Indicators of Carbon Sequestration and Climate Change Impacts in Agricultural and Forest Ecosystems

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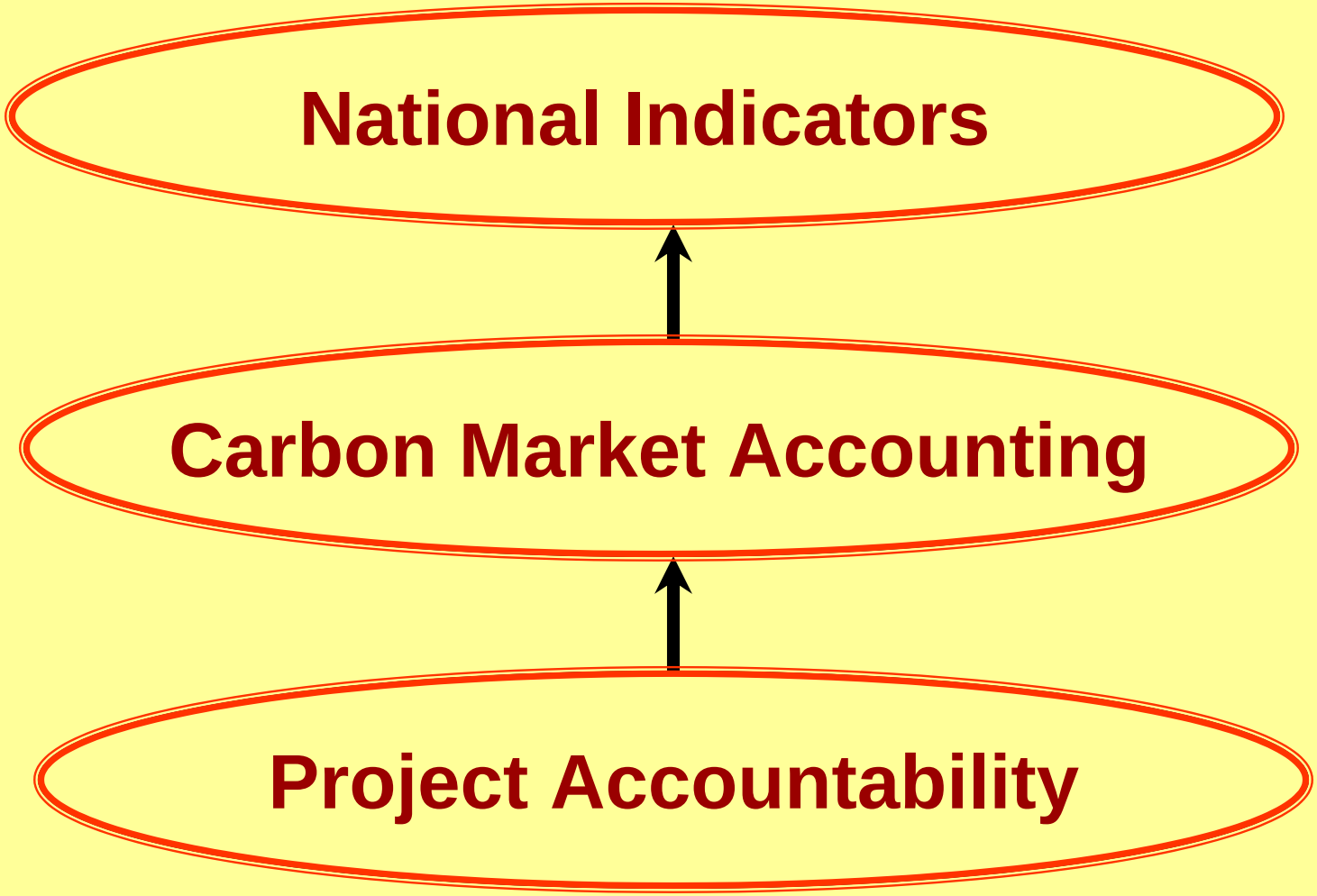
Why indicators?

