A discussion about accounting for allochthonous sedimentary organic carbon

DISCUSSION OUTLINE:

- Define topic
- Define goal
- Sediment production and transport in the global carbon cycle
- Possible approaches

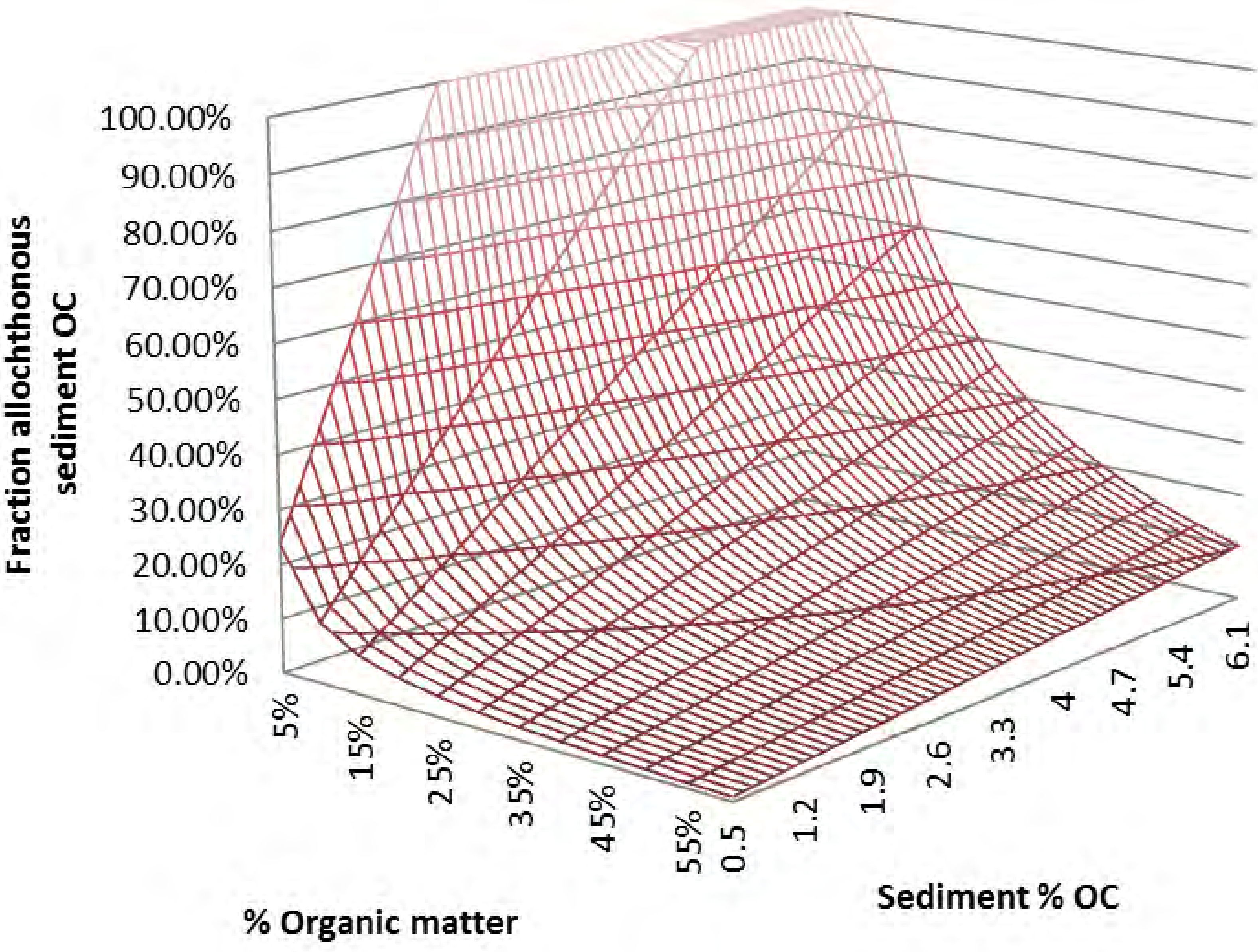
CARBON ACCOUNTING

What is the proper way to account for carbon associated with sediment used for restoration and sediment accreted during wetland growth?

