**DATASCAPES**

The ‘datascapes’ are visualizations designed to make quantities which are otherwise hard to comprehend intelligible. Data manifested in the visualizations are generally based on the ecological footprint of an average American which, for polemical purposes, is then extrapolated to a hypothetical global population of 10 billion people living at the same (American) standard.[[1]](#footnote-1) The reason for using the figure of 10 billion people is that it is a round number roughly mid-way between the latest UN global population projections which suggest a range between 9.5 and 13.3 billion people by 2100.[[2]](#footnote-2)

The datascapes show that if the world were to live (in material terms) as contemporary Americans do, there would be a major discrepancy between global levels of consumption and what the earth, according to today’s technologies, can reasonably provide. The datascapes do not intend to be alarmist nor pass moral judgment on highly consumptive lifestyles. What they do make clear, however, is that as large numbers of people aspire to higher material standards of living throughout the 21st century, if ecological calamity is to be avoided, our systems of production and consumption will need to be better designed and better tuned to the earth’s systems.

**Earth for 10 billion**

The average American (2012 data) has an ecological footprint of 8.2 global hectares.[[3]](#footnote-3) The Global Footprint Network defines a global hectare as “a biologically productive hectare with world average biological productivity for a given year. Global hectares are needed because different land types have different productivities.”[[4]](#footnote-4)Ten billion Americans will create a footprint of at least 82,000,000,000 gha. This is 670% of the Earth’s current biological capacity of 12,243,512,050 gha.[[5]](#footnote-5)

**National Biocapacity and Ecological Footprints**

National biocapacity and ecological footprints are derived from data provided by the Global Footprint Network according to the productive area of land required to provide a society with its resources and absorb its waste. Biocapacity is a “measure of the amount of biologically productive land and sea area available to provide the ecosystem services that humanity consumes”.[[6]](#footnote-6) Ecological footprints are a “measure of the demand populations and their activities place on the biosphere in a given year, given the prevailing technology and resource management.”[[7]](#footnote-7) The total footprint is reached by adding data for food, energy, forest products, urban area and waste.

In this datascape each nation’s per capita biocapacity and per capita ecological footprint are superimposed upon one another to reveal the discrepancy (surplus or deficit) between the two. Where ecological footprints exceed biocapacity it means those nations draw resources from and distribute waste to regions beyond their own national territory. Where ecological footprints are within the biocapacity of the nation’s territory it means that said nation is living within its means in terms of its national landscape. In an ideal and sustainable world all nations would have ecological footprints smaller than their biocapacity, but because nations are political not ecological units and because globalism enables the planetary distribution of resources, what ultimately matters is the relationship between the planet’s total biocapacity and its total ecological footprint.

The world’s current (2012 data) ecological footprint is 20,114,439,677 global hectares and the planet’s biological capacity in terms of our current methods of using resources is 12,243,512,050 global hectares.[[8]](#footnote-8)

**Carbon Consumption and Emissions**

An average American today (2012 data) produces 21.55 metric tons (47,510 lbs) of CO2 equivalents a year.[[9]](#footnote-9) A world of 10 billion people at the material standard of today’s average American would therefore produce 216 billion metric tons of CO2, a pyramid of CO2 equivalent[[10]](#footnote-10) in volume to 48 million the Great Pyramid of Giza. The charcoal spheres and the pyramid represent the volumes of CO2 at normal temperature and atmosphere (NTP).[[11]](#footnote-11)

**Carbon Forest**

A mature tree can absorb as much as 21.77 kg (48 lbs) of CO2 a year, which means it would take about 990 such trees to sequester the carbon emissions of one average American.[[12]](#footnote-12) The 216 billion metric tons of CO2 emitted by a hypothetical global population of 10 billion such Americans would require 9.9 trillion trees to sequester its emissions.[[13]](#footnote-13) With a 3.65 m (12 ft) spacing between trees this equates to a 132,250,000 km2 forest – almost the entire 149,000,000 km2 terrestrial area of the planet (minus its current 15,000,000 km2 of ice covered land). Discounting the 39,990,000 km2 of the world’s existing forest (including the world’s protected areas) we are left with the need to construct a 92,260,000 km2 forest in order to sequester the carbon emissions of the equivalent of 10 billion Americans.[[14]](#footnote-14)

If we consider the feasibility of constructing such a forest, we must also subtract from this some 15,300,000 km2 of current crop land and 33,800,000 km2 of current grazing land. (Although this grazing land has some tree cover it is not at the density required to meet the sequestration demand). Furthermore, we must also subtract the 26,780,400 km2 of potentially arable land which is not yet, but surely will be farmed if we are to feed 10 billion by 2100. This leaves a total of only 16,469,600 km2 on which to develop a sequestration forest, all of which is presently desert. This is also assuming no expansion of the world’s current grazing land. In short, as this century unfolds there will not be enough land to utilize forestry as the single mechanism for carbon sequestration.

