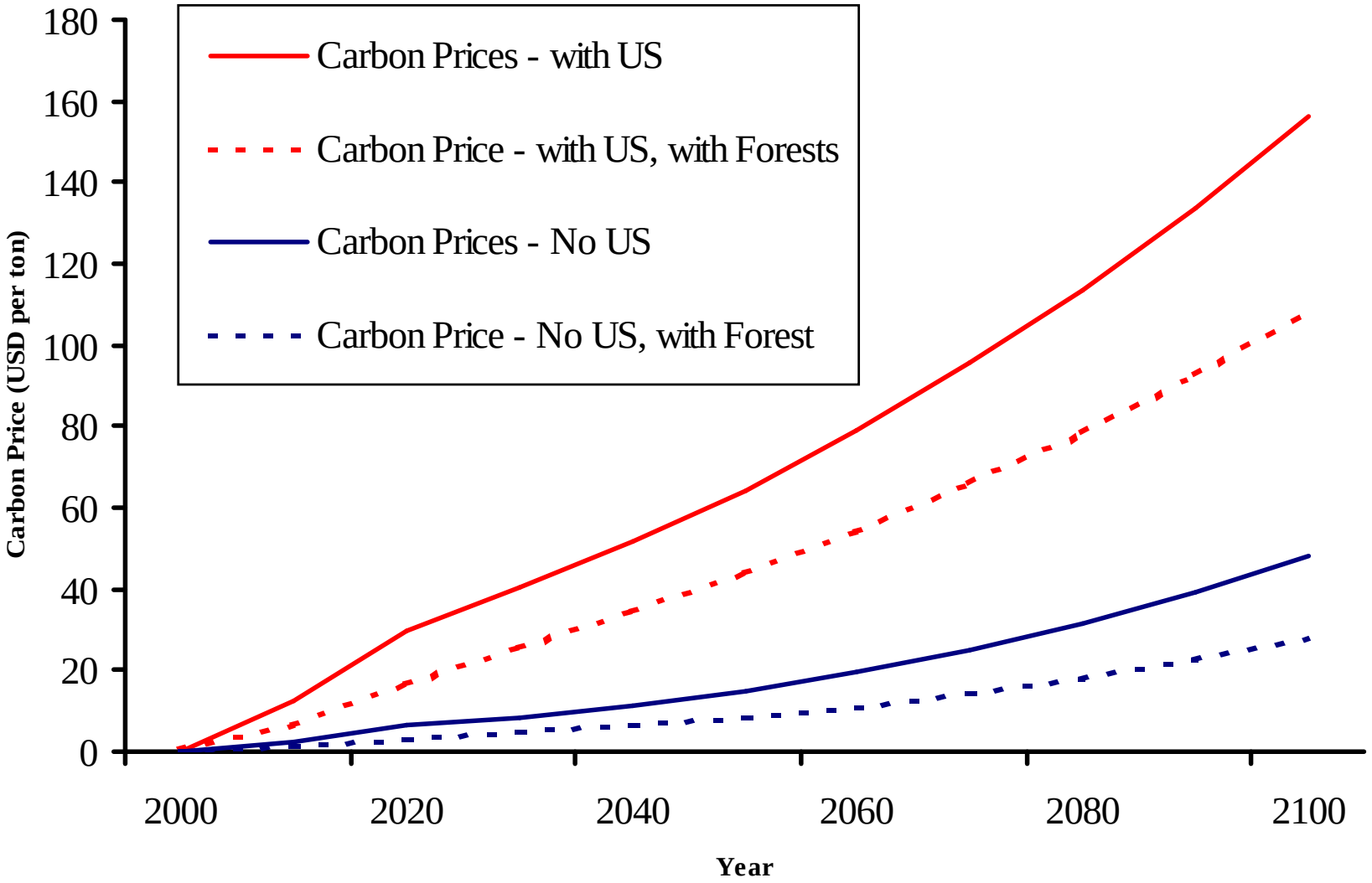
Benefit Cost Analysis of "Optimal Policies"

	Only Abatement	**Sequestration Abatement**
	Billions (1990 USD)	
Expected Damages		
Reduced Damages	$251.47	$348.71
Abatement Costs	179.84	177.21
Sequestration Costs	0.00	74.72
Total Costs	179.84	251.93
Benefit Cost Ratio	**1.40**	**1.38**
Uncertain Damages		
Reduced Damages	2123.13	2877.70
Abatement Costs	1540.81	1461.97
Sequestration Costs	0.00	609.57
Total Costs	1540.81	2071.54
Benefit Cost Ratio	**1.38**	**1.39**

Analysis of Kyoto Protocol

- Examine Four Scenarios:
  - Kyoto Protocol with US
    - Forest sequestration allowed
    - Forest sequestration not allowed
  - Kyoto Protocol without US
    - Forest sequestration allowed
    - Forest sequestration not allowed
- Following Nordhaus and Boyer, assume Kyoto targets forever.

