www.anthroponumbers.org/catalog/entry/81043

A **Atmospheric CO_2 concentration**

B Atmospheric & Biogeochemical Cycles | Carbon Dioxide

This quantity comes from a time series measurement and the most recent value (1964-2021) is reported.

C **Value:**

≈ 415 parts per million — see this value in other units

This is equivalent to...

≈ 4.15×10^{-4} mol CO_2 mol^{-1} air

≈ 6.30×10^{-4} kg CO_2 kg^{-1} air

≈ 3.25×10^{15} kg CO_2

D **HuID:** 81043

E **Relevant Year(s):** 1964-2021

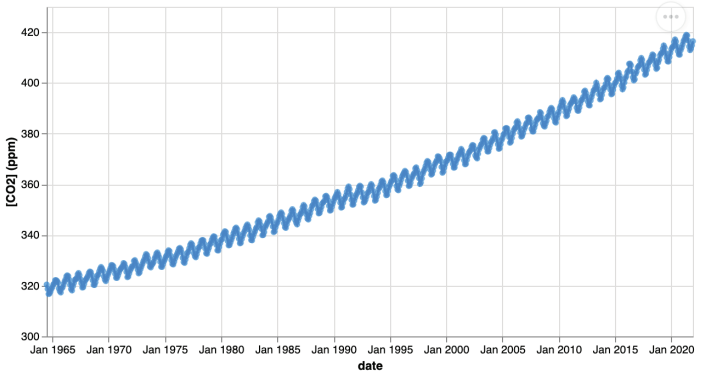
F **Summary:** The present carbon dioxide (CO_2) concentration in the atmosphere as measured at the Mauna Loa Observatory. Temporal variations in the CO_2 concentration can be seen as periodic oscillations corresponding to seasonal changes. The carbon dioxide data on Mauna Loa constitute the longest record of direct measurements of CO_2 in the atmosphere. They were started by C. David Keeling of the Scripps Institution of Oceanography in March of 1958 at a facility of the National Oceanic and Atmospheric Administration.

G **Method:** Uncertainty in measurements is not reported in original source, and it is assumed lower than the monthly variability. The Mauna Loa data are being obtained at an altitude of 3400 m in the northern subtropics, and may not be the same as the globally averaged CO2 concentration at the surface. The mass of CO_2 is obtained from the concentration using the molar mass of CO_2, 44 g mol^{-1}; the molar mass of air, 29 g mol^{-1}; and the mass of the atmosphere, 5.15×10^{18} kg.

H **Source:** Scripps CO2 Program *Primary Mauna Loa CO2 Record.* (2021)

I **Dataset:** Monthly atmospheric CO2 measurements from Mauna Loa Observatory (monthly_co2_data_processed.csv)

J **Trend**



K **Added by:** ilopezgo

scrippsco2.ucsd.edu

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Scripps CO_2 Program

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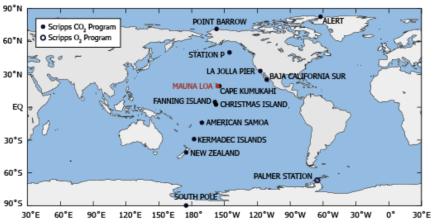
HOME / DATA / ATMOSPHERIC CO_2 / PRIMARY MAUNA LOA CO_2 RECORD

Data

- Atmospheric CO_2
- Primary Mauna Loa CO_2 Record
- Sampling Station Records
- Campaign Data
- Ice-Core Merged Products
- Seawater Carbon
- Early Cruise pCO_2
- Ocean Time-series

Atmospheric CO_2 Data

Primary Mauna Loa CO_2 Record



Station Name	Station Code	Latitude	Longitude	Elevation (m)
Mauna Loa Observatory, Hawaii	MLO	19.5 °N	155.6 °W	3397