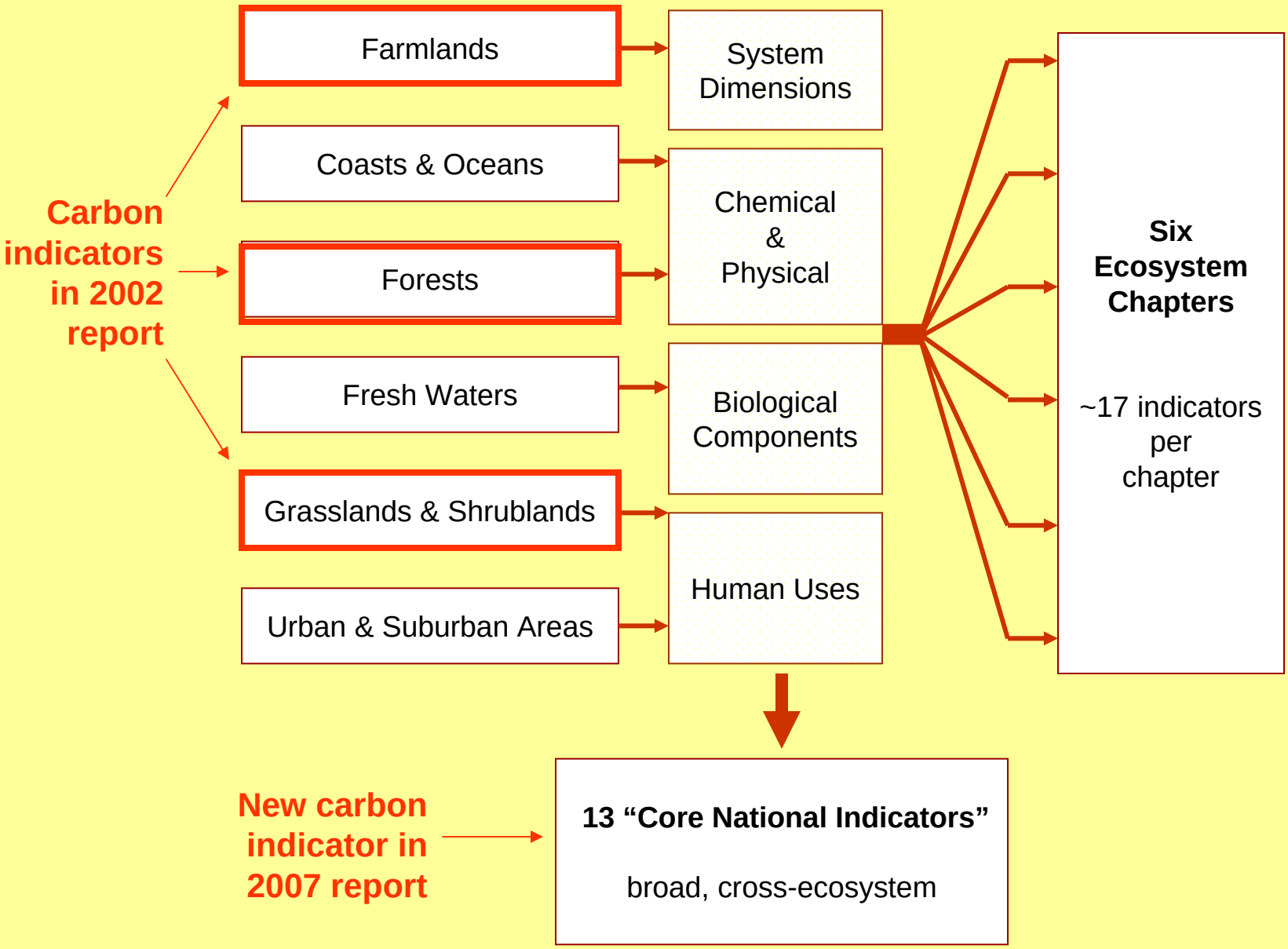


What makes a good indicator?

- Focused on ecosystem state and trends
  - Measure actual changes
  - Integrate multiple factors
- Balanced metric selection
  - Science, business, government
- Scientifically credible
  - Extensive peer review
  - Highlight data gaps
- Timely and responsive reporting

