Will US Forests Continue To Be a Carbon Sink?

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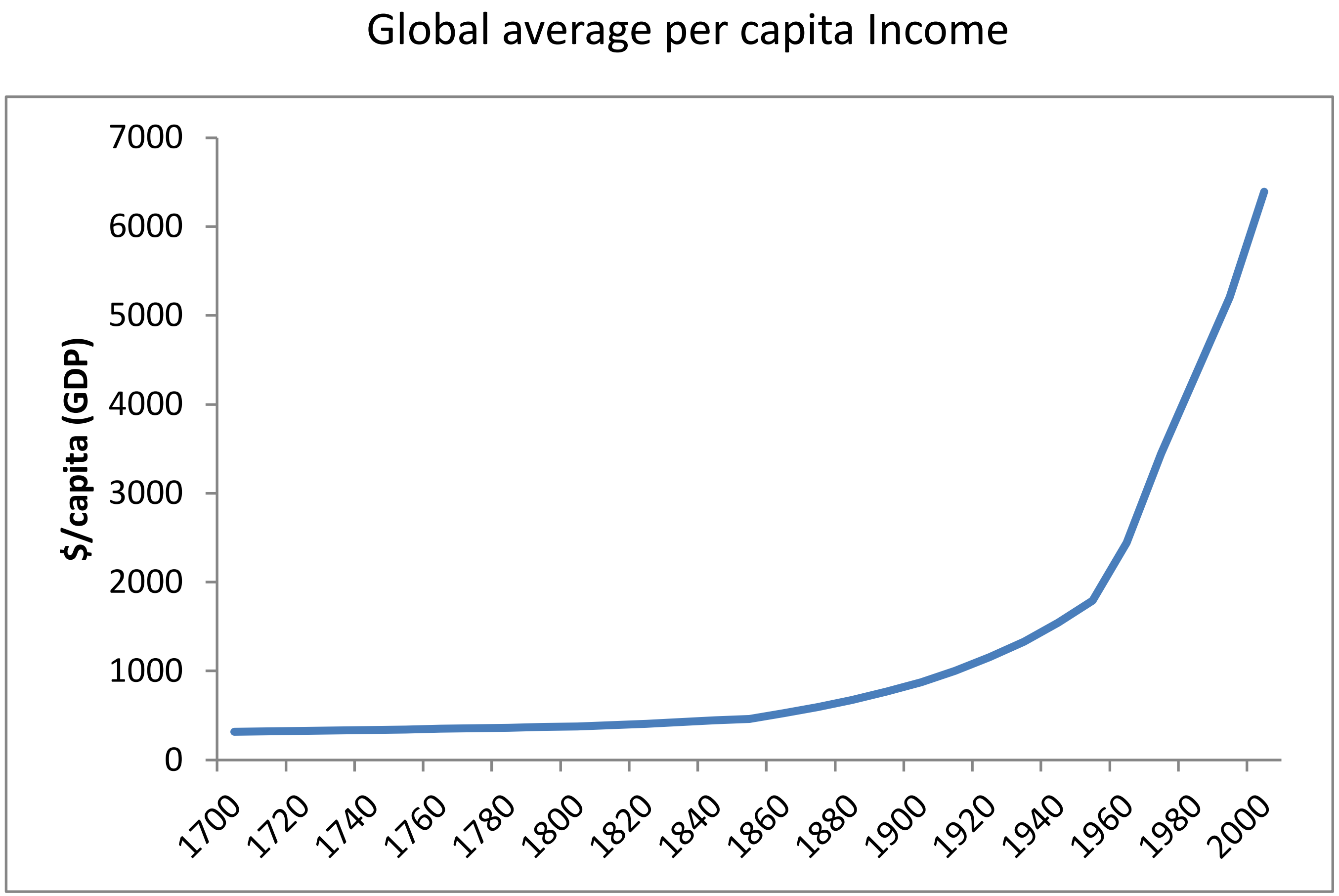
Over the last century…

- Income per capita rose from $679/person to $7500/person (Maddison; DeLong; Nordhaus)
- Population rose from 1.6 billion to 6.1 billion
- An additional 800 million ha was deforested and converted to agriculture (Houghton, 1999, 2003), and 500 million ha was officially reserved.
- New values for environment reserved large additional areas of private lands with non policy intervention.
- Unprecedented increase in human welfare.