In-situ CO_2 Data

Measurement	Frequency	Data File	Dates

```
year,month,date (decimal),Reported value,Concentration (ppm)
1958,3,1958.203,monthly mean,315.7
1958,4,1958.288,monthly mean,317.45
1958,5,1958.37,monthly mean,317.51
1958,6,1958.455,monthly mean,
1958,7,1958.537,monthly mean,315.86
1958,8,1958.622,monthly mean,314.93
1958,9,1958.707,monthly mean,313.21
1958,10,1958.789,monthly mean,
1958,11,1958.874,monthly mean,313.33
1958,12,1958.956,monthly mean,314.67
1959,1,1959.041,monthly mean,315.58
1959,2,1959.126,monthly mean,316.49
1959,3,1959.203,monthly mean,316.65
1959,4,1959.288,monthly mean,317.72
1959,5,1959.37,monthly mean,318.29
1959,6,1959.455,monthly mean,318.15
1959,7,1959.537,monthly mean,316.54
1959,8,1959.622,monthly mean,314.8
1959,9,1959.707,monthly mean,313.84
1959,10,1959.789,monthly mean,313.33
1959,11,1959.874,monthly mean,314.81
```

Figure 1: A representative entry in the Human Impacts Database. The entry page for HuID 81043 - "Atmospheric CO_2 concentration" is diagrammed with important features highlighted. Each entry in the Human Impacts Database has a (A) name, (B) primary and secondary categorization, (C) the numerical value with other units when appropriate, (D) a 5-digit permanent numeric identifier, (E) years for which the measurement was determined, (F) a brief summary of the quantity, (G) the method of determination, (H) a link to the source data, and (I) a link to a processed version of the data saved as a .csv file. When possible, a time series of the data is presented. (K) Finally, each entry lists the username of the administrator who curated the quantity. Their contact information is available on the anthroponumbers.org "About" page.

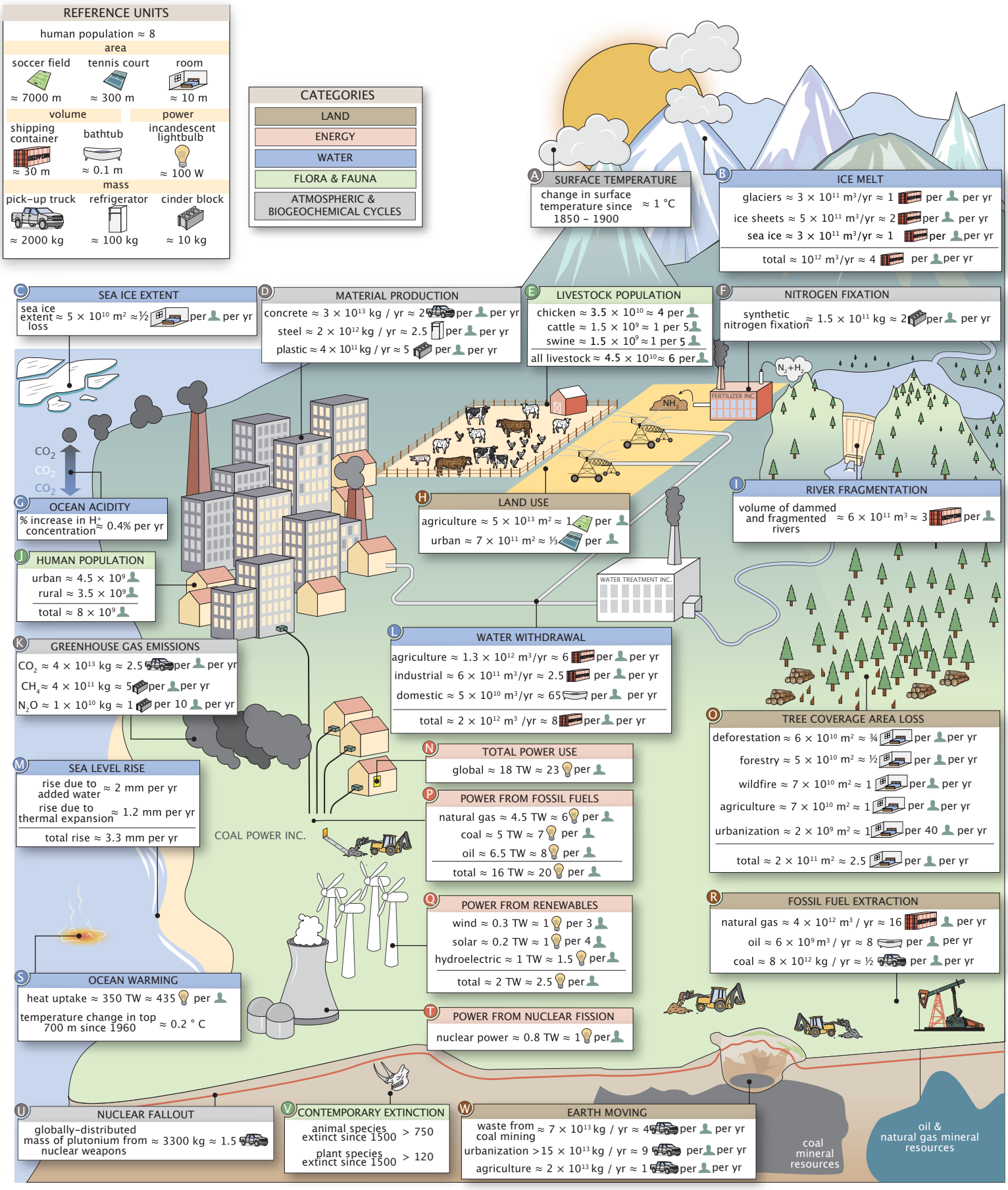
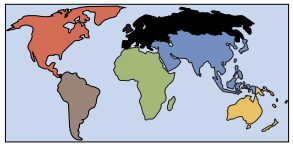