$$C_{seq} = C_{wet} - C_{sed}$$

$$C_{seq} = f_{wet}C_{seq} - f_{sed}C_{seq}$$

Detrital OM and DOC import and export excluded



100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Fraction allochthonous sediment OC
5%
15%
25%
35%
45%
55%
% Organic matter
0.5
1.2
1.9
2.6
3.3
4
4.7
5.4
6.1
Sediment % OC

NEED TO COME UP WITH APPROACH

- Consensus approach
- Documented
  - Not left to project or verifier
- Scientifically defensible
- Conservative
- Cookbook and inexpensive to implement

GOAL

Reduce all the disagreements and intricacies of the several applicable scientific fields to simple, inexpensive measurements that yield conservative estimates of the net result of many complex processes about which we actually know very little.

A NOTE ON METHODS FOR DETERMINATION OF CARBON CONTENT

Loss on ignition vs. combustion GC

LOI can provide OC values much higher than actual in sediments because waters of hydration are lost. This may lead to an over estimate of the amount of carbon.

Agricultural soil erosion and global carbon cycle: controversy over?

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Global Change Biology

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Carbon cycling in eroding landscapes: geomorphic controls on soil organic C pool composition and C stabilization

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The impact of agricultural soil erosion on biogeochemical cycling

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The Impact of Agricultural Soil Erosion on the Global Carbon Cycle

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Environment International 29 (2003) 437–450

Soil erosion and the global carbon budget

R. Lal*

Changed the type, size, timing and organic carbon of sediment delivery to aquatic ecosystems

