A Global Perspective on the Economics of Sequestering Carbon in Forests

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Presented at the Workshop: "Forest Ecosystem Carbon and its Economic Implications"
Finnish Forest Research Institute, Helsinki, Finland
March 16, 2006

Acknowledgements:
Roger Sedjo (RFF) and Robert Mendelsohn (Yale)
US Environmental Protection Agency, Climate Analysis Branch
US Department of Energy, Office of Biological and Environmental Research

Global Carbon Sequestration

- Where is the forest carbon currently and how might it change in the future?
- Description of Global Forestry Model
- How much is possible at different prices and in different regions?
- Five general results from global forestry analysis.
- Policy Implications and future research.

Where is the world's carbon?

Forestland Area and Total Carbon Storage

	Total Carbon Storage		Forestland Area		C Intensity
	Billion Tons	%	Million ha	%	Tons/ha
Boreal/Temperate/Mid-Latitude					
North Am.	277	24%	729	18%	380
Europe	34	3%	279	7%	122
Russia	323	28%	887	21%	364
China	33	3%	132	3%	250
Oceania	51	4%	398	10%	128
Subtotal	**718**	**63%**	**2,425**	**58%**	**298**
Tropical/Low-Latitude					
South Am.	222	19%	888	21%	250
Asia-Pacific	91	8%	312	8%	292
Africa	115	10%	525	13%	219
Subtotal	**428**	**37%**	**1,725**	**42%**	**248**
Global Total	1,146	100%	4,150	100%	277

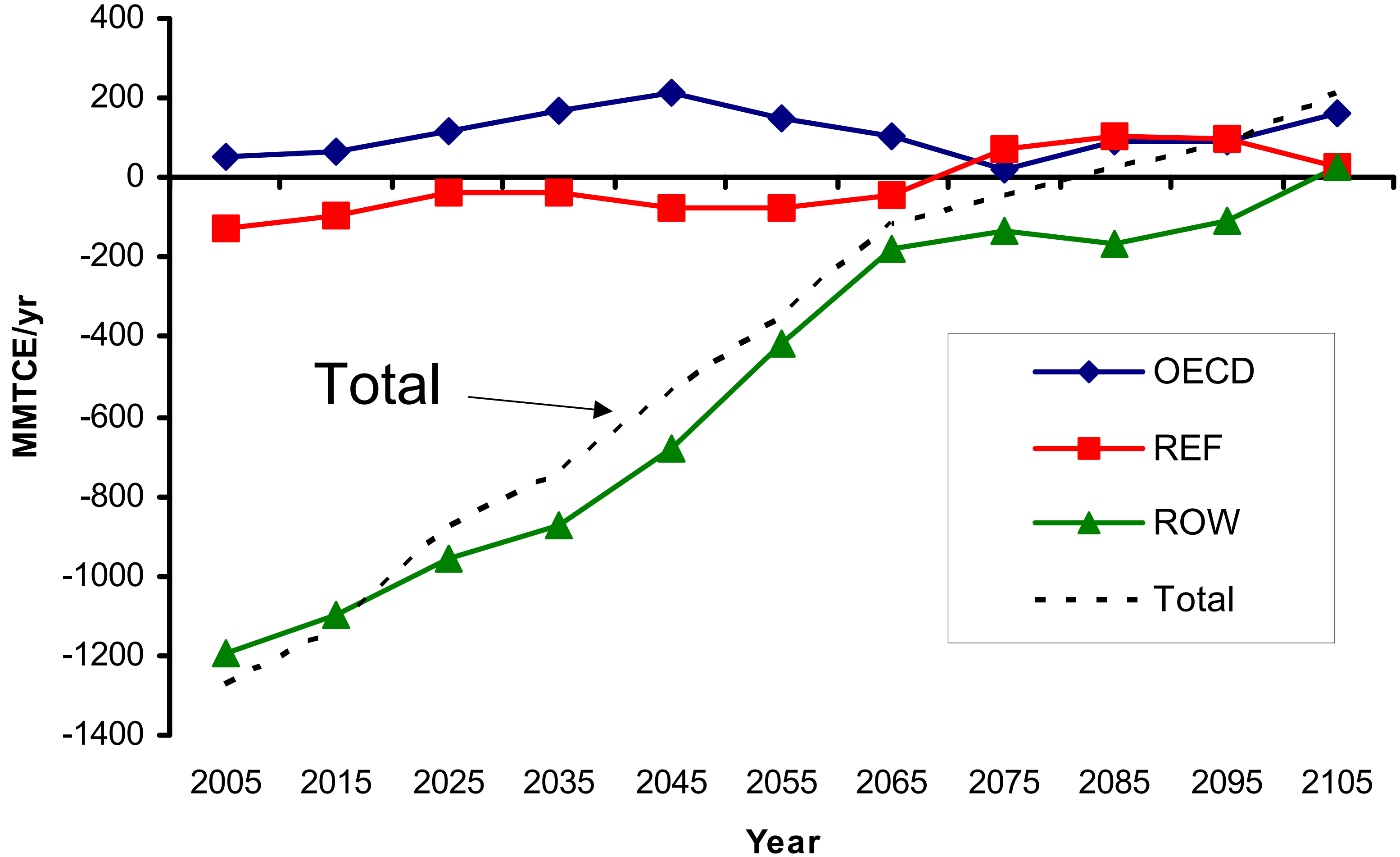
Source: Dixon et al. (1999; 1994)