Figure 2: Human impacts on the planet and their relevant magnitudes. Relative units and the broad organizational categories are shown in the top-left panels. Source information and contextual comments for each subpanel are presented in the Supplemental Information.

A THE GEOGRAPHY OF HUMAN IMPACTS

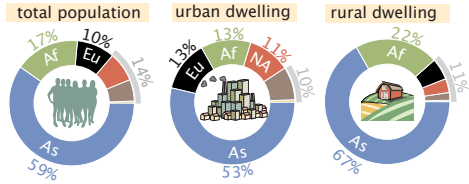
Page 1 represents the impact humans have on the Earth at a global scale. While these numbers are handy, it is important to acknowledge that they vary from country-to-country and continent-to-continent. Furthermore, the consequences of these anthropogenic impacts are also unequally distributed, meaning some regions experience effects disproportionate to their contribution. Here, we give a sense of the geographic distribution of several values presented on page 1, broken down by continental region as shown below.



Asia — (As)
North America — (NA)
South America — (SA)
Europe — (Eu)
Oceania — (Oc)
Africa — (Af)

B THE HUMAN POPULATION

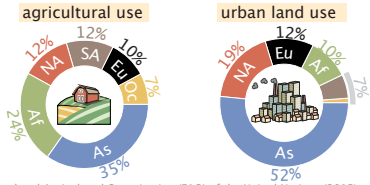
There are ≈ 8 billion humans on the planet, with approximately 50% living in 'urban' environments. The majority of the worlds population (as well as the majority of both urban and rural dwellers) live in Asia.



Sources: Food and Agricultural Organization of the United Nations – World Population
Notes: Urban/rural designation has no set definition and follows the conventions set by each reporting country.

C LAND USE

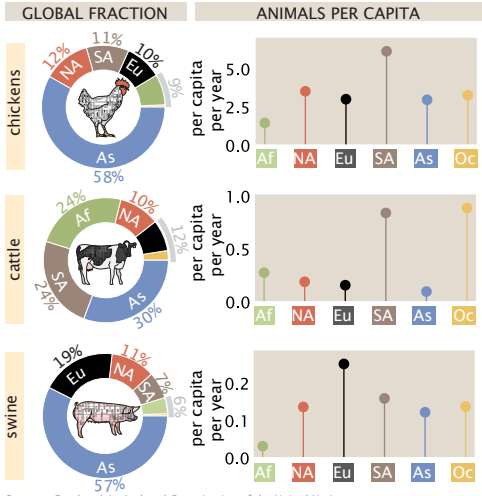
Though humans are nearly evenly split between urban and rural environments, agricultural land is the far more common use of land area. Together, Asia and Africa contain more than half of global agricultural land. Asia alone accomodates more than half of the global urban land area.



Sources: Food and Agricultural Organization (FAO) of the United Nations (2015) — Land Use [agricultural area]. Florczyk et al. 2019 — GHS Urban Centre Database 2015 [urban land area] **Notes:** Urban is defined as any inhabited area with ≥ 2500 residents, as defined by the USDA.

