ALL NUMBERS PROVISIONAL -- NEED TO CHECK EVERYTHING SEVERAL TIMES OVER

HUMAN IMPACTS by the numbers

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THE ANTHROPOCENE BY THE NUMBERS

ANTHROPOMASS NUMBER

$$Am = \frac{\text{total anthropomass}}{\text{total biomass}} \approx \frac{\text{anthropomass}}{\text{biomass}} \approx \frac{\quad}{550\ \text{Gt C}} \approx 1$$

PLASTIC NUMBER

EROSION NUMBER

$$Er = \frac{\text{soil moved by humans}}{\text{soil moved by rivers}} \approx \frac{40\ \text{Gt / year}}{5\ \text{Gt / year}} \approx 8$$

DEFORESTATION NUMBER

$$Df = \frac{\text{annual forest area lost to human action}}{\text{annual forest area lost to natural wildfire}} \approx \frac{10^7\ \text{ha/year}}{3\times10^6\ \text{ha/year}} \approx 3$$

SUMMARY

Total anthropomass (non-biological mass of human origin) is approximately equal to the planetary biomass.

Humans rival natural processes as the planets' most significant geomorphologigcal agent, moving ≈ 40 Gt of soil annually.

Annual forest loss due to human activity (including agriculture, logging, and forestry) is ≈ 3 times larger than that due to wildfires of natural origin.

AGRICULTURE BY THE NUMBERS

BARNYARD NUMBER

$$Bn = \frac{\text{livestock population}}{\text{human population}} \approx \frac{3\times10^{10}\ \text{animals}}{7\times10^9\ \text{people}} \approx \frac{4\ \text{animals}}{1\ \text{person}}$$

BARN-TO-TABLE NUMBER

$$Bt = \frac{\text{livestock processed annually}}{\text{human population}} \approx \frac{10^{11}\ \text{animals/yr}}{7\times10^9\ \text{people}} \approx \frac{15\ \text{animals/yr}}{1\ \text{person}}$$

TERRA NUMBER

$$Fa = \frac{\text{agricultural land area}}{\text{land area on Earth}} \approx \frac{5\times10^{13}\ \text{m}^2}{1.5\times10^{14}\ \text{m}^2} \approx 0.3$$

FARM-TO-TABLE NUMBER

$$Ft = \frac{\text{area harvested annually}}{\text{human population}} \approx \frac{2\times10^{13}\ \text{m}^2\text{/yr}}{7\times10^9\ \text{people}} \approx \frac{3000\ \text{m}^2\text{/yr}}{1\ \text{person}}$$

SUMMARY

At a population of ≈ 30 billion, agricultural animals outnumber the human population by a factor of 4. Chickens alone account for ≈65% of the livestock population.

The generation of animal products requires ≈ 15 animals per person per year.

Land used for agriculture, both in terms of harvest and animal husbandry, accounts for ≈30% of Earth's total land area.

The plant-based diet of most humans requries ≈ 3000 m^2 or ≈ 1 acre of land per year. Harvests of cereals, wheat, and corn account for ≈50% of harvested cropland.

ATMOSPHERIC EMISSIONS BY THE NUMBERS

KEELING NUMBER

$$Ke = \frac{\text{CO}_2\text{ added by humans}}{\text{CO}_2\text{ added by a volcanic eruption}} \approx \frac{2\times10^{15}\ \text{kg CO}_2}{10^{10}\ \text{kg CO}_2} \approx 2\times10^5$$

HABER-BOSCH NUMBER

$$Ha = \frac{\text{N}_2\text{ through Haber-Bosch process}}{\text{N}_2\text{ through biological processes}} \approx \frac{200\ \text{Tg N}}{200\ \text{Tg N}} \approx 1$$

METHANE NUMBER

$$V = \frac{\text{annual anthropogenic methane}}{\text{annual biological methane}} \approx \frac{???}{\quad} \approx$$

OZONE NUMBER

$$Oz = \frac{\text{depletion rate of ozone}}{\text{recovery rate of ozone}} \approx \frac{\quad}{???} \approx$$

SUMMARY

Humans have released1 1500 Gt of CO_2, equal to ≈200,000 large volcanic eruptions. Of this, 40% is absorbed by the ocean, leading to a net increase of ≈ 1000 Gt of atmospheric CO_2.

