

The Anthropocene Age and the Challenges of Global Warming for the Evolution of Human Civilization

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Abstract.

For centuries, humanity has evolved following the ideals of the Renaissance. The pursuit of knowledge and science, the views of the esthetically beautiful as a value, the belief in the possibilities of creative potential have placed at the center in the subsequent events and their manifestations. The industrial revolutions and the technological advances that have taken place, as a higher skill in adapting to nature, are a feature that subsequently gives it a decisive role in the appearance of the surrounding world. The subsequent socio-economic and chemical changes inevitably lead to the new era Anthropocene - "Age of humans". It is no coincidence that the term "Anthropocene" emerges as a term for the geological epoch. According to scientists, the end of the preceding Holocene era, which lasted 11 700 years and the beginning of the new era, was 1950, due to indisputable evidence of an unprecedented rate and global scale of human impact on the Earth system. Increasing the concentration of global carbon dioxide after 2000 is about 20 parts per million per decade, which is 10 times more than any steady increase over the last 800 000 years.

Biodiversity is one of the key indicators for the vitality of our ecosystem. This process has began before more than 2.5 billion years during the Proterozoic period with the development of prokaryotes in eukaryotes and the first multicellular life forms. Biosphere is notable with its independence in terms of matter, because of the complete biochemical circulation of substances. The concept of the Anthropocene, in which man and his needs are with fundamental meaning, should confirm the nature of contemporary processes and their consequences. Wildlife habitat fragmentation, as result of human activity has been much more noticeable in the last century, in part because of the rising demographics –the population has increased fourfold to 7 billion. "The pattern of the human population growth in the 20th century was more bacterial than primate" writes biologist Edward Wilson. He estimated that human biomass is already about 100 times larger than any other large animal ever inhabited Earth. The invasion and impact on habitats of almost all known species, whether directly or indirectly, is caused by the basic processes in the development of human civilization.

Keywords: global warming, climate, anthropogenic activity, greenhouse gases

„A man’s home is his castle “

Climate change public activity

This sentence is increasingly expressed and confirmed by eco-activists in their fight against global warming. The last United Nations leaders meeting in New York in September 2019, which coincided with the 51st IPCC¹ meeting in Monaco, was accompanied by the most numerous and widespread protest against climate change. Six million people have taken to the streets, uniting across timezones, cultures and generations to demand urgent action on the escalating ecological emergency. German police have reported that over 100 000 people have been demonstrated in Berlin. Approximately 1.4 million people gathered in a number of cities across Germany against governments inactivity on climate change. Australia had the biggest protests since the start of the war in Iraq from 2003, bringing together around 300 000 people in 110 cities. Greta Thunberg’s

¹ IPCC - Intergovernmental Panel on Climate Change is an intergovernmental body of the United Nations that is dedicated to providing objective, scientific information relevant to understanding the risk of human-induced climate change

words "Change is coming, whether you like it or not" has become emblematic of global strikes. After just one month at the 25th United Nations Climate Change Conference in Madrid, she notice that "our voices" had been heard but had not yet been placed in action.

Greenhouse gases caused by anthropogenic activity

The first legally binding global document to engage developed countries with a specific quantitative reduction in their greenhouse gas emissions is the Kyoto Protocol, adopted in December 1997. For the first time it officially defines the 6 major greenhouse gases:

- **Carbon dioxide (CO₂);**
- **Methane (CH₄)**
- **Nitrous oxide (N₂O)**
- **Hydrofluorocarbons (HFCs)**
- **Perfluorocarbons (PFCs)**
- **Sulfur hexafluoride (SF₆)**

According to the report on the United Nations Environment Program (UNEP), despite the advances in climate policies of many of the related countries, the trend in global GHG emissions continues to grow at a steady growth rate of 1.6 percent each year from 2008 to 2017, when it reaches 53.5 gigatons of carbon dioxide. In 2018 continues to rise and break the record from 2017. CO₂ levels at the end of 2019 are almost as much as they were expected to reach in 2020. The implications of climate policy have not had a significant impact on key indicators, like the main methods for economic growth. The findings of the same report conclude that efforts to achieve the objectives of the Paris Agreement must be tripled in order to achieve global warming restriction of up to 1.5 °C. The period from 1970 to 2011 is the largest increase by nearly 90%. CO₂ emissions observed.

The largest share of GHG in 2019 is due to carbon dioxide, exceeded 414.7 ppm and represented 65% of total greenhouse gas emissions. For a period of 115 years, from 1900 to the present day the value has increased from 2 billion tonnes to 36 billion tonnes, with levels progressively increasing.

