



*Impact of climate change on  
timber markets and global  
carbon sequestration*

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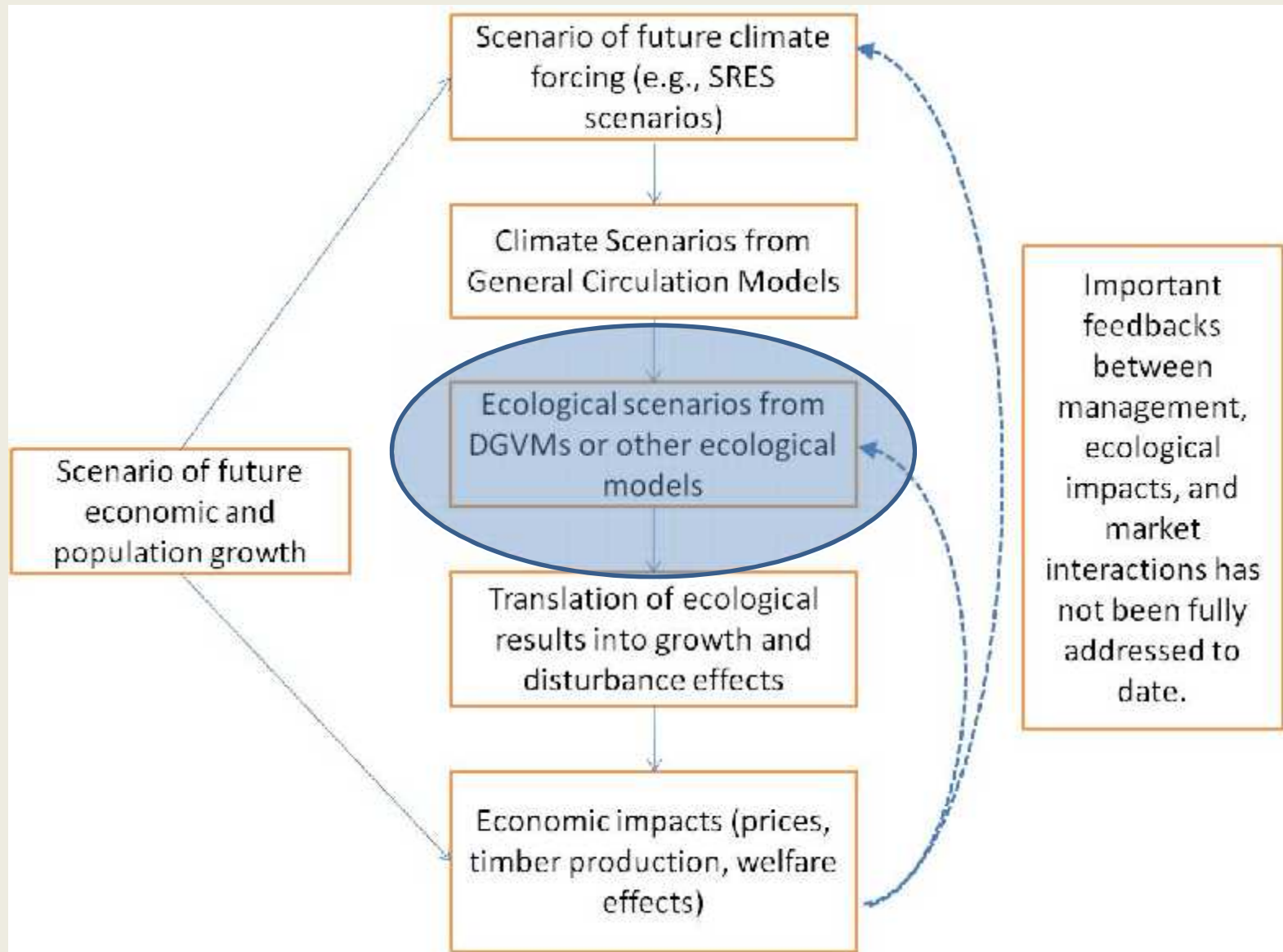
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# Outline of Presentation

- Methods for assessment
- Results for markets
- Implications for carbon
- Implications for sequestration policy

