Geoglyphs on deforested land at the Fazenda Colorada site in the Amazon rainforest. (Credit: Sanna Saunaluoma)

Furthermore, they appear to be widespread: as much as ten percent of Amazonia may be covered by anthropic black soils.

The second clue is more subtle. The first human inhabitants of the Amazon, the Paleoindians, are thought to have been foragers, eating fish from the rivers and fruits and nuts from the trees. But when populations began to settle they would cut wood and discard seeds in the vicinity of their settlement. Over time this would have changed the make-up of the forest, producing small concentrations of palm groves and fruit trees. The Amazonian rainforest is traditionally thought to be very diverse such that individual trees in any one particular species are widely spaced. Therefore, concentrations of a specific species are very noticeable. Some of the groves that were created at prehistoric settlements are still intact today and are now major resources. However, the extent of these anthropic forests isn't known and a major challenge for future research is to map their distribution across the entire Amazon basin since doing so would give an indication of the extent of human settlement.

Since the first sedentary sites around 9,000 years ago, there are numerous other indications of large human communities in the Amazon. The oldest of these is from the Faldas de Sangay culture in Ecuador: between 1400 and 2700 years ago an urban-scale development of soil mounds and connecting roads existed in the middle of the western Amazon jungle. The requisite anthropic black soils have been discovered on the tops of the mounds along with fine art, pottery, sculptures and tools. Meanwhile, at Marajo Island, right at the mouth of the Amazon River, more than 400 earth mounds have been discovered over an area of 20,000 square kilometres and are up to 1300 years old. Discoveries like these came as a real surprise: until lately it had been thought the soil quality throughout much of the Amazon was too poor to support static societies of any great size, but these and other major earthworks would seem to suggest otherwise.

The most curious signs of human habitation, though, are features called geoglyphs, large-scale designs etched into the ground. The Nazca Lines, in the Nazca Desert of southern Peru, are probably the most famous example. But in the dense jungle of the Amazon, it is only recently that whole series of geometric shapes have been revealed due to the ongoing deforestation. Now, hundreds of these enigmatic structures have been discovered hidden beneath the canopy. One of the clearest is at Fazenda Colorada in the state of Acre on the western tip of Brazil. A giant circle, diamond, and square were dug into the ground more than a thousand years ago. Their purpose is much debated in the academic literature, but it has been suggested that they might serve a religious or political function.

The research that has accumulated over the last few decades is incontrovertible: the Amazon is not the untouched, exotic paradise we thought it was. Furthermore, the long history of human habitation in the Amazon indicates that people in former ages were able to live in the forest, changing its composition and structure in a way that was compatible with its survival. Perhaps we ought to be trying to do the same?

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No black-and-white issue: how dark aerosols affect the icy heights of the Himalayas

More than a billion people depend on water that runs off from the glaciers of the Himalayas for drinking water, irrigation and hydroelectric power. However, the pressures placed on this enormous water resource by anthropogenic climate change are still surprisingly poorly understood. The importance of better quantifying the effects of human-made changes and their future impacts is clear: not only do more people depend directly on the ice in Earth's 'Third Pole' than that in Greenland or Antarctica, the complex topography of the Himalayas also means that it is impossible to extrapolate from relatively few studies to a larger scale.

An aerosol known as black carbon – droplets or particles of soot suspended in the atmosphere – is of particular concern. A by-product of the incomplete combustion of fossil fuels, it is the most light-absorbing aerosol we know. Emissions of black carbon have skyrocketed over the last 250 years, coinciding with the beginning of

Light absorbing impurities in snow are present on snow and glacier melt in the mountains and polar regions of the globe. This picture shows the Colorado Rocky Mountains snowpack with dust from deserts of the western US. (Credit: T. H. Painter, Snow Optics Laboratory, JPL/Caltech)

the industrial revolution. Some argue that the proposed Anthropocene era should cover this period because of the way in which we humans have shaped the Earth system since the onset of industrialisation. Others suggest that the Anthropocene began much earlier and spans several millenia, but as far as black carbon emissions are concerned, the last two centuries mark a significant deviation from background concentrations. Now, the impact of black carbon on high Himalayan glaciers is the focus of a recent study published in the journal The Cryosphere.

Black carbon has been found to be the second most important anthropogenic emission – behind carbon dioxide, but ahead of methane – in terms of its impact on global radiative forcing. This means that it increases the amount of solar radiation absorbed by the Earth system instead of being reflected back into space. But black carbon has been found to remain in the atmosphere for much less time than previously thought.

The short residence time of black carbon in the atmosphere means that large amounts of the material are deposited on the ground – or, in the case of the Himalayas, on snow or ice. The black particles lower the albedo of the white ice and snow, meaning that far more solar radiation is absorbed rather than reflected. To quantify how much extra melting black carbon has caused in the Himalayas over the last decade, Patrick Ginot of the University of Grenoble and his co-investigators studied a shallow ice core containing ice accumulated from 1999 to 2010 at the summit of Mera Peak in northeastern Nepal, at 6,376 m above sea level.

The researchers chose the inaccessible study site on purpose. Very few studies of the impact of black carbon on glacier mass balance exist from altitudes of above 6,000 m, where its aerosol effect increases considerably. Since ice persists year-round, black carbon deposits become part of the layers of ice as they accumulate year after year; its abundance can be measured in the ice core. Finally, Mera Peak is situated on the south side of the Himalayas, where the monsoon and the westerly winds that prevail during the rest of the year supply air from different parts of the world and with different black carbon concentrations.

Measuring the concentrations of black carbon and dust in the ice core, Ginot and his colleagues found that black carbon peaked immediately before and after each monsoon. During this time, air is transported up from India and displaces the westerly winds that usually dominate. During the monsoon itself, however, black carbon is washed out of the atmosphere by rain before the air reaches the Himalayas.

Despite its strong effect on albedo, black carbon proved not to be the only important driver of changes in ice melt at the summit of Mera Peak. The amount of dust, another material that lowers the albedo of ice, was up to 1,000 times greater than the amount of black carbon in the ice core. Using models to simulate the energy balance of the glacier and the net amount of energy available for melting, the researchers calculated that black carbon and dust together could have caused up to a quarter of all ice melt over the 2009–10 period.

The consistently high levels of dust throughout monsoon and non-monsoon periods suggest that its source is local and relatively nearby. To verify whether the strong contribution of dust to glacier melt is a local anomaly, Ginot and his colleagues plan to collect another ice core from a different high-altitude site.

While the team did not detect a rising trend in the black carbon content of the ice at Mera Peak over the last decade, the subject warrants further study, particularly as black carbon patterns are known to be much more complex in the Himalayas than in the other two great reservoirs of ice in Greenland and Antarctica. It remains to be seen whether measures to cut down black carbon emissions in India and worldwide will continue to be effective. If concentrations of this dangerous aerosol can be reduced, millions of people may continue to rely on the mighty rivers flowing down from the Himalayas as their main water source.

The number of ways in which the growing human population has affected the Earth system in the last 10,000 years is beyond counting, making an exact definition of an era such as the Anthropocene a challenging issue. This study of black carbon in the Himalayas contributes to one of the most prominent debates at present, relating to emissions of aerosols such as black carbon and other particles contributing to global climatic change over the last few centuries.

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