Global Timber Model

- Originally developed by Sedjo and Lyon (1990)
- Updated in Sohngen et al. (1999); Sohngen and Sedjo (2001); Sohngen and Mendelsohn (2003).
- Model Framework
  - Maximizes welfare in timber markets
  - 200 year time horizon in 10 year increments.
  - Harvests and manages timber by age class.
  - Incorporate values for carbon sequestration and storage in products
- Updates in 2004 version (from 1999 – 2003)
  - 146 - 250 timber types in 13 regions (depending on version)
  - Use most recent inventory and yield data for US, Russia, China, Argentina, Chile, Brazil, Australia, New Zealand.

Baseline C Emissions

("+" = sequestration; "-" = emission)

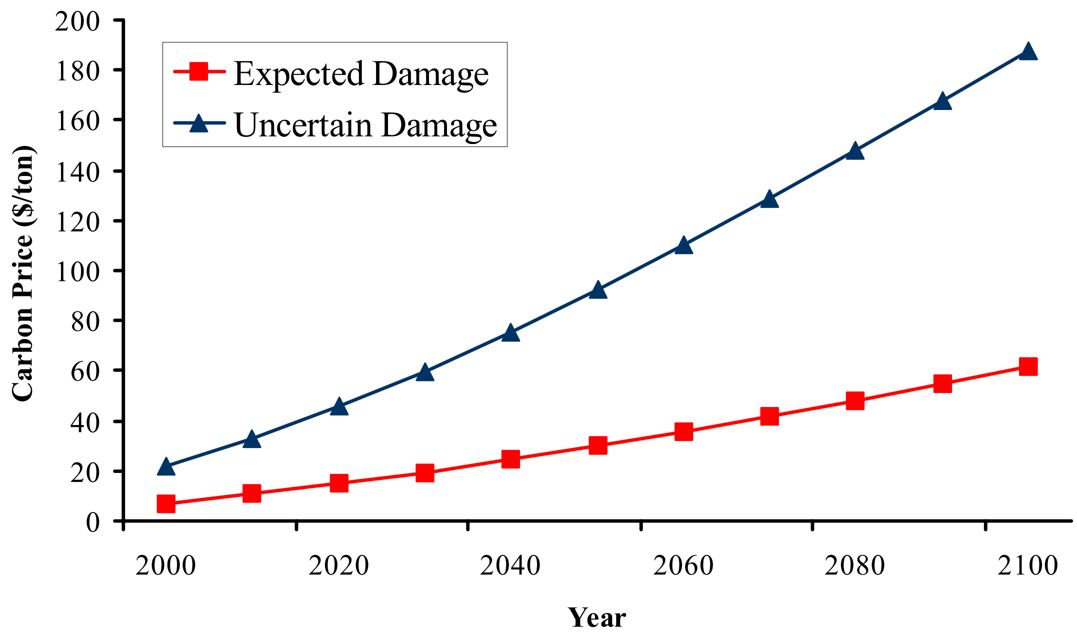


REF = Russia, China, India;
ROW=SA, Central Am, SE Asia, Africa

"Optimal" Carbon Sequestration

Carbon prices from Sohngen and Mendelsohn (2003)

Integrated with Energy Model (DICE-2000)



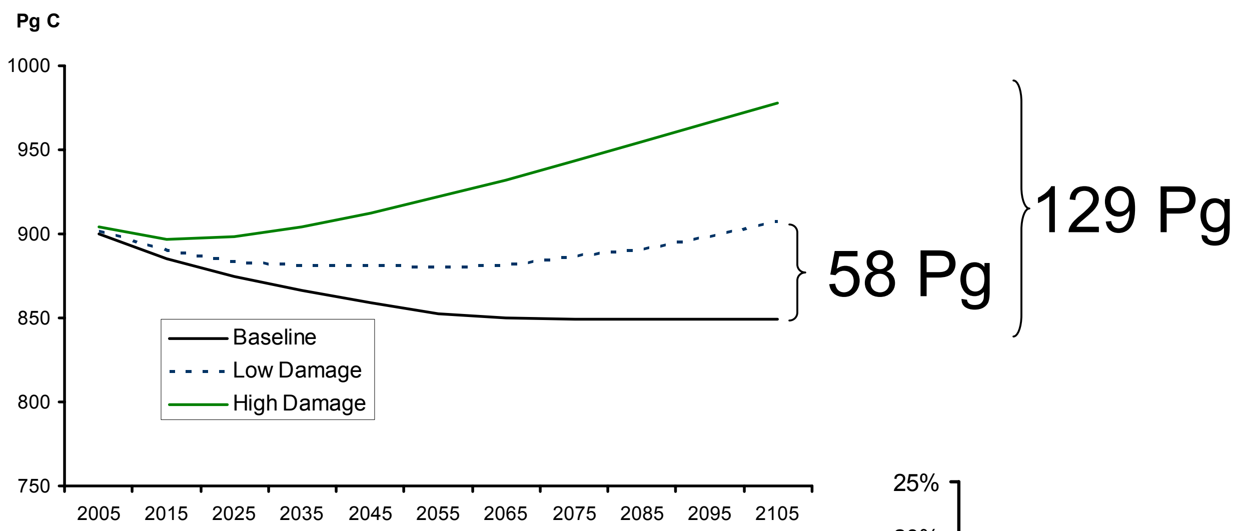
Rent carbon gains according to:

