Carbon Sequestration by Forests on Reclaimed Mines

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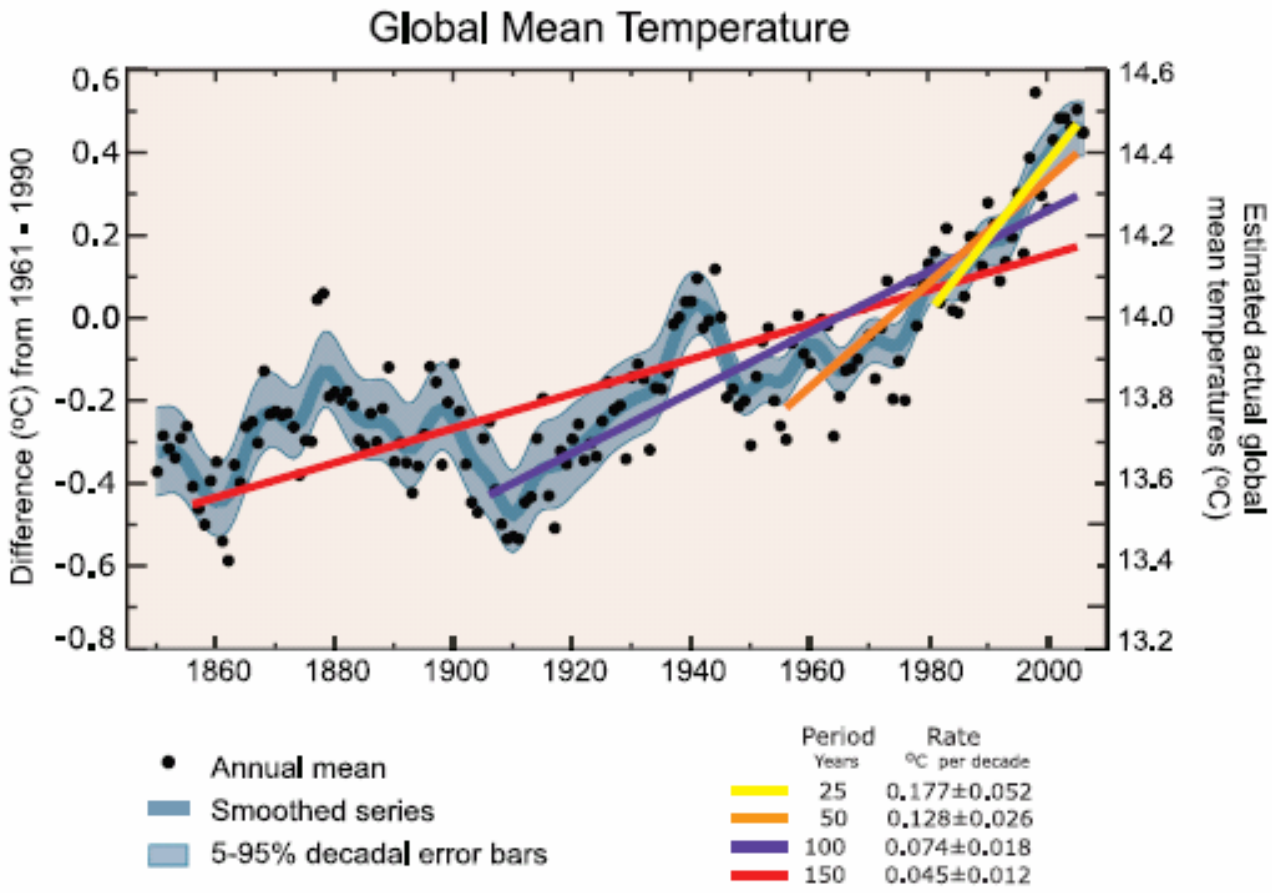
Global Climate Change