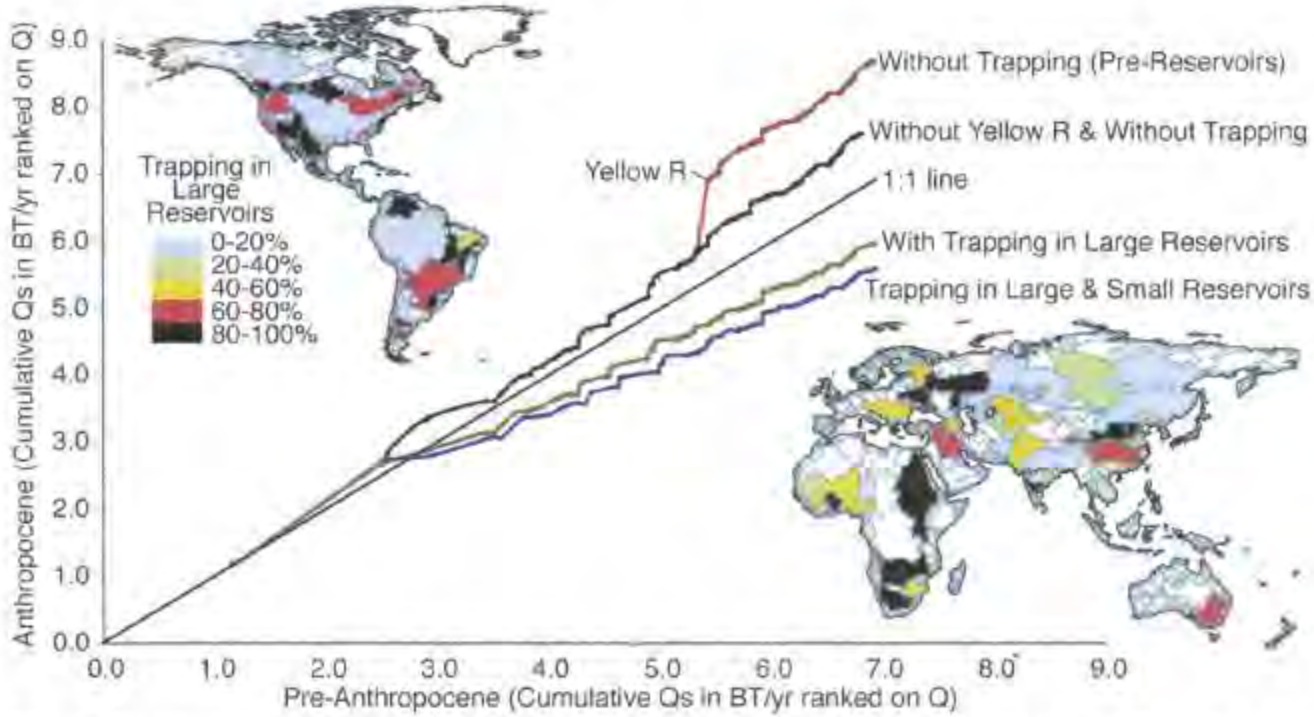
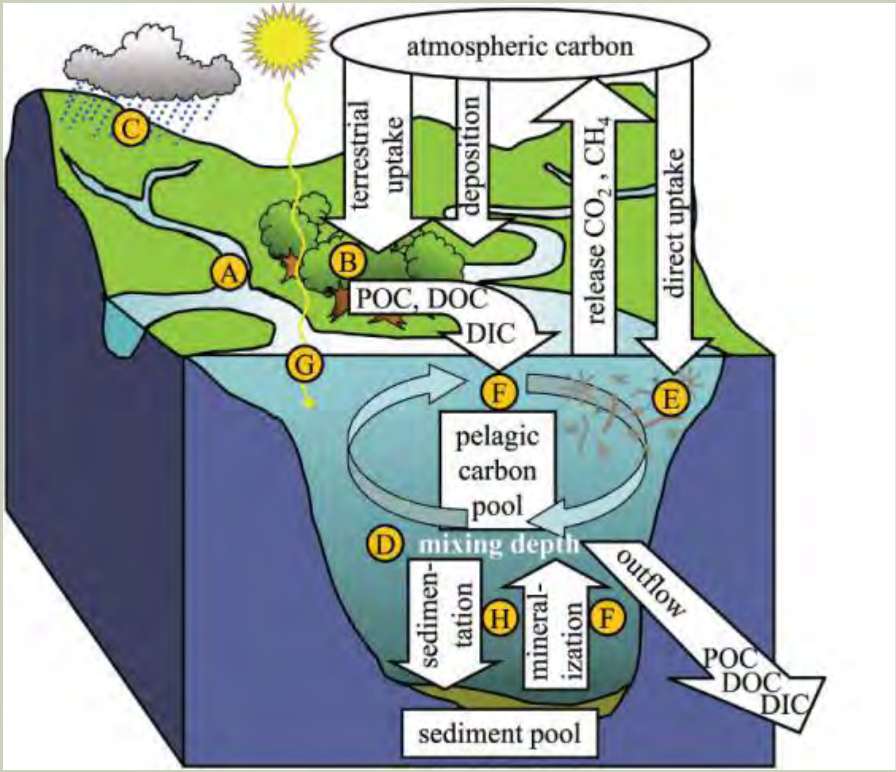
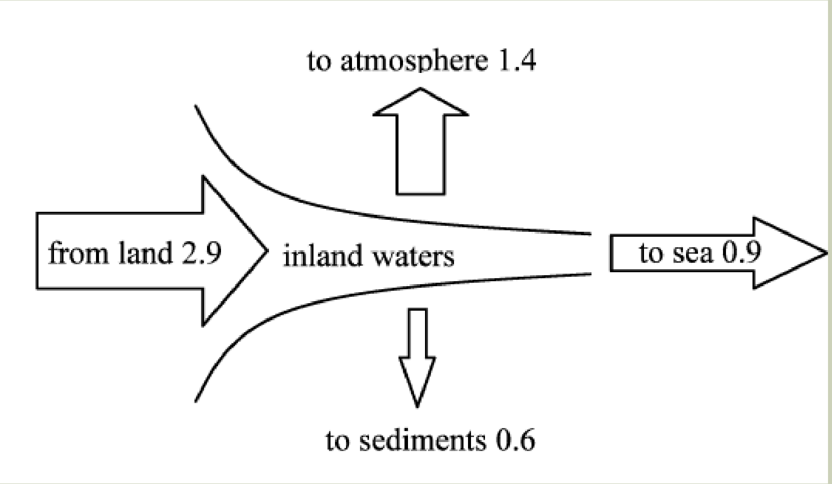