A 2015 Yale University study likewise attempted to calculate the scale of forest necessary to sequester future global carbon emissions. They calculate that, in addition to the 3 trillion existing trees, 6.9 trillion more trees would be needed to establish a global forest capable of sequestering the carbon emissions of 10 billion average contemporary Americans.[[15]](#footnote-15) The establishment of this forest would also need to counter the fact that, according to the same study, some 15 billion trees are cut down each year. In short, a world of 10 billion such people would need to double, if not triple, the current global forest in order to sequester their carbon emissions. Some overlaps between sequestration forestry and grazing land could occur, but the problem remains that forestry at the requisite density of tree cover to significantly sequester carbon and the land area needed for increased food production this century, are fundamentally at odds.

**Energy Consumption**

In 2012, the total American population of 314,112,078 people used 4,069,054,975,224 kWh of electricity a year.[[16]](#footnote-16) If this usage pattern were to stay the same 10 billion Americans would use 129,541,532,600,000 kWh a year. The amount of land required to produce this amount of electricity is shown for different types of power generation; nuclear[[17]](#footnote-17), solar[[18]](#footnote-18), and wind[[19]](#footnote-19) power at the scale such installations typically require.

**Foodscape**

The earth’s ice-free terrestrial area is 149,000,000 km2. According to the United Nation’s Food and Agriculture Organization (FAO), croplands in 2015 cover 15,300,000 km2 and pasture for animal grazing covers another 33,800,000 km2, a total of 49,100,000 km2 (38% of the earth’s ice-free land). Theoretically, there remains some 26,780,400 km2 of land with potential for crop production worldwide.[[20]](#footnote-20) Assuming all this land (represented by the middle square on the map) is under production by 2100 (as will be necessary to feed a global population of circa 10 billion) it would leave 75.8 million km2 or 50% of the earth’s ice free land for other uses – such as carbon sequestration, evapotranspiration and biodiversity. If however grazing rangelands expand into this remaining 50% as would also be likely then its capacity to provide ecosystems services will reduce accordingly.

However, into this calculation needs to be factored that 33% (49 million km2) of the earth’s terrestrial surface is desert - by definition land unsuited to forestry and of limited biodiversity value. If we remove the deserts from the equation, we are left with 40.2 million km2 or 17% of the earth’s ice-free terrestrial area precisely that which the Convention on Biological Diversity aims to secure by 2020.

This breakdown of the global foodscape is based on reaching the limit of the world’s remaining arable land. The other, more problematic way to approach it is to imagine that our hypothetical 10 billion people would, (if they could) consume what the average American does today.

The average American requires 1.4 hectares of land for their total food requirements. 10 billion such consumers would therefore require 140.4 million km2 of land for food production (the large square on the map) which is 93% of the earth’s ice-free terrestrial surface (including land for crops and grazing). In this case not only would all the world’s arable land be used for agriculture but an additional 64 million km2 (43%) would need to be converted to arable land, essentially the entirety of the world’s deserts, plus some. According to this breakdown a mere 7% of the earth’s terrestrial surface would then be left for biodiversity - essentially a big zoo in the midst of a global monoculture of corn and cattle irrigated by desalination plants.

Put another way, if the world’s total arable land (not including expansion into deserts) were distributed evenly, each of 10 billion people would have 0.14 hectare—about four basketball courts—from which to survive.[[21]](#footnote-21) By 2050 people in developed countries are predicted to consume food requiring almost triple this amount.[[22]](#footnote-22)

**Urban Growth**

In calculating this datascape it was assumed that of the additional 3.9 billion people forecast to be added to the world’s population by 2100, three billion of them will live in cities. To accommodate them the equivalent of 464 New York Cities (NYC) will need to be constructed in the next 84 years, at a steady rate this is 5.5 per annum.[[23]](#footnote-23) Whilst this illustration reveals the sheer mass of historically unprecedented construction taking place, the image of New York is misleading for much of the world’s urban growth is in informal settlements in Africa and South and Central America. The Urban Growth datascape shows the urban footprint of three billion people at four different typologies: 1) hyper density (NYC)[[24]](#footnote-24), high density informal settlement (Mumbai)[[25]](#footnote-25), medium density (Barcelona)[[26]](#footnote-26), and suburban density (Los Angeles).[[27]](#footnote-27)

1. Global Footprint Network, “National Footprint Accounts,” http://www.footprintnetwork.org/pt/index.php/GFN/page/footprint\_data\_and\_results/ (accessed June 1, 2016).

