

# Greenhouse gas 'bookkeeping' turned on its head

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Credit: NASA

For the first time scientists have looked at the net balance of the three major greenhouse gases—carbon dioxide, methane, and nitrous oxide—for every region of Earth's landmasses. They found surprisingly, that human-induced emissions of methane and nitrous oxide from ecosystems overwhelmingly surpass the ability of the land to soak up carbon dioxide emissions, which makes the terrestrial biosphere a contributor to climate change. The results published in the March 10, 2016, *Nature*, revises our understanding of how human activity contributes to global warming.

Co-author Anna Michalak of Carnegie's Department of Global Ecology remarked, "Typically we think of land as a net 'sink' of carbon dioxide. But we found that the sign of the human-induced impact is reversed if we also take into account methane and nitrous oxide."

The scientists looked at the so-called biogenic fluxes or flow of the three greenhouse gases on land that were caused by human activities over the last three decades and subtracted out [emissions](#) that existed "naturally" during pre-industrial times. Biogenic sources include [gas emissions](#) from plants, animals, microbes, and the like. They were interested in finding out how human activities have changed the biogenic fluxes of these gases. Historically, such emissions have included methane emissions from wetlands and [nitrous oxide emissions](#) from soil. Human activity and human-caused [climate change](#) have changed the magnitude of these fluxes, however, as well as added new categories of biogenic fluxes such as those resulting from sewage, cattle, and fertilizer use.

The scientists first added up all biogenic emissions of carbon dioxide, methane, and nitrous oxide, then subtracted out those that occurred naturally prior to human intervention to get to the net amount. The study did not include non-biogenic gas emissions from activities like fossil fuel burning or natural gas production.

The team discovered that the human impact on biogenic methane and nitrous oxide emissions far outweighed the human impact on the terrestrial uptake of carbon dioxide, meaning that humans have caused the terrestrial biosphere to further contribute to warming. In other words, the terrestrial biosphere, through human action, is now contributing to climate change rather than mitigating climate change. This runs counter to conventional thinking based on previous studies, which had focused only on [carbon dioxide](#) and had emphasized the climate change mitigating effect of human impacts terrestrial carbon uptake.

The scientists found that [greenhouse gas emissions](#) vary considerably by region. Interestingly, the human-induced emissions of the gases in Southern Asia, including China and India, had a larger net warming effect compared to other areas. Southern Asia contains some 90% of the world's rice fields and more than 60% of the world's nitrogen fertilizer use. Thus, [methane emissions](#) in this region are largely from rice cultivation and livestock, while man-made fertilizers are a major source of [nitrous oxide](#).

Lead author of the study, Hanqin Tian director of the International Center for Climate and Global Change Research, School of Forestry and Wildlife Sciences at Auburn University said, "This finding reveals for the first time that human activities have transformed the land biosphere to a contributor to climate change."

"This study should serve as a wake-up call to governments, policymakers, and individuals around the world," said Michalak. "We must expand our focus and devise strategies that target the biogenic emissions of these other greenhouse gases if we are to change the course of climate change."

**More information:** The terrestrial biosphere as a net source of greenhouse gases to the atmosphere, *Nature*, [DOI: 10.1038/nature16946](https://doi.org/10.1038/nature16946)

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