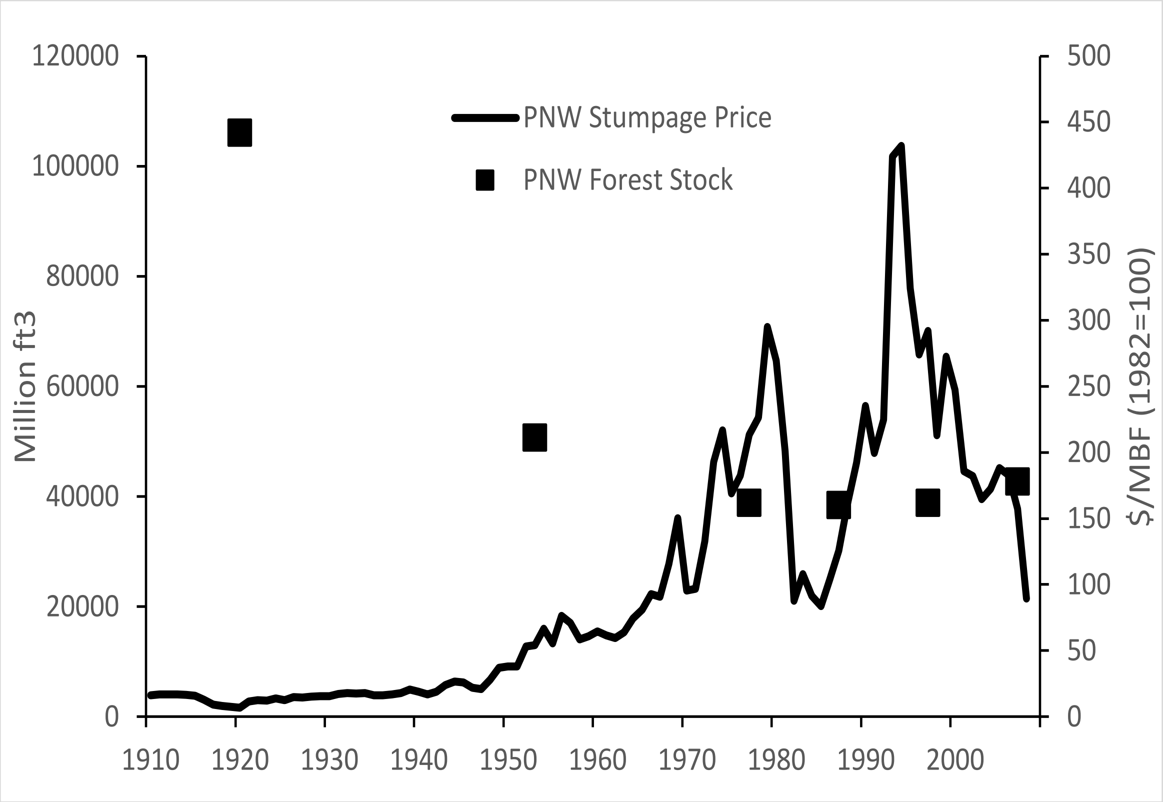


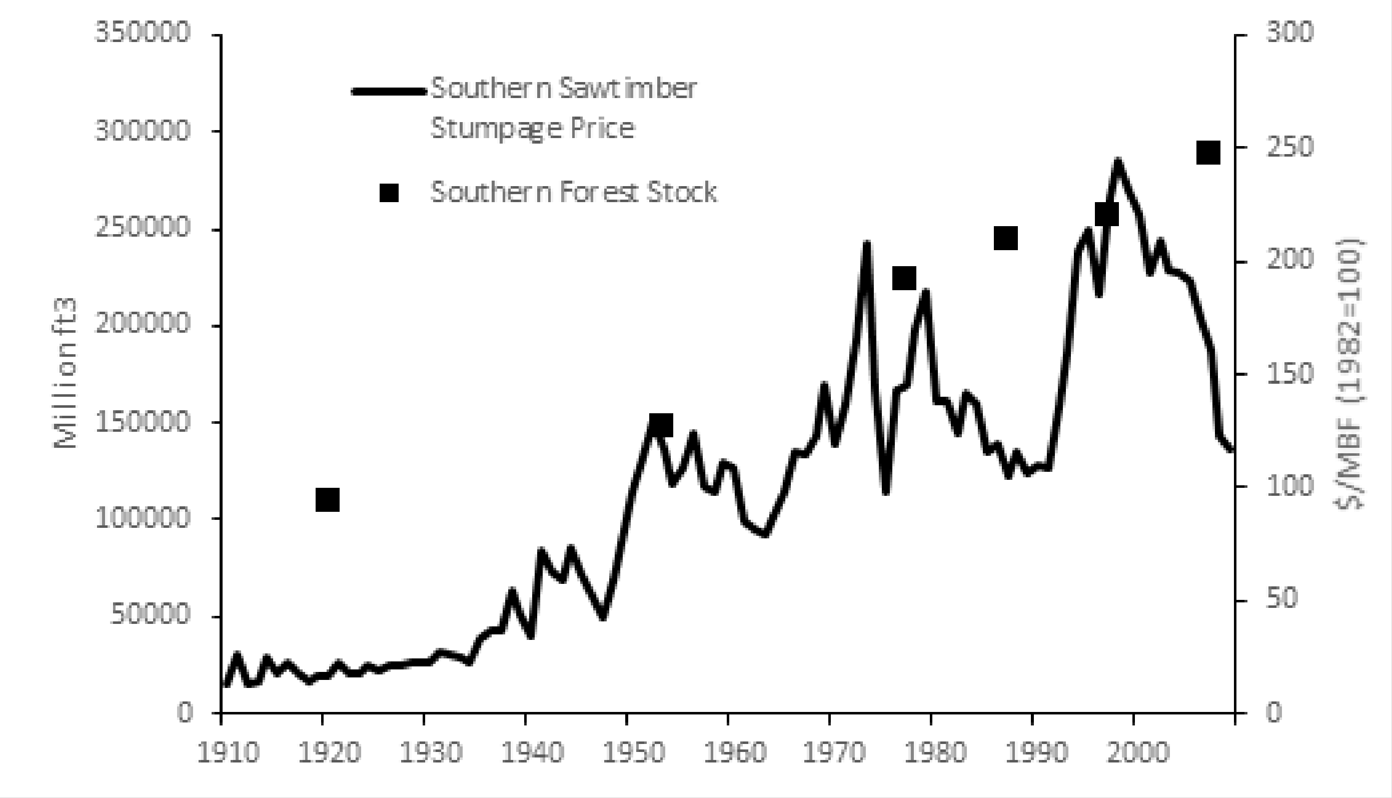
What happened to the world’s forests?

Forestry became sustainable on a global basis

Prices and stocks stabilized...

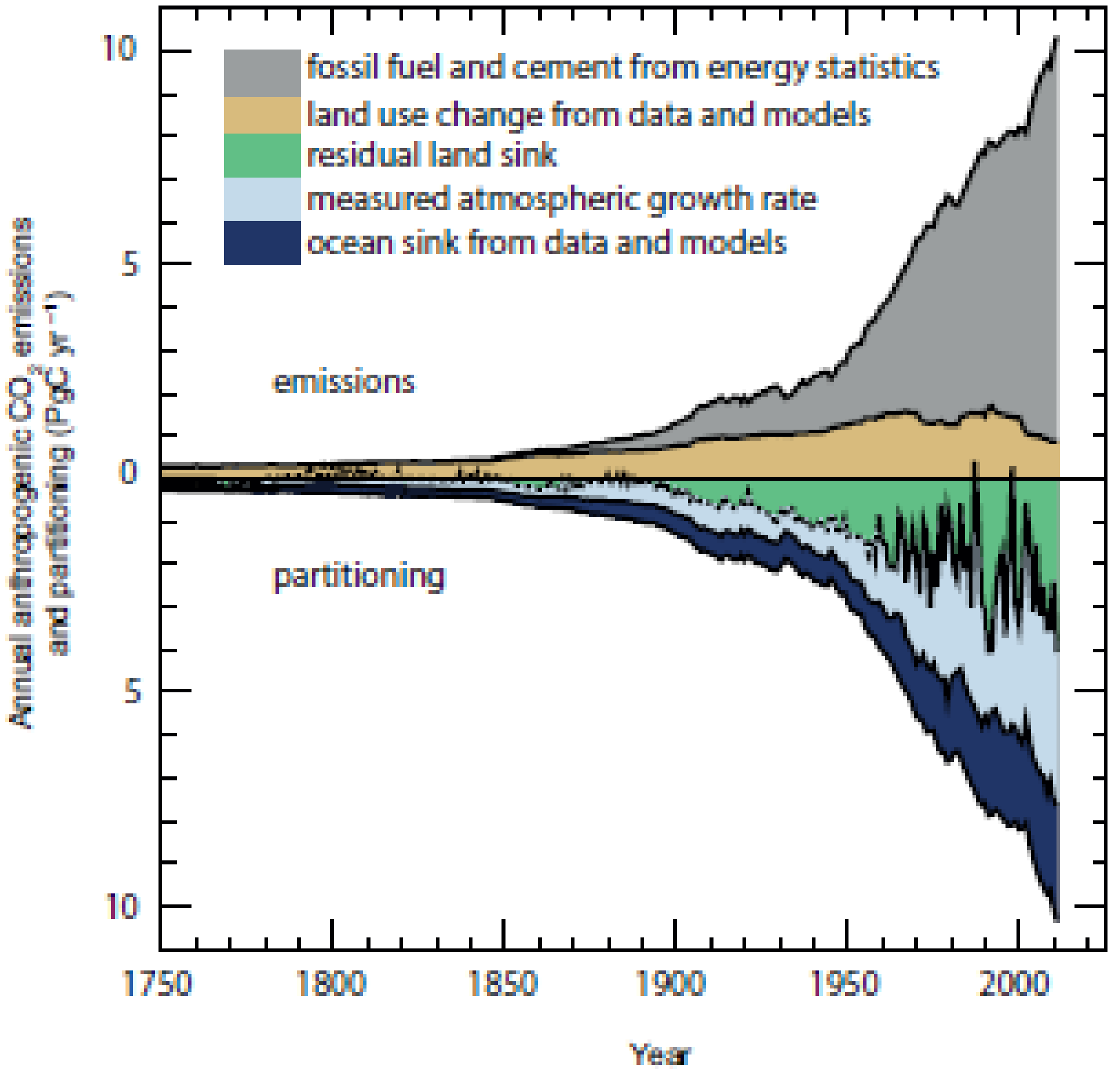
$$\frac{\dot{P}}{P} + \frac{\dot{V}}{V} = r + \frac{R}{PV}$$





