

HUMAN IMPACTS by the numbers

Griffin Chure¹, Avi Flamholz², Nicholas Sarai³, Tine Valencic¹, Yinon Bar-On⁴, Ron Milo⁴, and Rob Phillips^{2,5,*}

¹Department of Applied Physics, California Institute of Technology, Pasadena, CA, 91125

²Division of Biology and Biological Engineering, California Institute of Technology, Pasadena, CA, 91125

³Division of Chemistry and Chemical Engineering, California Institute of Technology, Pasadena, CA, 91125

⁴Department of Plant and Environmental Sciences, Weizmann Institute of Science, Rehovot 7610001, Israel

⁵Department of Physics, California Institute of Technology, Pasadena, CA, 91125

ICE MELTING
 glacial melt volume $\approx ??? / \text{yr}$
 ice-cap melt volume $\approx ??? / \text{yr}$
 permafrost melt volume $\approx ??? / \text{yr}$
 total melt volume $\approx 10^{12} \text{ m}^3$

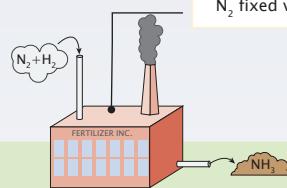
MATERIAL OF HUMAN ORIGIN

concrete production $\approx ?? \text{ kg} / \text{yr}$
 plastic production $\approx ?? \text{ kg} / \text{yr}$
 total production $\approx ?? \text{ kg} / \text{yr}$

RISING SEA LEVELS

total annual sea-level rise $\approx 3 \text{ mm} / \text{yr}$
 rise from melt-water $\approx 2 \text{ mm} / \text{yr}$
 rise from thermal expansion $\approx 1 \text{ mm} / \text{yr}$

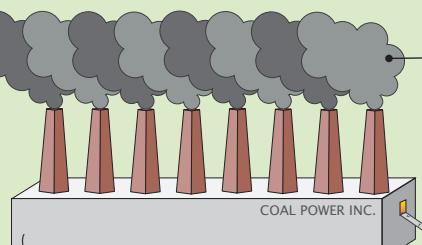
NITROGEN FIXATION
 N_2 fixed via Haber-Bosch process $\approx 1 \text{ Tg}$



GLOBAL POWER USAGE
 global power usage $\approx 20 \text{ TW}$



CARBON DIOXIDE RELEASE
 annual CO_2 released from $\approx 10 \text{ Gt} \approx 1000$ volcanoes
 human action



OCEAN pH
 $[\text{H}^+]$ increase in oceans from CO_2 absorption $\approx 0.001 \text{ pH units} / \text{year}$

LIVESTOCK

chicken population $\approx 20 \text{ billion}$
 cattle population $\approx 2 \text{ billion}$
 pig population $\approx 1 \text{ billion}$

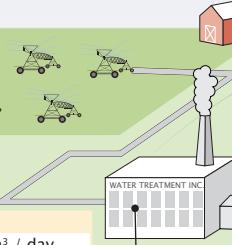
total livestock population $\approx 30 \text{ billion}$

EXTENT OF TERRESTRIAL LAND USAGE

agricultural area $\approx 5 \times 10^{13} \text{ m}^2$
 urban area $\approx ???$
 other land area $\approx ???$

total area $\approx ???$

HUMAN WATER USAGE
 power plant cooling $\approx 2 \times 10^9 \text{ m}^3 / \text{day}$
 agriculture $\approx 1 \times 10^9 \text{ m}^3 / \text{day}$
 personal use $\approx ???$
 total water use $\approx 10^{10} \text{ m}^3 / \text{day}$



DAMMING OF RIVERS

global volume of dammed rivers $\approx 10^{12} \text{ m}^3$
 hydroelectric power generation $\approx 1 \text{ TW}$



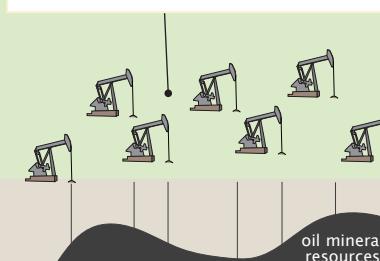
DEFORESTATION
 forestland area loss due to human action $\approx ???$



EROSION
 soil moved by humans $\approx 40 \text{ Gt} / \text{yr}$



FOSSIL FUEL MINING
 volume of fossil fuels mined \approx annually



oil mineral resources

coal mineral resources

HUMAN IMPACTS by the magnitudes

Griffin Chure¹, Avi Flamholz², Nicholas Sarai³, Tine Valencic¹,
Yinon Bar-On⁴, Ron Milo⁴, and Rob Phillips^{2,5,*}

THE ANTHROPOCENE

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet, cons ectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod

THE MAGNITUDE OF HUMAN WATER USAGE

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet, cons ectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod

HUMANS AS THE EARTH'S GREATEST EVOLUTIONARY FORCE

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet, cons ectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod

HUMAN IMPACTS ON ATMOSPHERIC AND BIOGEOCHEMICAL CYCLES

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet, cons ectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod

THE MAGNITUDE OF HUMAN ENERGY USAGE

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet, cons ectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod