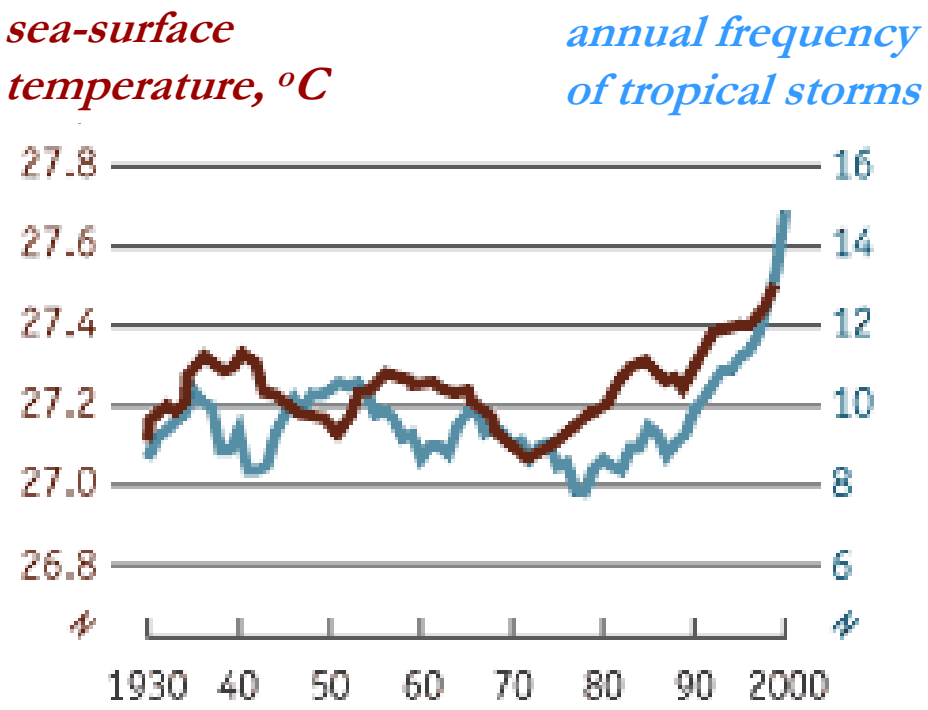
Global Warming



Source: IPCC

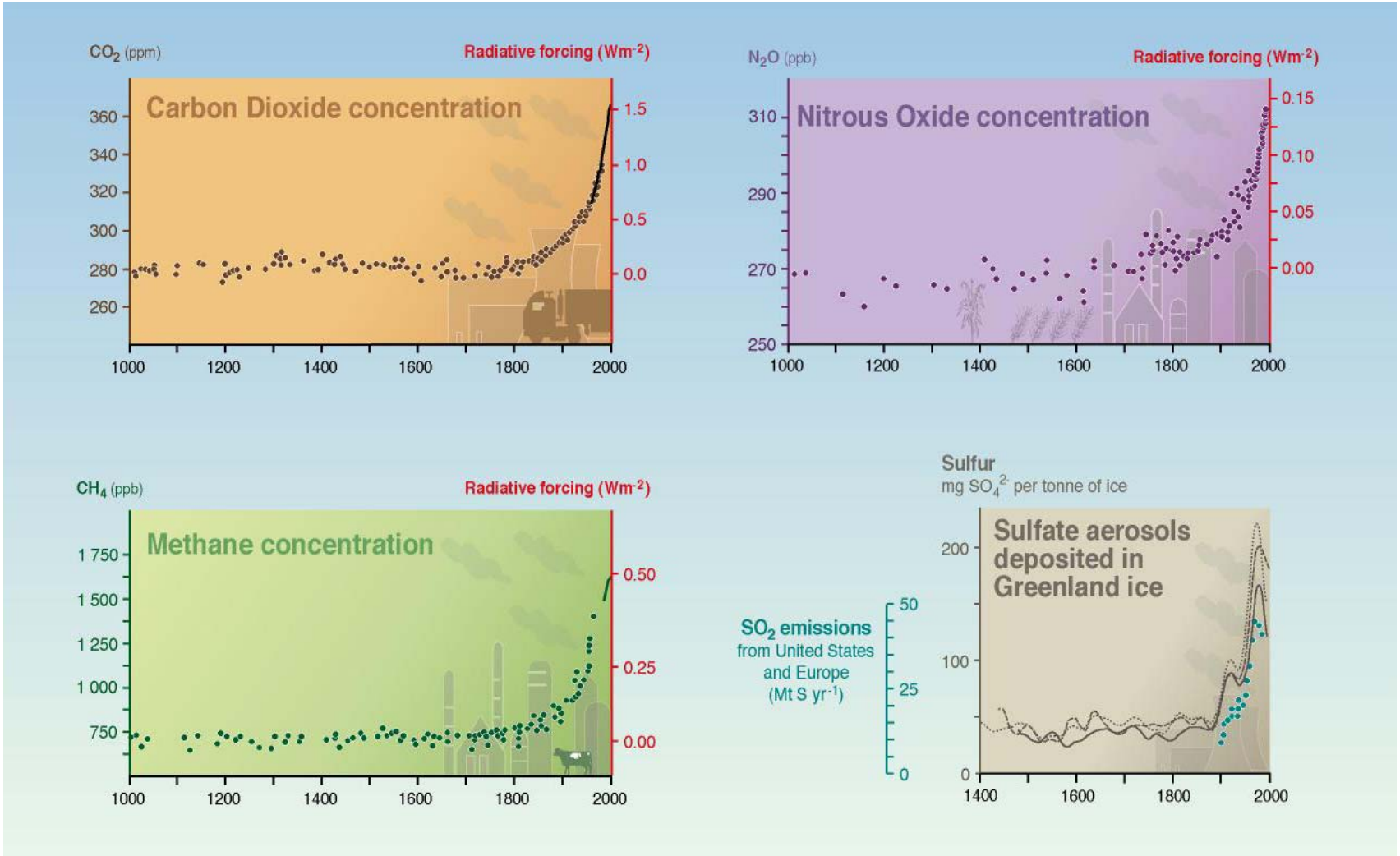
Stormy Weather

North Atlantic



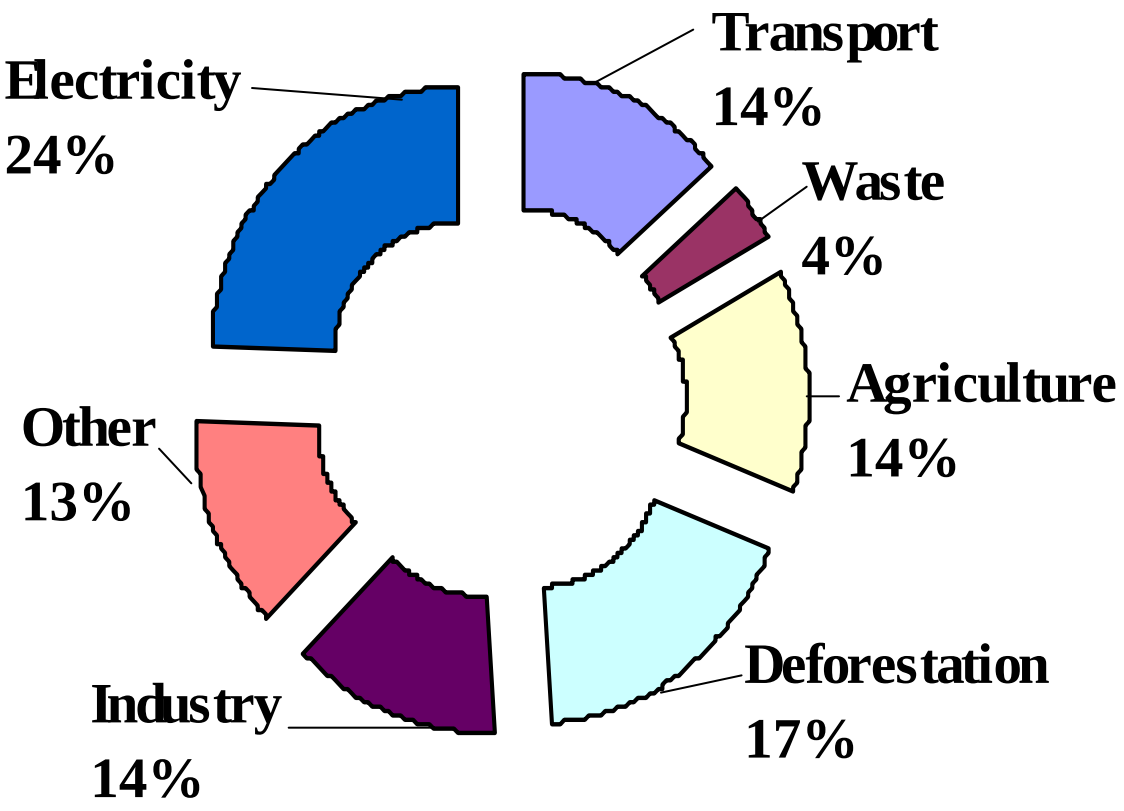
Source: NOAA

Industrialization Influence



Source: IPCC

Greenhouse Gas Contributors



Source: World Resources Institute

Climate Change Mitigation Strategies

- Increase efficiency of current energy sources (conservation of energy)
- Increasing use of no-C or low C energy sources
- Capturing and storing C from the atmosphere into terrestrial, geologic or oceanic ecosystems (C sequestration)
- Create a C program (market based approach)

Carbon Sequestration on Mined Lands?

- C sequestration through reforestation provides CO_2 abatement and complements traditional reclamation objectives.
- Globally, C accumulation on degraded lands have been estimated at 0.3 Mg C ha^{-1} yr^{-1}
- Rates ranging from 0.7 to 6.7 Mg C ha^{-1} yr^{-1} were found on 20 to 55 yr reforested pre-SMCRA mined lands in the eastern coal region.
- Four pre-SMCRA forested sites in KY accumulated 4.51 Mg C ha^{-1} yr^{-1} , while a non mined forest accumulated 3.44 Mg C ha^{-1} yr^{-1}.

Sources: IPCC, Lal and Bruce, Amichev

Carbon Sequestration on Mined Lands?

≈ 600,000 hectares of "disturbed" surface mine lands

- **Question 1: Will Trees Grow on *Post* SMCRA Surface Mined Lands?**
- **Question 2: How Much Carbon is Sequestered on Post SMCRA Surface Mined Lands?**
- **Question 3: How Do We Maximize Carbon Sequestration on These Sites?**

Q1: FRA to the Rescue!