Forestry became sustainable on a global basis

Carbon has continued to increase in the world's forests



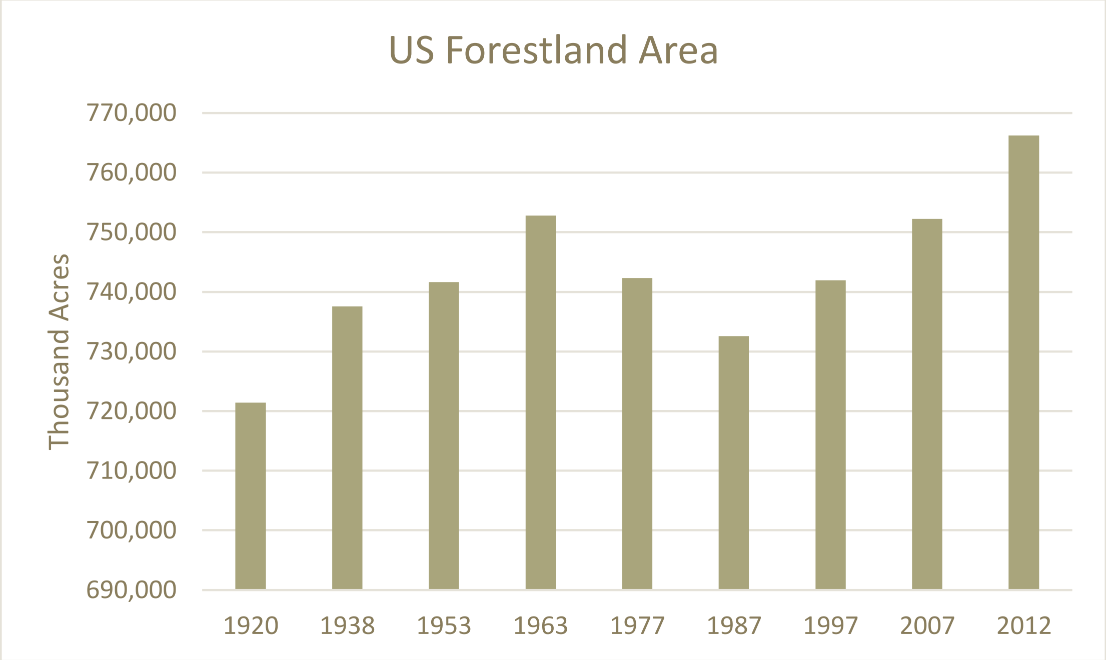
Since 1900, the net of the Residual land sink and Deforestation has been an Increase in carbon by over 200 million tons C/yr globally

IPCC, 2014

Why?

Forest Sustainability

- Land use change – forest expansion
- Harvesting patterns
  - Age class of harvest
  - Land set-aside for economic and environmental purposes.
- Forest investments (plantations)
- Fire exclusion/rotation management
- CO_2 fertilization



Oswalt et al. (2012)

This trend has emerged throughout the world
Europe, Russia, China, South America

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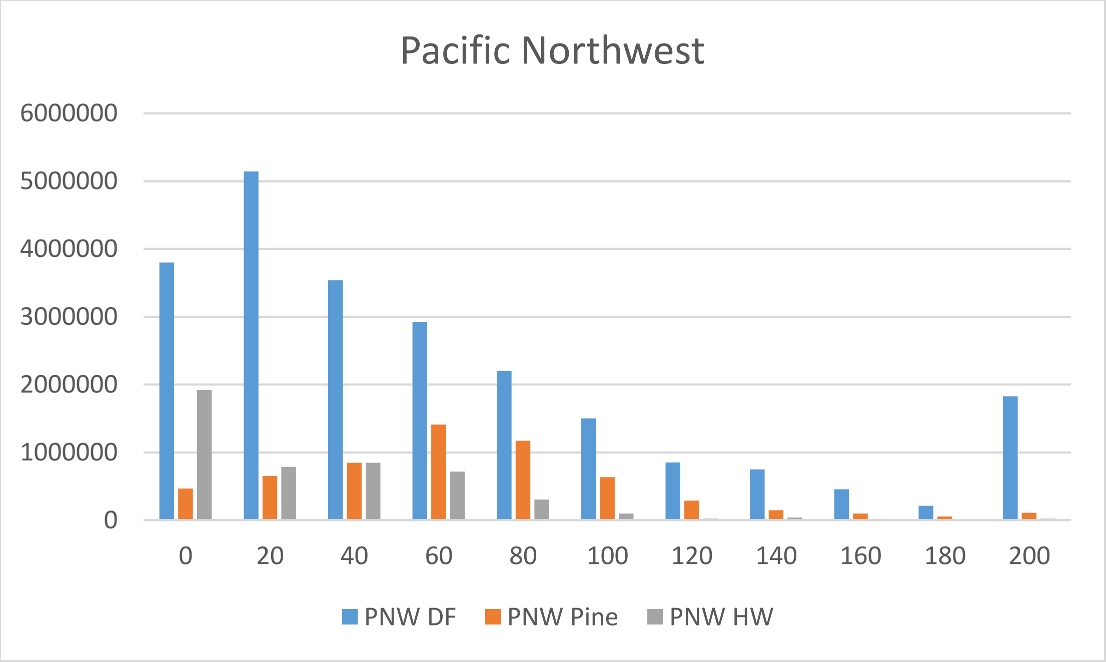

USDA Forest Service FIA data
Forest Inventory Data Online
http://apps.fs.fed.us/fia/fido/index.html

Forest Sustainability

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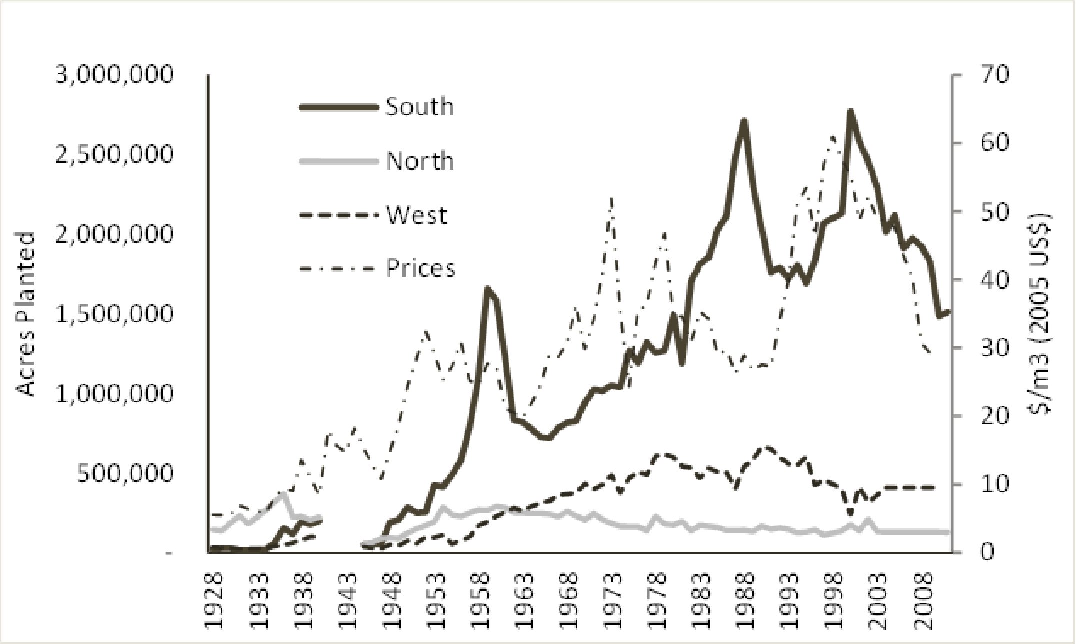