Forestry induces large changes in carbon prices, with or without US.

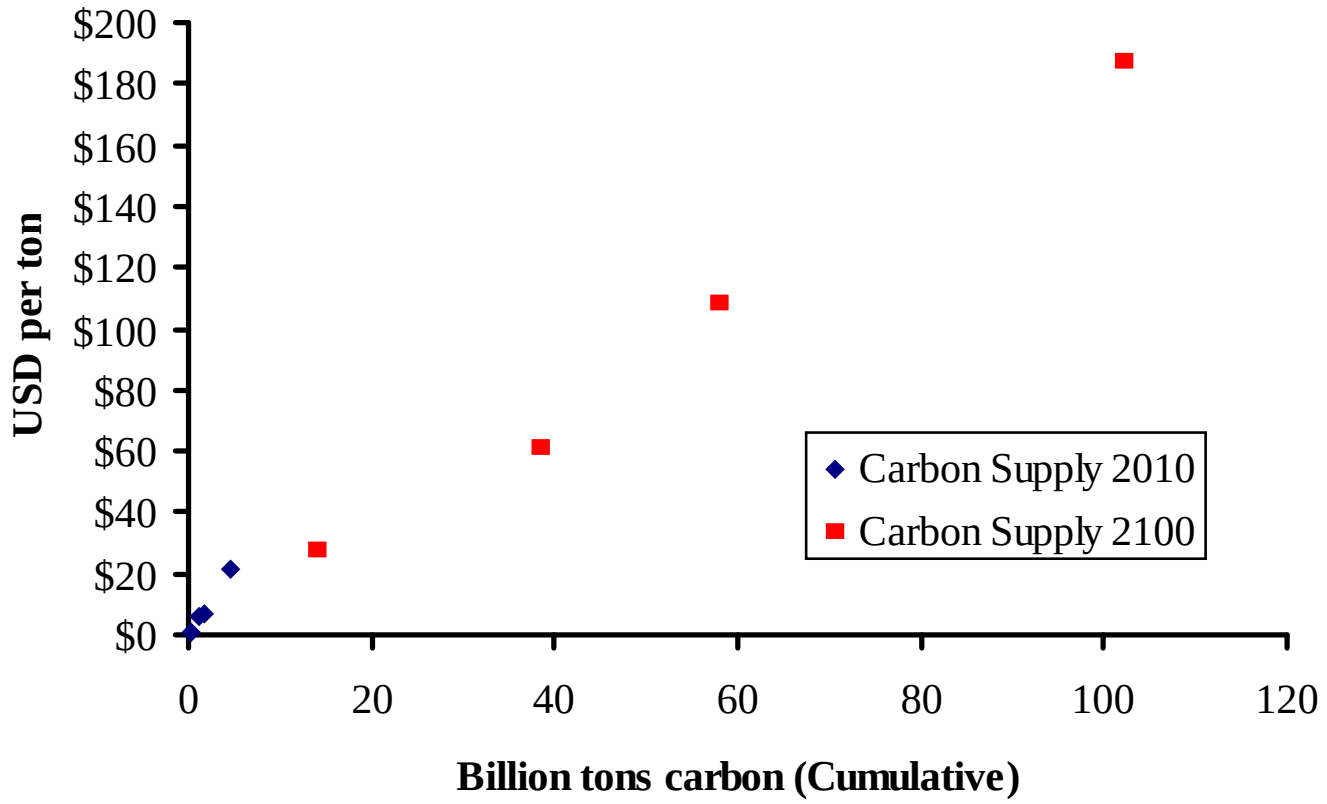


Where does Land Use Change?

