A Child Born Today May Experience Earth 5°F Warmer than Preindustrial Earth

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2020 and 2016 are the hottest years ever recorded, but our children may remember them as cool. Rapid warming of the land and oceans harms everyone, particularly children and future generations. Climate change is already reducing agricultural and seafood harvests; compromising fresh water sources; causing droughts, wildfires, floods, sea level rise, more powerful tropical storms, and increasing the spread of some infectious diseases. Many people will become ill and die from extreme heat exposure. Climate change is a health emergency.

There is a solution. Emissions of heat-trapping gases can be reduced to zero to re-stabilize Earth's climate and reduce the frequency of climate disasters.

Earth's atmosphere, like a blanket, slows the movement of heat from Earth to outer space. Human activities destabilize Earth's climate by adding greenhouse gases (GHG = carbon dioxide, methane, nitrous oxide) to the atmosphere. GHG absorb and emit infrared energy (heat), a process that accumulates heat energy in the atmosphere. Because of GHG emissions, the global mean surface temperature (GMST, average atmospheric temperature at Earth's surface) increased by 1°C (1.8°F) from 1900 to 2017 and is rising by 0.2°C (0.3-0.4°F) per decade. By 2100 GMST could rise by 2.6°C (4.7°F). If GHG emissions continue as they are today, the rate of temperature change may increase and temperatures could go even higher.

Exposure to high ambient temperatures (more than 35°C or 95°F) for several hours without relief may cause a failure of temperature regulation in humans (called hyperthermia or heat stroke). The World Health Organization predicts that hyperthermia due to global warming may cause 250,000 deaths annually between 2030 and 2050. As a result of several years in hot outdoor environments workers may also develop heat-related chronic kidney disease. Since about 1980, there have been cases of chronic kidney disease and kidney failure recognized in persons who work in hot outdoor environments, mostly farms in tropical countries. Most of those affected are young, healthy men who have worked in a hot environment for more than two years.

Global harvests of wheat, rice, and corn are declining as weather/climate disasters and temperatures increase. Extreme heat reduces crop growth and pollination of crops. There are droughts and wildfires in some areas when temperatures become hotter, but rain does not increase to make up for evaporation of water from soil and plants (US West, 5-fold increase in wildfires since 1965). In other areas, depending on local weather conditions, higher temperatures provoke more precipitation and flooding (US Midwest, 5-15% increase in precipitation 1986-2015 compared to 1900-1960). Droughts, floods, wildfires, and extreme heat will continue to increase if GHG emissions are not reduced.

Carbon dioxide from Earth's atmosphere dissolves into and reacts with water to form carbonic acid causing water to become more acidic: $H_2O + CO_2 \rightarrow H_2CO_3$. Acidification makes

shell formation more difficult for some sea organisms (corals, mollusks, oysters, some plankton). In addition, as water warms, it holds less dissolved oxygen (O_2) compromising breathing of sea organisms. Cold water contains an abundance of oxygen for organisms to breathe while warm water contains less. When the oxygen level falls too low to sustain life, "dead zones" form in oceans and lakes. Oceans and lakes may be able to sustain fewer living things due to warming, acidification, and deoxygenation. Ocean phytoplankton produce about half the O_2 in Earth's atmosphere; we depend on the sea for our breath. Many also depend on the sea for food. (Commercial overfishing unrelated to climate change is also a great threat to the ocean.)

Toxic blooms occur when manure, sewage, or fertilizer run-off from land encounters unusually warm ocean or lake water. This causes rapid growth of microorganisms in water. When microorganisms grow rapidly and in large numbers, they consume all available oxygen in water and suffocate everything else living there. Warming of oceans and lakes by GHG emissions makes toxic blooms more likely. Toxic blooms, droughts, and floods compromise fresh water sources. Floods cause water sources to become contaminated by microorganisms from fertilizer, manure, or human waste. In the US floods contaminating water sources are the most common cause of diarrheal outbreaks.

When water warms, the average distance between water molecules becomes greater (thermal expansion of water) increasing ocean volume. Melting of ice on land also increases sea water volume. At the present time, sea level rises at the rate of 3.6 millimeters per year and this rate is increasing. As sea levels rise, coastal cities are threatened by flooding and contamination of their fresh water aquifers by salt water. A sea level rise of 0.9 meters (3 feet) might displace 100 million people worldwide. In 2019 the government of Indonesia abandoned its capital city of Jakarta due to flooding and sea level rise. A report by the US Army War College suggests that sea level rise and extreme heat will cause forced migrations of human populations. Weather/climate catastrophes are the most common cause of forced human migration today.

Warming of ocean water as a result of climate change makes tropical storms more powerful and with heavier rainfall. Tropical storms extract heat energy from water and convert this energy into wind. As the ocean warms, more heat is available for tropical storms. Warm water is the fuel that induces a storm to intensify, as heat and moisture move from the ocean to the atmosphere. Sea surface temperatures are usually above 28°Celsius (82°F) when hurricanes form.

Insects and ticks migrate as global temperatures rise. Anopheles mosquitoes transmit malaria and are expanding to higher altitudes in Africa. Aedes tropical mosquitoes are moving towards the North and South Poles and infecting more people with Dengue. Ixodes ticks transmit Lyme disease (an infection caused by bacteria of genus Borrelia) and Culex mosquitoes transmit West Nile encephalitis (a viral disease). Both Lyme disease and West Nile encephalitis have migrated from the U.S. to Canada since 2000 as temperatures have warmed. Not only will human diseases change their geographic ranges, but also diseases and pests that affect crops and forests.

Poverty and climate change are interrelated because the poor are disproportionately affected and have fewer resources to cope. Climate devastation reduces food and water security

and displaces populations. The World Bank estimates that climate change could force 100 million more people into extreme poverty by 2030.

Loss of nature and species extinction cause grief and fear. This is a normal and reasonable psychological response. Those directly affected by a climate catastrophe may also experience suffering from loss of homes, food, water, jobs, and social connections. There are increased mental health problems such as depression, anxiety, suicide, substance abuse, and post-traumatic stress disorder as people are overwhelmed by events.

In addition to GHG emissions, combustion of fossil fuels is the major source of air pollution. Oxides of nitrogen and inhaled particles of soot exacerbate asthma, infectious pneumonia, chronic obstructive pulmonary disease, heart attack, and stroke. Approximately 4 million persons per year worldwide, mostly those with chronic lung and heart disease, die prematurely from outdoor air pollution. When a woman is pregnant today, her baby's placenta contains soot particles that she inhaled. Reducing air pollution will save millions of lives each year by cleaning our air and water and reducing exacerbations of heart and lung disease.

Every year for the rest of your life will be one of the hottest on record. The faster we reduce carbon emissions, the better off our children will be. They are in the crosshairs of climate change. The goal of the Paris Agreement—limiting global warming to no more than 2 degrees Celsius—may be humanity's most important public health goal.

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