Over 100 million ha of plantations globally
With significant investment in subtropics

Forest Sustainability

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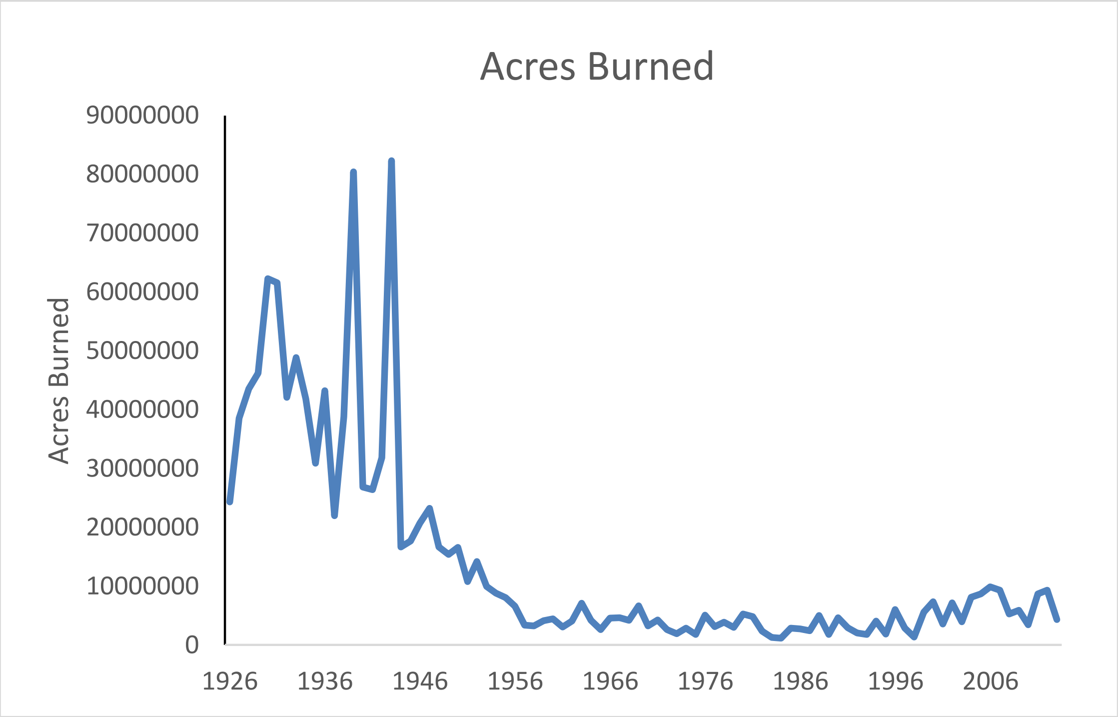
		Cubbage et al. 2008		Sedjo (1983) ca. 1978		
		Rotation	$m^3/ha/y$	Rotation	$m^3/ha/y$	Annual Increase (%)
Brazil	P. taeda	15	30	15	16	2.1%
	E. grandis	15	35	16	22	1.6%
Chile	P. radiata	19	26	27	19	1.0%
New Zealand	P. radiata	28	17	23	18	-0.1%
South Africa	P. patula	30	14	20	15	-0.2%
USA	P. taeda	27	14	33	10	1.1%
	Ps. Menzeseii	45	19	40	14	0.9%
Average			22.0		16.2	0.9%

Forest Sustainability

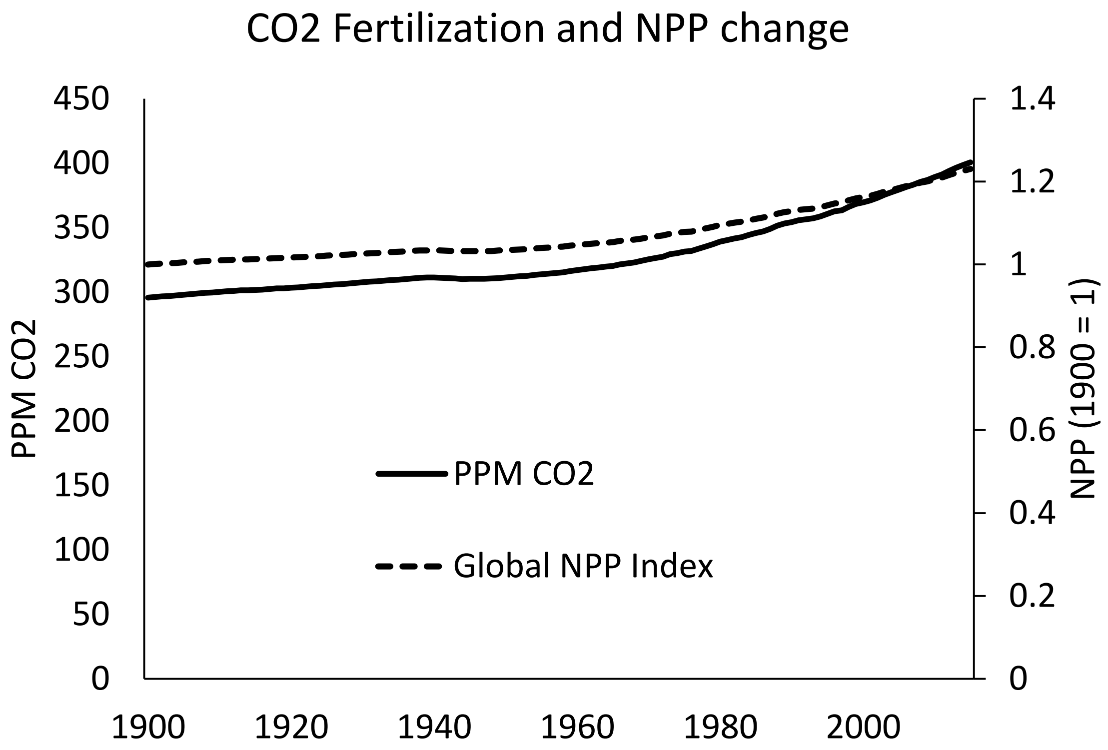
- Land use change
- Harvesting patterns
  - Age class of harvest
  - Land set-aside for economic and environmental purposes.
- Forest investments (plantations)
- **Fire exclusion/rotation management**
- CO_2 fertilization



Various Sources

What drives the current sink?

