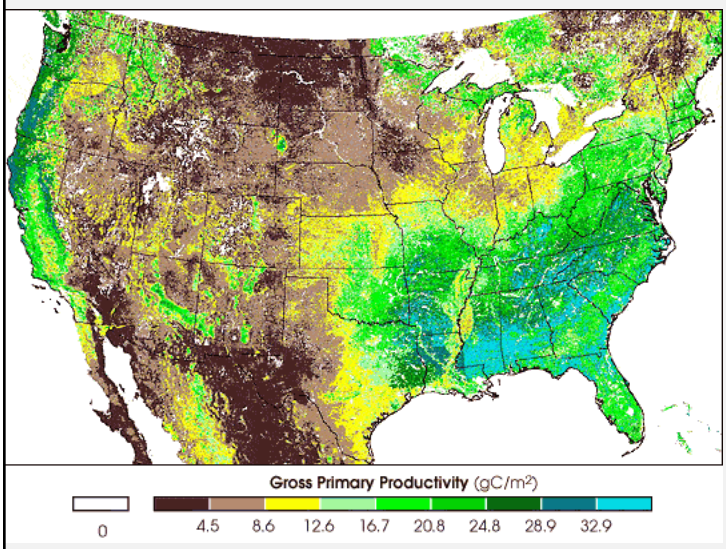
Terrestrial Primary Productivity



March 26–April 10, 2000.

Data from the Moderate-resolution Imaging Spectroradiometer (MODIS)

Total Global Storage of Carbon in Soils

- Highest mean soil organic matter in swamp areas = 68.6 kg C/m^2
- Highest total soil organic carbon in tropical forests = 255 mt C x 10^9
- Total Global C in soils estimated at 1456 x 10^{15} g C
  - Minor compared to that of anoxic marine sediments

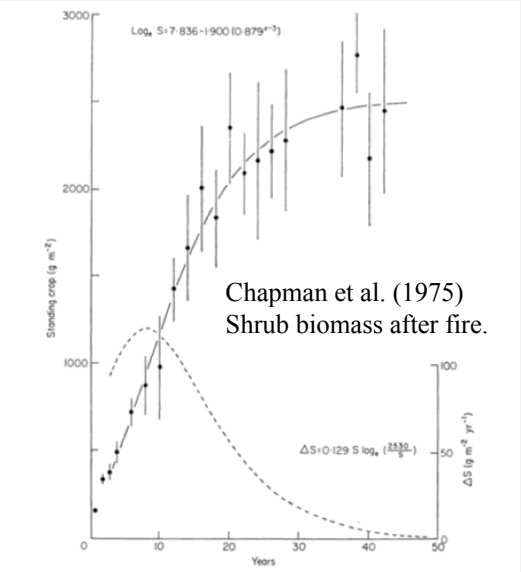
Carbon Loss from Soils Due to Human Activities

- Generally 20-30% soil organic matter is lost after the first ~20 years of cultivation
  - Oxidation
  - Erosion
- Large losses of soil organic matter when wetlands and peatlands are drained

Carbon Storage and cycling

- Biota
  - living biomass
- Detritus
  - litterfall
  - root turnover
- Soil
  - resistant organic matter
  - carbonate
- GLOBAL TOTAL: ~2000 x 10^{15} g C

Accumulation of carbon



Chapman et al. (1975)
Shrub biomass after fire.

FIG. 2. Standing crop (continuous line) and rate of increment (pecked line) of the total above ground vegetation in relation to the age of the heathland since the last fire (with 95% confidence limits).

Carbon can be lost quickly when an ecosystem is disturbed.

Accumulation may be non-linear (as in post-fire shrubland)

Durability of stored carbon may also change.

Carbon storage vs. time

Succession from barren land → brush → forest: net storage of NPP

Mature ecosystem reaches steady state

Net Ecosystem Productivity (NEP)

= NPP – (Rh + Rd) = GPP – (Rh + Rd + Rp)