	US in Treaty			US Not in Treaty		
	2010	2050	2100	2010	2050	2100
Permit Price (USD per ton)	$6.30	$43.89	$107.88	$1.12	$8.28	$27.65
Annex I	**Million Hectares Above Baseline**					
US	5.7	19.5	47.3	0.0	-0.5	-2.9
Canada	4.1	13.3	24.5	0.7	4.3	13.0
Australia/New Zealand	1.1	3.6	6.6	0.8	1.7	2.3
EU	6.7	14.1	25.7	1.6	4.8	10.0
Eastern Europe/FSU	18.8	78.4	114.9	3.6	25.2	70.4
Rest of World						
China	5.6	15.8	29.6	3.3	5.8	12.7
South America	4.1	33.6	157.3	0.8	7.8	35.9
Africa	2.8	25.4	136.4	0.6	6.0	37.0
Asia-Pacific	5.4	34.6	70.9	0.8	7.2	25.9
Global	**54.3**	**240.6**	**621.2**	**12.14**	**61.9**	**204.3**

Carbon Supply Possibilities in 2010 and 2100

- Large increases in forest carbon storage are possible, although costs are relatively high:



Limitations

- Partial equilibrium approach
- Land rental functions are exogenous.
  - Marginal opportunity costs of land in forestry rise as additional land is converted to forests, but this function does not incorporate an agricultural sector.
- Regions and management classes are highly aggregated.
- Age class data lacking in many regions.