$$\text{Rent}_t = P_t - [P_{t+1}/(1+r)]$$

Rent Above- & Below- ground carbon

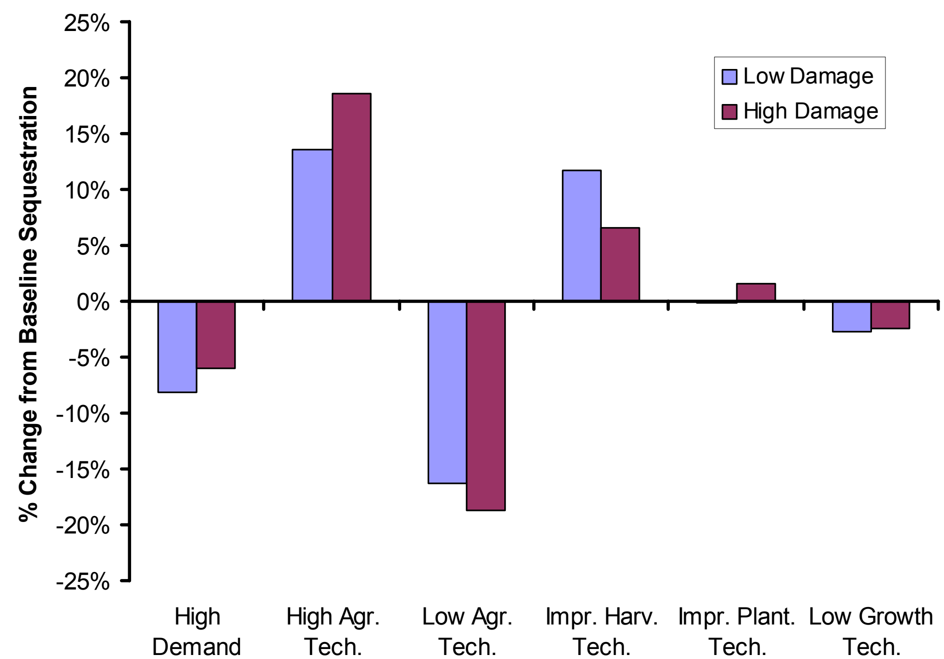
Pay for Market carbon at P_t

How Much Carbon is Possible? How Sensitive are the Results?