Method	White Oak	White Ash	White Pine	Red Oak	Black Walnut	Yellow Poplar
	----------Survival (%) ----------					
Compact	21 (a)	80 (a)	3 (a)	18 (a)	18 (a)	10 (a)
Strike-Off	69 (b)	81 (a)	50 (b)	64 (b)	55 (b)	52 (b)
Uncompact	81 (c)	82 (a)	82 (c)	82 (c)	68 (b)	80 (c)
	---------- Height (cm) ----------					
Compact	63 (a)	104 (a)	87 (a)	93 (a)	58 (a)	125 (a)
Strike-Off	197 (b)	236 (b)	307 (b)	242 (b)	116 (b)	203 (b)
Uncompact	217 (b)	308 (c)	431 (c)	278 (b)	184 (c)	276 (c)

Conventional Reclamation

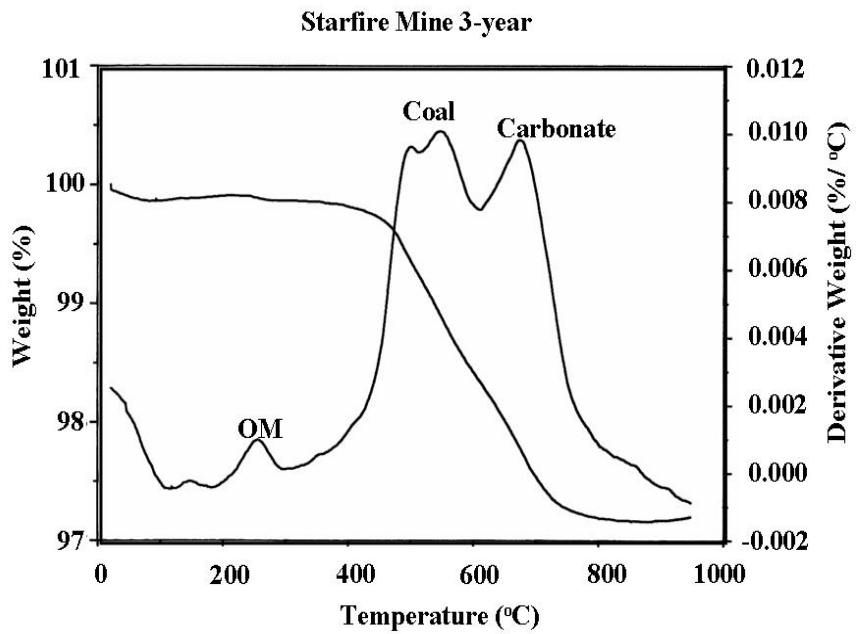
End-dump (RAM 124) Reclamation

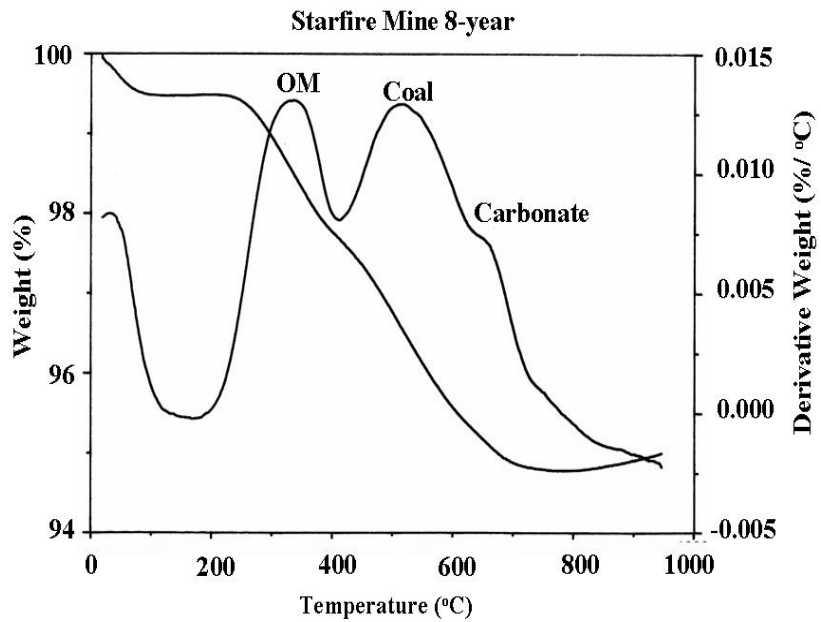
Q2: How Much Carbon is Sequestered on Post SMCRA Surface Mined Lands?

Below Surface Sequestration?