Thanks to: US EPA Climate Change Division; US DOE; Fulbright Foundation; Ohio Agricultural Research and Development Center; Ohio State University Climate Water and Carbon Initiative

# How are impacts measured?



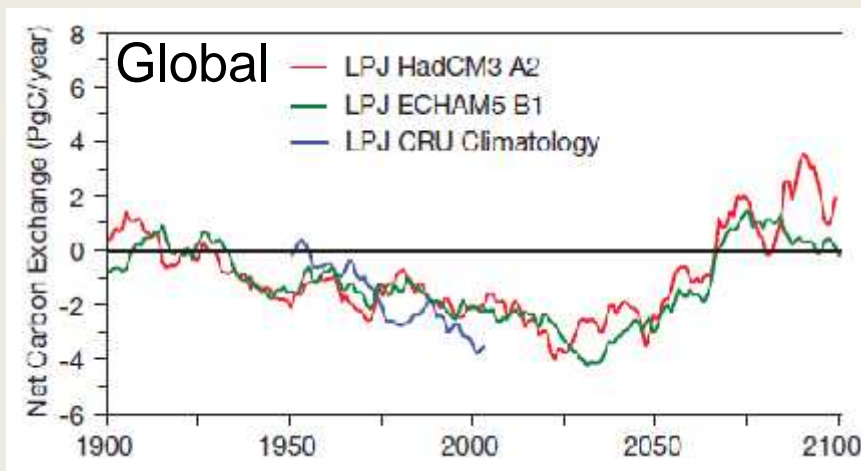
Adaptation of Forests and People to Climate Change. 2009. Alexander Buck, Pia Katila and Risto Seppälä. (eds.). IUFRO World Series Volume 22. Helsinki. 224 p.

# Ecosystem Impacts

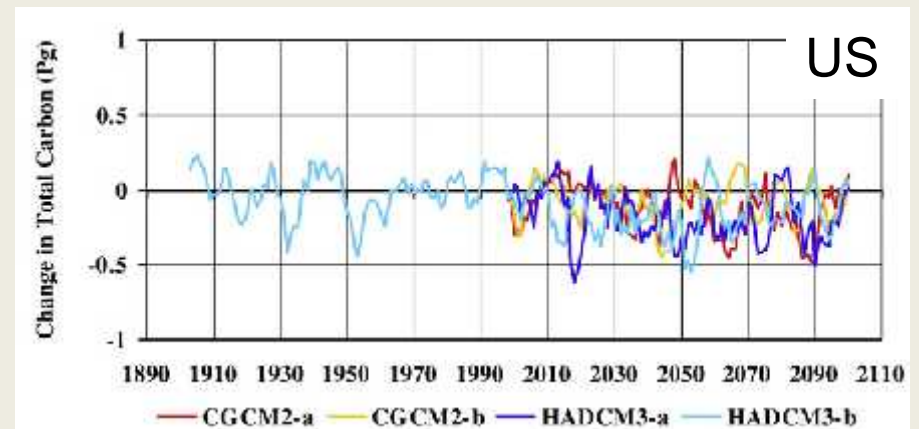
- Productivity changes (IPCC, 2007)
  - CO<sub>2</sub> fertilization (e.g., Norby et al., 2006).
  - Warming in colder climates.
  - Precipitation gains where water is limited.
- Some current evidence that historical climate change and CO<sub>2</sub> change have increased productivity to date (e.g., Myneni et al., 1997; Boisvenue and Running, 2006; McMahon et al., 2010).
- Potential limits to productivity gains: Net impacts
  - Species composition, age structure, seasonal and daily precipitation and temperature patterns, etc.
  - Drying and forest fire effects

# Ecosystems only...

- *Losses ultimately weigh down gains:* Ecosystems turn from carbon sink to source within the next several decades, due to fire and other disturbance