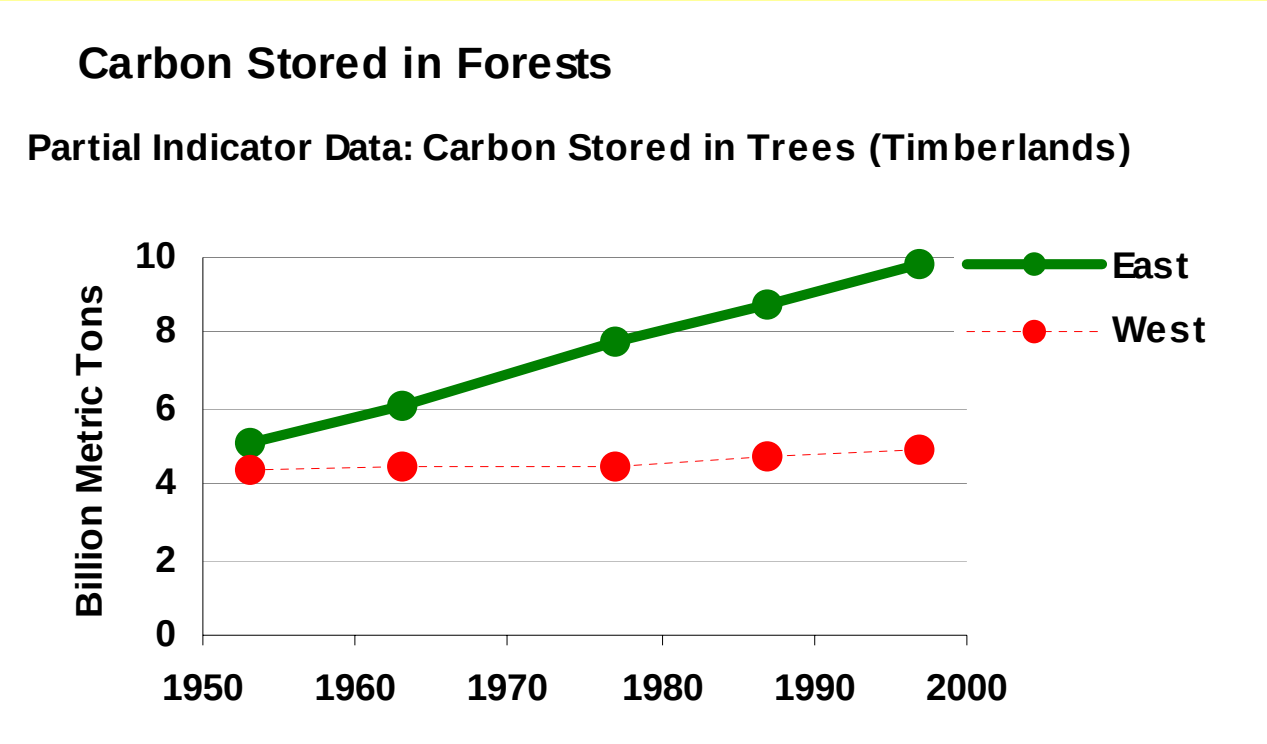
What makes a good system of indicators?

- Trends over time
- Limited number
- Spatially integrated
  - land cover type
  - geography
- Management and policy relevant
- Ecological conditions AND goods and services


Carbon indicators in 2002 report
Farmlands
Coasts & Oceans
Forests
Fresh Waters
Grasslands & Shrublands
Urban & Suburban Areas
System Dimensions
Chemical & Physical
Biological Components
Human Uses
Six Ecosystem Chapters
~17 indicators per chapter
New carbon indicator in 2007 report
13 "Core National Indicators"
broad, cross-ecosystem

Carbon storage indicators in 2002 Report

- Forests: Carbon stored in Trees, on timberlands only
- Grasslands/Shrublands: data gap
- Soil Organic Matter in Farmlands: data gap



Designing a national-scale carbon storage indicator

- Importance of measuring change over time as well as stocks
- Inclusion of areas sensitive to climate change
- Distinguish the effects of land cover conversion from the effects of management, climate and disturbance

Policy context for carbon storage in forests and farmlands

Responsive to shifts in practices and resulting changes in carbon storage:

