What Is Climate Change and What Are Its Consequences?

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Some of the energy from the Sun is reflected back into space by the Earth. So called "greenhouse gases" such as carbon dioxide trap some of this energy and reflect it back to the Earth, and this plays an important role in keeping the average temperature of the Earth at a level where humans can thrive. The problem now is that humans are pumping increasing amounts of heat-trapping greenhouse gases into the atmosphere (at a rate of around 2.5 million lbs per second!), which increases the global mean temperature.

Climate is the average weather in an area over many years, which usually remains stable for a long time, perhaps thousands or even millions of years. Due to the enormous amount of greenhouse gases that have been added to the atmosphere since pre-industrial times and the resulting rise in the global temperature, the Earth's climate is now changing much more rapidly in many regions and we are already seeing the effects.

Where Are We Now?

The global mean temperature has increased by just over 1°C (1.8°F) since pre-industrial times and we are beginning to see some serious consequences of this warming.

A warmer atmosphere can hold more water vapor, which should lead to more extreme rainfall events, perhaps causing severe flooding. This is indeed exactly what we are starting to see. The trend is particularly dangerous when the increased rainfall is associated with a hurricane. Hurricane Harvey in 2017 produced more than 50 inches of rain in the Houston area, leading to catastrophic flooding. Hurricane Dorian in 2019 produced a deluge of over 40 inches of rainfall in the Bahamas, again leading to devastating flooding. Five states set rainfall records related to tropical storms between 2017 and 2019. There is also a trend towards stronger, more intense hurricanes (Category 4 or 5) due to rising ocean temperatures.

Heat waves now tend to last longer and maximum temperatures are higher. These heat waves can be deadly, particularly in countries that already experience high summer temperatures, such as India and Pakistan and countries in the Middle East.

The intense heat dries vegetation, which becomes kindling for wildfires. Research has shown that climate change has already at least doubled the risk of extreme wildfires in California and was a major factor in causing the enormous wildfires in recent years. Siberia experienced the unprecedented temperature of 100°F in June 2020, and the heat wave caused massive fires even in the permafrost and tundra.

Sea levels are rising, in part due to the normal expansion of water with increasing temperature. The melting of the Greenland ice sheet is now also contributing to the rise. As a result coastal communities, such as the Miami region, are seeing many days of flooding as ocean water enters their streets even without an assist from wind. The very existence of some small island nations in the Pacific is threatened by rising sea levels.

Climate change is one factor causing the recent decline in biodiversity. The survival of a species will depend on how rapidly it is able to migrate away from unfavorable climate conditions and many species will not "move" fast enough to prevent extinction. Insects are particularly vulnerable to loss of habitat. Bird populations in the United States and Canada have declined by a third since 1970, mainly due to the loss of insects. There are many reasons for the decline in insect populations but climate change is now becoming a significant factor.

Ocean warming is leading to increasing "ocean heat waves" which produce mass die-offs of marine life and the creatures, such as sea birds that feed on them. Carbon dioxide dissolves in water producing carbonic acid, so increasing the amount of carbon dioxide in the atmosphere increases the acidity of the oceans. This is producing a catastrophic mass die-off (bleaching) of coral reefs worldwide and destruction of the coral reef ecosystems.

One of the most striking consequences of climate change in recent years has been the loss of sea ice around the Arctic, which has lost two thirds of its volume in the summer over the past 40 years. The image from NASA shows the sea ice extent inSeptember 2016. The sea ice would usually extend almost a far as the coasts of Siberia and Alaska in this month.

The loss of sea ice causes more heat to be absorbed by the ocean, which further increases sea ice melting and also the melting of the Greenland ice sheet.. How this affects the rest of the planet is not yet known with certainty, but it has been suggested that it weakens ocean currents and the jet stream, leading to an increase in extreme weather events.

The Future

The 2018 United Nations Climate Change Conference in Paris set a goal of keeping the global temperature rise below 2° C (the "stretch" goal of 1.5° C may already be unattainable given that we have reached more than 1° C). Even if this goal were met climate change would have severe impacts in many parts of the world. All of the impacts of global warming that are being seen at 1 °C warming will become significantly more severe at 2° C.