- Land use change – forest expansion
- Harvesting patterns
  - Age class of harvest
  - Land set-aside for economic and environmental purposes.
- Forest investments (plantations)
- Fire exclusion/rotation management
- **CO_2 fertilization**

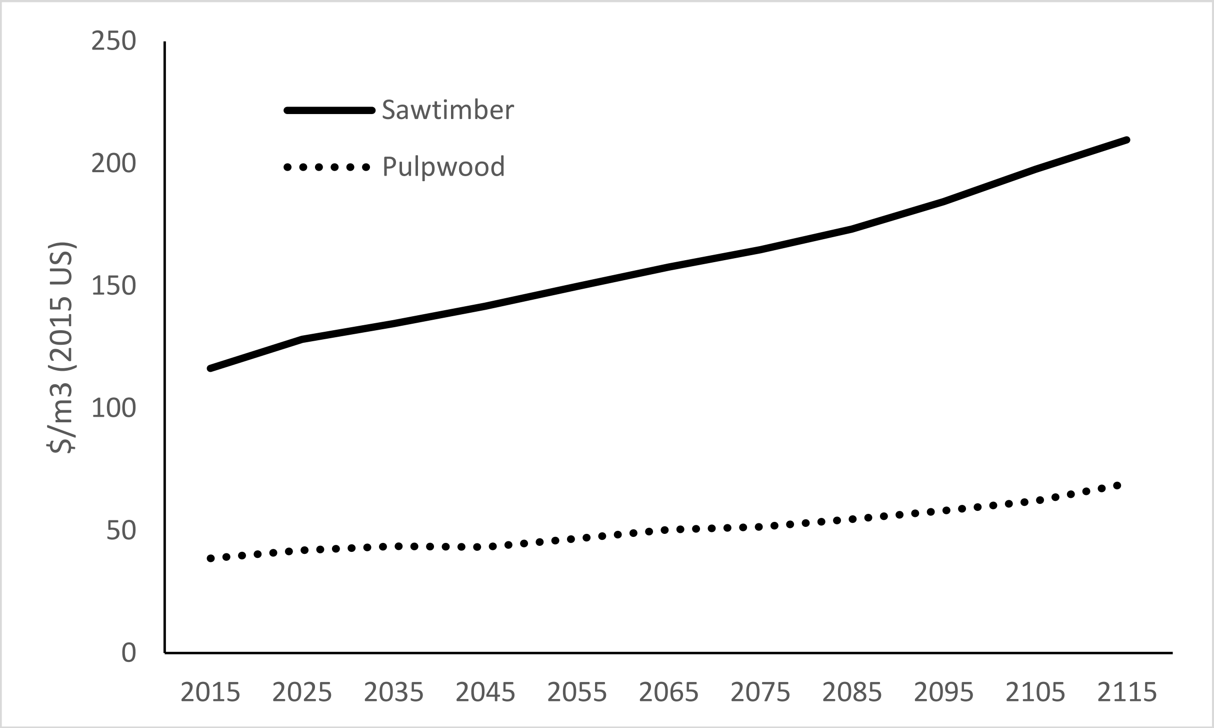


Intertemporal economic model

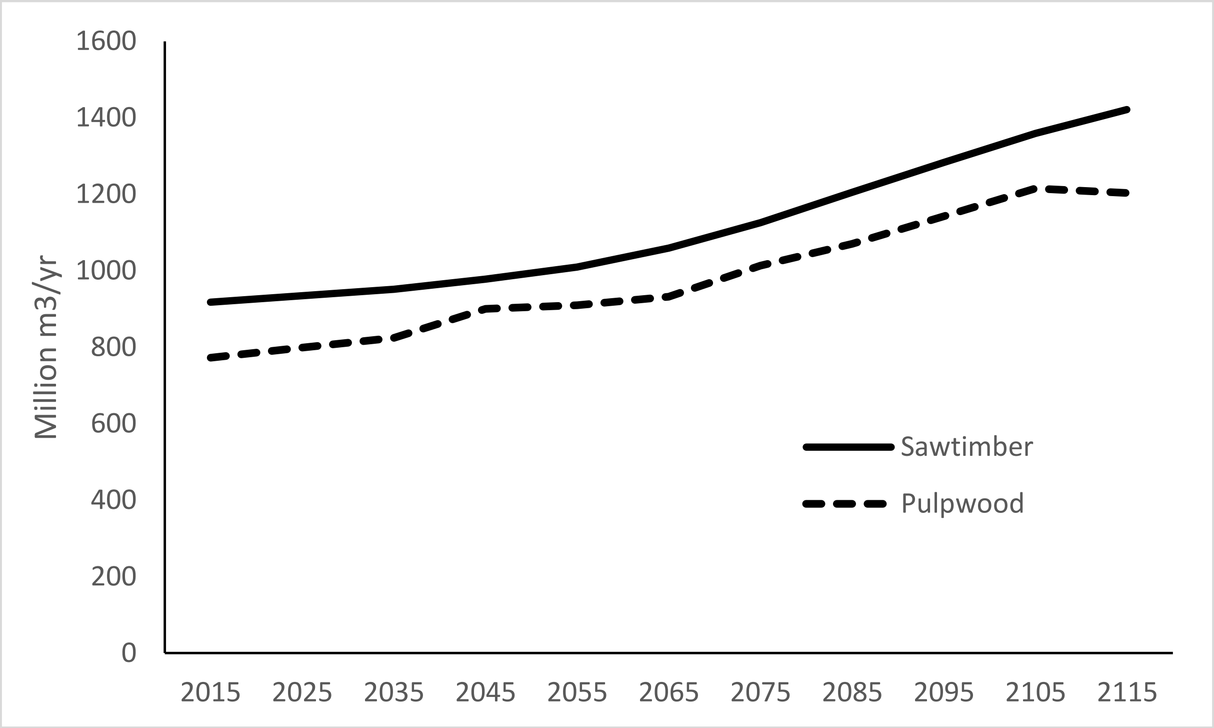
- Based on earlier TSM and GTM (Sedjo and Lyon, 1990; Sohngen et al., 1999).
- Global timber demand is exogenous and driven by population, income and technology change.
- Dynamic forests: Timber production determined by optimization over forest age classes, area of accessible and inaccessible land, planting, and management intensity.
  - Keep track of age classes.
  - Keep track of investments.
  - Keep track of where forests are located.
- Prices endogenously determined.
- Land demand driven by agricultural markets, but exogenous to model (rents exogenously specified).

