



Machinery secures human domination

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The role of machinery in promoting human dominance of Earth's ecosystems is quantified with the assistance of some recent estimates.

In accordance with the ancient command to “have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth”,¹ man has come to dominate the planet, as well documented by Vitousek et al.,² building on earlier work.³ More recent work on estimating the biomass of different taxa has revealed how human beings have rapidly come to outquantify wild mammals more than tenfold in mass,⁴ and further evidence of domination comes from the recent estimate that the mass of human-made materials now exceeds biomass.⁵ Within the context of sustainable existence,⁶ these trends may be alarming. For example, it is already recognized that anthropogenic influence may be having an unfavourable effect on Earth's climate.⁷

None of these works^{2–5} considers the role of machines in the achievement of dominance. The author of *The Book of the Machines* points out that machines may be considered to be akin to artificial limbs, strengthening, or enormously amplifying, man's physical powers,⁸ a view similar to that adopted by Spengler.^{9,10} The purpose of this note is to quantify the the amount of machinery that man has created to assist in achieving dominance.

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¹ Genesis 1, 28.

² P.M. Vitousek et al., Human domination of Earth's ecosystems. *Science* **277** (1997) 494–499.

³ P.M. Vitousek et al., Human appropriation of the products of photosynthesis. *BioScience* **36** (1986) 368–373.

⁴ Y.M. Bar-On et al., The biomass distribution on Earth. *Proc. Natl Acad. Sci. USA* **115** (2018) 6506–6511.

⁵ E. Elhacham et al., Global human-made mass exceeds all living biomass. *Nature* **588** (2020) 442–444.

⁶ J.J. Ramsden, Doomsday scenarios: an appraisal. *Nanotechnol. Perceptions* **12** (2016) 35–46.

⁷ G.C. Holt and J.J. Ramsden, *Climate Change from First Principles*. Basel: Collegium Basilea (2019).

⁸ *The Book of the Machines*. In: *Erewhon* (by S. Butler), chs 23–25. London: Penguin (1985) (first published anonymously in 1872).

⁹ O. Spengler, *Der Untergang des Abendlandes*, Bd 2, ch. 5, II. Die Maschine. Munich: dtv (1993); first published by C.H. Beck (1923).

¹⁰ O. Spengler, *Der Mensch und die Technik*. Munich: C.H. Beck (1931).

Table 1 summarizes biomass and machine mass. To estimate the latter, we can draw on recent estimates of anthropogenic mass.⁵ Most machines are made of iron or steel, hence we simply use the mass of Fe as the equivalent of the mass of C used to quantify biomass.⁴ Some ferrous metals are of course used in human artefacts (e.g., bridges, houses) that are not machines, but on the other hand some machines (e.g., railways) use a considerable mass of materials other than ferrous (e.g., for sleepers).

Table 1. Biomass and machine mass before and after the emergence of human beings.

	10 ⁵ years BP ^a	Present	Ref.
Wild mammals/Gt C	0.04	0.007	4
Livestock/Gt C	0	0.1	4
Human beings/Gt C	0	0.06	4
Machines/Gt Fe	0	30	5
Total biomass/Gt C	?	550	4

^a Before present.

Livestock clearly aids human dominance:¹¹

Wenn ich sechs Hengste zahlen kann,
Sind ihre Kräfte nicht die meine?
Ich renne zu und bin ein rechter Mann,
Als hätt ich vierundzwanzig Beine.

Although the sum of the mass of human beings and their agents is still dwarfed by total biomass (most of which is attributed to plants),⁴ the trend is for the former to rapidly increase whereas the latter may be roughly stationary. Furthermore, the mass of machines exceeds the total mass of all life forms other than plants and bacteria.⁴

While the quantification of the loss of wild mammals due to human activities is striking, it merely echoes sentiments expressed many decades ago, such as those of the animal artist C.F. Tunnicliffe, who remarked “Soon, unless man becomes suddenly more intelligent, we shall have to face the fact that where he lives and works, animal life will continue to suffer, and where he is in complete control the animals must disappear completely”.¹² In the case of these creatures, competition with man was more or less direct, but modern agricultural practices, especially the large-scale use of potent pesticides and herbicides, seems to be leading to great collateral losses in the populations of insects and other microfauna apart from those specifically targeted.¹³

It is an intriguing question whether a decrease in human population to a more sustainable level of 2 milliard¹⁴ would diminish anthropogenic dominance. Quite possibly the growth of

¹¹ J.W. Goethe, *Faust, der Tragödie erster Teil*. Basel: Birkhäuser (1948) (first published in 1808).

¹² In the introductory material to *Asian Wild Life*. London: Brooke Bond (1962) (picture card booklet).

¹³ R.A. Mason, The sixth mass extinction and chemicals in the environment: our environmental deficit is now beyond nature's ability to regenerate. *J. Biol. Phys. Chem.* **15** (2015) 160–176.

¹⁴ J.J. Ramsden, A.A. Mamali and N.T. Athanassoulis, A sustainable world population. *J. Biol. Phys. Chem.* **19** (2019) 11–21.

machinery will continue apace regardless, a possibility also foreseen by the author of *The Book of the Machines*.⁸ It may then be that only wholehearted adoption of the Bionarrative¹⁵ will avert disaster to the global ecosystem. Stent has pointed out that Confucianism and Taoism both endeavour to provide for man's harmony with his environment,¹⁶ the domination narrative being a distinctively Western concept, but at present no part of the world can be said to be striving for such harmony.

¹⁵ S. Boyden, *The Bionarrative*. Acton: Australian National University Press (2016).

¹⁶ G. Stent, The dilemma of science and morals. *Zygon* **10** (1975) 95–112.