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Another interesting example of this relates to a fascinating group of insects known as the water striders, which, as their name implies, can walk on water. One genus from this group, *Halobates*, comprises several flightless species that are the only insects known to inhabit the open ocean. The insects' legs have tiny hairs that trap air and prevent them from getting wet. This characteristic also makes the insect buoyant such that, together with its lack of wings, mean it is confined to a two-dimensional niche, where air meets water.

One important requirement for *Halobates*' life cycle is that it must have a hard surface on which to lay its eggs. And here it makes use of plastic. In one case, it was estimated that a plastic jug found at sea had over 70,000 *Halobates sobrinus* eggs attached to it. The use of plastic as an egg-laying substrate by *Halobates* appears to be common (Majer *et al*. (2012) Mar. Pollut. Bull. *64*, 1143–1147), suggesting the potential for plastic to have important yet to be seen impacts on ecosystems.

Plastic makes landfall

While much of the attention has been focused on the effect of plastic in the ocean, we are beginning to learn that plastic pollution is a global phenomenon, affecting freshwater bodies and terrestrial environments as well. A recent headline in *The Guardian* read "It's raining plastic", referring to a study by the US Geological Survey finding plastic fibers in samples of rainwater taken in the Colorado Front Range (Wetherbee *et al*. (2019), U.S. Geological Survey Open-File Report). Similar surveys have been done in urban and suburban environments alike, showing that humans are exposed to plastic in the form of a persistent atmospheric fallout. As a basis for comparison, it has been estimated that the amount of plastic fibers humans are exposed to in their homes far exceeds the dose they would receive from eating shellfish (Catarino *et al*. (2018) Environ. Pollut. *237*, 675–684). But, again, the health consequences for this are unknown.

Plastic is found even in the most remote corners of the globe. A survey of an isolated lake in Mongolia, for example, found microplastic levels of 20,264 particles/km^2, which is higher than that seen in some of the Great Lakes in North America (Free (2014) Mar. Pollut. Bull. *85*,156–163). Microplastics have even been found in Arctic sea ice.

Solving the problem

Clearly, our knowledge of the effects of plastic on animal and human health is in its nascent stage, especially with regard to microplastics. But it certainly makes sense, given what we know so far, to try to limit or completely stem the flow of plastic into the environment. Here, there are a whole host of solutions that will probably need to be implemented simultaneously. An obvious problem is the lack of proper trash disposal in developing countries, which results in plastic being directly dumped into the rivers and oceans. Such improper dumping means that countries like India release even more plastic into the environment than the US, despite the latter producing much more plastic waste.

Increased recycling is another area that needs to be implemented on a broader scale, like that seen in some European countries that now outlaw plastic in landfills. This can sometimes be hard in practice to implement. In the US, a large amount of material normally shipped to China for recycling has been banned due to ongoing problems with contamination of the material and the increasing costs associated with recycling it.

Yet another solution is to decrease our reliance on single-use packaging, which accounts for 40% of the plastic produced. Some communities in the UK, for example, have gone back to the milkman with his glass bottles in attempt to cut down on plastic use. Finally, biodegradable forms of plastic have been developed and used successfully in small-scale trials, such as compostable shopping bags in Milan, and a move by the city of Seattle to require all food service businesses to use biodegradable containers and utensils. These efforts make a plastic-free world in the future seem possible. As in the case of climate change, many possible solutions are in hand but require the political will to implement them.

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Quick guide

The Anthropocene

William F. Laurance

What is the Anthropocene? If aliens should one day visit Earth, would they conclude that this planet suddenly went topsy-turvy at a time coincident with the rise of a particular species of hairless ape? How could they not see that something really, really dramatic happened, right about now?

That is, in essence, the idea behind the Anthropocene era — the view that the changes presently wrought by humanity are so monumental they could rival epic natural events such as ice ages, tectonic shifts, volcanic upheavals and possibly even killer asteroids that have profoundly altered our planet and its biodiversity time and again during the past few billion years and consequently were used as landmarks for new geological epochs.

The term 'Anthropocene' (from Greek: *anthropos*, for 'human', and *cene*, connoting 'new' or 'recent') was popularized by atmospheric chemist and Nobel laureate Paul Crutzen, but it was used by Soviet Union scientists already in the 1960s. The Anthropocene is not yet formally recognized as a new geological epoch. But the idea is being seriously considered by stratigraphers and other geological authorities that make such decisions.

