



IEAGHG Information Paper: 2017-IP9; The Anthropocene Equation

Scientists have developed a mathematical equation to describe the impact of human activity. This unique development has recently been published in the Journal Anthropocene Review. The full paper published by researchers from Stockholm University, Sweden, the Royal Swedish Academy of Sciences and the Australian National University can be referenced at:

<http://journals.sagepub.com/doi/10.1177/2053019616688022>

The abstract from the journal paper summarising the research findings is given below.

The dominant external forces influencing the rate of change of the Earth System have been astronomical and geophysical during the planet's 4.5-billion-year existence. In the last six decades, anthropogenic forcing's have driven exceptionally rapid rates of change in the Earth System. This new regime can be represented by an 'Anthropocene equation', where other forcing's tend to zero, and the rate of change under human influence can be estimated. Reducing the risk of leaving the glacial–interglacial limit cycle of the late Quaternary for an uncertain future will require, in the first instance, the rate of change of the Earth System to become approximately zero

One of authors (Owen Gaffrey) discusses the equation they have developed in the article in New Scientist. Please see: <https://www.newscientist.com/article/2120951-simple-equation-shows-how-human-activity-is-trashing-the-planet/>

In the article in New Scientist he suggests that:

Homo sapiens now rivals the great forces of nature. Humanity is a prime driver of change of the Earth system. Industrialised societies alter the planet on a scale equivalent to an asteroid impact. This is how the Anthropocene – the proposed new geological period in which human activity profoundly shapes the environment – is often described in soundbites.

The Anthropocene Equation developed by the authors aims to create an unequivocal statement of the risks industrialised societies are taking at a time when action is vital. The Anthropocene equation homes in on the rate of change of Earth's life support system: the atmosphere, oceans, forests and wetlands, waterways and ice sheets and fabulous diversity of life.

For four billion years, the rate of change of the Earth system (E) has been a complex function of astronomical (A) and geophysical (G) forces plus internal dynamics (I): Earth's orbit around the sun, gravitational interactions with other planets, the sun's heat output, colliding continents, volcanoes and evolution, among others.

$$\frac{dE}{dt} = f(H)$$
$$A, G, I \rightarrow 0$$

The Equation showing the rate of change of the Earth system (E) over the last 40 to 50 years is purely a function of industrialised societies (H)



According to the author, the rate of change has been anything but steady of late. *“If we take a baseline of the last 7000 years, until recently, global temperature decreased at a rate of 0.01 °C per century. The current rate (last 45 years) is a rise of 1.7 °C per century – 170 times the baseline and in the opposite direction. The warmest 12 years since records began have all occurred since 1998”.*

The rate of carbon emissions to the atmosphere is the highest in 66 million years. The loss of biodiversity in recent decades prompted researchers in 2015 to argue that the Anthropocene marks the third stage in the evolution of Earth’s biosphere, following on from the microbial stage 3.5 billion years ago and the Cambrian explosion 650 million years ago¹.

The authors’ key conclusion is that the rate of change of the Earth system over the last 40 to 50 years is a purely a function of industrialised societies (H).

In the equation, astronomical and geophysical forces tend to zero because of their slow nature or rarity, as do internal dynamics, for now. All these forces still exert pressure, but currently on orders of magnitude less than human impact.

The authors acknowledge that their conclusion is a bold statement. But they consider that; *“viewed this way, arguments about humans versus natural causes disappear”*. They reference a recent event as part of their argument to support this theory.

“In 2016, Earth experienced a massive El Niño event affecting the global climate. But this is balanced by the cooler La Niña – taken together, the net rate of change of the Earth system resulting from these is zero over a decade or so”.

The authors end their article with some points of concern.

- Far from living on a deeply resilient planet, we live on a planet with hair triggers.
- Industrialised societies are fumbling around with the controls, lulled into a false sense of security by the deceptive stability of the Holocene, the last 11,700 years.
- Remarkably and accidentally, we have ejected the Earth system from the interglacial envelope and are heading in to uncharted waters.
- While the rate of change of the Earth system needs to drop to zero as soon as possible, the next few years may determine the trajectory for millennia.
- The dominant neoliberal economic systems still assume Holocene-like boundary conditions – endless resources on an infinite planet.
- Instead we need “biosphere positive” Anthropocene economics, where economic development stores carbon not releases it, enhances biodiversity not destroys it and purifies waters and soils not pollutes them.

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¹ <https://www.newscientist.com/article/dn27162-all-hail-the-anthropocene-the-end-of-holocene-thinking/>