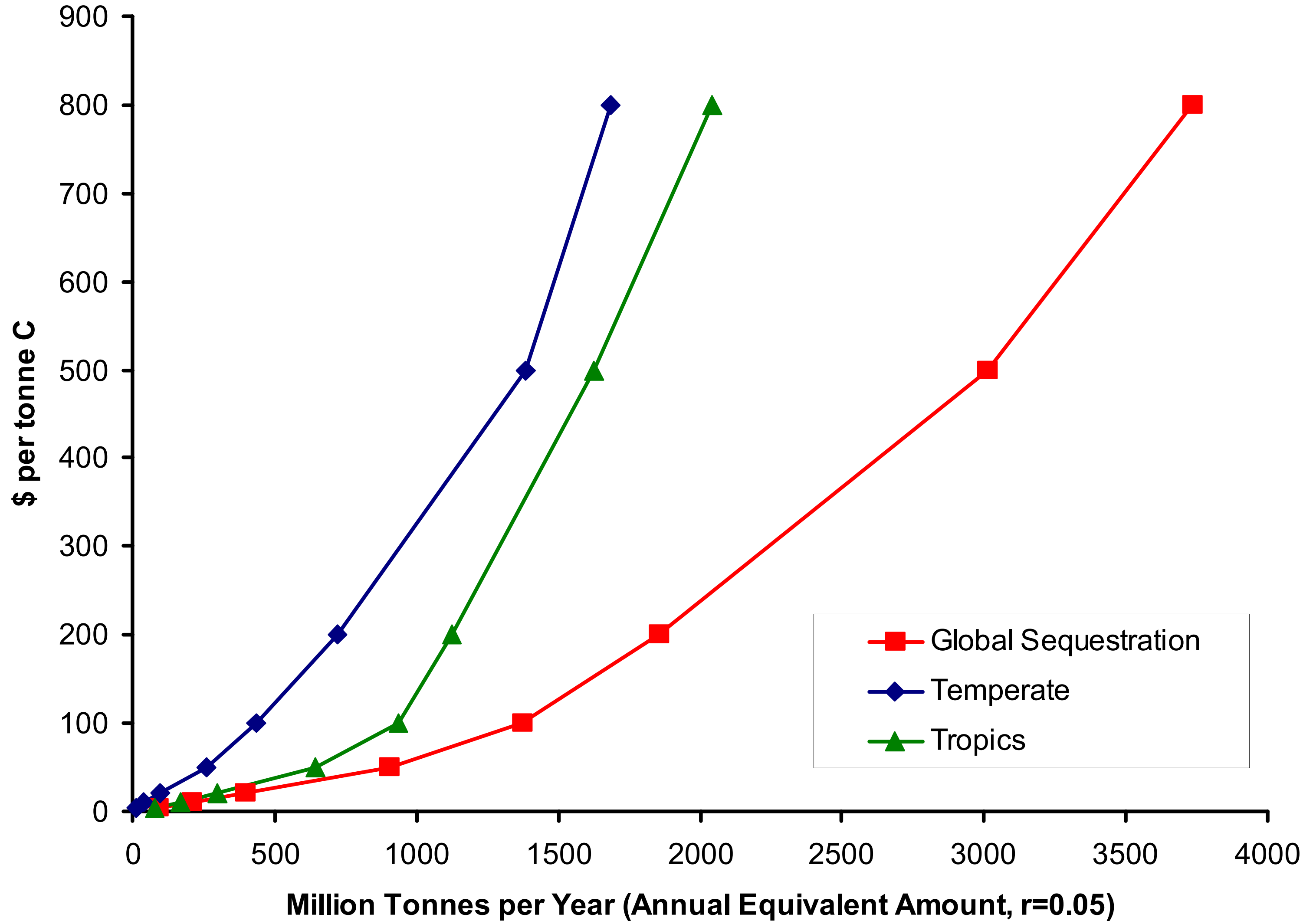


Carbon Storage in Ecosystems

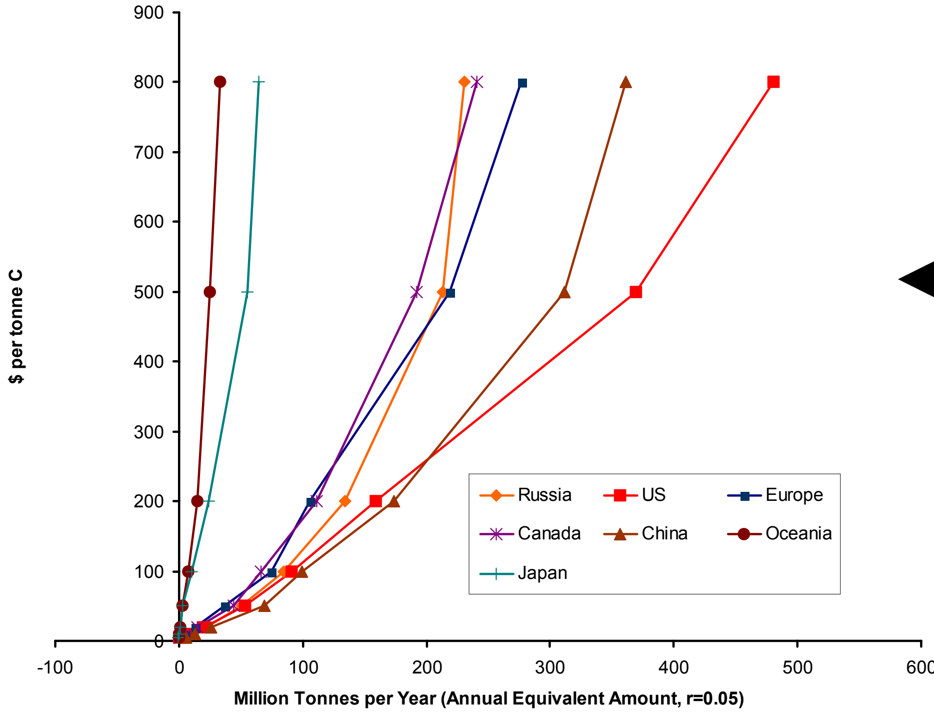
Sensitivity of C Storage Results



Where Does the Sequestration Occur?

