
1.2 The “Anthropocene”

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Abstract. Human activities are exerting increasing impacts on the environment on all scales, in many ways outcompeting natural processes. This includes the manufacturing of hazardous chemical compounds which are not produced by nature, such as for instance the chlorofluorocarbon gases which are responsible for the “ozone hole”. Because human activities have also grown to become significant geological forces, for instance through land use changes, deforestation and fossil fuel burning, it is justified to assign the term “anthropocene” to the current geological epoch. This epoch may be defined to have started about two centuries ago, coinciding with James Watt’s design of the steam engine in 1784.

The Holocene

Holocene (“Recent Whole”) is the name given to the post-glacial geological epoch of the past ten to twelve thousand years as agreed upon by the International Geological Congress in Bologna in 1885 (Encyclopaedia Britannica 1976). During the Holocene, accelerating in the industrial period, mankind’s activities grew into a significant geological and morphological force, as recognised early by a number of scientists. Thus, in 1864, G. P. Marsh published a book with the title “Man and Nature”, more recently reprinted as “The Earth as Modified by Human Action” (Marsh 1965). Stoppani in 1873 rated mankind’s activities as a “new telluric force which in power and universality may be compared to the greater forces of earth” [quoted from Clark]. Stoppani already spoke of the anthropocene era. Mankind has now inhabited or visited all places on Earth; he has even set foot on the moon. The great Russian geologist and biologist Vernadsky (1998) in 1926 recognized the increasing power of mankind in the environment with the following excerpt “... the direction in which the processes of evolution must proceed, namely towards increasing consciousness and thought, and forms having greater and greater influence on their surroundings”. He, the French Jesuit priest P. Teilhard de Chardin and E. Le Roy in 1924 coined the term “noösphere”, the world of thought, to mark the growing role played by mankind’s brainpower and technological talents in shaping its own future and environment.

The Anthropocene

Supported by great technological and medical advancements and access to plentiful natural resources, the expansion of mankind, both in numbers and per capita exploitation of Earth's resources has been astounding (Turner et al. 1990). To give some major examples:

During the past 3 centuries human population increased tenfold to 6000 million, growing by a factor of four during the past century alone (McNeill 2000). This growth in human population was accompanied e.g. by a growth in the cattle population to 1400 million (McNeill 2000) (about one cow per average size family). Urbanisation has even increased 13 times in the past century. Similarly large were the increases in several other factors, such as the world economy and energy use (see Table 1.2.1). Industrial output even grew forty times (McNeill 2000). More than half of all accessible fresh water is used by mankind. Fisheries remove more than 25 % of the primary production of the oceans in the upwelling regions and 35 % in the temperate continental shelf regions (Pauly and Christensen 1995).

In a few generations mankind is exhausting the fossil fuels that were generated over several hundred million years, resulting in large emissions of air pollutants. The release of SO_2 , globally about 160 Tg/year to the atmosphere by coal and burning, is at least two times larger than the sum of all natural emissions, occurring mainly as marine dimethyl-sulphide from the oceans (Houghton et al. 1996). The oxidation of SO_2 to sulphuric acid has led to acidification of precipitation and lakes, causing forest damage and fish death in biologically sensitive regions, such as Scandinavia and the Northeast of North America. Due to substantial reduction in SO_2 emissions, the situation in these regions has improved in the meanwhile. However, the problem is getting worse in East Asia.

From Vitousek et al. (1997) we learn that 30-50 % of the world's land surface has been transformed by human action; the land under cropping has doubled during the last century at the expense of forests which declined by 20 % (McNeill 2000) over the same period. Coastal wetlands are also affected by humans, having resulted for instance in the loss of 50 % of the world's mangroves.

More nitrogen is now fixed synthetically and applied as fertilisers in agriculture than fixed naturally in all terrestrial ecosystems. Over-application of nitrogen fertilisers in agriculture and especially its concentration in domestic animal manure have led to eutrophication of surface waters and even groundwater in many locations around the world. They also lead to the microbiological production of N_2O , a greenhouse gas and a source of NO in the stratosphere where it is strongly involved in stratospheric ozone chemistry. The issue of more efficient use of N fertiliser in food and energy production has recently been summarised in a special publication of Ambio (2002).

The release of NO into the atmosphere from fossil fuel and biomass combustion likewise is larger than the natural inputs, giving rise to photochemical ozone ("smog") formation in extensive regions of the world. Human activity has increased the species extinction rate by thousand to ten thousand fold in the tropical rain