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Revolutions in energy input and material cycling in Earth history and human history

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Table S1. Data and sources for Figure 1: energy capture in the biosphere and society (EJ yr^{-1})

Revolution	Start date	Date for energy estimate	Marine	Terrestrial	Biosphere total	Biomass	Fossil	Anthropo-sphere total
Anoxygenic photosynthesis (R1)	3.7 Ga	3 Ga	80 [a]	1 [b]	81	0	0	0
Oxygenic photosynthesis (R2)	2.7 Ga	1.5 Ga	1260 [c]	60 [d]	1320	0	0	0
Land plants (R3)	470 Ma	350 Ma	1800 [e]	2500 [f]	4300	0	0	0
Paleolithic fire use (R4)	1500-790 Ka	10,000 BC	1800	2000	3800	0.2	0	0.2 [j]
Neolithic revolution (R5)	10000 BP	1850 CE	1800	2000 [g]	3800	60	0	60 [k]
Industrial revolution (R6)	1850 CE	2000 CE	1800 [h]	2100 [i]	3900	222	396	618 [l]

Notes:

All carbon to energy conversions assume 37 MJ kgC^{-1}.

[a] Estimate for Fe-recycling biosphere based on corresponding carbon flux of 1.7 x10^{14} molC yr^{-1} (1).

[b] Maximum productivity considering that terrestrial anoxygenic photosynthesis would be competing with marine anoxygenic photosynthesis for gaseous electron donors such as H_2.

[c] COPSE model (2) gives ~0.7 of present [PO_4] and marine productivity during Proterozoic.

[d] From estimate for the net primary productivity of cyanobacterial desert crust today 11.7 gC m^{-2} yr^{-1} (3) multiplied by global land area, giving ~1.5 PgC yr^{-1}.

[e] COPSE model (4) gives 0.7-1.4 of present [PO_4] and marine productivity over Phanerozoic time so opting for present value as best estimate.

[f] COPSE model (4) gives 1-1.4 of present terrestrial NPP since establishment of vascular plants 350 Ma so taking 1.2 of present as best estimate.

[g] Based on subtracting current terrestrial net carbon sink of ~2.7 PgC yr^{-1} from 2000AD estimate.

[h] From satellite-based global marine NPP estimate of 48.5 PgC yr^{-1} (5) which is very close to mean of global models of 50.7 PgC yr^{-1} (6).

[i] From satellite-based global terrestrial NPP estimate of 56.4 PgC yr^{-1} (5), which is fairly central in the range from models of 44.4-66.3 PgC yr^{-1} (7).

[j] Based on (8)

[k] Own calculation based on (8, 9) and Clio Infra (2015) (data retrieved March 1, 2015, clio-infra.eu)

[l] Based on (10)

References:

1. Canfield DE, Rosing MT, & Bjerrum C (2006) Early anaerobic metabolisms. *Philosophical Transactions of the Royal Society B: Biological Sciences* 361(1474):1819-1836.
2. Mills B, Lenton TM, & Watson AJ (2014) Proterozoic oxygen rise linked to shifting balance between seafloor and terrestrial weathering. *PNAS* 111(25):9073-9078.
3. Brostoff WN, Rasoul Sharifi M, & Rundel PW (2005) Photosynthesis of cryptobiotic soil crusts in a seasonally inundated system of pans and dunes in the western Mojave Desert, CA: Field studies. *Flora - Morphology, Distribution, Functional Ecology of Plants* 200(6):592-600.
4. Bergman NM, Lenton TM, & Watson AJ (2004) COPSE: a new model of biogeochemical cycling over Phanerozoic time. *Am. J. Sci.* 304:397-437.
5. Field CB, Behrenfeld MJ, Randerson JT, & Falkowski PG (1998) Primary production of the biosphere: integrating terrestrial and oceanic components. *Science* 281:237-240.
6. Carr M-E*, et al.* (2006) A comparison of global estimates of marine primary production from ocean color. *Deep Sea Research II* 53(5-7):741-770.
7. Cramer W*, et al.* (1999) Comparing global models of terrestrial net primary productivity (NPP): overview and key results. *Global Change Biology* 5(S1):1-15.
8. Fischer-Kowalski M, Krausmann F, & Pallua I (2014) A sociometabolic reading of the Anthropocene: Modes of subsistence, population size and human impact on Earth. *The Anthropocene Review* 1(1):8-33.
9. Krausmann F, Schandl H, & Sieferle RP (2008) Socio-ecological regime transitions in Austria and the United Kingdom. *Ecological Economics* 65(1):187-201.
10. Krausmann F, Fischer-Kowalski M, Schandl H, & Eisenmenger N (2008) The Global Sociometabolic Transition. *Journal of Industrial Ecology* 12(5-6):637-656.