CO₂ emitted by economic sectors and countries

- By shares of economic sector, the highest percentage of CO₂ is emitted from **electricity and heating** – 25 percents. Fossil fuel use is the primary source of CO₂. CO₂ can also be emitted from direct human-induced impacts on forestry and other land use, such as through deforestation, land clearing for agriculture, and degradation of soils.

- **Agriculture, forestry and other land** uses account for 24% of total emissions. Greenhouse gas emissions from this sector come mostly from agriculture cultivation of crops, livestock and deforestation.

- **The industrial sector** emits 21% of the global share. Greenhouse gas emissions from industry primarily involve fossil fuels burned on site at facilities for energy. This sector also includes emissions from chemical, metallurgical, and mineral transformation processes not associated with energy consumption and emissions from waste management activities.

- **Transport** has a share of 14% of global GHG. Greenhouse gas emissions from this sector primarily involve fossil fuels burned for road, rail, air, and marine transportation. Almost all (95%) of the world's transportation energy comes from petroleum-based fuels, largely gasoline and diesel..

- **Buildings** produce 6% of these emissions. Greenhouse gas emissions from this sector arise from onsite energy generation and burning fuels for heat in buildings or cooking in homes.

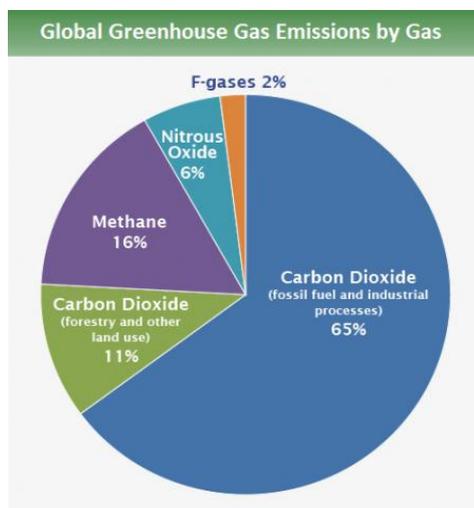


Figure 1. Global Greenhouse Gas Emissions by Gas

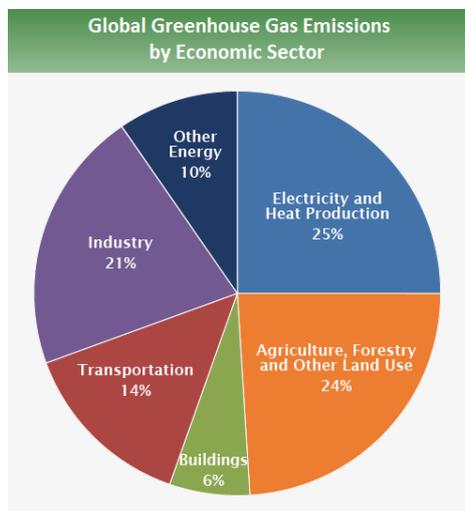


Figure 2. Global Greenhouse Gas Emissions by economic sector
source: IPCC Fifth Assessment Report

About 2/3 amount of CO₂ is emitted by the 6 most developed economies, with the following shares: China 30% (10 billion tonnes a year); USA 15%; EU 9%; India 7%; Russia 5%; Japan 4%. The remaining 30% are issued by the rest of the world. The interesting thing about this statistic is that in 2017, for example, countries in Africa and Latin America produce only 3.7% (1.3 billion tonnes) and 3.2% (1.1 billion tonnes) respectively, which means to a large extent, that these countries have a chance to start investing in alternative energy sources directly without having destabilization in the transition to low carbon economies. As the United Nation Climate Change Conference(UNCCC) from December held in Madrid, bulgarian Prime Minister Boyko Borisov announced that 46% of the country's energy production comes from coal burning, reaching 60% in winter.

Without policies to further reduce emissions, the average global temperature is expected to increase between 3.2 ° C and 3.9 ° C over the end of this century. Human activities such as burning fossil fuels, deforestation and agriculture lead to excessive release of carbon dioxide, methane, nitrous oxide and hydrofluorocarbons. These greenhouse gases capture the heat emitted from the Earth's surface and do not allow it to be released into space, thus causing global warming.

Temperature changes

The summarized calculations data from the average measured temperatures at meteorological stations around the world point that the global temperature is rising by 1,1°C since the preindustrial levels.