What is the evidence? Our alien visitors would have to be clueless not to see the abrupt, global-scale changes in the Earth's stratigraphic record — the dated sedimentary layers used by researchers to define different chapters in geological history. Even if humans were to disappear today, our geological signature in contemporary sediments would be striking. The aliens would discover, for instance, that the red junglefowl (*Gallus gallus*), formerly confined to Southeast Asia, had suddenly spread to every corner of the planet. With 60 billion junglefowl, also known as domestic chickens, consumed annually, it might become the most abundant animal in the fossil record. Thousands of other species have also become globally ubiquitous. Sediment cores would be overwhelmed by pollen from a handful of human crops,

Figure 1. Potential drivers of a mass extinction.
Top left: smoke from forest burning (photo: Meinrat Andreae). Bottom left: deforestation in the Congo Basin. Right: Forest elephant killed by poachers (photos: William Laurance).

while pollen from wild plants decreased simultaneously. This turbulent mixing of the planet's biodiversity — one of the unique signatures of humanity — is why some have also termed our present era the 'Homogenocene'.

Beyond this biological blender, the aliens would find that geophysics and geomorphology had seemingly gone mad. Erosion would skyrocket in most places given the zeal with which humans dig and scrape the Earth. Evidence of ancient roads, mines, dams, and other human constructions would be unmissable. Human-made litter, debris, and microplastics would accumulate in marine sediments where they are preserved as 'technofossils'. Trace elements from atomic detonations, including radionuclides of plutonium (^{239}Pu) and carbon (^{14}C), would show sudden global spikes, as would mercury, black carbon and inorganic ash from the burning of coal and other fossil fuels.

And, of course, the aliens would see that biological diversity had plummeted, especially for rare or locally endemic species, top predators, large-bodied animals, old-growth trees, and scores of other extinction-prone groups. The current magnitude of global extinction is uncertain and debated, but many experts believe that contemporary extinction rates are 100–1000 times higher than natural background rates. Beyond this, the decline in the abundance of wild species would be remarkable. Humans and their livestock now account for 96% of all mammal biomass on Earth.

When did the Anthropocene begin? Marked human impacts stretch back at least to the hunting extinctions that decimated much of Earth's megafauna, as humans began to colonize and populate the planet tens of thousands of years ago. Another proposed date for the Anthropocene is 12,000–15,000 years ago, aligning with the agricultural revolution and sedentary human societies. Some prefer more recent and definitive dates. One is the industrial revolution — nominally starting in 1784 with Watt's improved steam engine. Another is the Trinity test of the first atomic bomb in 1945, which initiated an era of above ground nuclear testing that littered the planet with radioactive isotopes. To our alien visitors in the distant future, such distinctions would be splitting hairs. Except for recent strata (<60,000 years old), the temporal resolution of the stratigraphic record is relatively coarse — typically tens to hundreds of thousands of years, at best. From the aliens' perspective, the Earth would have changed radically in a geological heartbeat.

Why does it matter? Labeling our current era as the Anthropocene could have big implications. Among other things, it suggests we could be driving a global mass extinction (Figure 1) — conceivably on par with Earth's five great extinction events, including the End-Permian extinction that decimated the oceans and much life on land. This idea of a human-caused extinction spasm on such a scale is hotly debated, as it should be. During the earlier mass extinctions, great swaths of life were extinguished. Were this to happen now, we'd lose not just rare frogs or songbirds, but also widespread, adaptable species such as rats and coyotes. Biological genocide on this scale would require a true cataclysm. Nuclear holocaust is one such possibility. Runaway synergisms among climatic change, habitat disruption, and wildlife overkill might be another.

Is it a useful term? In environmental circles, the term Anthropocene is now firmly established as a buzzword. In 2018, the term appeared in nearly 200 peer-reviewed articles, and it is the title of a new journal. A key question is whether labeling our current era as the Anthropocene will act as a wake-up call, galvanizing humanity to take preventative actions. Humans tend to ignore or downplay a problem until it becomes an in-your-face crisis. Sometimes this is smart, as it ensures we don't run around tilting at windmills. But sometimes it's dangerous and dumb, providing a means to reconcile ourselves to a 'new normal' that is not normal at all. Even future alien visitors would recognize the Anthropocene for the lurking monster it has now become.

Where can I find out more?

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