Fig. 2. Comparison between pre-Anthropocene (Fig. 1) and modern sediment loads, using 217 global rivers with good observational before- and after-dam data. Data are presented as cumulative curves ranked by decreasing river discharge (e.g., the first value to the left is the Amazon). 1:1 line represents no influence by humans. Two curves (with and without the Yellow River) had trapping by reservoirs removed and represent the increased sediment yield caused by human activity (e.g., deforestation). Two other curves show the impact of sediment sequestering in large or small reservoirs. Inserts include the global geography of basinwide trapping of sediment by large reservoirs (*22*).

Syvitski, J. P. M., C. J. Vörösmarty, A. J. Kettner, and P. Green. 2005.
Impact of humans on the flux of terrestrial sediment to the global coastal ocean.
Science **308**:376-380.

Much sediment is trapped in the terrestrial system





Tranvik, L. J., et al.. 2009. Lakes and reservoirs as regulators of carbon cycling and climate. Limnology and Oceanography **54**:2298-2314

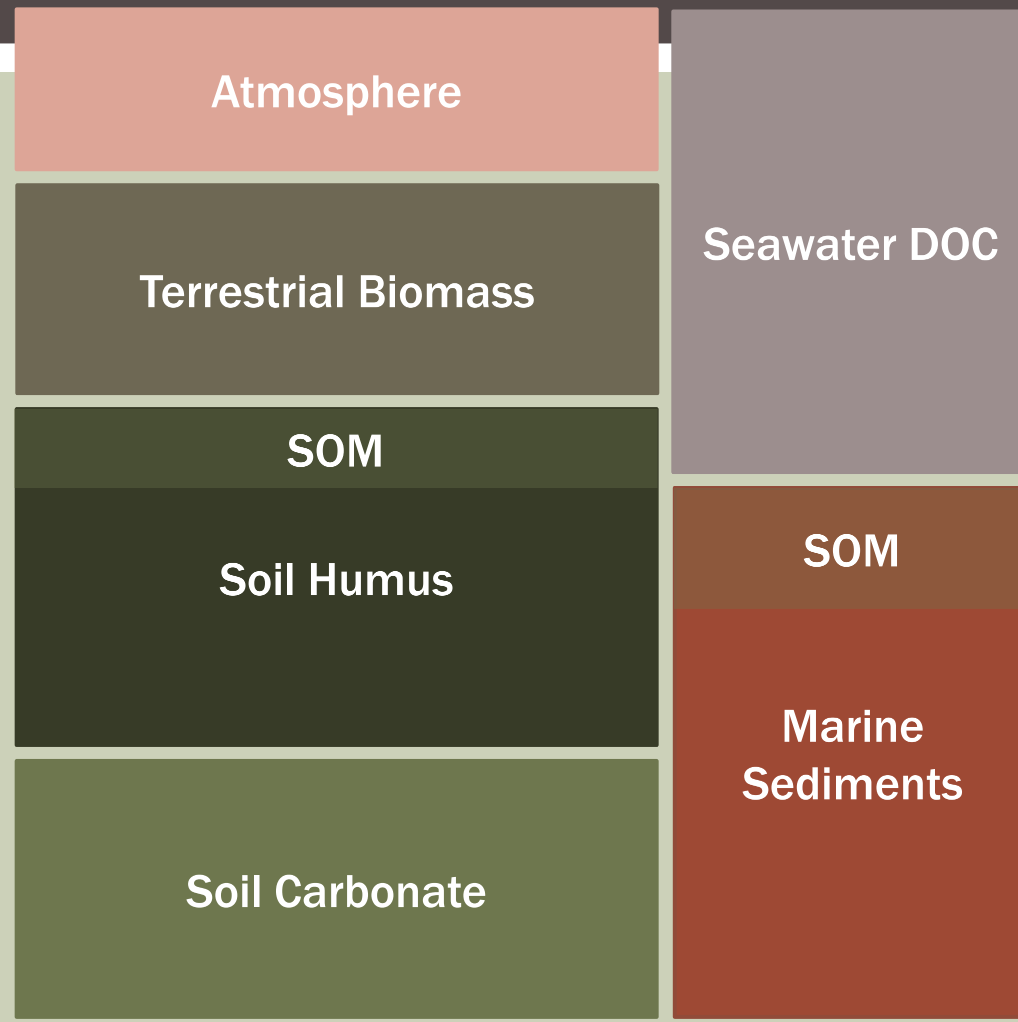
Important transformations take place:
(1) Remineralization (2) Equilibration (3) Replacement with autochthonous and locally-derived organic matter.