According to data by the European Outdoor Conservation Association (EAOC) the average tempe on the European continent has risen 1.3°C during the past decade (2002-2011). For the decade of 2009-2019 the increase is 1.6-1.7°C. This is twice as much of the average global temperature. The warmest years in Europe so far are 2014, 2015, and 2018 with anomalies of approx 2°C higher, then during the pre-industrial period. The Summer of 2018 is the hottest to date, Especially strong heating up is observed above the Iberian peninsula, Central and Northeastern Europe, especially in the mountainous regions and Southern Scandinavia. The winter temperatures have risen the most in Northern Europe, while in Southern Europe the yearly increase is higher in the Summer.

The climate changes in Bulgaria have been proven by the method of calculating the increase of tropical nights – time intervals that have above 20°C across every region of the country. All regions in Europe are at risk from the climate changes, but some will face more negative effects than others. The forecasts are that Southern and Southeastern Europe will be strongly affected by these changes, as they will face the most negative effects. These regions will observe a significant increase in maximum temperatures and reduction of rainfall, and river volume, which leads increases the risk of extended drought, weaker harvest, loss of biodiversity and forest fires. The weaker river stream, due to limited rainfall will lead to higher concentration of pollution due to the decreased water volume that dissolves pollutants.

The global warming leads to more extreme meteorological, forest fires, loss of glaciers and increase of water level, food and water shortage and migration of people. The science shows that the risks irreversible and catastrophic changes will greatly increase if the global warming reaches more than 2°C above the levels of the pre-industrial period.

“The sea, the great unifier is man’s only hope. Now as never before,

the old phrase has literal meaning:
we are all in the same boat”

Jacques-Yves Cousteau – French oceanographer and explorer

The effects of the global warming on the oceans

Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC) of IPCC The Intergovernmental Panel on Climate Change is major institution dealing with the problems of global warming. Founded in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Program. Its main goal is to present a complete, objective and transparent evaluation of the scientific, technical and socioeconomic information, which is of importance to understanding of the climate changes caused by people, its potential effects, as well as adaptation and possibilities of mitigating these effects. The latest reports by IPCC is dated on September 24th 2019, and its entirely focused on the scientific research on the changes in the oceans and the cryosphere². The data shows, that the speed of which the oceans warm up is 2 to 3 times higher compared to the atmosphere, due to the higher density of water and its slower cooling process. Some of the main conclusions of the report are as follows:

- The loss of ice covering the arctic territories has tripled during the decade of 2007-2016, and doubled in Greenland compared to previous century.
- The strength of The Atlantic Meridional Overturning Circulation (AMOC) has weakened by almost 15% - an important ocean stream, regulating the climate in the Atlantic ocean, part of which is known as Gulfstream. A major weakening effect has the melting of fresh water deposits in Greenland.
- The pace ocean level rising is 3.6mm every year.
- Increase of the frequency and strength of some extreme meteorological events, such as tropical storms.
- Migration of sea species in the direction of polar zones since 1950 by a distance of 29 to 59 km per decade, following the structural and functional changes of the ecosystem.
- Loss of polar ice cover narrows the habitats of the birds and mammals depending on it, decreasing their survivability, due to lower abundance of feeding grounds.
- Increase of growth in the Tundra and a decrease in the northern forests.
- The Arctic spring phytoplankton bloom begins considerably earlier and spreads into waters without an ice cover.
- The Ocean warming contributes to the reduction of maximum fishing quantities and creates a risk of over-fishing

Arctic Ocean

According to the data from The US National Snow and Ice Data Center (NSIDC), sponsored by NASA the average size of the Arctic sea ice in October of 2019 is 5.66M sq. km – the lowest recorded in 41 years of continuous satellite measuring. This is 230 000 sq. km. lower than the previous lowest level of 2012 and 2.69 sq. km. under the average level for the period of 1981–2010. The global shrinkage of the total ice covered area results in considerably less reflection of Sun energy back into space, which contributes to even stronger warming effects.

Greenland

Researches at the Irvine University of California and NASA have summarized the past 46 years of data on the glaciers of Greenland, measuring the amounts of ice lost on the island for every decade. The research has been conducted through an integrated approach, measuring the height of the surface, speed, the mass of surface balance of 260 glaciers from 1972 to 2018. According to their estimates, the glaciers of Greenland had an average yearly loss of 51B tonnes of ice (1980 – 1990), and a 286B tonnes loss for 2010-2018. This amounts to a sea

² Cryosphere - an all-encompassing term for those portions of Earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps, ice sheets, and frozen ground.

level increase of 0.7mm/year. The loss of ice in Greenland caused 25% of the global sea level increase in 2014, compared to just 5% in 1993.