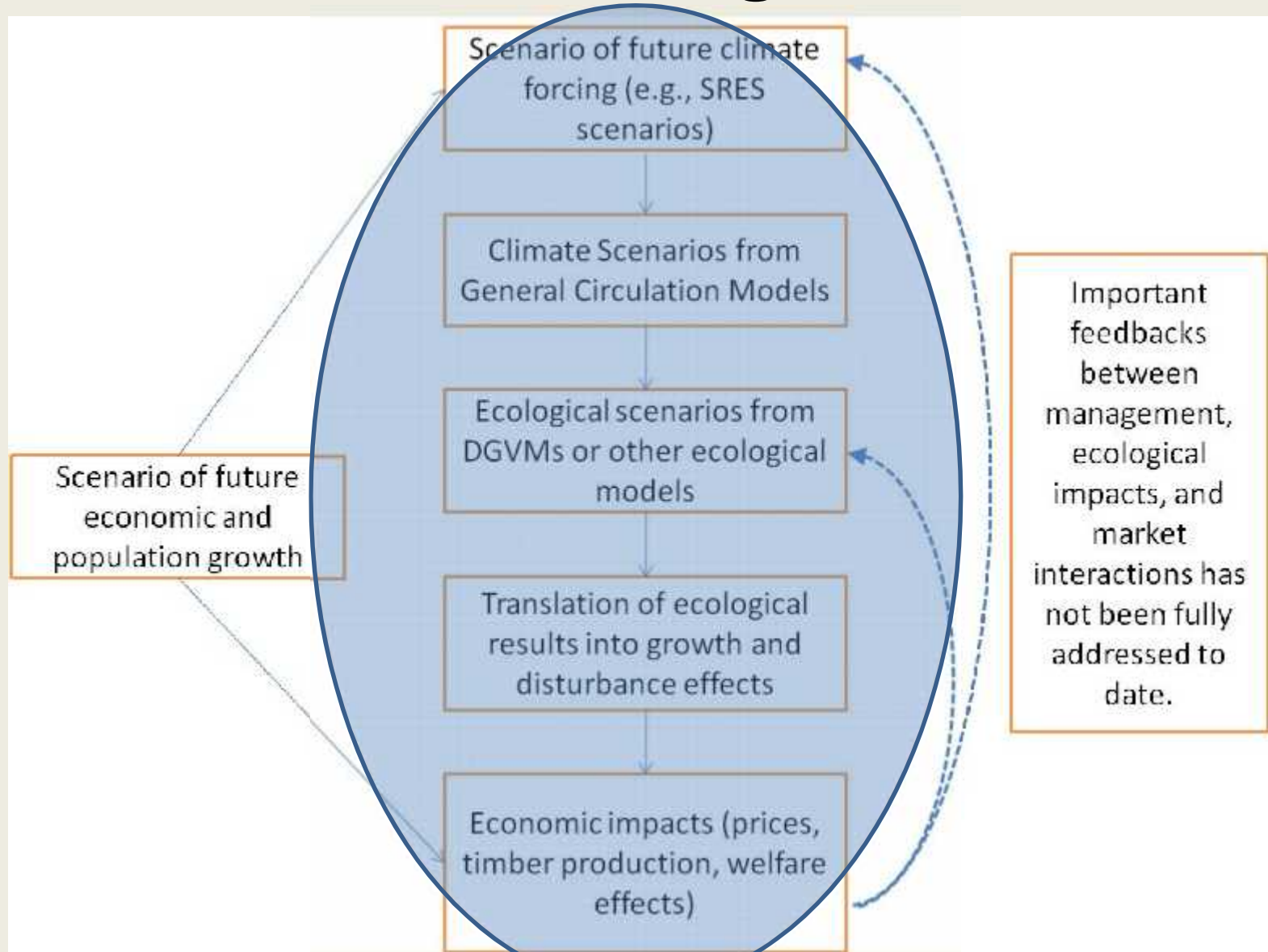


IPCC (2007) WG 2, Chapter 4, Figure 4.2



Bachelet et al. (2008)

# Need to integrate...



Adaptation of Forests and People to Climate Change 2009. Alexander Buck, Pia Katila and Risto Seppälä. (eds.). IUFRO World Series Volume 22. Helsinki. 224 p.