Parent Material vs. Soil Organic Matter

Spoil Carbon Change





- **OM fraction increased from 0.095 to 1.47%**
- **Decrease in carbonate fraction (~ 36%)**

Chronosequence Approach
(White Oak – Strike Off)

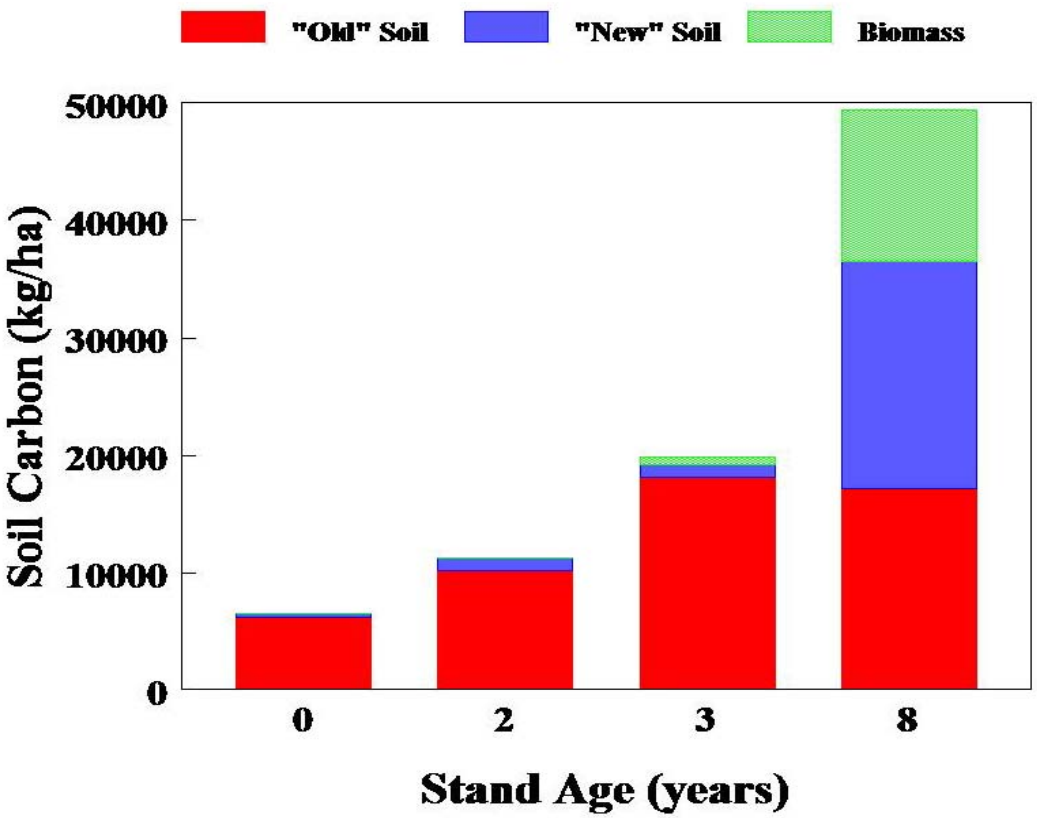
0-year

2-year- 60cm

3-year- 176 cm

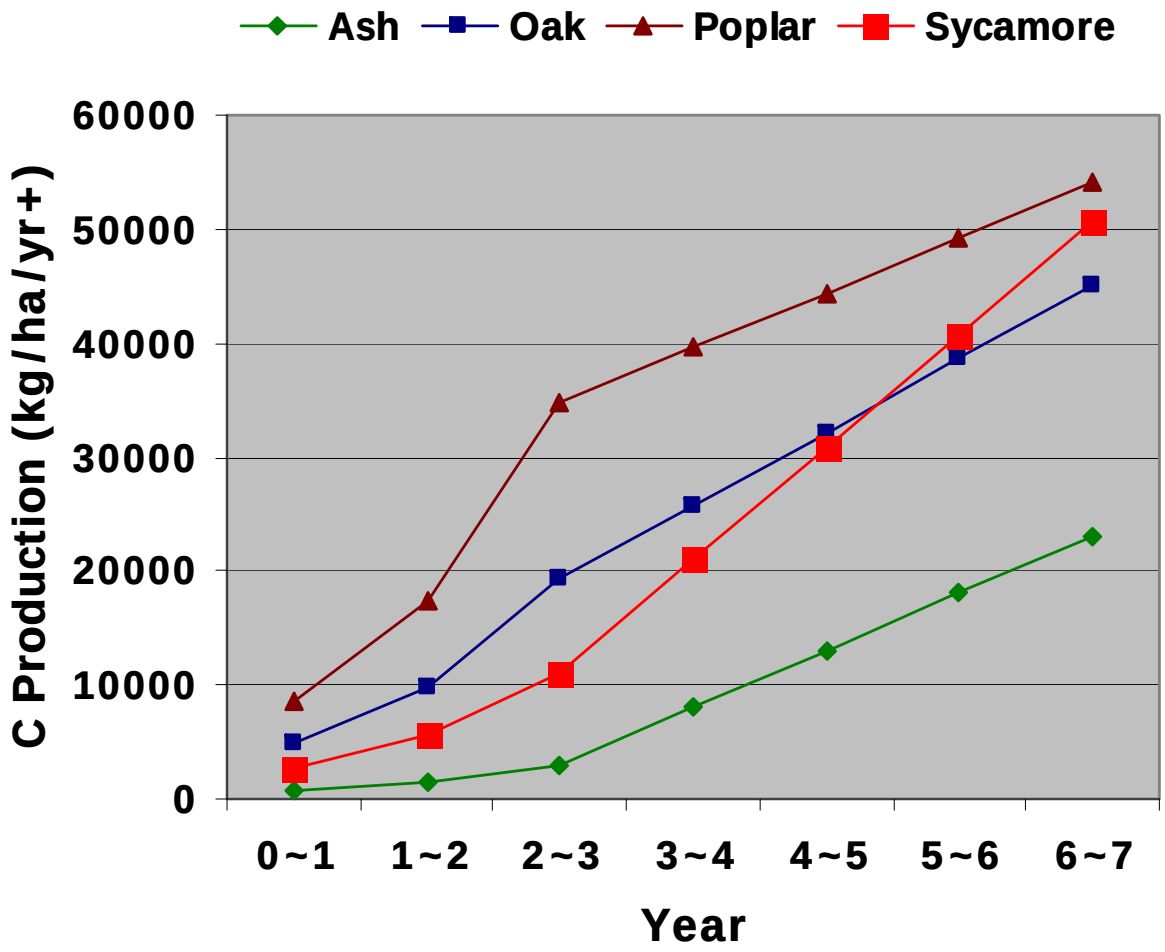
8-year- 600 cm

Q3: How Much Carbon is Sequestered?



- Biomass increase of > 12,000 kg/ha over 5 year period (year 3 to year 8)
- "New" C increase of ~ 19,000 kg/ha over same time period