D THE LIVESTOCK POPULATION

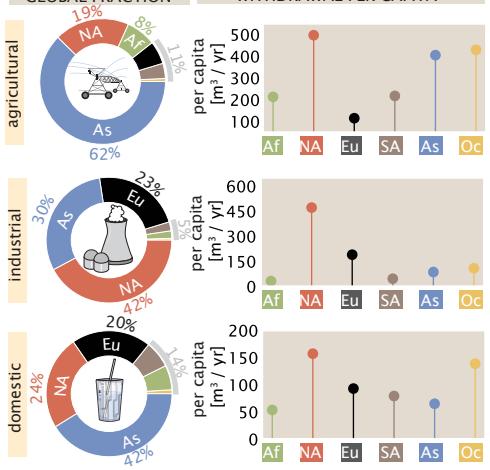
The global population of terrestrial livestock is around 30 billion individuals, most of which are chickens. Asia houses most of the global livestock population, though South America and Europe harbor more animals on a per-capita basis.



Sources: Food and Agricultural Organization of the United Nations

E WATER WITHDRAWAL

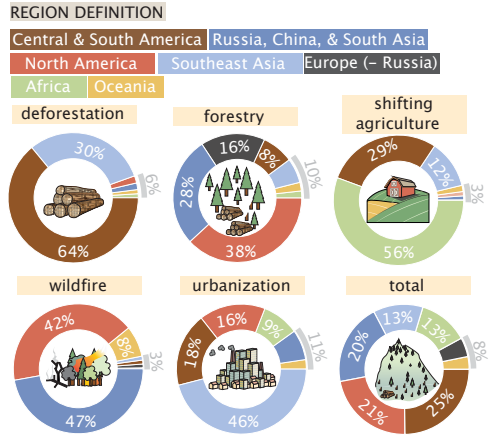
While Asia withdraws the most water for agricultural and municipal needs, North America withdraws the plurality of water for industrial purposes. North America also withdraws more water per capita than any other region.



Source: AQUASTAT Main Database, Food and Agriculture Organization of the United Nations.
Notes: Values are reported directly from member countries and represent average of 2013–2017 period. Per capita values are computed given population of reporting countries.

F TREE COVERAGE AREA LOSS

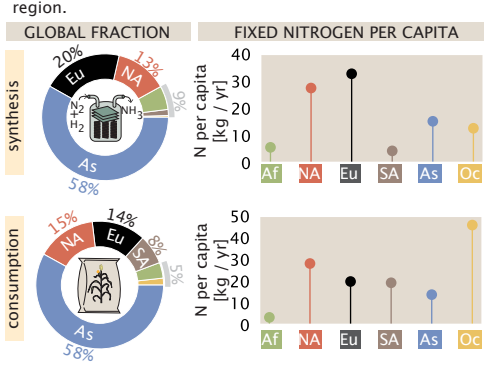
Most drivers of tree coverage area loss are comparable in their effect at a global scale. However, there are drastic regional differences in the relative magnitudes.



Source: Curtis et al. 2018 doi: 10.1126/science.aau3445.
Notes: Regions are as reported in Curtis et al. 2018. "Deforestation" here denotes permanent removal of tree cover for commodity production. "Shifting agriculture" here denotes forest/shrub land converted to agriculture and later abandoned. All values correspond to breakdown of cumulative tree cover area loss from 2001 – 2015.

G NITROGENOUS FERTILIZER USE & PRODUCTION

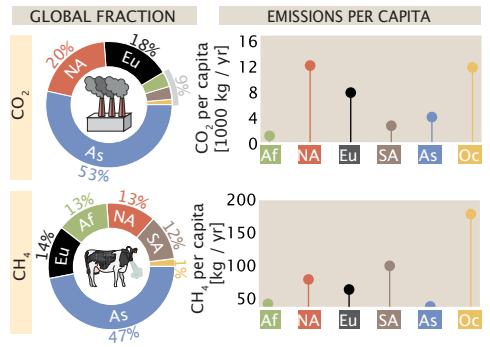
Modern agriculture requires nitrogen in amounts beyond what is produced naturally. Asia synthesizes and consumes a large majority of fixed nitrogen. However, Europe and North America dominate per capita synthesis whereas Oceania consumes more fertilizer per capita than any other region.



Source: Food and Agricultural Organization (FAO) of the United Nations.
Notes: Values account for reactive nitrogen production/consumption in context of fertilizer only and does not account for plastics, explosives, or other uses.