# Summary: Timber market results to date

Region	Output		Producer Returns
	2000–2050	2050–2100	
North America	-4% to +10%	+12 to +16%	Decreases
Europe	-4% to +5%	+2 to +13%	Decreases
Russia	+2 to +6%	+7 to +18%	Decreases
South America	+10 to +20%	+20 to +50%	Increases
Aus./New Zealand	-3 to +12%	-10 to +30%	Decr. & Incr.
Africa	+5 to +14%	+17 to +31%	Increases
China	+10 to +11%	+26 to +29%	Increases
SE Asia	+4 to +10%	+14 to +30%	Increases

Alig et al. (2002), Irland et al. (2001), Joyce et al. (1995, 2001), Perez-Garcia et al. (1997, 2002), Sohngen et al. (2001), Sohngen and Mendelsohn (1998, 1999), Sohngen and Sedjo (2005); <sup>2</sup> Karjalainen et al. (2003), Nabuurs et al. (2002), Perez-Garcia et al. (2002), Sohngen et al. (2001) ; Lelyakin et al. (1997),

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# Updated Analysis

- Climate Change:
  - A2, A1b scenarios
  - CSIRO, Hadley, MIROC models
- Ecological Analysis: DGVM
  - MC1 model (MAPPS and Century Model)
- Economic Analysis:
  - Global Land Use Model (Sohngen and Mendelsohn, 2007)



# Approach to Economic Analysis

- Ecosystem Model (DGVM) provides information on
  - Shift in range for timber species
  - Natural disturbance losses (% stock burned)
  - Net primary productivity, net ecosystem productivity, and net biological productivity
- Data provided by DGVM
  - 0.5 degree grid cells for globe.
  - Annually to 2100.

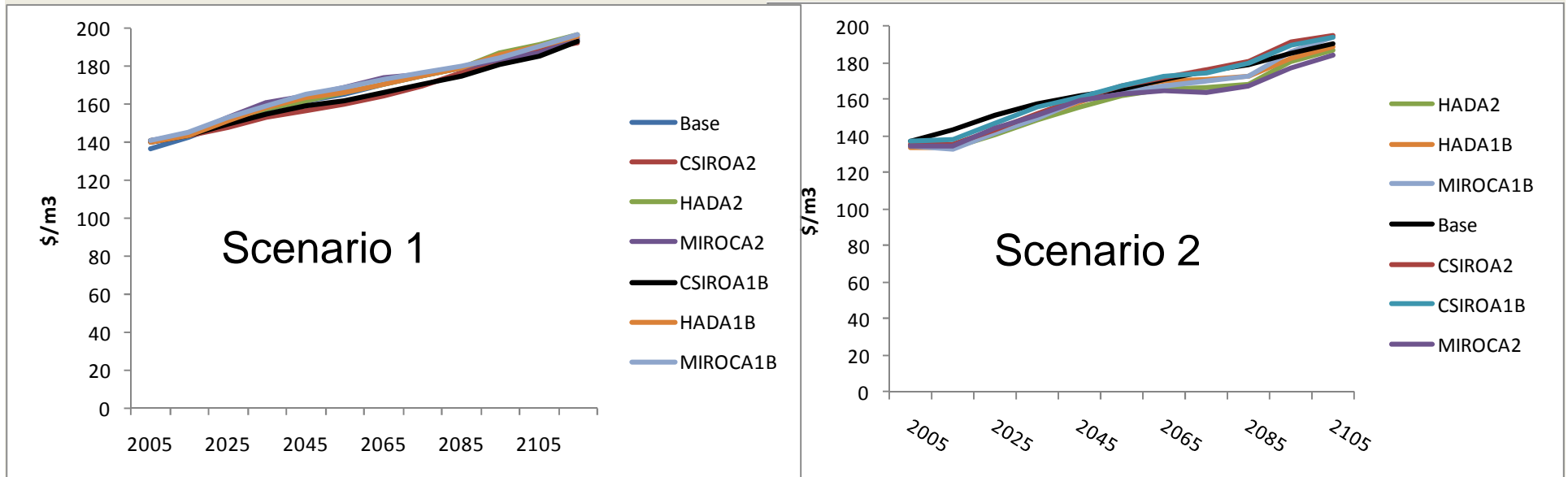
# Assess two scenarios

- Scenario 1:
  - Use changes in total ecosystem carbon to perturb forest yields.
  - Allow ecosystems to expand proportionally if type is expanding. Contract if type is contracting.
- Scenario 2:
  - Use changes in NPP to perturb forest yields
  - Incorporate proportion burned as a direct loss of stock.
  - Allow ecosystems to expand proportionally if type is expanding. Contract if type is contracting.