   NB There is a three-year delay in the process of calculating ecological footprints. [↑](#footnote-ref-1)
2. United Nations, Department of Economic and Social Affairs, Population Division, *World Population Prospects: The 2015 Revision, Key Findings and Advance Tables* (2015). Available at https://esa.un.org/unpd/wpp/Publications/. [↑](#footnote-ref-2)
3. Global Footprint Network, “National Footprint Accounts,” http://www.footprintnetwork.org/pt/index.php/GFN/page/footprint\_data\_and\_results/ (accessed June 1, 2016). [↑](#footnote-ref-3)
4. Ibid. [↑](#footnote-ref-4)
5. Ibid. [↑](#footnote-ref-5)
6. Michael Borucke, et al., *“*Accounting for demand and supply of the biosphere’s regenerative capacity: The National Footprint Accounts’ underlying methodology and framework,” *Ecological Indicators* 24 (2012): 518-533. Available at http://www.footprintnetwork.org/images/article\_uploads/NFA\_Method\_Paper\_2011.pdf. [↑](#footnote-ref-6)
7. Ibid. [↑](#footnote-ref-7)
8. Op. cit. Global Footprint Network, “National Footprint Accounts.” [↑](#footnote-ref-8)
9. - US Environmental Protection Agency, “U.S. Greenhouse Gas Inventory Report: 1990-2014” (2016), https://www3.epa.gov/climatechange/ghgemissions/usinventoryreport.html (accessed Month XX, YYYY).

   - International Carbon Bank & Exchange, “CO2 Volume Calculation,” http://www.icbe.com/carbondatabase/CO2volumecalculation.asp (accessed Month XX, YYYY). [↑](#footnote-ref-9)
10. Carbon dioxide equivalent is used to measure various types of greenhouse gases based upon their global warming potential. [↑](#footnote-ref-10)
11. NTP means at a temperature of 20°C (68°F) and an absolute pressure of 1 atm. [↑](#footnote-ref-11)
12. NC State University College of Agriculture & Life Sciences, “Tree Facts,” http://www.ncsu.edu/project/treesofstrength/treefact.htm (accessed Month XX, YYYY).

    *-* Sarah Moos, “50,000 Trees,” *Scenario 04: Building the Urban Forest* (2014)*,* http://scenariojournal.com/article/50000-trees/.

    ***~~- “Number of Trees per Acre by Spacing,” The University of Georgia, modified December 1996;~~* ~~http://warnell.forestry.uga.edu/SERVICE/LIBRARY/for96-054/index.html~~ (This should be removed, the link is broken, plus the other two references significantly cover the data in the sentence)** [↑](#footnote-ref-12)
13. Of course, considerable CO2 equivalents are already absorbed by the earth through ocean-atmosphere gas exchange (the ocean not only absorbs but also releases carbon), freshwater outgassing, rock weathering, geological activities (volcanic eruptions), respiration and fire, etc. For more detailed information regarding the carbon cycle, please refer to the IPCC Fifth Assessment Report (AR5)

    http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5\_Chapter06\_FINAL.pdf. [↑](#footnote-ref-13)
14. Food and Agriculture Organization of the United Nations, “Global Forest Resources Assessment 2015” (Rome). Available at http://www.uncclearn.org/sites/default/files/inventory/a-i4793e.pdf. [↑](#footnote-ref-14)
15. T. W. Crowther, et al., “Mapping tree density at a global scale,” *Nature* 525, no. 7568 (2015): 201-205. [↑](#footnote-ref-15)
16. The World Bank, “World DataBank,” (2012),

    http://databank.worldbank.org/data//reports.aspx?source=2&country=USA&series=&period=# (accessed August 8, 2015). [↑](#footnote-ref-16)
17. U.S. Energy Information Administration, “Frequently Asked Questions,” http://www.eia.gov/tools/faqs/faq.cfm?id=104&t=3 (accessed Month XX, 2014). [↑](#footnote-ref-17)
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    - Project Gutenberg Self-Publishing Press, “Topaz Solar Farm,” http://self.gutenberg.org/articles/topaz\_solar\_farm (accessed Month XX, YYYY). [↑](#footnote-ref-18)
19. European Wind Energy Association, “Wind energy’s frequently asked questions (FAQ),” http://www.ewea.org/wind-energy-basics/faq/ (accessed Month XX, 2015).

    - Wind farm: On an 8Dx4D grid with 100m diameter rotors; EDF Energy Renewables, “FAQ,” http://www.edf-er.com/AboutWindEnergy/FAQ.aspx (accessed Month XX, YYYY).

    - National Wind Watch, “FAQ-Output,” https://www.wind-watch.org/faq-output.php (accessed Month XX, YYYY). [↑](#footnote-ref-19)
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22. Christine Chemnitz & Jes Weigelt (eds), *The Soil Atlas 2015* (Berlin & Potsdam: Heinrich Böil Foundation & Institute for Advanced Sustainability Studies, 2015). Available at http://globalsoilweek.org/wp-content/uploads/2014/12/soilatlas2015\_web\_141221.pdf. [↑](#footnote-ref-22)
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26. Instituto Nacional de Estadística (2008), http://www.ine.es/en/welcome.shtml (accessed Month XX, YYYY). [↑](#footnote-ref-26)
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