H GREENHOUSE GAS EMISSIONS

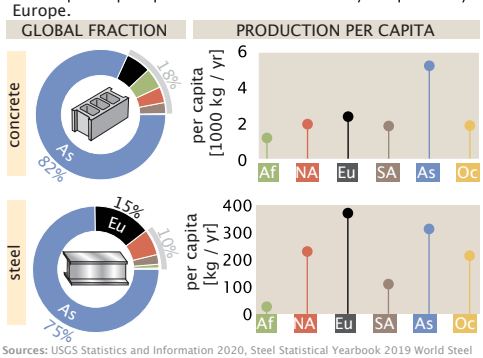
CO_2 and CH_4 are two potent greenhouse gases which are routinely emitted by anthropogenic processes such as burning fuel and rearing livestock. While Asia emits roughly half of all CO_2 and CH_4, North America and Oceania produce the most on a per capita basis, respectively.



Sources: CO_2 data collated by: Friedlingstein, P. et al. (2019). doi: 10.5194/essd-11-1783-2019. See Panel K on Pg. 4 for complete list of sources. CH_4 data from Saunois et al, 2020 doi: 10.5194/essd-12-1561-2020 **Notes:** Values report decadal averages in kg CO_2 or CH_4 per year over time period 2008–2017.

I MATERIAL PRODUCTION

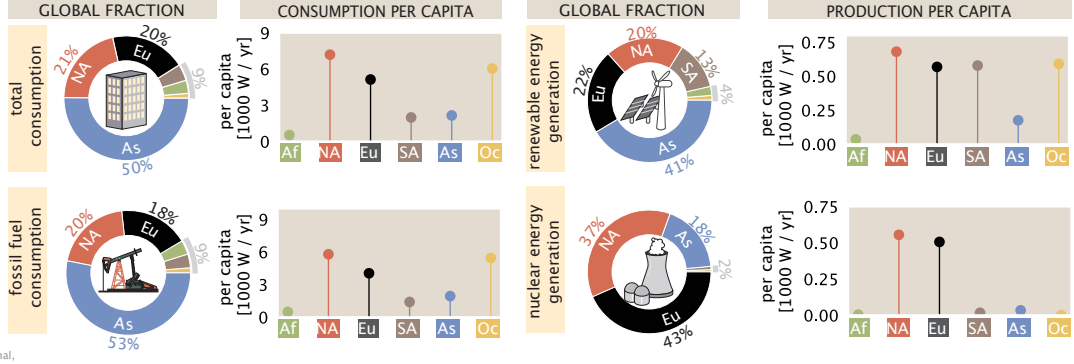
Humans excavate an enormous amount of material from the Earth's crust and transform it to build our structures. Two of these materials, concrete and steel, are produced primarily in Asia on both a global and per capita basis. Asia's per capita production of steel is only outpaced by Europe.



Sources: USGS Statistics and Information 2020, Steel Statistical Yearbook 2019 World Steel Association. Food and Agricultural Organization (FAO) of the United Nations — Annual Population. **Notes:** Reported values for cement and steel production corresponds to 2017 and 2018 values, respectively. Mass of concrete was calculated using a rule-of-thumb that 1 kg of cement yields 7 kg of concrete (Monteiro et al. 2017. doi: 0.138/nmat4930).

J POWER GENERATION AND CONSUMPTION

From heating water, to powering lights, to moving our vehicles, nearly every facet of modern human life requires the consumption of power, culminating in nearly 20 TW of power use in recent years. Asia consumes over half of the power derived from combustion of fossil fuels, with Europe and North America each consuming around 20% of the global total. Asia also produces the plurality of power from renewable technologies, such as hydroelectric, wind, and solar, however, North America, South America, and Europe each produce more on a per capita basis. Nuclear energy, however, is primarily produced in Europe, with North America and Asia coming in second and third place, respectively. On a per-capita basis, North America consumes or produces more energy than all other regions considered here, yielding a total power consumption of nearly 10,000 W per person.



Source: Energy Information Administration of the United States (2017)
Notes: "Renewables" includes hydroelectric, biofuels, biomass (wood), geothermal, wind, and solar. "Fossil fuels" includes coal, oil, and natural gas.

Figure 3: Regional distribution of anthropogenic effects. Several quantities from Figure 2 were selected and the relative magnitudes were broken down by subcontinental area (A). Donut charts in all sections show the relative contributions of each quantity by region. Ball-and-stick plots show the per capita breakdown of each quantity across geographic regions. All data for global and per-capita breakdowns correspond to the latest year for which data were available. The regional breakdown for deforestation uses the regional convention as reported in the source data[45].