# Adaptations Incorporated

- Manage existing stock by
  - changing rotations
  - Salvage
- Replant new species if growing and economic conditions warrant
- Manage future stock by
  - Changing rotations
  - Changing management & investments

# Results: Prices

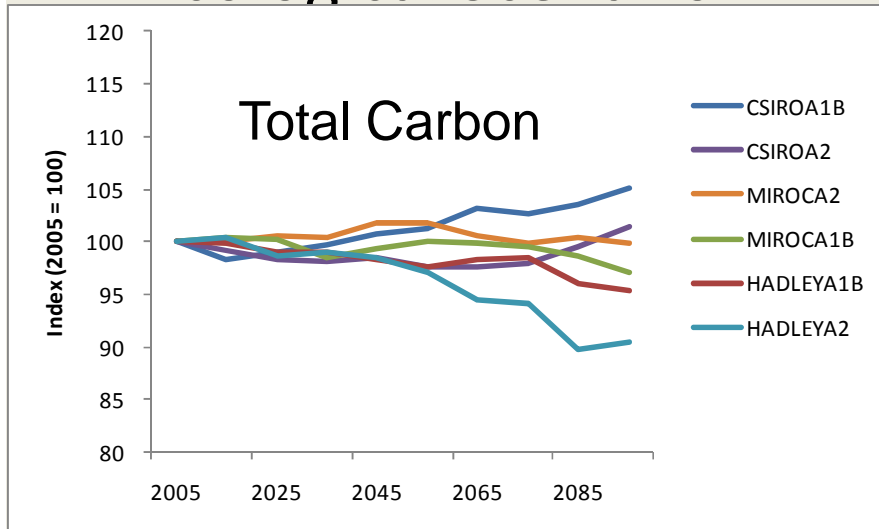