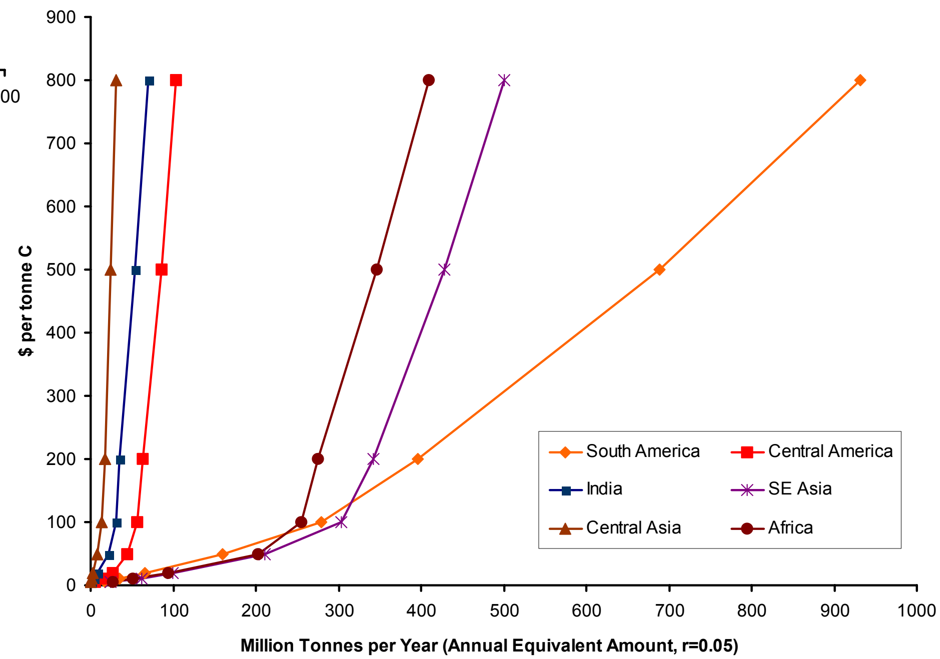


Regional Sequestration



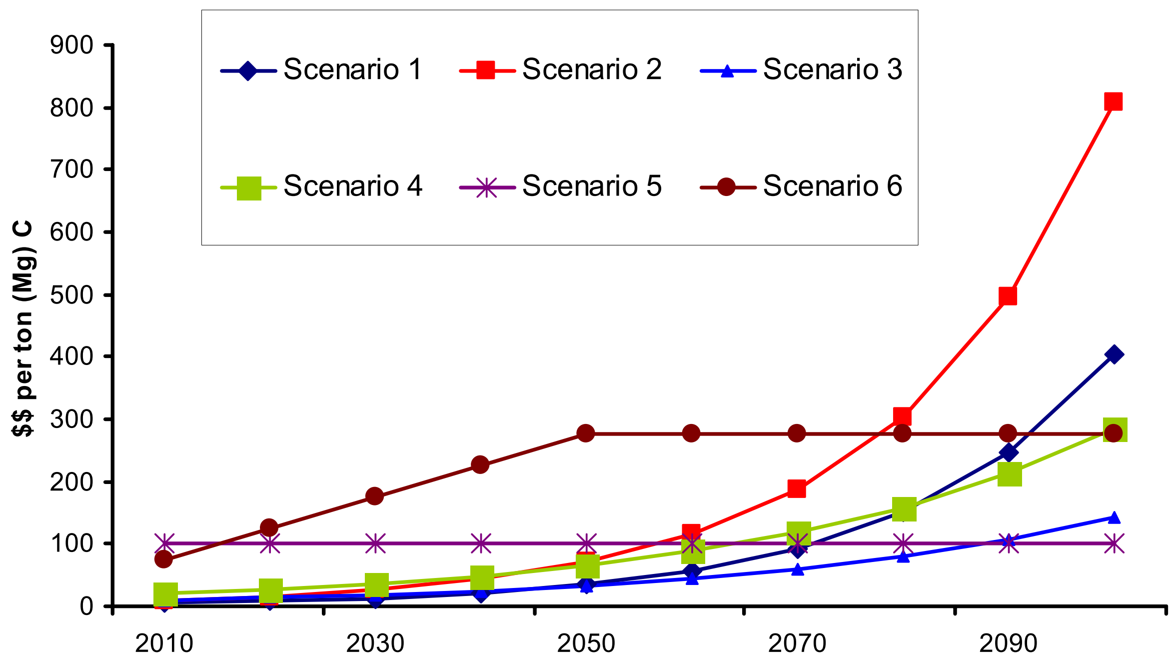
Temperate/Boreal Regions

Tropical Regions



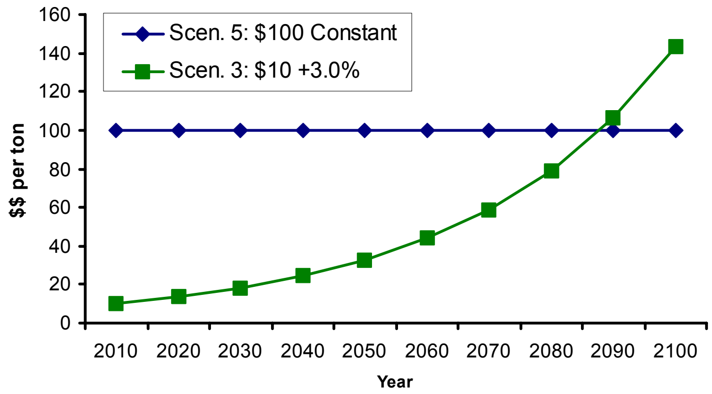
Results with Different Price Paths

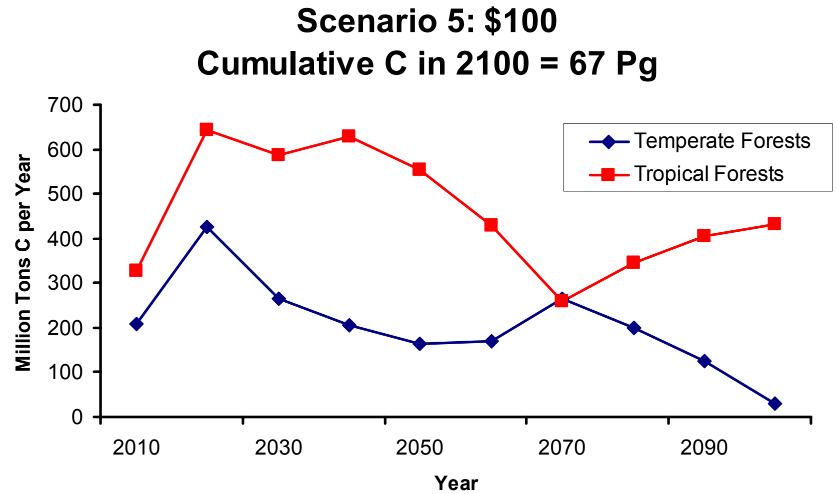
Scenario 1	♦	$5 in 2010, rising by 5% per year
Scenario 2	■	$10 in 2010, rising by 5% per year