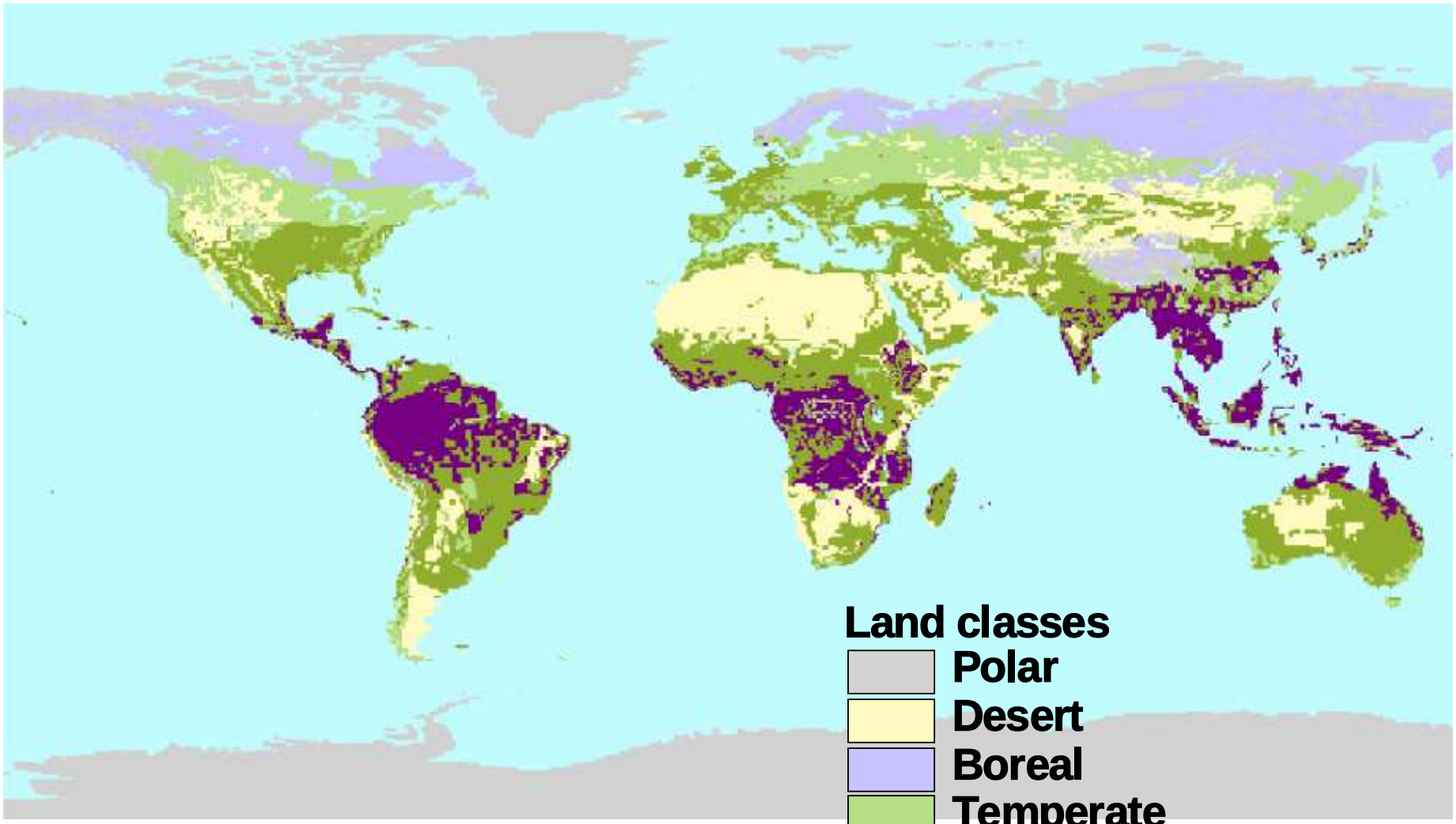
2. Dynamic CGE Model

- Global trade model with ecological information on forest cover and ecosystem types.
- Core economic data and framework from the Global Trade Analysis Project at Purdue University, 1995 base year.
- Ecological data from GIS maps developed for the FAO's Forest Resource Assessment 2000 (similar to Darwin's approach).

CGE Methodology – Economic component

- Perfectly competitive market structure - Producer behavior is endogenous and driven by profit maximization principles, under a constant elasticity of substitution production structure.