- Price range =  
-2% to +3%
- Hadley mostly higher;
- Miroc mostly lower

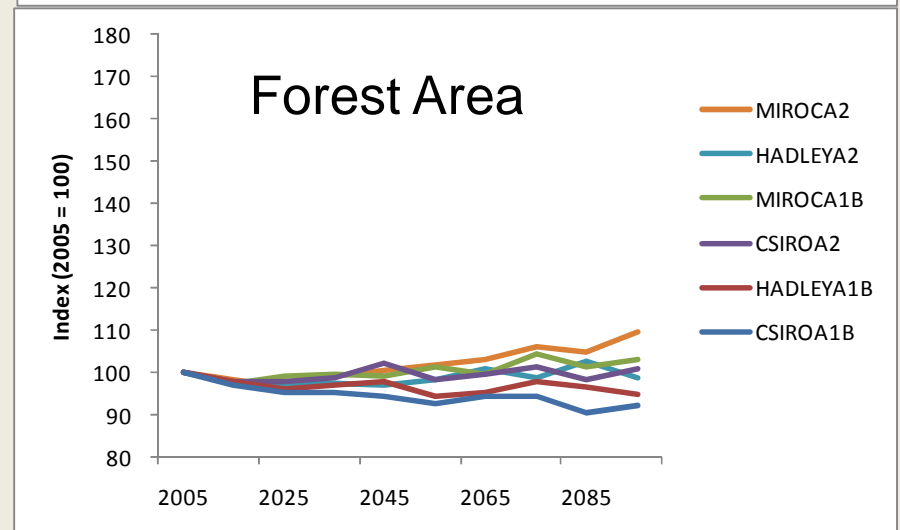
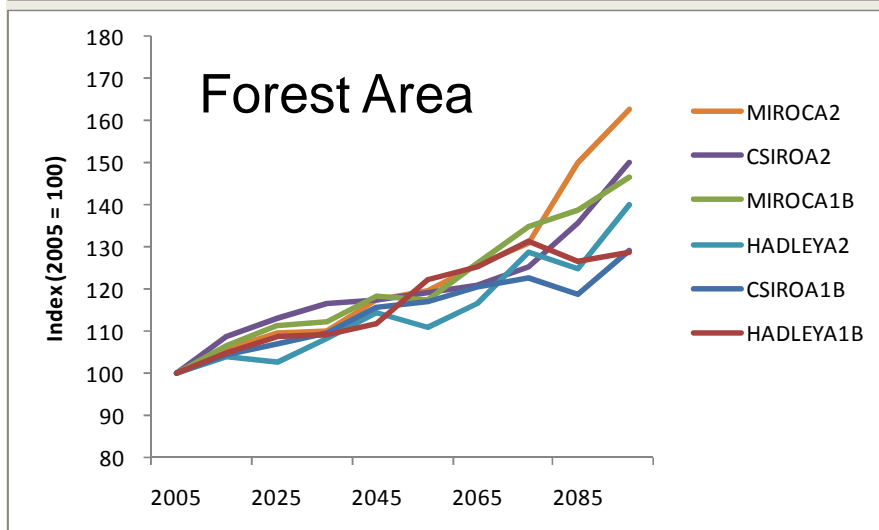
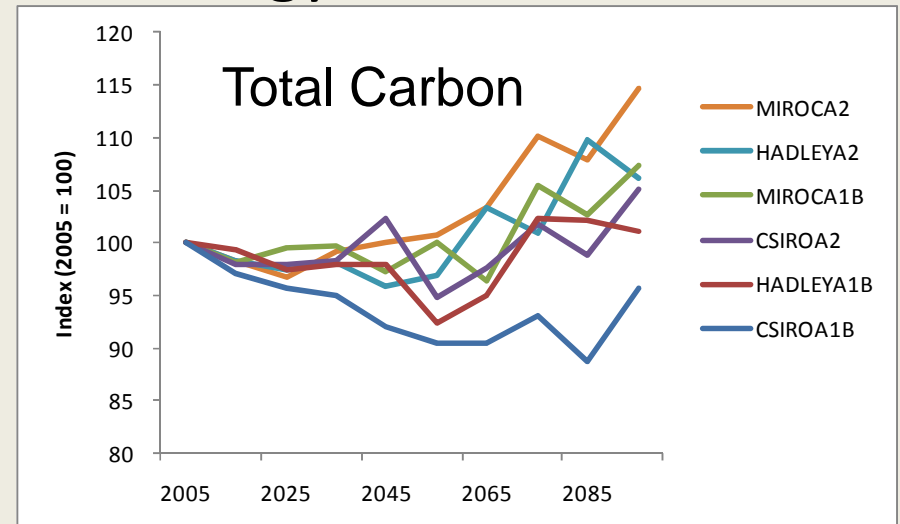
- Price range =  
-7% to +2%
- Hadley & Miroc have  
mostly lower prices (7%  
max)