RIVER SEDIMENT C FACTOIDS

- Half or more of river sediment is derived from mass wasting, not soil, and thus originates with extremely low C loading.
- ~ Half of OM associated with suspended river sediments is autochthonous in origin
- Suspended sediments are typically much higher in OM content than bed sediments
- Sediment C content is highly altered in estuaries and coastal systems

SEDIMENTS IN GLOBAL C CYCLE

Active Carbon Pools



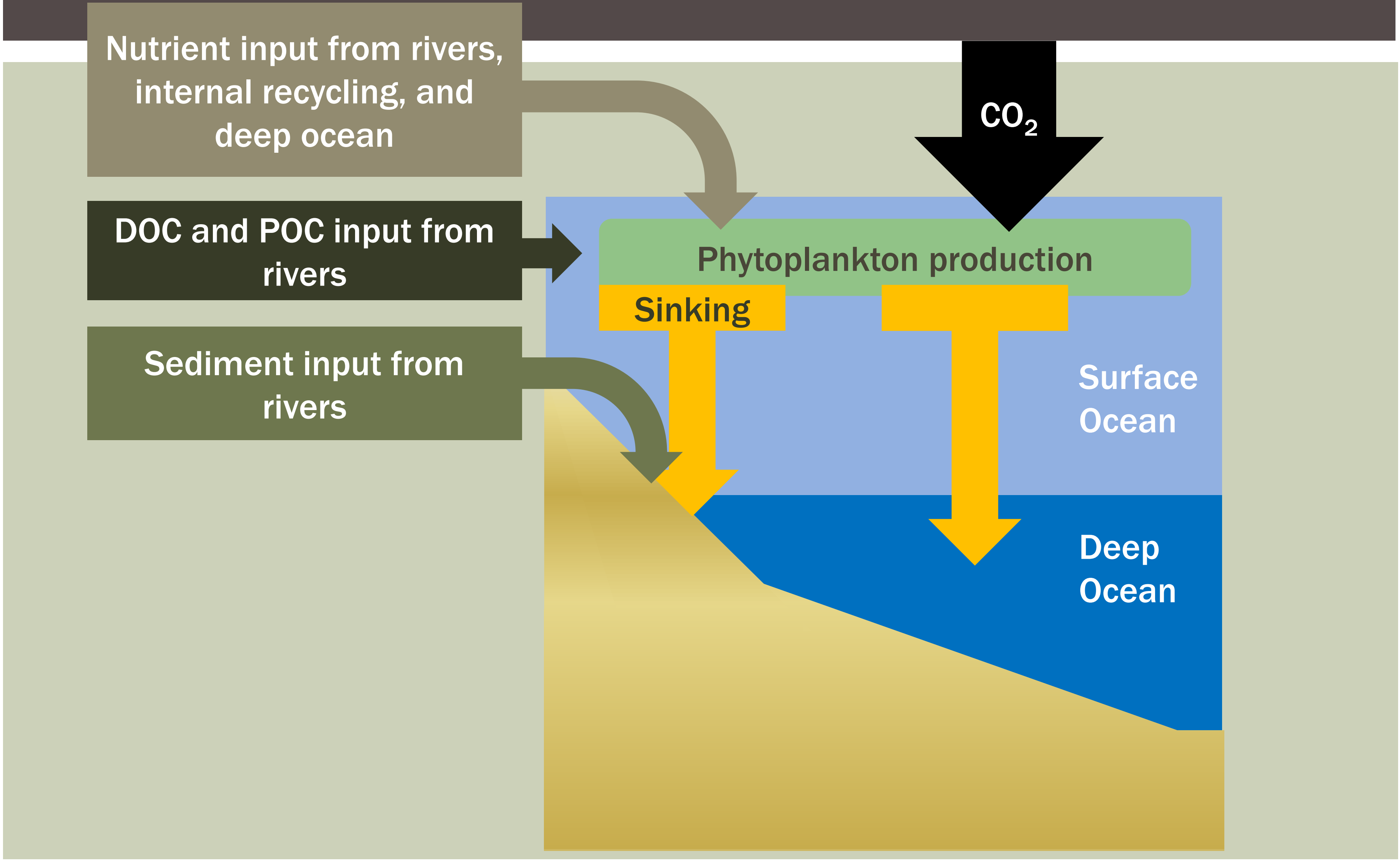
After Hedges (1994) Global Biogeochemical cycles: progress and problems