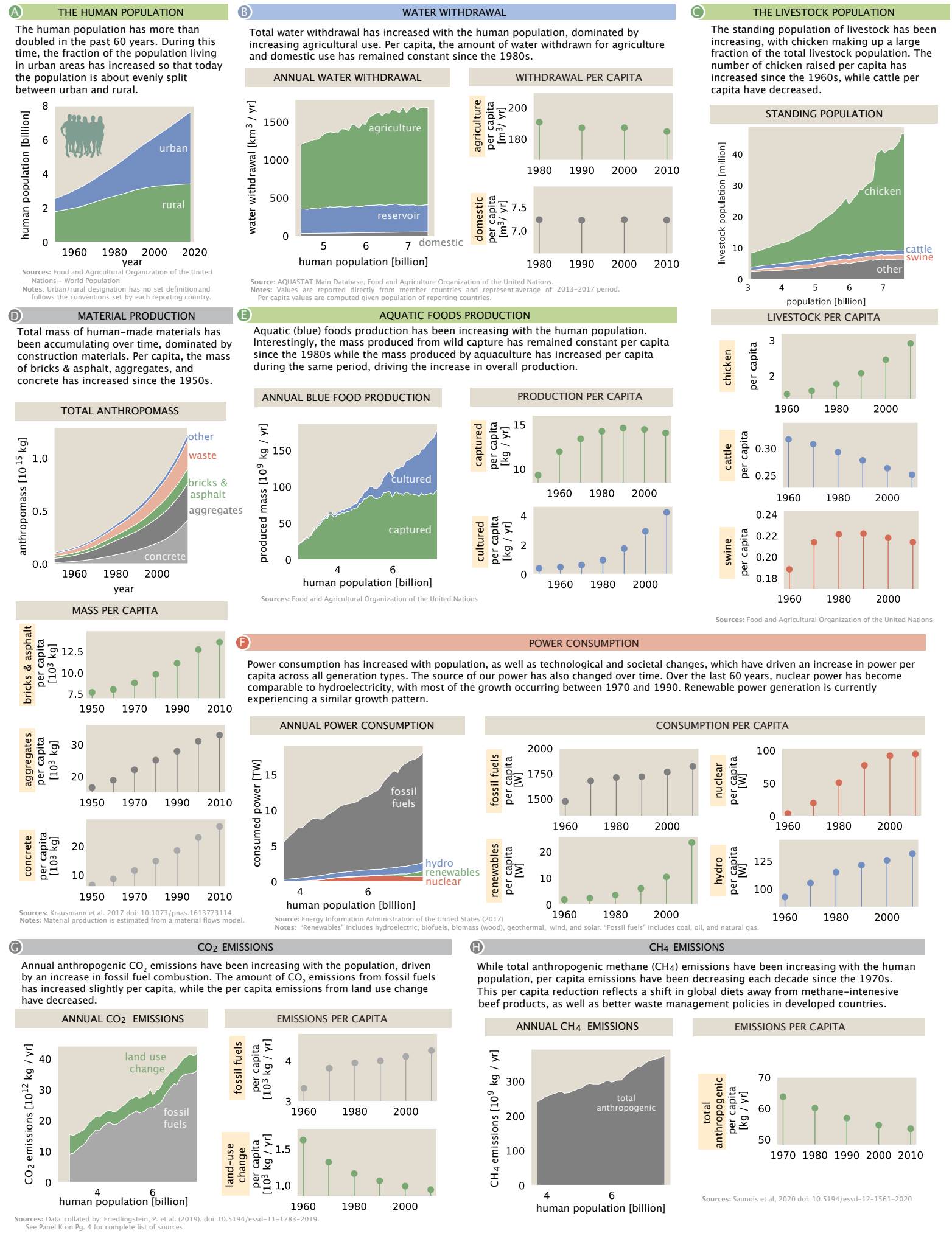


Figure 4: Temporal dynamics of key human impacts. Several quantities from Figure 2 were selected and the magnitudes were plotted either as a function of time (for cumulative quantities such as anthropomass) or human population (A). Ball-and-stick plots show the per capita breakdown as decadal averages to give a more reflective view of cultural and technological shifts than year-to-year variation.