Scenario 3	▲	$10 in 2010, rising by 3% per year
Scenario 4	■	$20 in 2010, rising by 3% per year
Scenario 5	X	$100 Constant Price
Scenario 6	●	$75 in 2010, rising by $5 per year through 2050

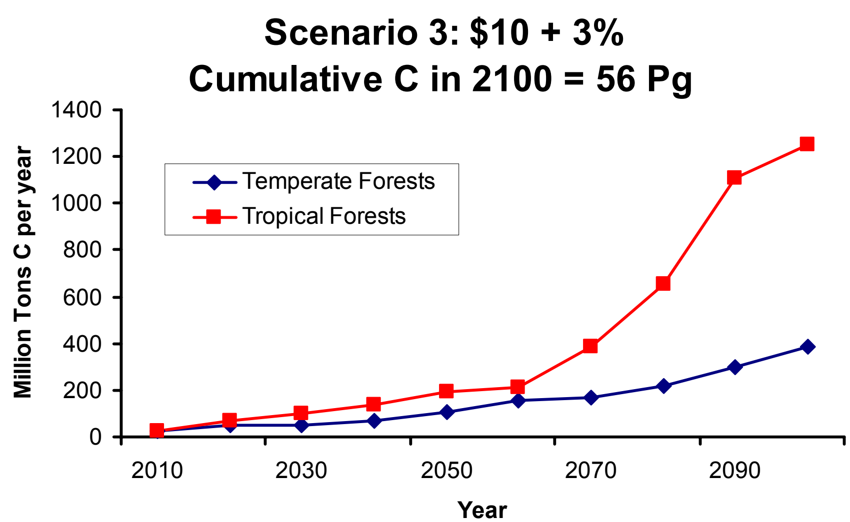


Result 1: If society is willing to pay, it can obtain substantial carbon in the near term