Rh (herbivore respiration) typically < 20% NPP

Rp (plant respiration) ≈ NPP

Therefore *Rd* (decay) ≈ 70-80% NPP in steady-state ecosystem

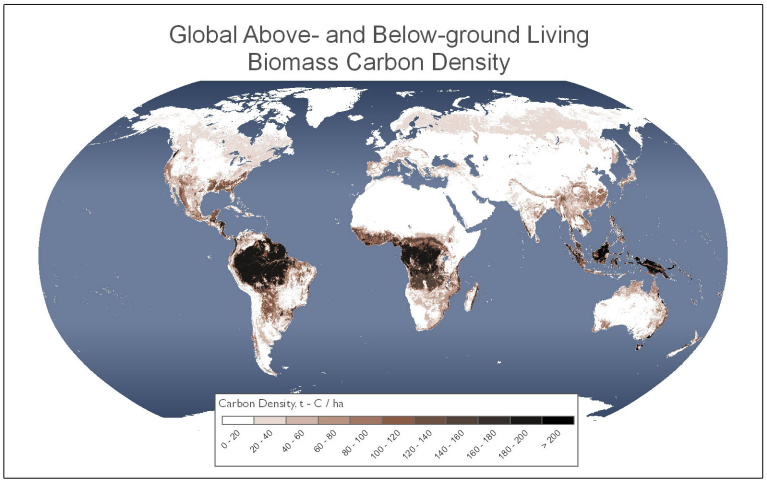
Reset by wildfire/harvest.

Long-term NPP storage possible only if *Rd* inhibited

Medium-term storage in wood (forest), humus (O-horizon in soil)

Decomposition radically slowed below 15cm, by low T, low H_2O, or low O_2 + SO_4^{2-}

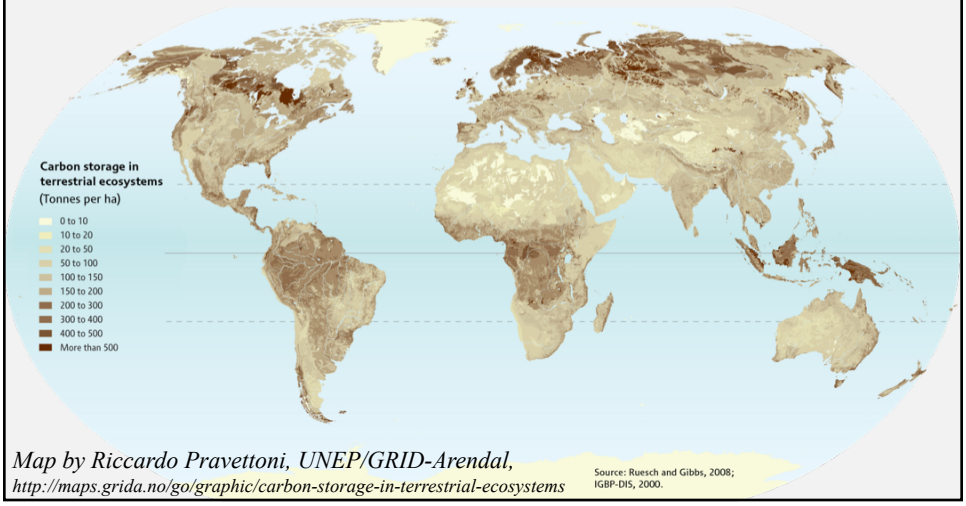
Living & "dead" carbon



IPCC Tier-1 Global Biomass Carbon Map for the Year 2000
http://cdiac.ornl.gov/epubs/ndp/global_carbon/FINAL_DATASETS.jpg

Total Global Storage of Carbon in Soils

- Highest mean soil organic matter in swamp/peat areas = 68.6 kg C/m^2 (686 t./ha)
- Highest total soil organic carbon in tropical forests = 255 mt C x 10^9
- Total Global C in soils estimated at ~1500 x 10^{15} g C
  - ~twice living terrestrial biomass (~600-800 x 10^{15} g C).



Map by Riccardo Pravettoni, UNEP/GRID-Arendal,
http://maps.grida.no/go/graphic/carbon-storage-in-terrestrial-ecosystems

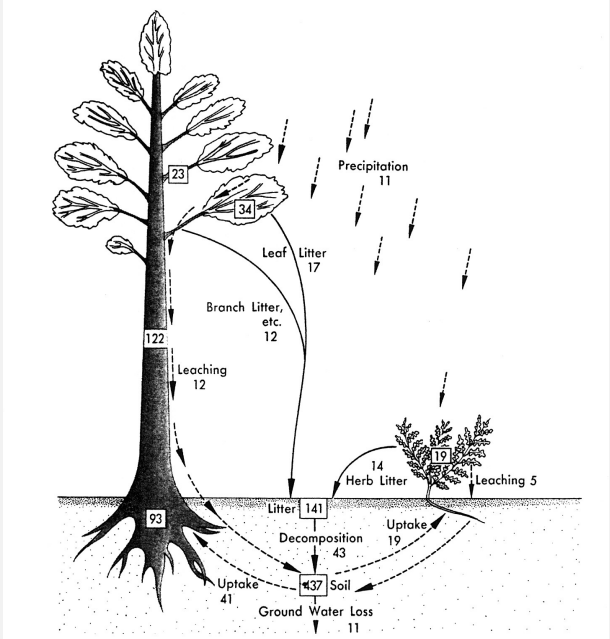


Figure 6.6 The intrasystem cycle for Ca in a forest ecosystem in Great Britain. Pools are shown in kg/ha and annual flux in kg ha^{-1} yr^{-1}. From Whittaker (1970).