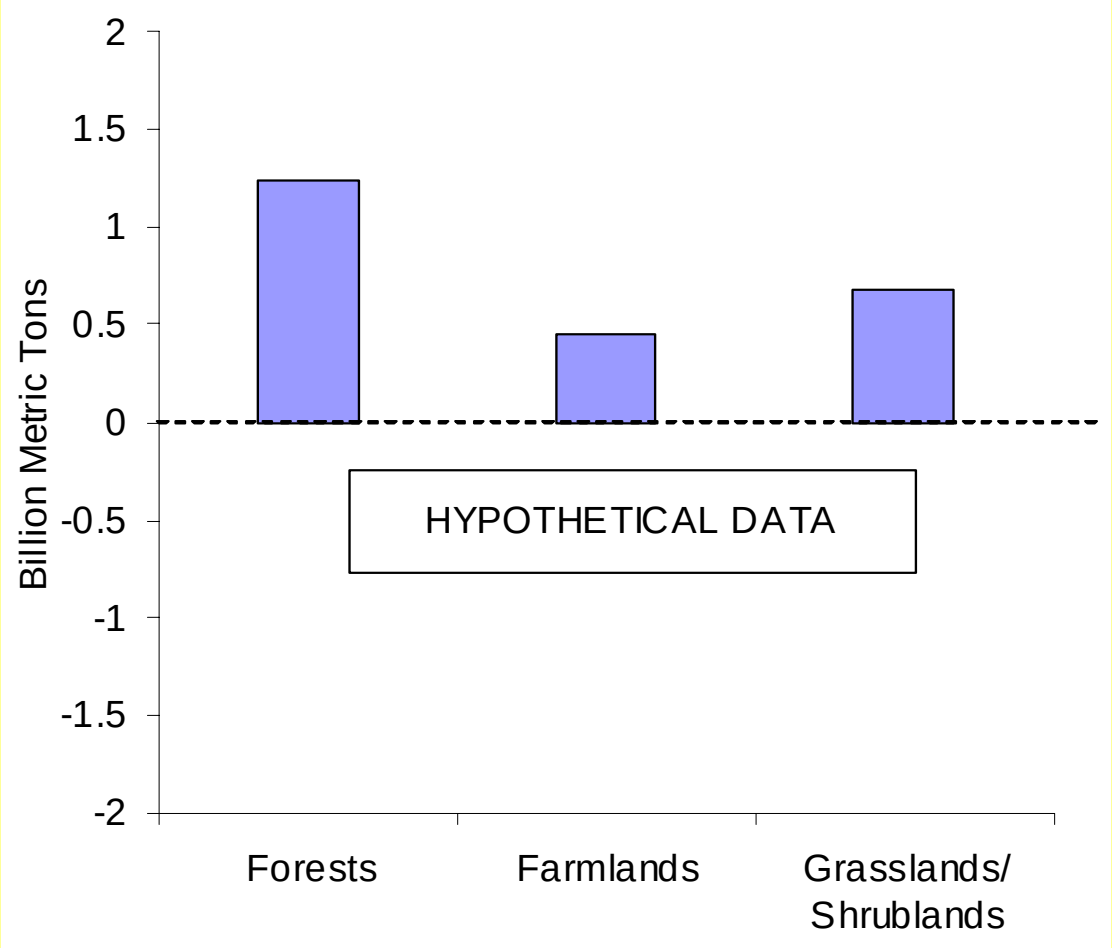
- 2007 Farm Bill
  - Increase in energy crops
  - Need for impact assessment
- Kyoto carbon cap and trade system
  - Likely U.S. carbon credit trading program
  - Need for reliable baseline