Glaciers melting

The melting of glaciers worldwide is strongly correlated to the quantities of fresh drinking water. The reduction of **Himalayan** ice caps will likely have a negative effect over the sustenance of the people living beneath them. The highest mountain range on the planet is supplying fresh water to the Ind river, which has hundreds of millions of people living next to it. The largest mountain range in Europe is losing vast amounts of ice mass each year, as well. Many of the glaciers are already extinct, and its highest peak **Monblanc** is melting with increasing speed, now moving by approximately 60cm a day. These processes create an enduring danger of landslide and avalanches for the population living in the proximity. The ice cap of **Kilimanjaro** is the only area in Africa that has snow all year round. It had shrunk by 80% in the past century. By 2035 the cap could disappear entirely.

Siberia

The vast Siberian taiga is also facing a serious climate modification as a result of the increasing temperatures. Its permafrost territories carry a potential environmental risk. There are enormous quantities of methane under the Siberian fields that transform into gaseous state when the soil melts, creating craters in the process. This speeds up greenhouse effects in the atmosphere. Ice melting in the region of the Russian Arctic coastline creates another substantial risk by revealing the old graveyards for animals that perished by Pustula Maligna. Russia has 400 registered zones of infection just in the Arctic region. The spores of the Pustula Maligna disease (Anthrax) can remain active in the soil for 50 years. This could lead to highly resistant infection zones, and a real threat of epidemics affecting wild and domestic animals, and people alike.

The rise in temperatures has a favorable effect on the spread on infectious diseases as a whole, since the carriers become active during warmer periods. This also causes to the migration of breeding territories for ticks and mosquitoes and increase in frequency of people being infected with Lyme disease and tick encephalitis.

Negative effects of the raise in temperatures in the world ocean

It is still a difficult task to describe the full extent of its effect on the climate cycles and in the context specific of environmental events, but it's a scientifically established fact, that the ocean temperatures are a main moving part of the global climate.

Natural events caused by the imbalance in Atlantic meridional overturning circulation. Environmental anomalies such as Hurricane Xavier sweeping over Northern Europe with wind speeds of 225 km/h in 2013, Hurricane Leslie that reached the coastline of Portugal with winds of 180 km/h in 2018, and the Level 5 Hurricane Lorenzo of October 2019, that spanned in an 800 km area with wind speeds of 252 km/h are becoming the norm in the European continent. Another example of such phenomenons is the Zorba cyclone in the Mediterranean sea which is highly unusual for this region. The correlation between the hurricanes and the global warming is complex, but there is a consensus, that the climate changes caused by people makes the hurricanes more intensive. The warmer waters exude higher energy which makes for stronger storms, and the rise of sea levels contributes to larger floods. Recent studies also show that climate changes make the hurricanes to be of higher humidity and slower movement. The latter is especially dangerous as the storms cause increased damage passing over the affected regions.

Floods. Floods are another characteristic of the changing climate, which seems to become more frequent during seasonal cycles, not only in Europe, but in all regions that have higher concentration of evaporating waters. Following the torrential rains in November 2019 Venice has been flooded by the largest tidal wave in the past 50 years and 90% of the city has been flooded, with damages estimated to nearly €1Billion. Floods have affected 5.5M people and have had caused € 90B in damages, between the period of 1980 and 2011.

Coral reefs. The water temperature is one of the most active regulators in the biological processes of the sea organisms. The warming of the oceans has a direct effect over the vital characteristics and properties of their inhabitants. An increase in frequency of the so called coral bleaching is being observed in the past two decades. Coral reefs constitute 3% of the total ocean area, but they amount for 1/4 of all ocean species. The Grand Barrier Reef illustrates the severity of the damage caused: 30% of the corals have perished in 2016, with another 20% in 2017. The reefs are the natural habitat of many ocean species. Their survival is of the essence for the biodiversity

and the strength of populations. Nearly 800 million people sustain themselves by fishing, which can lead to a food crisis.

Rate of desertification and wildfires. With the increase of global temperatures and human population, more regions become vulnerable to drought. The interpretation of the term 'drought' varies, but it consists of land degradation, caused by people in regions with low or volatile rainfalls, known as dry zones. They represent about 40% of the earth's surface. While land degradation has been occurring throughout history, today's pace has accelerated, reaching 30 to 35 times the historical rate. This degradation tends to be driven by a number of factors, including urbanization, mining, agriculture and deforestation. During these activities, trees and other vegetation are removed, with some regions having excessive animal grazing, and crops depleting the nutrients in the soil. All this contributes to soil erosion and the inability of the earth to retain water to restore landscaping levels. In China, a method of sowing in dry areas around the Gobi Desert is used with the help of biodegradable granules that retain moisture in the soil. "Great Green Wall" in Africa is the largest afforestation project. 8 billion dollars have been mobilized for this purpose. in landscaping at the southern border of the Sahara for 8000 km. in more than 20 countries.