- Consumers maximize utility - Household demands are represented by a constant difference of elasticities structure.
- Dynamics are driven by investment theory, and solved in a recursive, non-linear way.
- All markets clear in each time period.

Ecological zones map



Source: FAO FRA 2000

Model Simulations (2000-2015)

Examined possible Kyoto Protocol scenarios, exogenous increase in forestland follows Sohngen and Sedjo (2000).

1.Temperate Policy:

(Creation of carbon plantations)

- ANZ = **1.4** mil ha
- US = **4.6** mil ha
- CAN = **4.6** mil ha
- EU = **8.5** mil ha
- FSU = **26.7** mil ha

2.Global Policy:

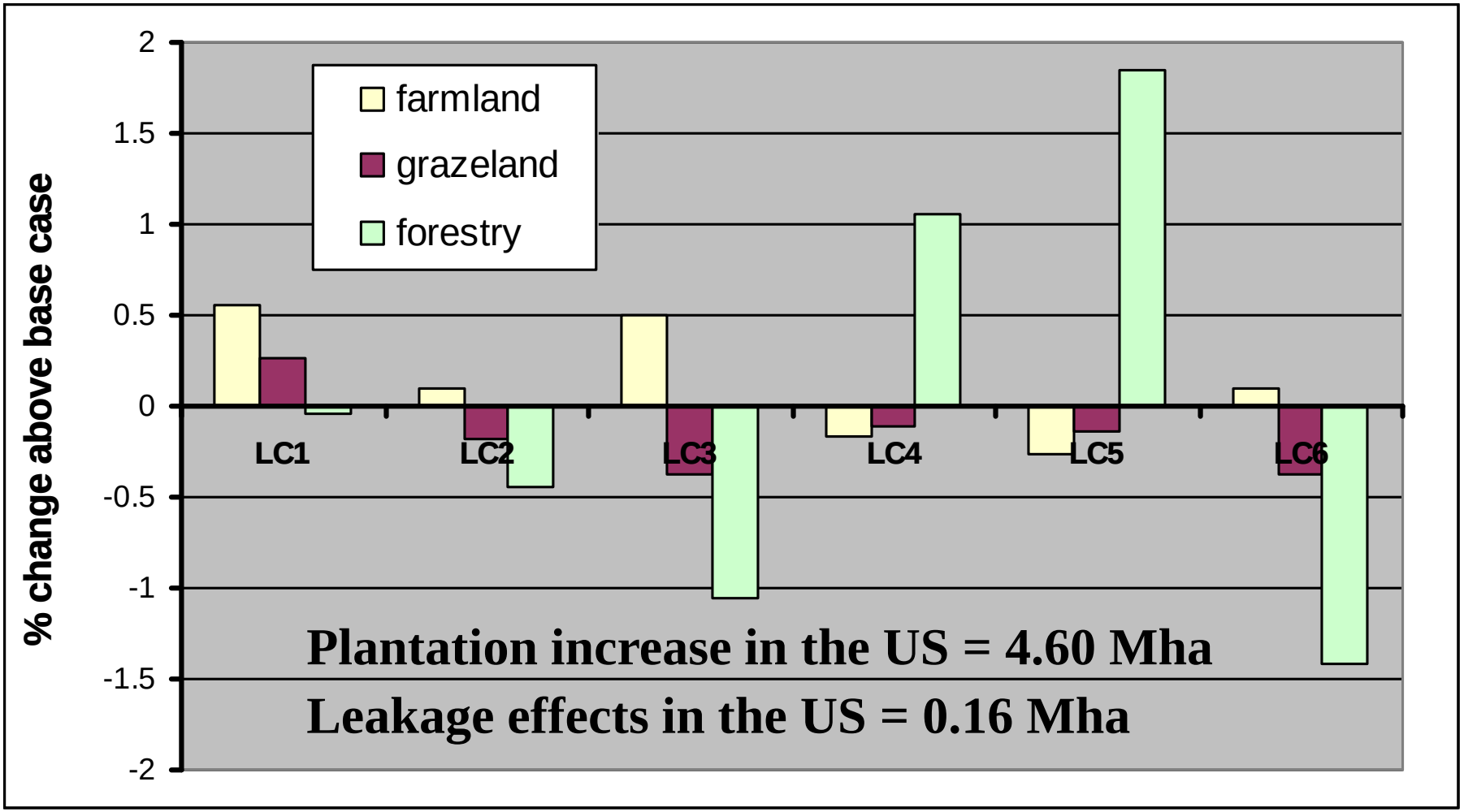
(Forest set-asides in the tropics)