Carbon gained or lost by ecosystems, 1995-2005

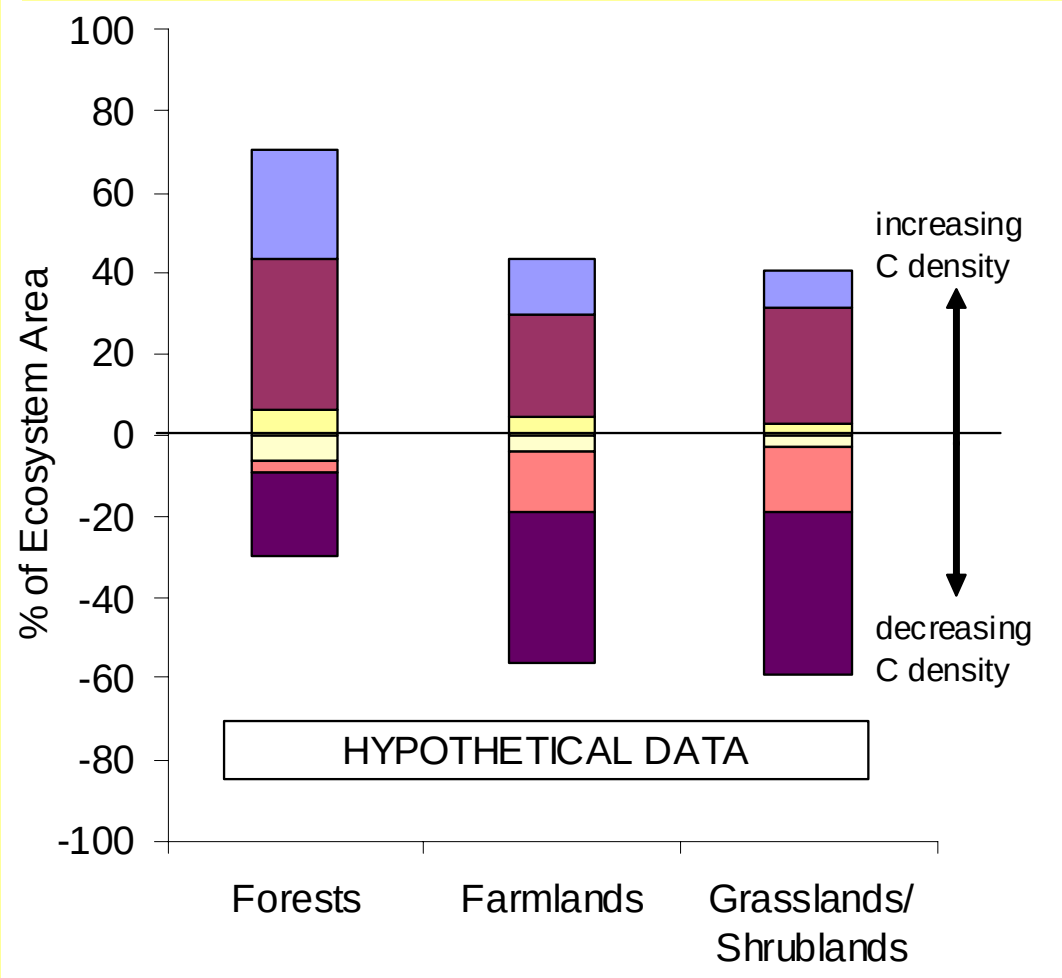
Reports *total annual change* in carbon, averaged over ten years.

More detail about carbon in pools (plants, litter, soil) are presented in each ecosystem's chapter indicator.

Currently analyzing data from USDA Forest Service and the Natural Resource Ecology Laboratory at CSU