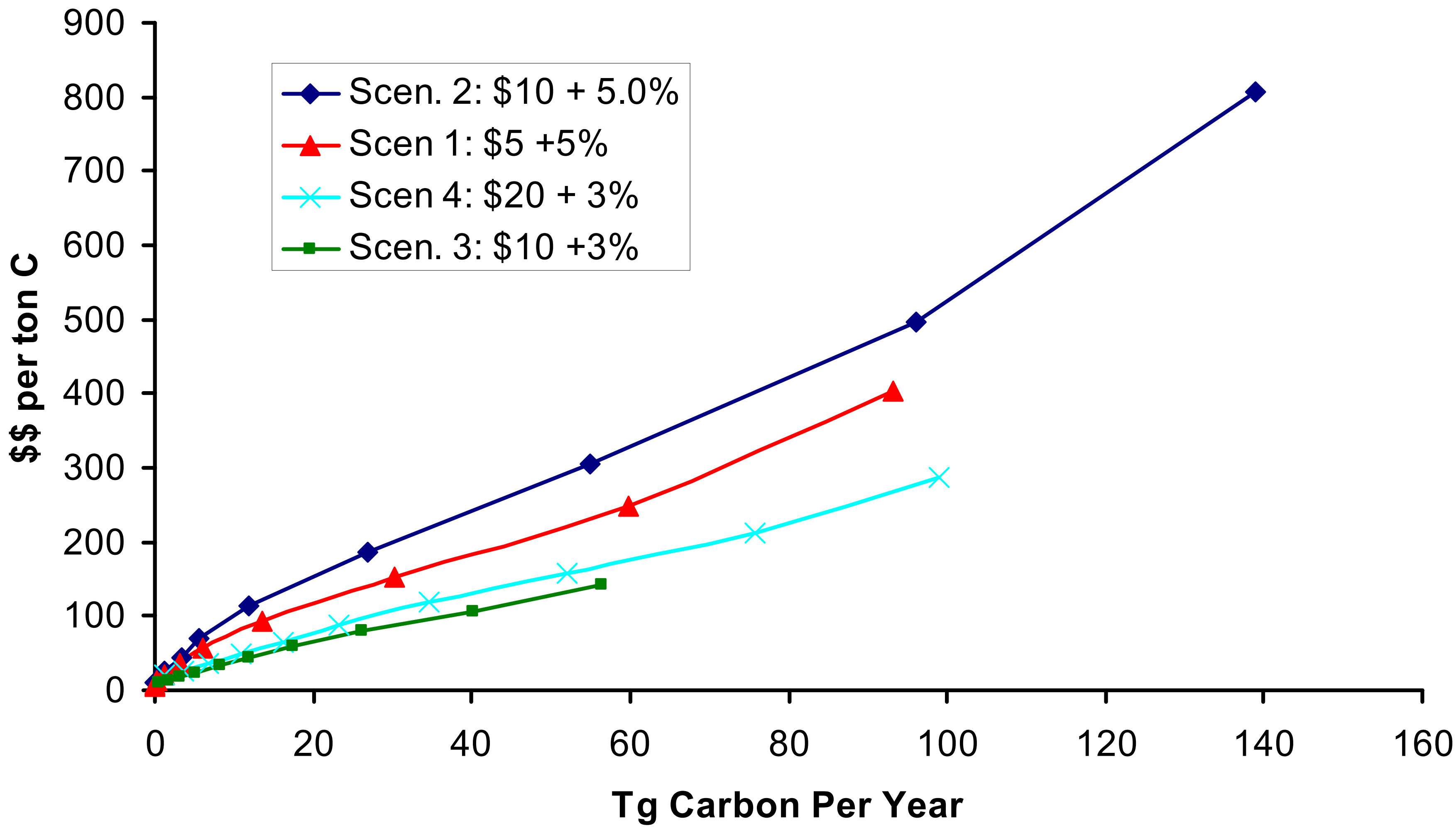
Scen. 5 [$100 Constant] VS Scen. 3 [$10 + 3% ($143)]







Result 2: Sequestration is delayed if prices rise quickly.



Result 3: 60-70% of carbon due to land use change (red. Def/aff.)

	Percentage C from Land Use Change in 2100[1]					
Scenarios →	1	2	3	4	5	6
Temperate						
North America	42	40	43	35	25	27
Europe	42	38	31	37	38	42
Russia	50	49	56	50	46	56
China	47	46	51	47	31	34
Oceania	54	43	46	44	24	24
Temperate Total	45	43	46	41	33	37
Tropical						
South America	85	75	88	87	88	84
India	67	62	61	45	51	46
SE Asia	74	70	81	76	73	50
Africa	87	79	95	90	95	83
Tropical Total	82	75	88	84	85	73
Global Total	71	65	75	70	69	62

Large scope for set-asides, management inputs, rotation age ext.