- SEA = **3.9** mil ha
- LAM = **4.0** mil ha
- AFR = **2.5** mil ha

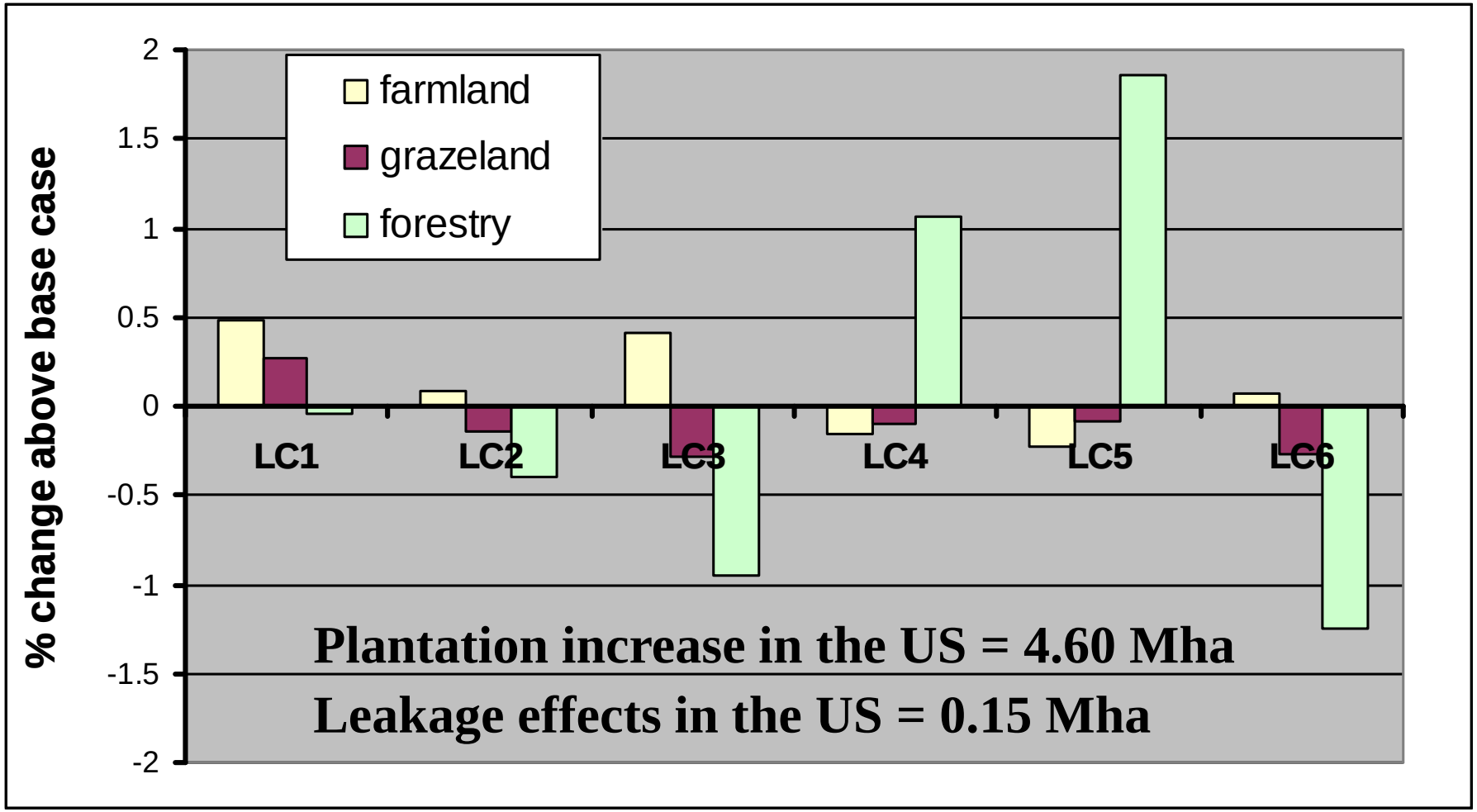
+ Temperate policy

3.Global policy w/out US

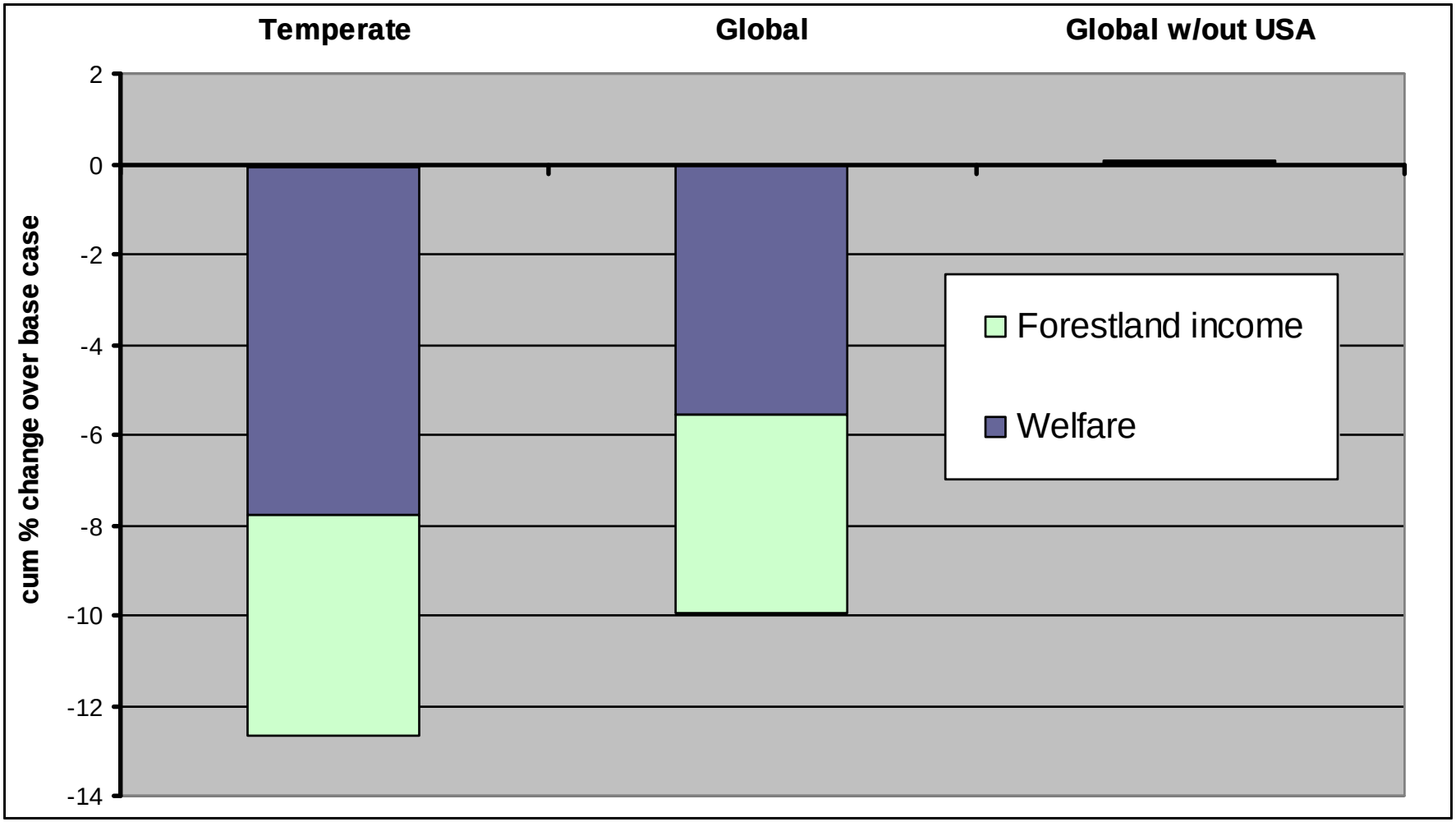
Land use changes in the US, under the Temperate policy