Change in Carbon Density, 1995 to 2005

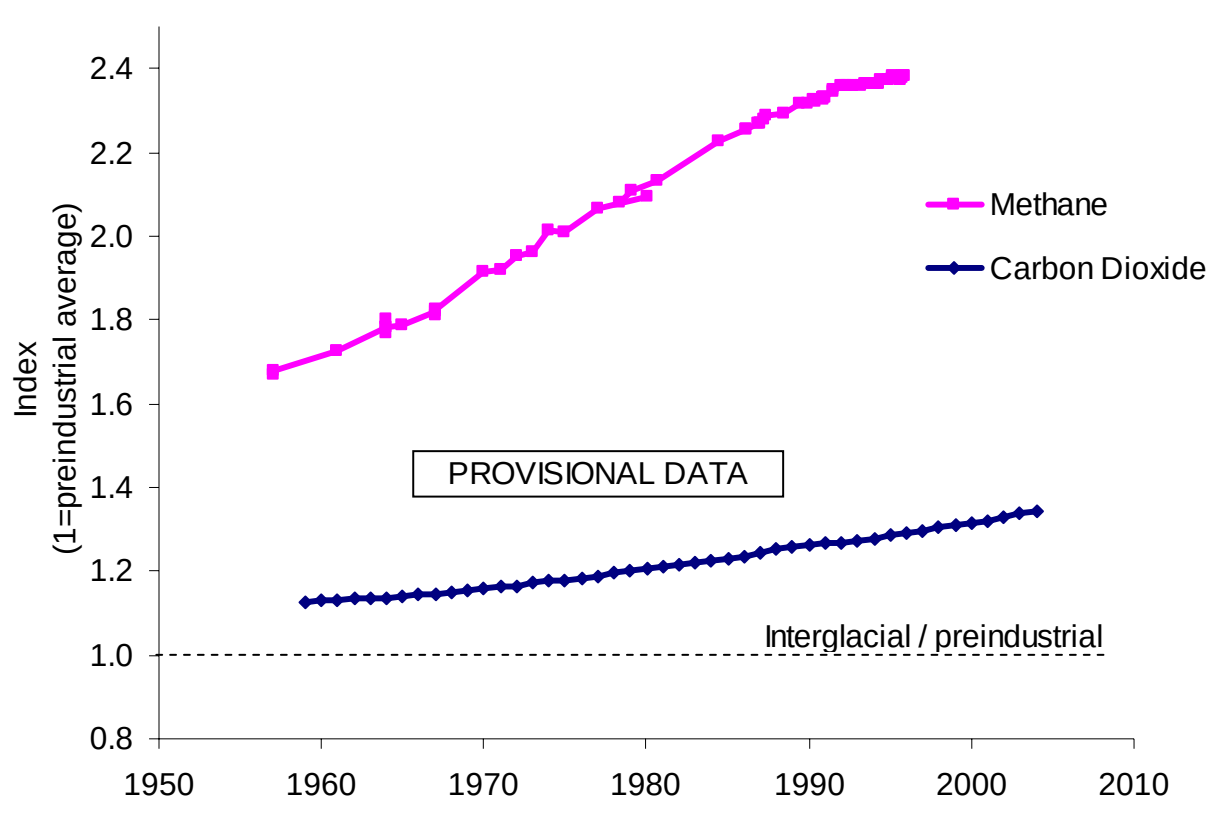


Metric tons C
per acre per year

- > +2.0
- +0.1 to +2.0
- No Change (-0.1 to 0.1)
- -0.1 to -2.0
- < -2.0
- -0.1 to 0

Reports *annual change per unit area* in carbon, averaged over ten years.

Change in Atmospheric Carbon Dioxide and Methane Concentrations



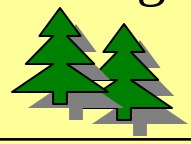
Global, not national, scale

Used index to compare current CO_2 and CH_4 concentrations (1950's-present) to pre-industrial/ interglacial concentrations

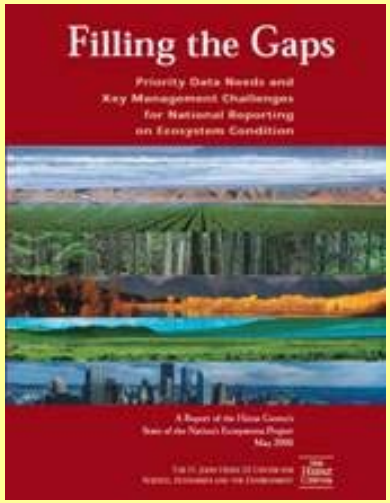
Summary: Carbon storage reporting in 2007

- New core national Carbon Storage
  - Reports change in density and stocks for farmlands, forests, and grasslands
- Forest Carbon Storage
  - New data on non-soil forest carbon
- Grassland/Shrubland Carbon Storage
  - Possibly new data, soils only
- Soil Organic Matter
  - Possibly new data

Other climate-related indicators

Ecosystem extent	Forest cover types increasing or decreasing in area since the 1960s 
Productive capacity	Plant growth index (photosynthesis); crop yields (corn, soybeans, etc.) 
Disturbance regimes	Large-scale changes in fire, insects, and disease patterns in forests 
Hydrology	Changes in stream high-flow, low-flow, variability in flow due to altered precipitation, temperature patterns 
Biotic condition, ecosystem services	Require further development of scientific and management consensus 

Report: Priority data needs



- Carbon storage/soil organic matter
- Non-native species
- At-risk species and communities
- Biological community condition

Data systems needed

- Monitoring
  - Ongoing
  - Appropriate sampling
- Evolving techniques
  - Remote sensing
  - Modeling
- Transparent reporting and independent review

Summary

- Project accountability → Carbon market accounting → National indicators
- Indicators: Policy-relevant, scientifically sound, and integrated
- Fill gaps in knowledge
  - Enhance monitoring programs and techniques
  - Transparency


Urban and Suburban Areas
Farmlands
Grasslands and Shrublands
www.heinzctr.org/ecosystems
Fresh Waters
Forests
Coasts and Oceans