Result 4: Plantations are a small part of the overall land-use story…

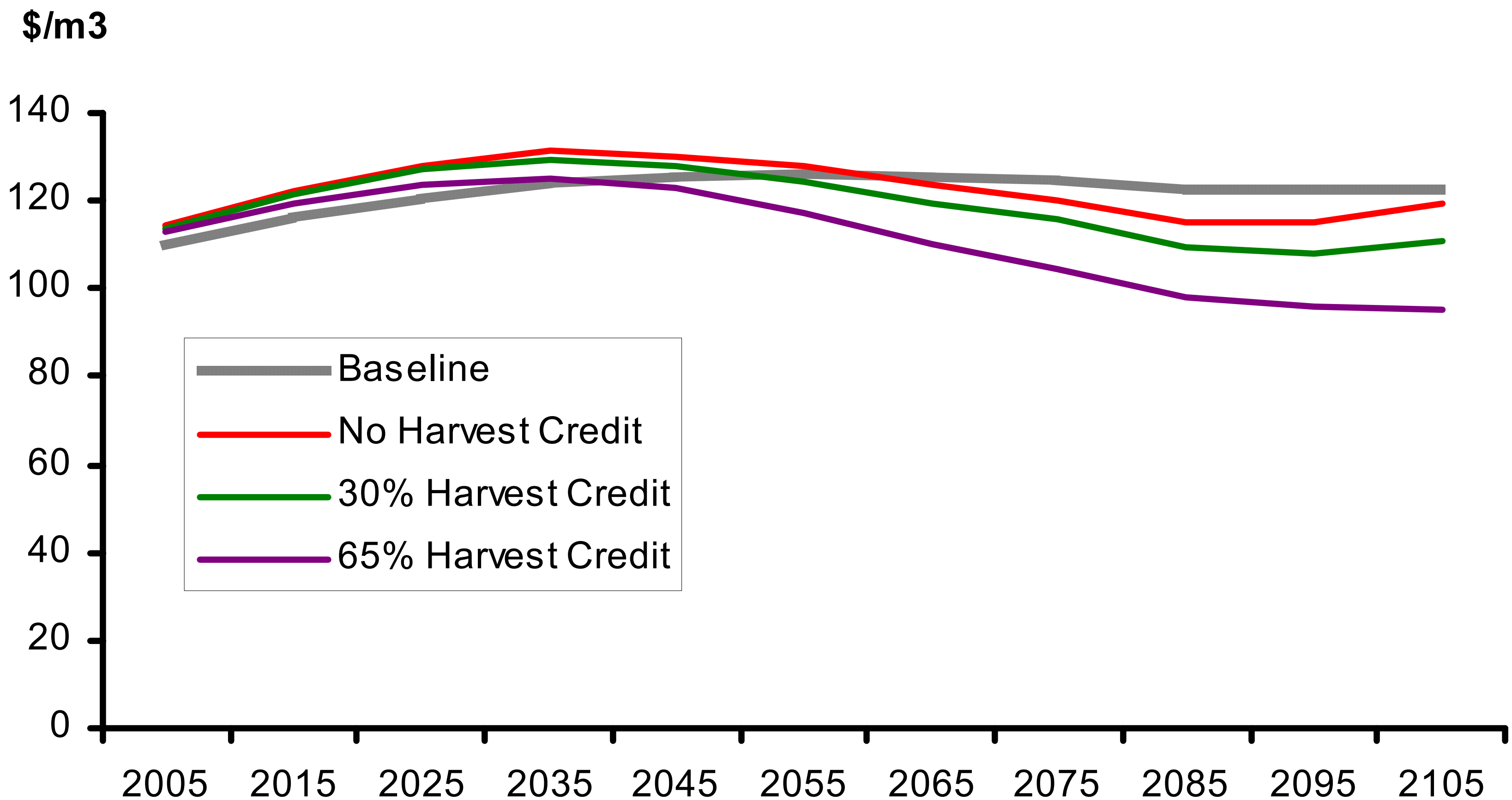
	Area (in 2100)			Change Relative to Baseline		
	All Forests	Plantations	Plantation	All Forests	Plantations	Plantation
Scenario	Million hectares		%	Million hectares		%
Base	3,321	115	3%	-	-	-
1	4,371	194	4%	1,051	78	7%
2	4,784	277	6%	1,463	161	11%
3	3,914	149	4%	593	34	6%
4	4,257	181	4%	936	66	7%
5	3,758	136	4%	437	21	5%

… but, they are relatively more important when C prices are higher, or rising more rapidly.

Result 5: Credits for harvested products reduce net sequestration

	Above	Market	Above + Market	Total (+Soil)
2025		Pg C		
No Harvest Credit	22.4	-0.6	21.9	22.4
30% Perm. Strg.	22.1	-0.5	21.6	22.2
30% PS + 35% Biom.	21.4	-0.4	21.0	21.5
2105				
No Harvest Credit	130.2	-1.3	128.9	133.5
30% Perm. Strg.	129.3	-0.4	128.9	133.6
30% PS + 35% Biom.	122.3	1.8	124.1	129.1

Why? Prices rise in the short run and in the long run lower prices reduce incentives to increase forest carbon.



Conclusions

- Sequestration Potential:
  - 50 – 140 Pg are available for $100 - $800 per ton by the end of the century.
  - Approximately 60 – 75% in tropics; 25 – 40% in temperate.
  - Tropics relatively more important at lower prices.

- Possible to use forests as “interim” climate change measure, but costs would be very high.
  - IPCC levels of sequestration (60 – 80 Pg by 2050) are possible, but costs could be as high as $3 trillion.

- Faster price growth delays carbon sequestration, particularly in tropics and subtropics.

- Land use is important, but set-asides, increasing mgmt., and increasing rotations can enhance sequestration.

- Plantations are a small part of the story (4 – 11%). Technological change also is not a large part of story. Access at margins is much more important.