SEDIMENTS IN GLOBAL C CYCLE

Active Carbon Pools

After Hedges (1994) Global Biogeochemical cycles: progress and problems

SIMPLIFIED VIEW OF COASTAL C PROCESSES



WHERE THE SEDIMENT LANDS MATTERS

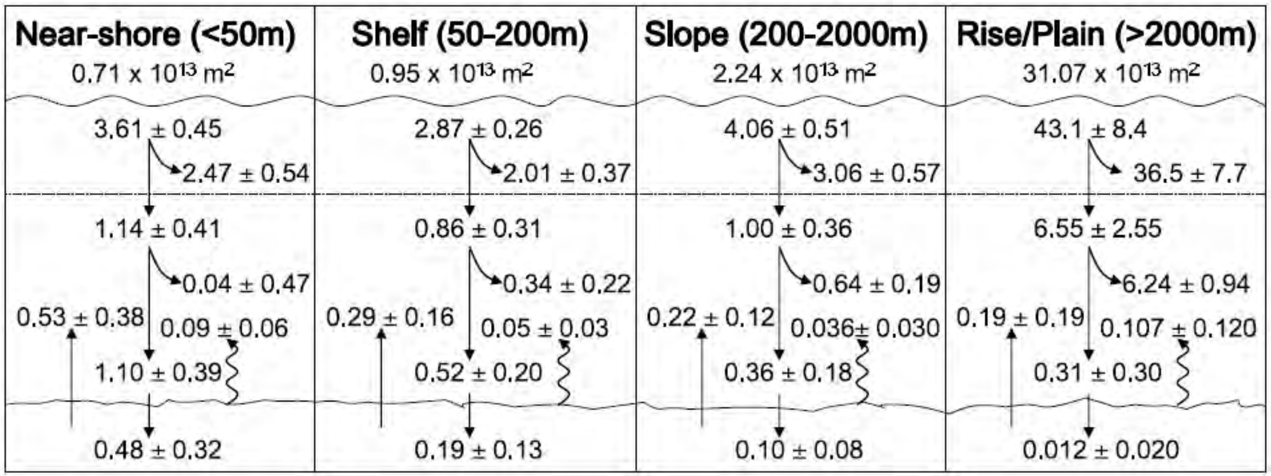


Figure 7. Synthesis of organic carbon fluxes broken down by depth regimes. Down arrows are organic carbon fluxes (Pg a^{-1}). Curved arrows and straight up arrows are remineralization fluxes. Squiggly up arrows are dissolved organic carbon fluxes.