GTM Global Prices and Harvests

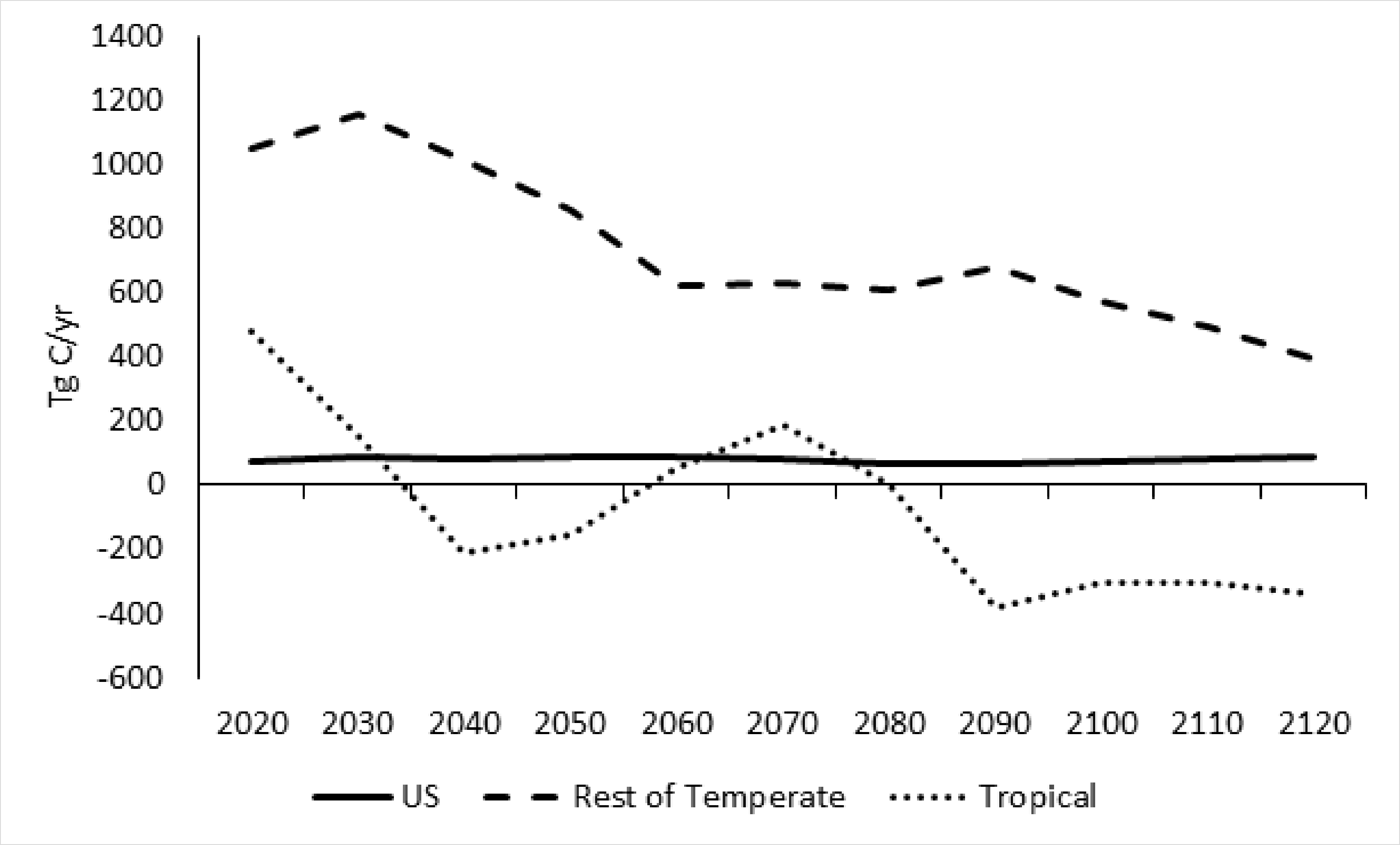
Prices



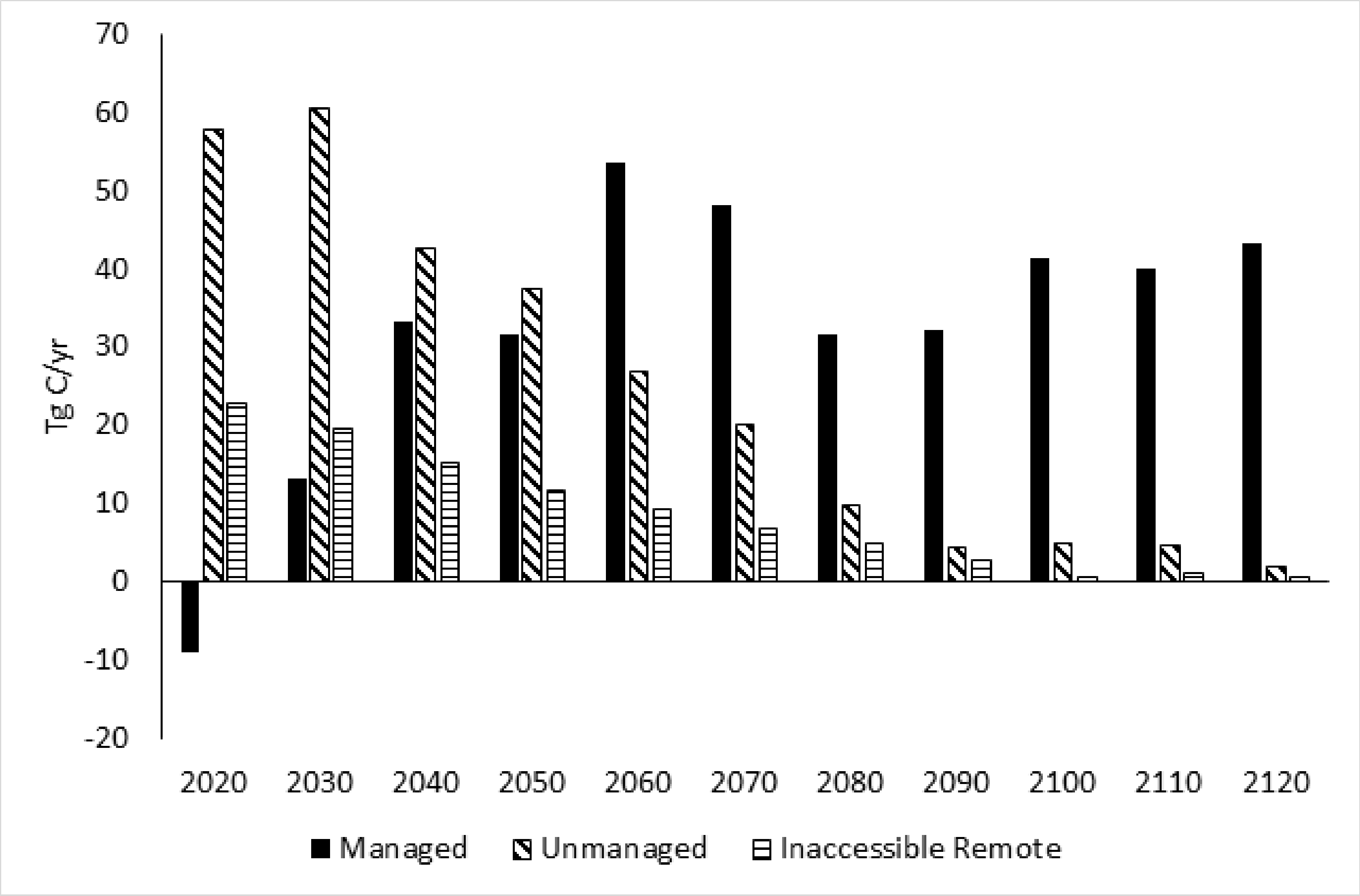
Quantities



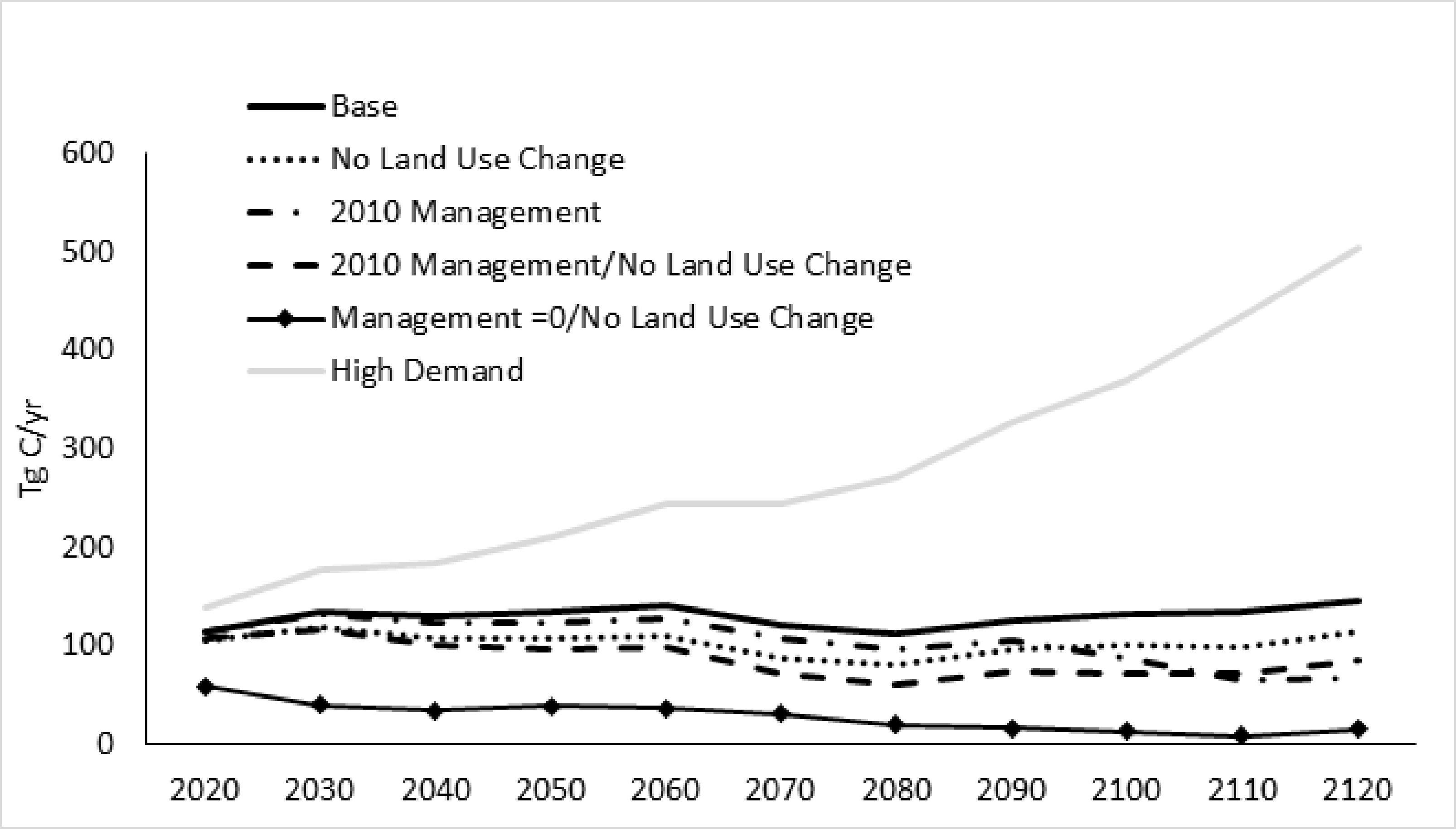
Global Carbon Sequestration