# Effect of Adaptation on Forest Carbon and Forest Area

- Ecological Scenario

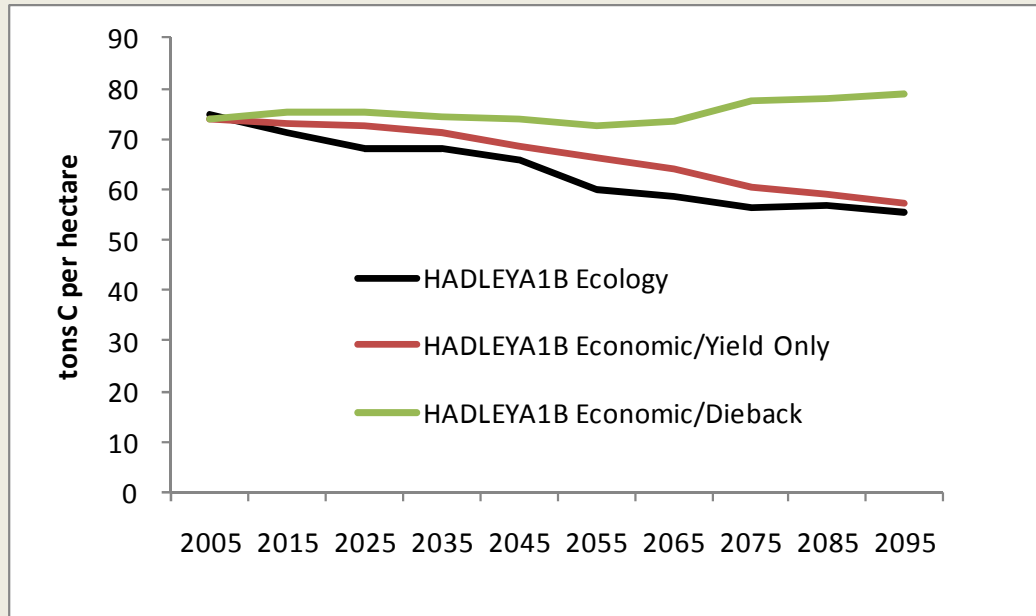


- Ecology + Economics



# Management enhances the carbon on hectares in forest.

Tons C/ha, Hadley A1B Scenario



Average Carbon Change  
(2000-2100)

Ecological:

A1B: -23.3 TgC/yr

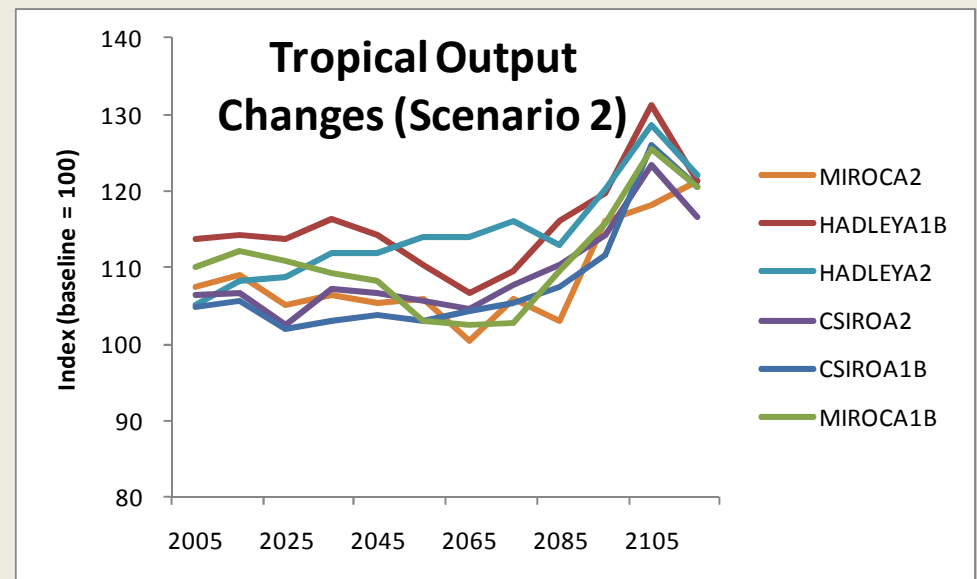
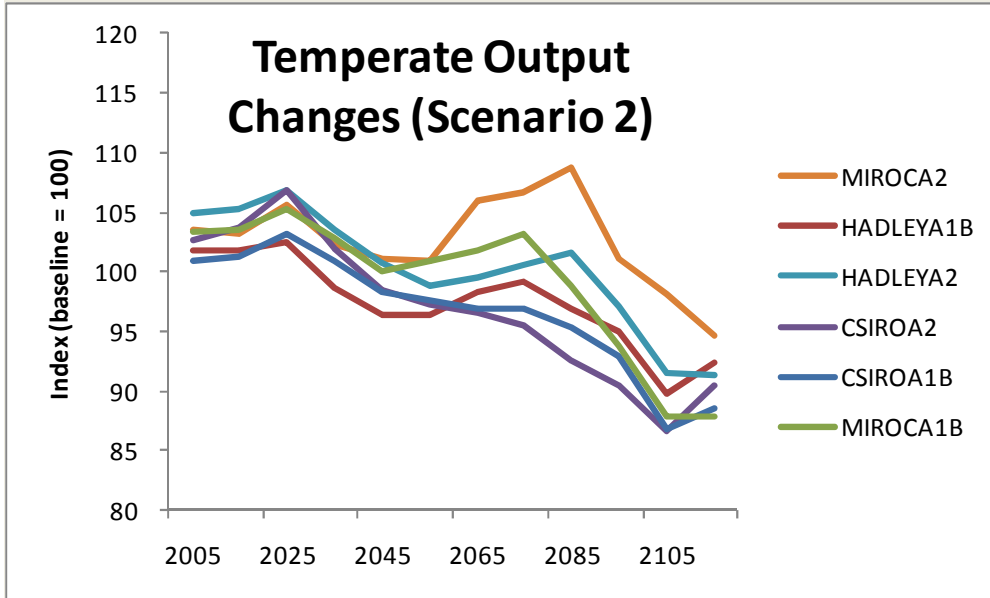
A2: -78.1 TgC/yr