Q3: Maximize Carbon Sequestration



Species Selection

9.1 – 3.83 Mg Total C ha^{-1} yr^{-1}

4.58 – 1.91 Mg "New" C ha^{-1} yr^{-1}

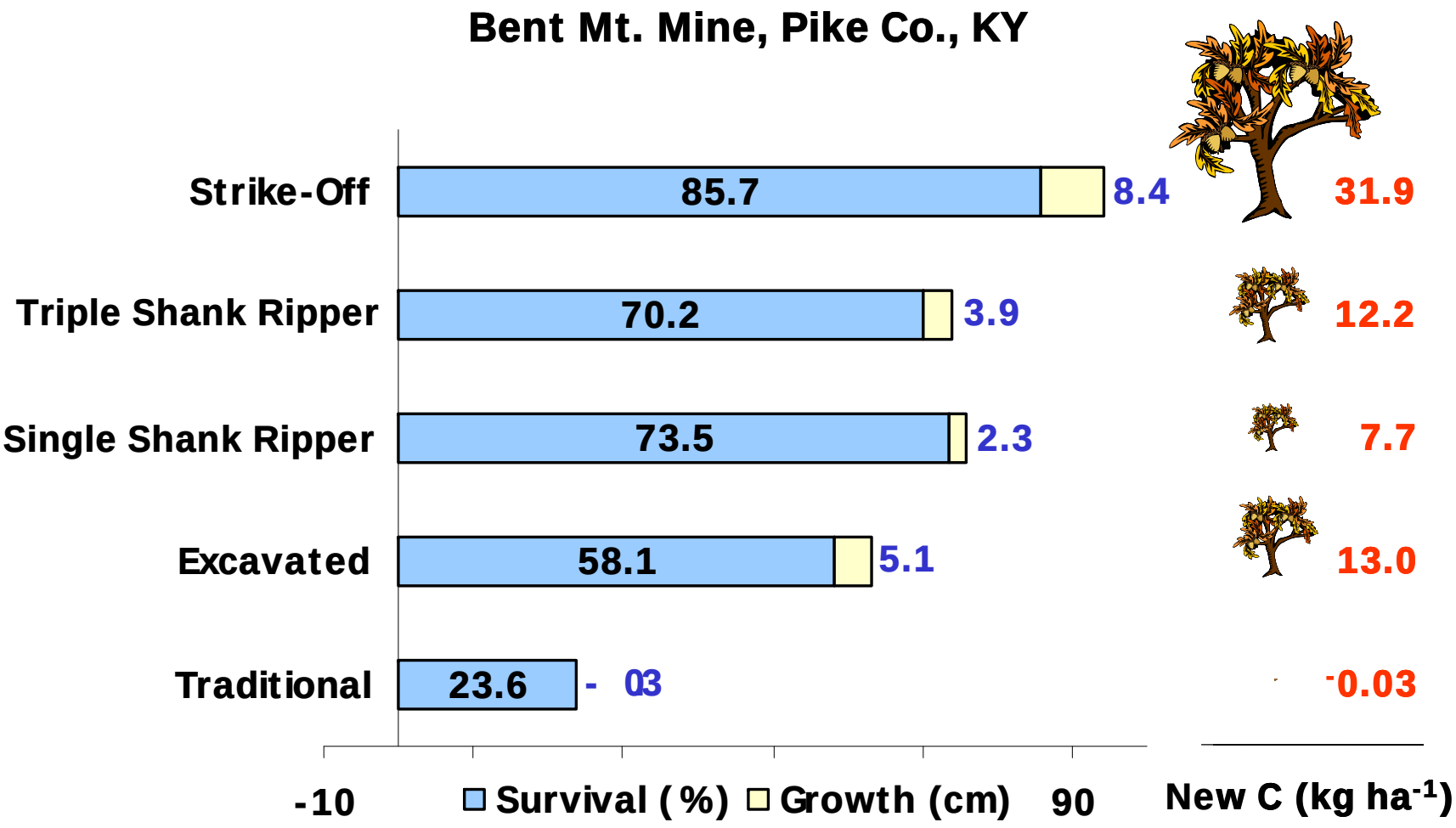
Chemical Limitations

4-YR Loblolly Pine

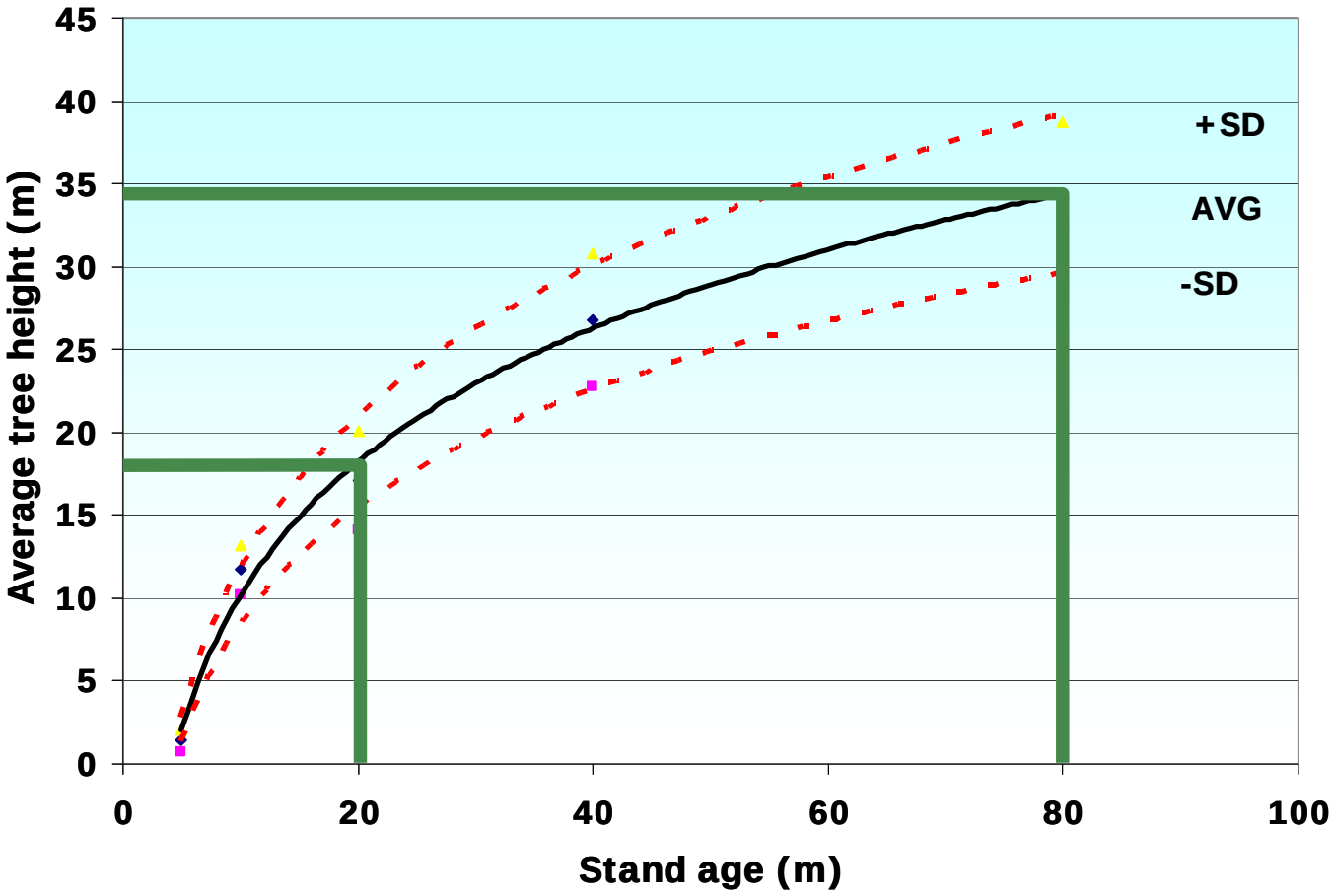
Ripped w/Amendments

Control

Physical Limitations



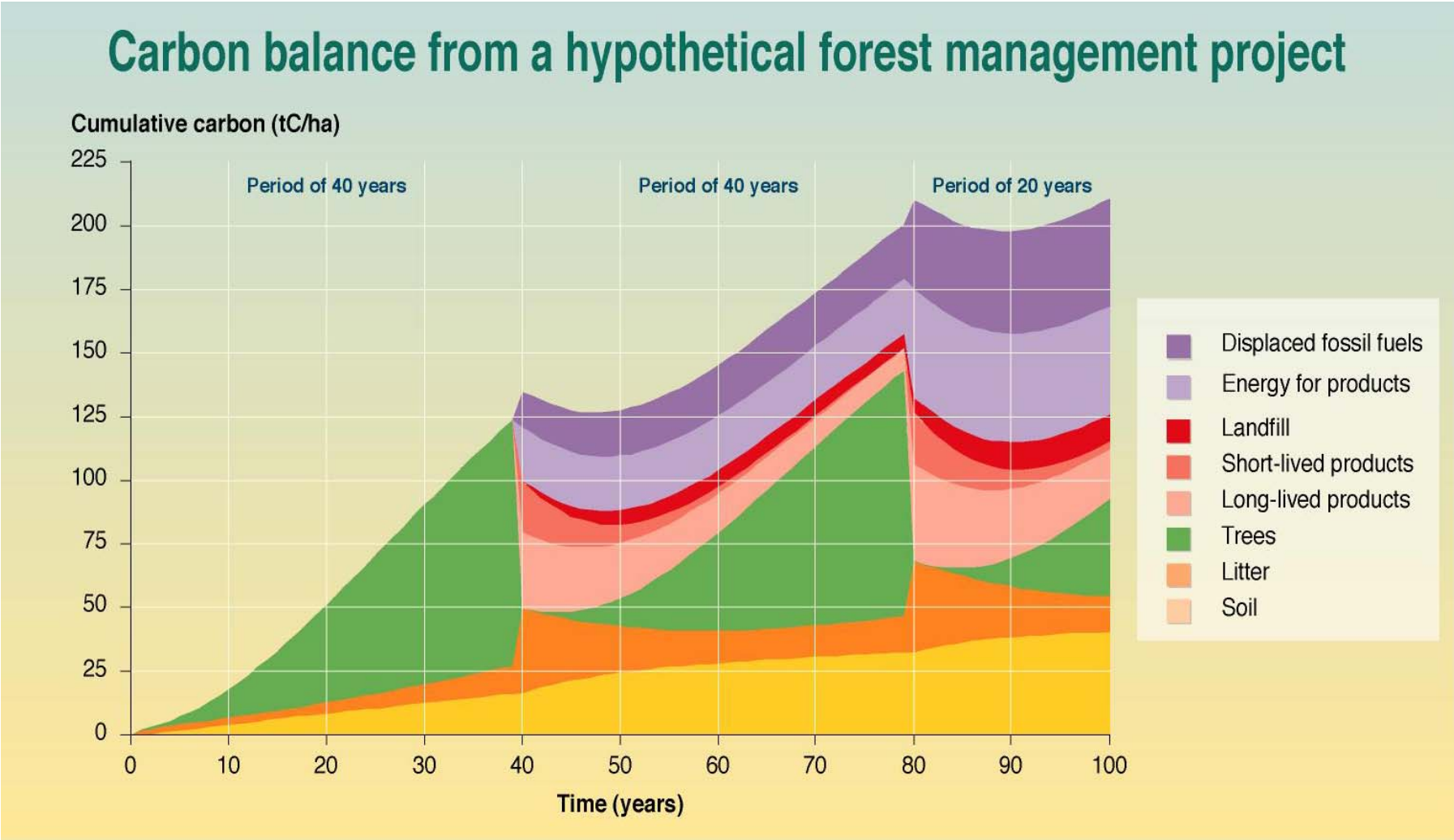
Consider Short Rotation Lengths



Yellow Poplar: 18-m height at 20 year, additional 16-m in following 60 years.

CO_2 Recycling

Manage for Carbon Sequestration



Source: IPCC

Incentive Programs
(market based)

CCX Chicago Climate Exchange

MACED Mountain Association for Community Economic Development

Dogwood Carbon™

Greening our Mines ($)

Conclusions

- Potential to sequester 100s million tonnes C per year (1.5 billion tonnes emitted by US in 2000)

- Appalachian spoils reclaimed per FRA can be deeper (less steep) than pre-mine soil with greater capacity for C storage

- Reclaimed forests sequester 20 – 30% more C than reclaimed grasslands

- Ancillary benefits…water, wildlife, economic

↑ Productivity = ↑ Carbon Sequestration