US Forest Carbon Sequestration by Type



Sensitivity of Results to Alternative Economic Assumptions

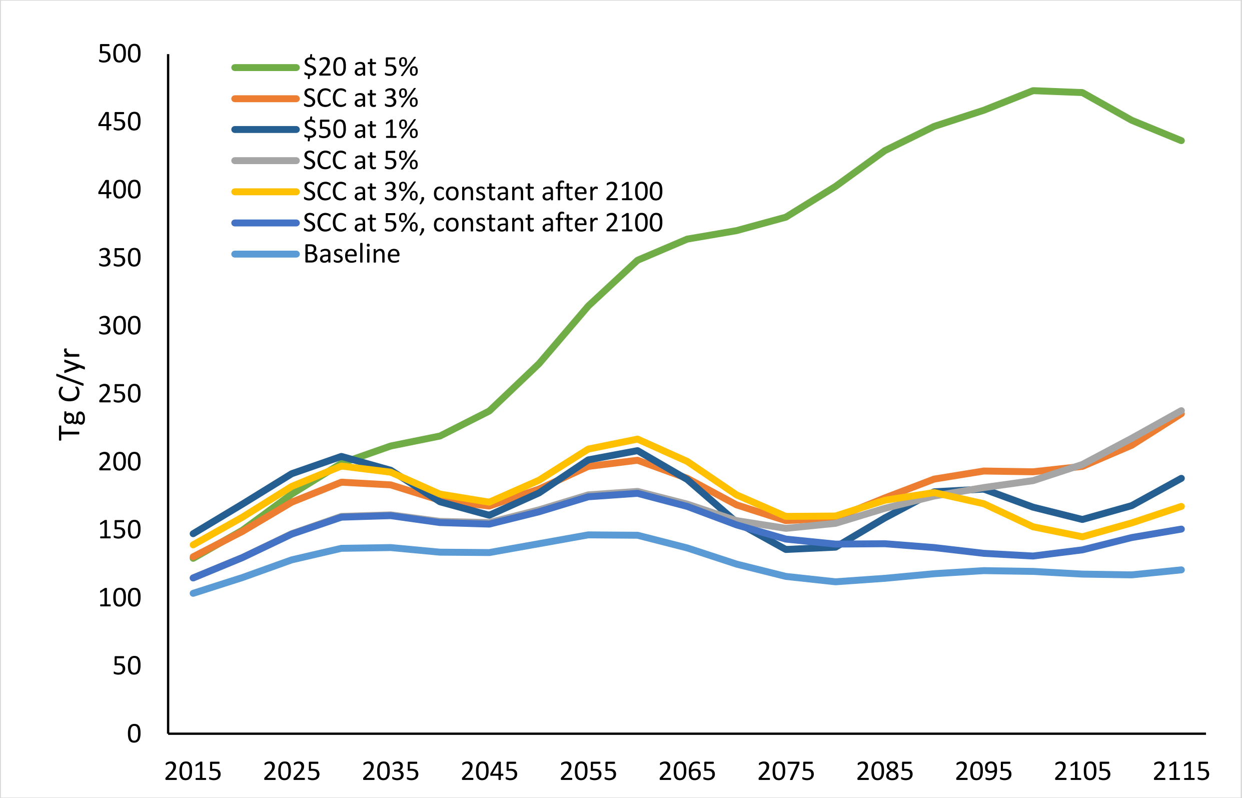


Does Climate Change Alter the Results?