Monitoring carbon budgets

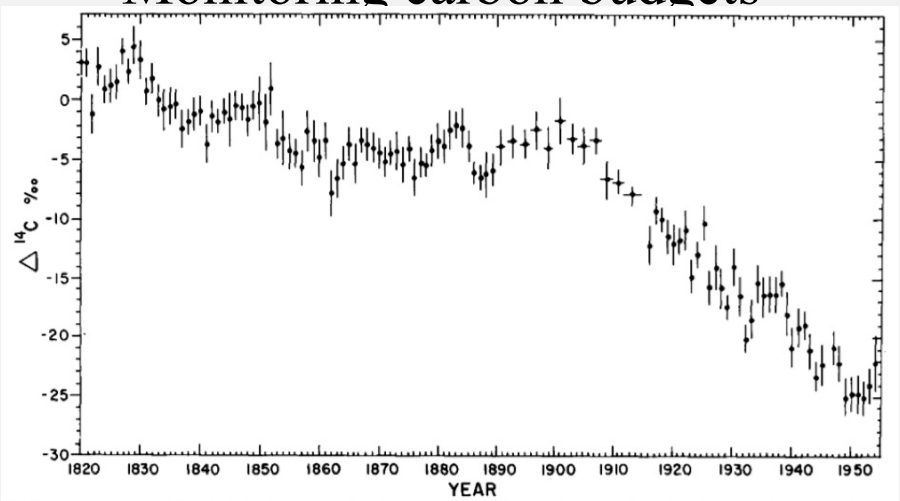


Fig. 2. Atmospheric $\Delta^{14}C$ levels, derived from tree rings, between 1820 and 1954. Single-year determinations are given, except for the 1890–1915 interval (Table 1). The vertical bar denotes one standard deviation. $\Delta^{14}C$ levels of the 1895–1915 interval probably give an upper limit only (see text).

Suess effect on $^{14}C/^{12}C$ in CO_2,
from Stuiver and Quay, 1981, EPSL 53:349-362

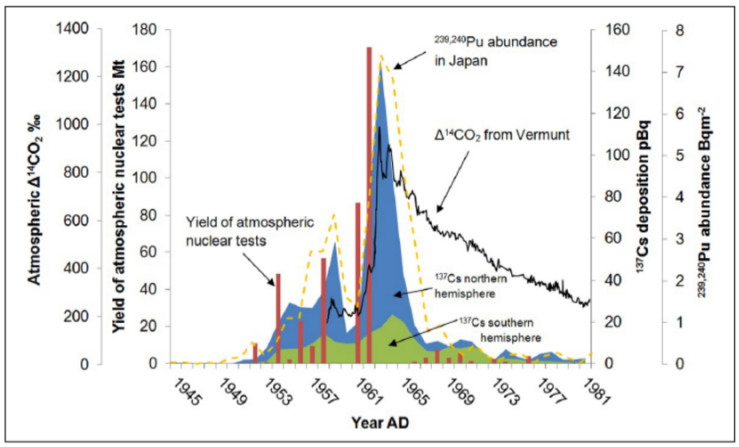


Figure 6. Yield of atmospheric nuclear tests per year shown by bars (UNSCEAR, 2000), ^{137}Cs deposition in Northern and Southern Hemispheres represented by areas (UNSCEAR, 2000), $^{239,240}Pu$ deposition in Japan shown by the dashed line (Hirose et al., 2000) and $\Delta^{14}CO_2$ measured at Vermunt, Austria shown by the solid line (Levin et al., 1985). The yield of atmospheric nuclear tests in the atmosphere peaked in 1962. $\Delta^{14}CO_2$ at Vermunt, $^{239,240}Pu$ in Japan and ^{137}Cs deposition in the Northern Hemisphere peaked in 1963 and ^{137}Cs in the Southern Hemisphere in 1964.