Economic:

A1B: 38.6 TgC/yr

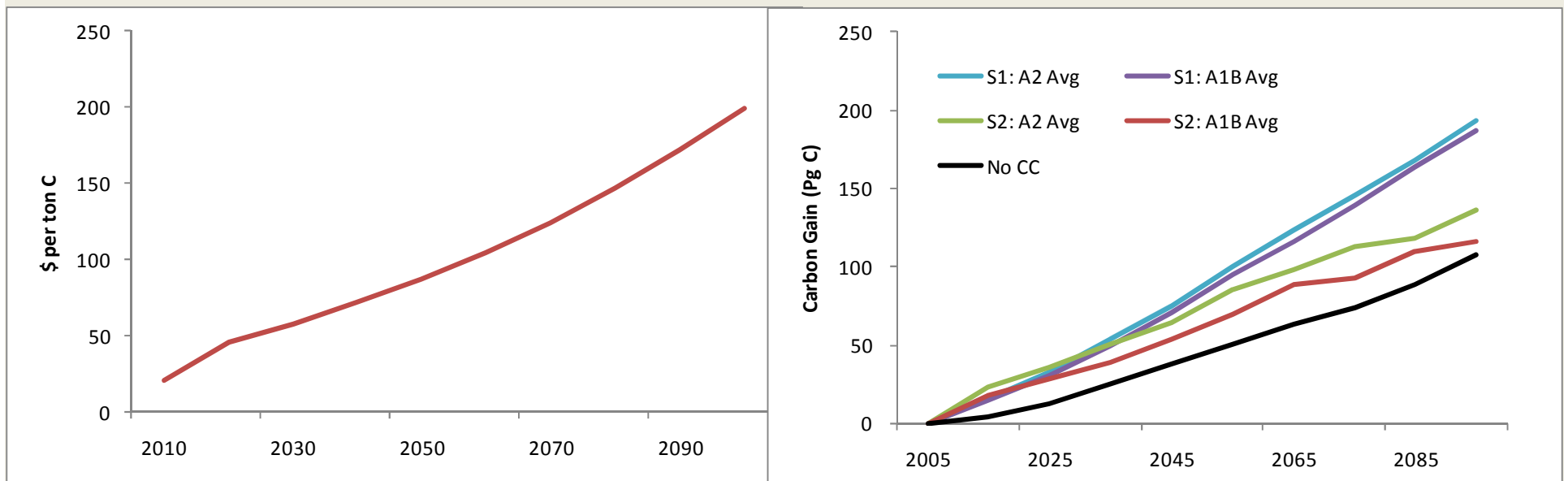
A2: 246.0 TgC/yr

# Output rises in tropics



# Effect on Carbon Sequestration Costs?

- Lowers costs, particularly in near-term
- Over the longer run, the extent of the gain depends on the scenario
  - Scenario 1: lower gains.





# Conclusions

- Effects on prices are relatively modest
- Economic analysis substantially changes the projected carbon emission path from ecosystems.
- Management mitigates most of the losses that are predicted to occur in ecosystems
- Output shifts towards tropics
- Climate change lowers costs of carbon sequestration.