A synthesis of global particle export from the surface ocean and cycling through the ocean interior and on the seafloor

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BIOGEOCHEMICAL CYCLES, VOL. 21, GB4006, doi:10.1029/2006GB002907, 2007

Past and present of sediment and carbon biogeochemical cycling models

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SEDIMENT PRESERVATION IS RELATED TO SURFACE AREA

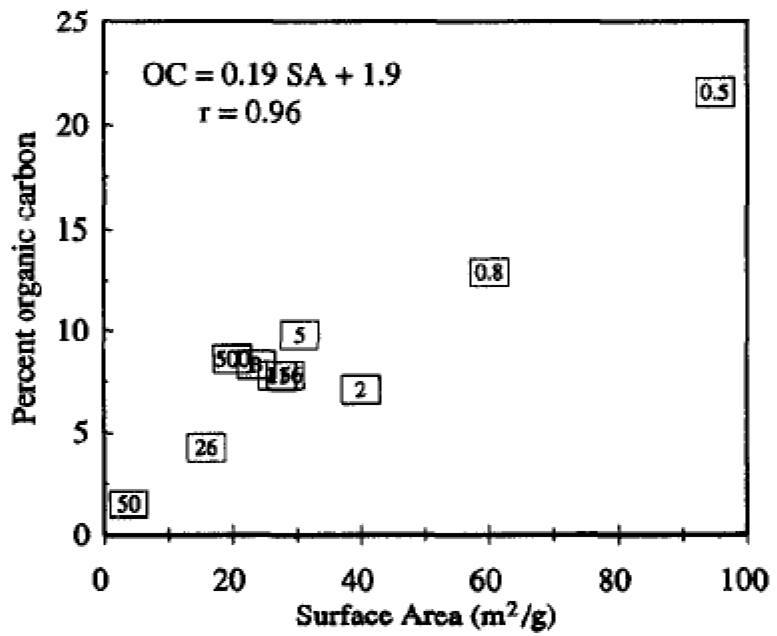


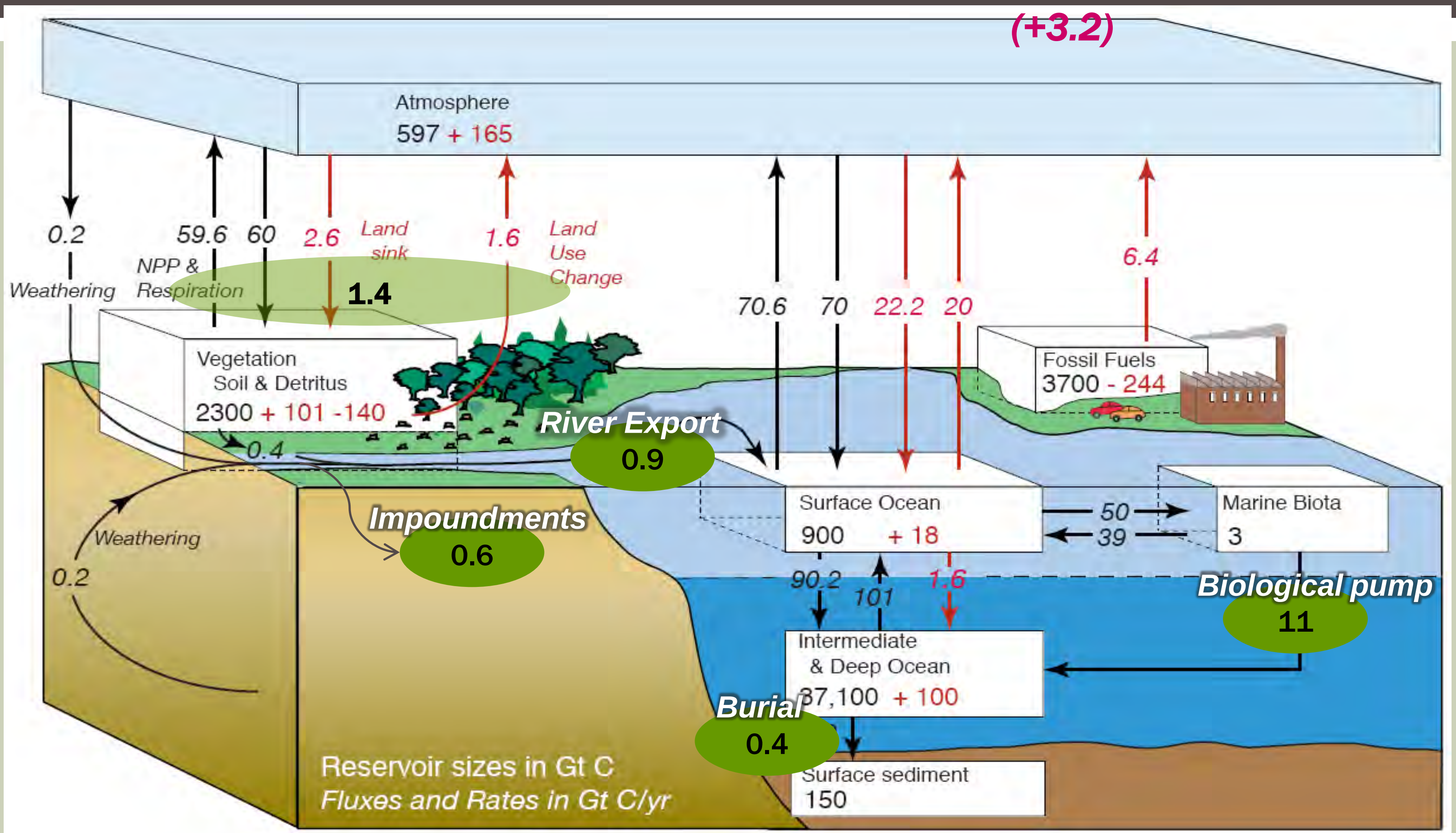
Fig. 7. Plot of weight percent organic C against specific surface area (m^2/g) for all grain size fractions. Data labels are as in Fig. 4.

Bergamaschi, B. A., E. Tsamakis, R. G. Keil, T. I. Eglinton, D. B. Montlucon, and J. I. Hedges. 1997. The effect of grain size and surface area on organic matter, lignin and carbohydrate concentration, and molecular compositions in Peru Margin sediments. Geochimica et Cosmochimica Acta **61**:1247-1260.

COASTAL C ACCUMULATION FACTOIDS

- 85% of marine organic carbon accumulation is in coastal oceans
- 85-95% of organic carbon buried in marine sediments is autochchonous – NOT terrestrial
- Two thirds of coastal carbon burial is in deltaic sedimentsHigh sedimentation rates contribute to elevated C burial
- There is high C burial at western continental margins – because of high sediment flux
- Hypoxia contributes to higher C burial
- Interactions and anthropogenic effects are largely unknown

SEDIMENTS IN PERSPECTIVE



(IPCC-4, 2007)

POSSIBLE APPROACHES

- Negligible
- Assume amount diverted doesn’t deplete existing C inventory
- Assume all degrades and is replaced with C_{wet}
- Assign value of the sediment source
- Assign value of offshore sediment/accumulation
- Use surface area of sediments (mg/m^2)
- Assume amount diverted does not appreciably alter C processes