Through synthetic means, humans convert as much nitrogen to ammonia as does the biosphere, but at much lower efficiency.

XX methane number description

ozone number description. Comment on ability to respond

WATER BY THE NUMBERS

NIAGARA NUMBER

$$Ni = \frac{\text{daily human water use}}{\text{Niagara Falls drainage rate}} \approx \frac{10^{10}\ \text{m}^3\text{/day}}{10^9\ \text{m}^3\text{/day}} \approx 10$$

HOOVER NUMBER

$$Hv = \frac{\text{water volume in dammed rivers}}{\text{water volume in free-flowing rivers}} \approx \frac{\text{dam}}{\text{river}} \approx \frac{10^{12}\ \text{m}^3}{10^{12}\ \text{m}^3} \approx 1$$

ICE-MELT NUMBER

$$Ic = \frac{\text{annual melt volume of glaciers \& ice-caps}}{\text{volume of Grand Canyon}} \approx \frac{\text{melting ice cube}}{\text{grand canyon}} \approx \frac{10^{12}\ \text{m}^3\text{/yr}}{10^{12}\ \text{m}^3} \approx 1\ \text{/ yr}$$

ACIDIC OCEAN NUMBER

$$Ac = \frac{\text{ocean } [H^+] \text{ in 1960}}{\text{ocean } [H^+] \text{ today}} \approx \frac{???}{???} \approx \frac{1\text{M}\times10^{-8.2}}{1\text{M}\times10^{-8.1}} \approx 0.7$$

SUMMARY

Daily human fresh water usage is equivalent to the daily discharge of 10 Niagara Falls or 1 Amazon river.

dam

Around half of the world river volume is used in the generation of hydroelectric power. The Amazon alone accounts for ≈ 25% of the global free-flowing (undammed) river volume.

melting ice cube

Increasing global temperature leads to a volume of ≈ 1000 km^3 of water released per year from glaciers, permafrost, and ice caps, a volume comparable to that of the Grand Canyon

melting ice cube

Over the past sixty years, increased CO_2 in the atmosphere has decreased the pH of the ocean by ≈0.1pH units, corresponding to a ≈30% increase in H^+ concentration.

RESOURCE EXTRACTION BY THE NUMBERS

SOLAR NUMBER

$$Su = \frac{\text{annual human energy usage}}{\text{annual incident solar energy}} \approx \frac{20\ \text{TW}}{2\times10^5\ \text{TW}} \approx 0.0001$$

FOSSIL FUEL NUMBER

$$Fo = \frac{\text{annual volume of mined fossil fuels}}{\text{volume of Grand Canyon}} \approx \frac{\quad}{\text{grand canyon}} \approx \frac{\quad}{10^{12}\ \text{m}^3} \approx$$

PHOSPHORUS NUMBER

$$Po = \frac{\text{annual mass of mined phosphorus}}{\text{mass of phosphorus in mineral resources}} \approx \frac{\text{bag of fertilizer}}{\text{phosphate rocks}} \approx \frac{\quad}{\quad} \approx$$

LITHIUM NUMBER

$$Li = \frac{\text{annual mass of mined lithium}}{\text{mass of lithium in mineral resources}} \approx \frac{\quad}{\text{lithium deposits ???}} \approx \frac{\quad}{\quad} \approx$$

SUMMARY

Total human energy usage is ≈0.01% of the solar energy incident on the planet.

Fossil fuels (crude oil and natural gas) is responsible for XX% of the global energy usage. Mining produces XX m^3 per year, comparable to XX the volume of the Grand Canyon.

bag of fertilizer

xx phosphorus number description

xx lithium number description