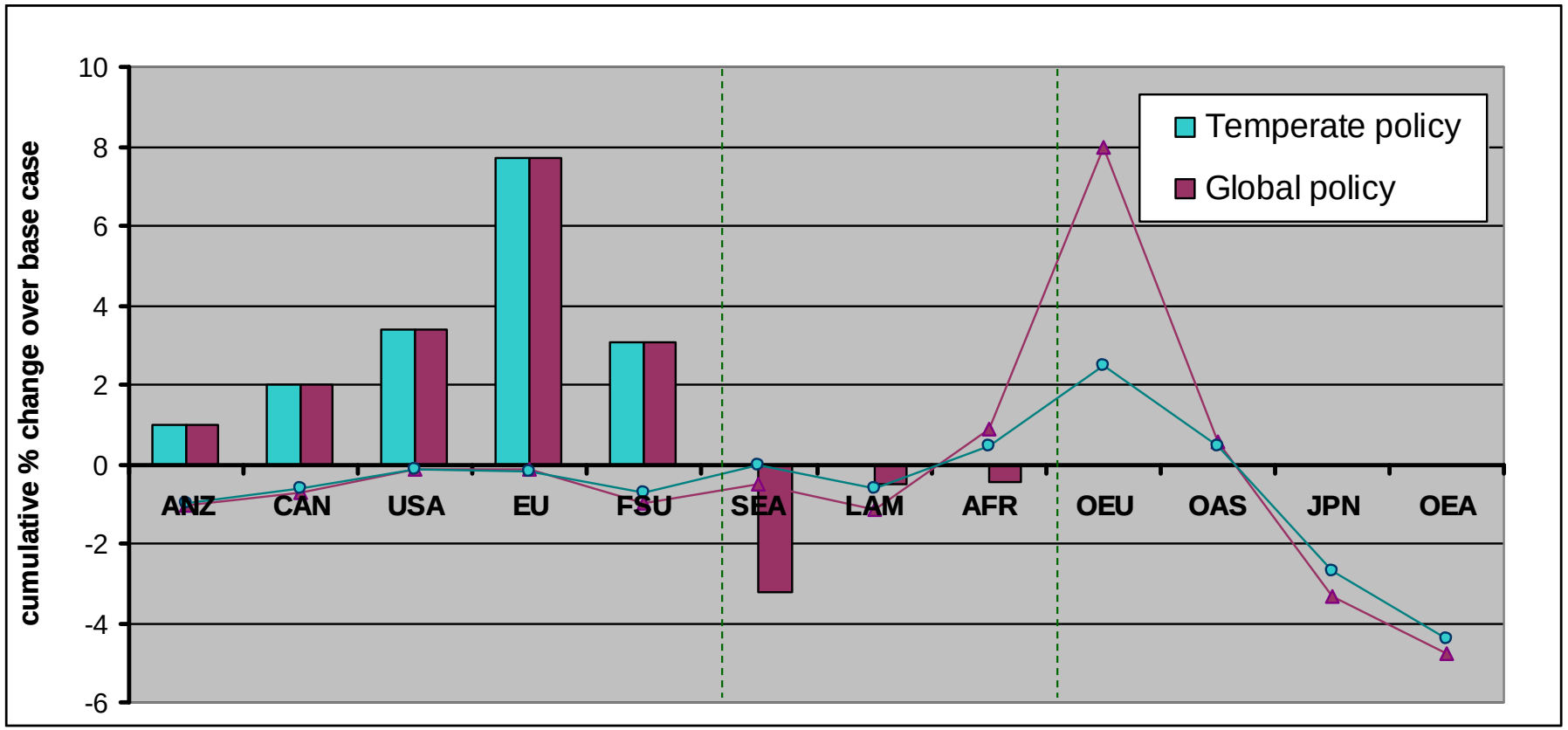
Land use changes in the US, under the Global policy