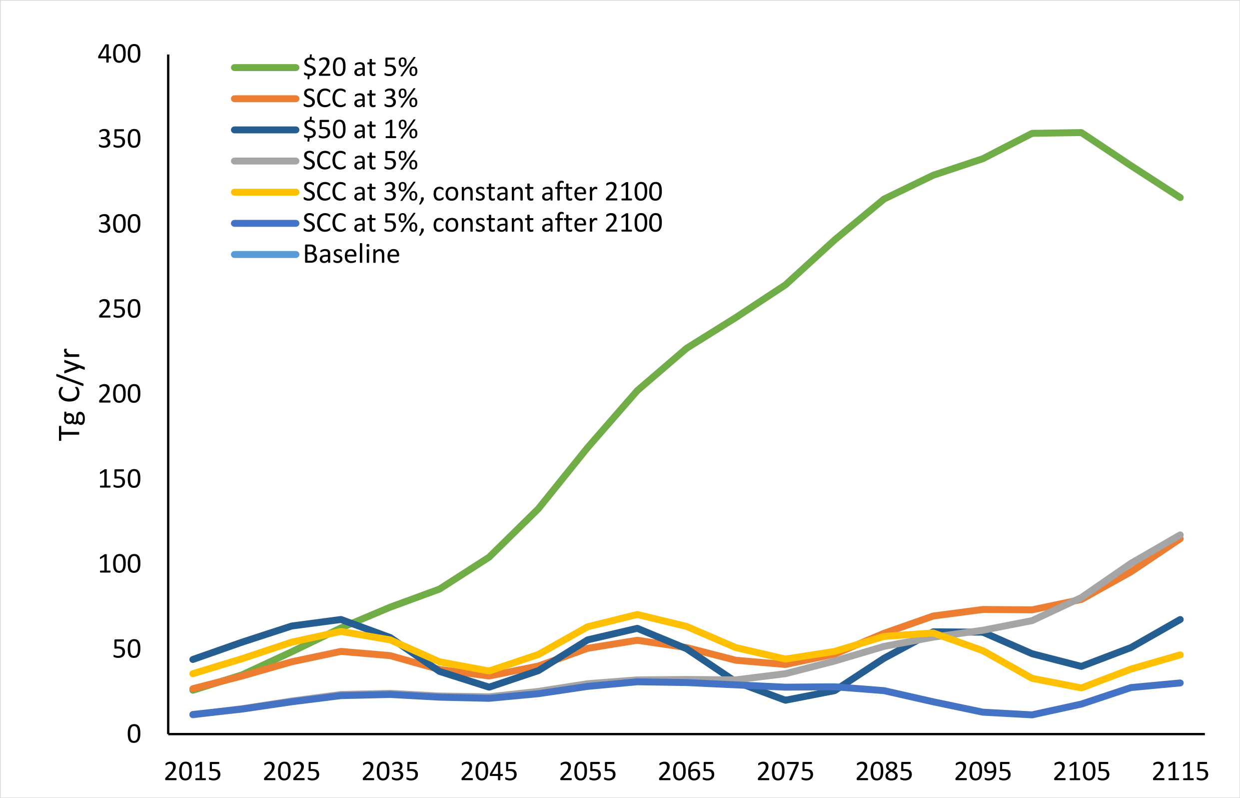
		Baseline	No Land Use Change	2010 Management	2010 Management/No Land Use Change	Management=0/ No Land Use Change	High Demand
Without Climate Change Impacts	Aboveground Tg C in 2050	24,654	24,088	24,570	24,082	23,182	25,732
	% difference from baseline		-2.3%	-0.3%	-2.3%	-6.0%	4.4%
	Aboveground Tg C in 2100	27,803	25,982	27,518	25,726	24,235	31,952
	% difference from baseline		-6.6%	-1.0%	-7.5%	-12.8%	14.9%
With Climate Change Impacts (Average and min and max of scenarios)	Aboveground Tg C in 2050	24,727 (24274,25221)	24,248 (23709, 24800)	24,638 (24118, 25182)	24,152 (23575, 24756)	23,439 (22802, 23937)	25,704 (25334, 26202)
	% difference from baseline		-1.9% (-1.7, -2.3)	-0.4% (-0.2, -0.6)	-2.3% (-1.8, -2.9)	-5.2% (-5.1, -6.1)	4% (3.9, 4.4)
	Aboveground Tg C in 2100	28,317 (27065, 29327)	26,638 (25243, 27393)	28,044 (26659, 29160)	26,336 (24874, 27187)	25,084 (23691, 25874)	32,211 (30768, 33789)
	% difference from baseline		-5.9% (-6.6, -6.7)	-1% (-0.6, -1.5)	-7% (-7.3, -8.1)	-11.4% (-11.8, -12.5)	13.8% (15.2, 13.7)

Role of Carbon Policies to Augment Sequestration

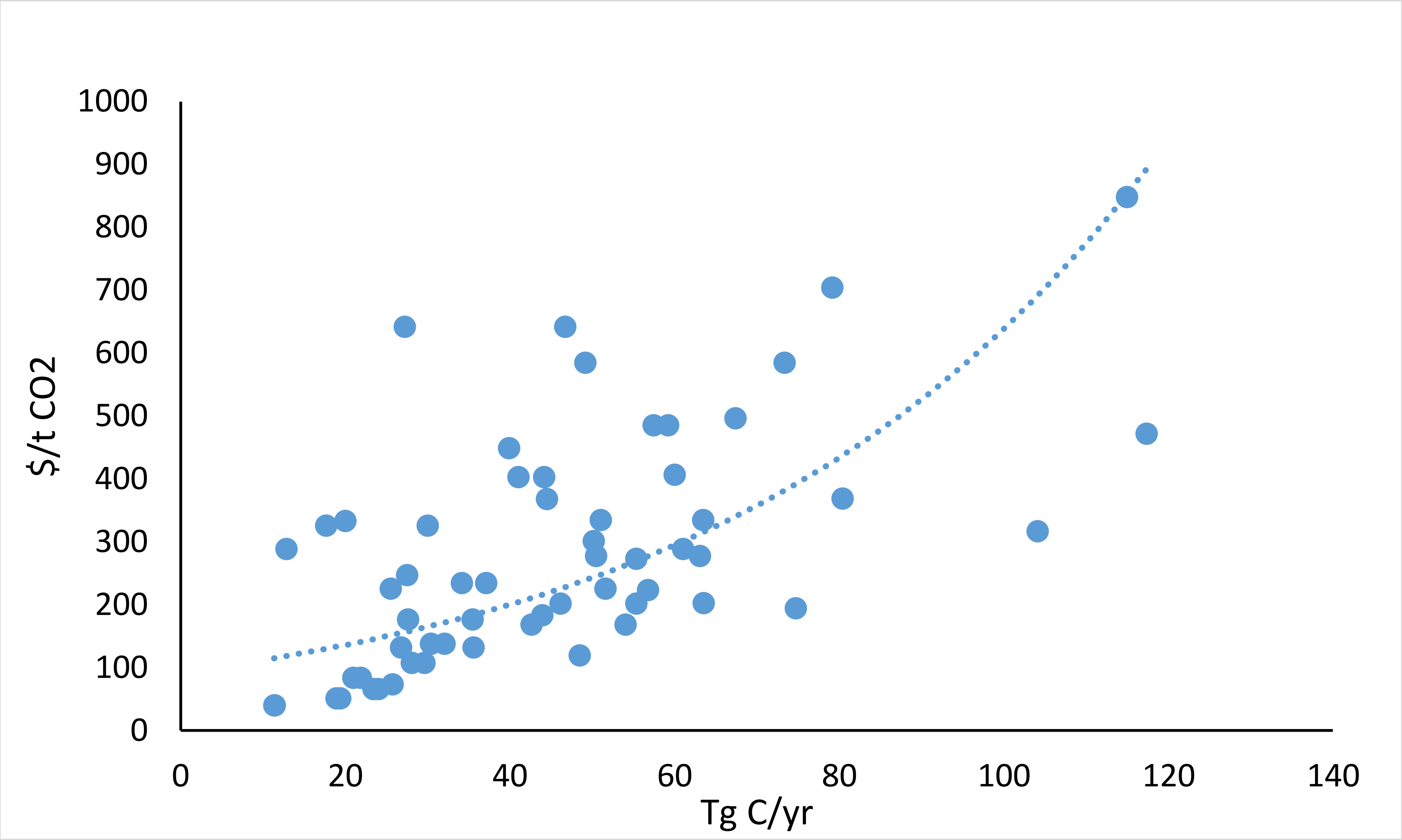
Forest Flux



Carbon Gain



Costs of C Sequestration?



Total Cost:

$1.5-$2.0 billion/yr ➔

22 – 42 Tg C/ yr

$8.0 - $10 billion/yr ➔

50 – 60 Tg C/yr

Conclusion

- Historical data suggests that management has played an important role in the US carbon sink.
- Management has strong long-term implications for forest carbon sequestration. Equally as important as land use.
- Higher demand for wood products increases incentives to manage
- Climate change can reduce sequestration, but most scenarios suggest positive sequestration.
- Policies can increase sequestration significantly.