Wildfires in the Amazonian rainforest. The Amazon is the largest tropical forest on Earth. When healthy, it absorbs billions of tons of carbon dioxide a year through photosynthesis. By removing CO₂ from the atmosphere, Amazon rainforest helps maintain temperatures and regulate the climate. It is a delicate system that is highly sensitive to drying and warming trends. Additionally, NOAA reported that, regionally, the temperatures in the January–July 2019 period were the second warmest year-to-date on record, followed by year-to-year increase of 88% in wildfire occurrences in June 2019. When a forest burns, it releases particles called aerosols into the atmosphere - among them, black carbon, commonly referred to as soot. When the black carbon absorbs heat from the sun, it causes the atmosphere to warm; it can also interfere with cloud formation and, consequently, rainfall. The clouds produce rain that replenishes the water in the soil, needed to allow the cycle to continue. Rainforests generate as much as 80 percent of their own rain, especially during the dry season. Scientists observed that the most significant and systematic drying of the atmosphere is in the southeast region, where the bulk of deforestation and agricultural expansion is happening. In addition to collecting timber, many trees in the Amazon are being cut down to plant soybeans or make more lucrative livestock pastures.

Global warming prevention and containment measures

Objectives and policy of the European Union. The EU Emissions Trading System (ETS) is the first major carbon market in the world to operate on a cap and trade basis. A limitation on the total amount of certain greenhouse gases has been set, that can be separated from installations covered by the system. The maximum threshold decreases over time so that total emissions fall. The projections for 2020 are that of emissions sectors covered by the system to be 21% lower than in 2005. The ETS operates in all EU countries, limiting emissions from more than 11,000 heavy-duty installations (power plants and industrial facilities) and airlines operating between those countries. It covers approx. 45% of EU greenhouse gas emissions. The targets set by the EU for 2030 are: a reduction of at least 40% of GHG emissions compared to 1990; at least 32% of total energy consumption to be from renewable energy sources; an increase of at least 32% in energy efficiency. Long term, the EU aims to significantly reduce its emissions by 80-95% by 2050, compared to 1990 levels. Building a highly efficient and low-carbon European economy will create jobs and increase Europe's competitiveness .

Financial mechanisms. At least 20% of the EU budget for 2014-2020, approx. € 180 billion, must be spent on climate protection. This will be complemented by funding from individual EU countries. Global investment in low-carbon energy development is expected to reach an average of \$ 1.6-3.8 trillion by 2050.

Another global platform with a financial mechanism is the Green Climate Fund (GCF)

To date, GCF has committed \$ 5.6 billion to 124 climate action initiatives around the globe. So far, \$ 3.38 billion has been spent to an anticipated reduction of 1.6 billion tonnes of carbon dioxide.

Renewable energy sources (RES). Solar energy is characterized as an inexhaustible source of energy, but its application depends on weather conditions. It is used in two basic forms: as a mean to heat water, air, oil, or other fluid that gives off heat in a facility or building; as a generation of electricity through photovoltaic modules. Wind energy uses kinetic energy when moving aerial forces to power electric generators. Hydroelectric power plants are artificially created systems for the use of energy from water masses. This method effects the ecosystem of the water basins. Geothermal energy is environmentally friendly and permanent. Almost anywhere at a depth of 3 meters , the temperature is between 10 and 16 degrees. It is widely used in residential and commercial heating, and electrical production. High hopes for limiting global greenhouse gas levels are put in the development of the electromobile industry. In the fall of 2019. German Chancellor Angela Merkel has allocated 1bn. Euro towards green transportation in India.

An optimistic view of the natural development of the human species, in coexistence with the surrounding biosphere, consists in the specific research on climate responses to every aspect of human activity and adequate measures to maintain balance in our ecosystem.

The positive outcome of such efforts to curb global warming would contribute to the favorable development of socio-political relations, and to a better understanding of human-ecosystem interaction.

Successful adaptation to the changing environment and the ability to balance the natural environment will bring about a fundamental change in the development of a democratic society from a consumeristic to a technological, biocentric one - a much-needed step towards consolidating a planetary society capable of colonizing and terraforming Mars.

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Appendix: some abbreviations

GHG – Green house Gases
CO2 – Carbon Dioxide
EEA - European Environment Agency
IPCC - Intergovernmental Panel on Climate Change
AMOC - Atlantic meridional overturning circulation
WMO - World Meteorological Organization
UNEP - United Nations Environment Programme
ETS – Emissions Trading System
GFC - Green climate fund
NSIDC - National snow and ice data center
ppm – parts per million