One consequence of 2° C warming will be a huge increase in the frequency of deadly heat waves. These could occur every summer in some areas, leading to the deaths of many tens of thousands of people. There will be a corresponding increase in the demand for air conditioning, which will require more power plants producing more carbon dioxide emissions in a vicious cycle.

At 2° C melting of the Antarctic ice sheets will start to make a significant contribution to sea level rise, on top of the contributions from the Greenland ice sheet and the melting of mountain glaciers, resulting in an acceleration of sea level rise. High tide flooding could inundate many coastal communities every year and some of these would probably be abandoned. Some small island states could become uninhabitable. Flooding inland would also increase due to the increase in frequency and intensity of extreme rainfall events. More intense monsoons, in particular the South Asian monsoon will unleash devastating flooding.

Some areas will suffer from drought rather than increased precipitation, especially countries in Africa. This will lead to a lowering in the yield of important food crops, such as corn, which must be added to the lowering caused directly by higher temperatures. The disappearance of mountain glaciers will severely affect those regions that depend on seasonal glacier meltwater, such as the nations of Central Asia.

In the Arctic, summers are likely to be nearly ice-free, which would strongly affect atmospheric circulation throughout the Earth. The Arctic would shift to a weather system dominated by rain rather than snow, disrupting its ecological balance and producing mass die-offs of wildlife.

Although the goal set by the Paris conference was a temperature rise of 2° C, even if all the pledges made by the participants were fulfilled the temperature rise would exceed 3° C (in a business as usual scenario, 3°C would be reached by 2050). In "The Uninhabitable Earth" David Wallace-Wells states "Warming of 3 or 3.5 degrees would unleash suffering beyond anything that humans have experienced through many millennia of strain and strife and all-out war.". Some areas of the Earth will be exposed to temperatures above the threshold at which it is no longer possible for humans to survive. Even more areas will experience temperatures at which it is not possible to work outside during the hot season.. This will produce mass migration from the affected countries towards areas with a more moderate climate.

Rapid melting of the Greenland and Antarctic ice sheets will produce a sea level rise that could attain as much as three feet by the end of the century (and a much further rise in the centuries to come). Flooding, both coastal and river flooding will affect many millions of people worldwide. People from low-lying coastal areas and flood plains will have to move. Coastal cities like New York will need to spend vast amounts of money to protect against flooding during hurricanes or superstorms. One study has predicted that New York will have to deal with three storms with the intensity of Superstorm Sandy *every year* even at 2.5° C warming.

At the other extreme large areas of the planet will not have enough rainfall and will suffer from "mega-droughts", in some cases will becoming deserts. Crop yields will be drastically reduced due to droughts and excessive heat, leading to famines and millions of climate refugees.

An important unknown in making predictions of the amount of global warming to be expected is the extent to which the release of greenhouse gases from the Arctic tundra will contribute to climate change. The additional warming will cause the release of even more greenhouse gases from the tundra, so the concern is that there will be a runaway "positive feedback" effect making global warming impossible to control, a frightening scenario. The thawing of the permafrost will of course lead to severe damage to any buildings and infrastructure built on it with enormous economic costs.

In view of the catastrophic effects of 3° C warming it is possible that the world will turn to geoengineering as a temporary fix in order to buy time while more permanent solutions are introduced. The most probable approach would be to seed the atmosphere with sulfate aerosols, which would block the sunlight and lower temperatures. However, the cooling effect will not be uniform across the planet and there may be unexpected and perhaps devastating consequences. Other methods seek to lower temperatures by withdrawing carbon dioxide from the atmosphere by, for example seeding the oceans with iron, which would increase the amount of carbon-capturing algae, but these methods are even less promising. Carbon dioxide removal by direct "carbon capture" from the atmosphere using absorbents, for example, could nevertheless make some contribution to lowering greenhouse gas levels, and the Paris Conference stated that such technology will be necessary if the goals of the conference are to be met.

In fact, as Jim Antal points out in "Climate Church, Climate World", we already have all the solutions we need to address climate change. The cost of renewable energy (solar, wind, etc.) is coming down rapidly and it is technically possible for nearly all countries to transition to 100% renewable energy by 2050. What is missing is the political will to end the dependence on fossil fuels and make the necessary investments in renewable energy that will prevent a catastrophic 3° C temperature rise. Above and beyond any technical solutions, what is most necessary, of course, is a change in our lifestyle and our attitude towards Creation.