Economy-wide impacts in the U.S. under the different policies



Global land use change and leakage effects



Temperate policy = 48.8 Mha plantations, Leakage = **21.68** Mha

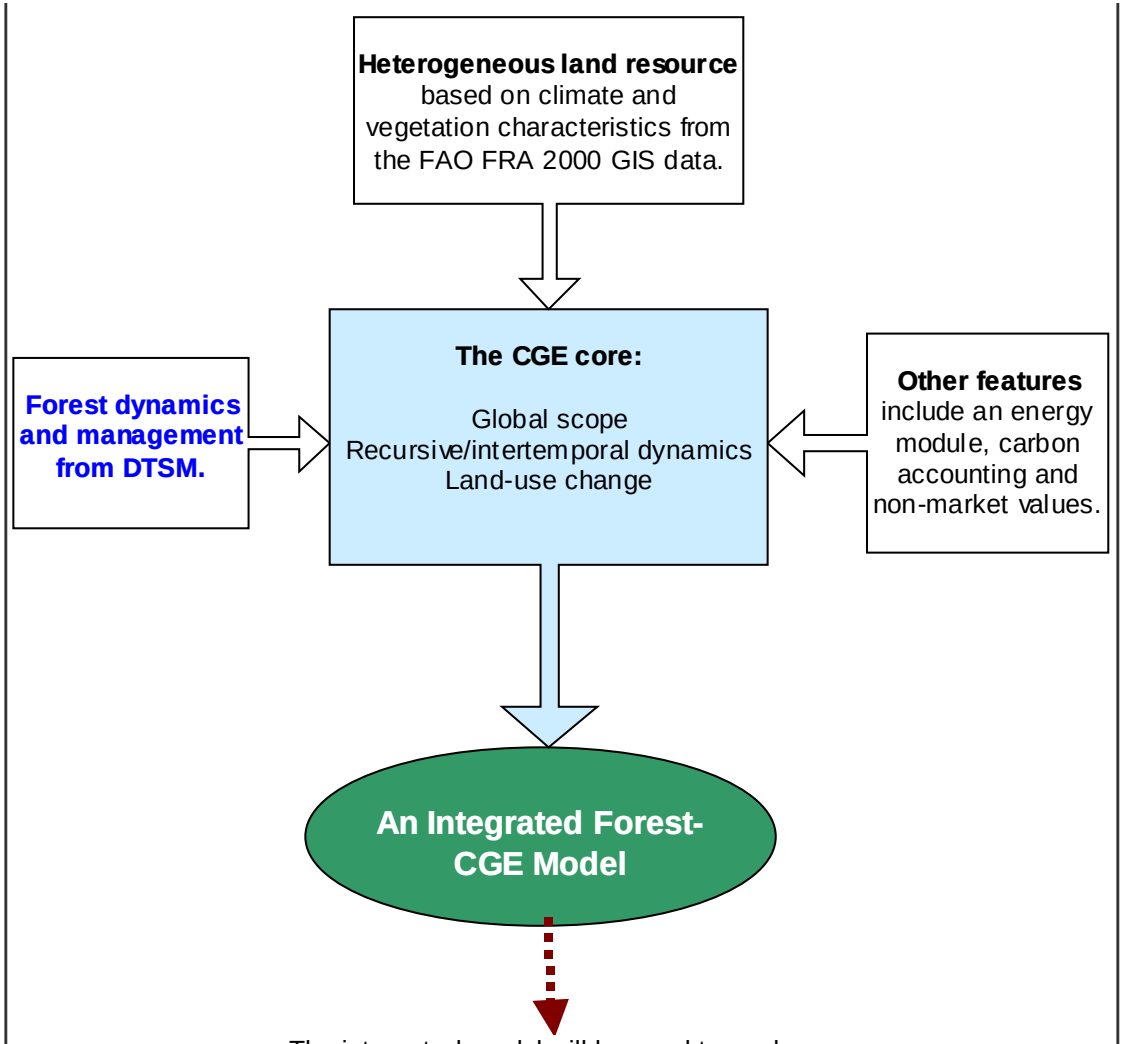
Global policy = 48.8 + 11.6 Mha set-asides, Leakage = **21.36** Mha

Limitations of the CGE

- Assumes steady-state timber output in the forest sector. Unable to capture the effects of dynamic changes in timber stock.
- Can only make inferences on changes in carbon sequestered in wood products, not on the net flux of carbon stored in standing forest.

The way forward:

Integrating the dynamic timber supply model within a CGE structure



The integrated model will be used to analyze:

- The adaptive behavior of forest producers in response to forest stock changes and climate-forest policies.
- Long-term impact on global forest markets.
- Global land use change and leakage effects.
- Overall cost effectiveness of forest carbon taxes and other carbon - related policies.
- Net carbon sequestered in forests relative to CO_2 emissions from other sectors in the economy.
- Distribution of costs and benefits within and between regions.
- Spillover effects to the other sectors.

Forest cover map