

CLIMATE CHANGE EXPLAINED IN A HEALTH CONTEXT *by Ann Gerhardt, MD 8/15/2010*

Bottom Line at the Top: Climate scientists agree that the earth is rapidly warming, and that human activity, particularly burning fossil fuels, contributes in a significant way. The resulting climate change is killing people and will kill many more, both directly from flooding, storms, fires and heat waves, and indirectly from infectious diseases, drought, famine, and resource wars.

The last decade was the hottest on record since record keeping began in the 1880's, according to a "State of the Climate" report released by the U.S. National Atmospheric and Oceanic Administration. Three hundred scientists analyzed data from 37 different climate indicators, including humidity, glacier cover, sea level, and land- and sea-surface temperatures. For the first time they analyzed all that data together and concluded that global warming is undeniable, and it's happening fast.

The Intergovernmental Panel on Climate Change report of February 2007 concludes that warming climate change, caused by human activities, has caused accelerated Arctic sea ice melting. The panel based their conclusions on research from hundreds of scientists and the approval of 113 governments, including the U.S. Global average air and ocean temperatures have climbed, along with widespread snow and ice melting. Heat expansion and influx from melting glaciers and arctic ice have pushed the global average sea level 4-8 inches. Scientists predict the summer Arctic ice will melt almost completely by 2040, destroying the polar bear's habitat, and the bear along with it.

Historically climate change evolved over centuries. That's all changed, with the current warming spike. The average surface temperature of the planet has risen by 1.8°F since the start of the Industrial Revolution, with most of the increase in the last 2 decades.

A measly 1.8°F temperature rise sounds small, but is sufficient to melt glaciers, alter precipitation patterns and generate ferocious storms, forest fires, droughts, flooding and heat waves. Water supplies are decimated in Africa, leaving farms unable to feed the population. Arctic people are watching the banks of their communities fall into the ocean. Permafrost melts out from under increasingly unstable roads and rail lines. People are dying from floods, storms and fires.

The United Nations-sponsored Intergovernmental Panel on Climate Change reported in 2001 that the average temperature is likely to increase by between 1.4 and 5.8 degrees Celsius (2.5 and 10.4 degrees Fahrenheit) by the year 2100. By then coral reefs and their entire ecosystems will die. Oceans will acidify, wiping out even more species and food sources. Thirty percent of species will be extinct. And humans will suffer a host of problems described below.

Global warming process: One of two things happens to sunlight upon entering the atmosphere. It is absorbed by the air, land and water, increasing ambient temperature. Or it is reflected off of clouds, ice, snow and light-colored surfaces back into space. Sunlight that makes it to land and water is converted to infrared radiation that dissipates in the atmosphere. It may drift all the way back into space, or be held in the atmosphere by the 'greenhouse gases,' CO₂, methane, water vapor, nitrous oxide and ozone.

As we combust more fossil fuels, we generate more of those gases, especially CO₂, nitrous oxide and ozone. Trees and plants usually pull CO₂ out of the air, but deforestation has wiped out huge numbers of trees that can do that. With greater generation and less removal, greenhouse gases accumulate. More radiation can be absorbed and retained in our atmosphere.

As glaciers melt and less snow falls, less solar radiation is reflected back to space. Melting ice uncovers land that absorbs more radiation. These both accelerate the whole process.

Individual greenhouse gases: Greenhouse gases aren't all bad. They keep the earth's average temperature warm

enough to support human life. Without them, we couldn't exist – the world's average temperature would be 0° Fahrenheit. In pre-historic times the atmosphere contained at most 300 parts per million (ppm) CO₂. Every 100,000 years or so, *in response to* a rise in global temperature, the CO₂ would rise. It would go from about 180 ppm to 280 ppm over a few thousand years, then slowly decline over another 30,000 years.

This time it's different. Until the industrial revolution humans existed at 280 ppm, enough to keep the earth at an average tolerable 57 degrees. Atmospheric CO₂ spiked with the industrial revolution, this time *preceding* earth's warming, and paralleling increased emissions from fossil fuels. By 1951 CO₂ reached 315 ppm, and has rocketed up to 380 ppm, mostly in the last 30 years. This rate is unequalled in history and has warmed the earth quickly. Eleven of the 12 warmest years on record have occurred since 1995. CO₂ continues to accumulate, at about 2 PPM per year.

China has edged out the U.S. for the number one CO₂ generator (6017.69 vs. 5902.75 million metric tons of CO₂ per year), but the U.S. generates far more emissions per capita than China and most other countries. With improved technology since the late 1990's, the U.S. emissions per person decreased from 20 to 19.5 tons of CO₂ per capita, leveling off for data through 2007.

Petroleum, coal and natural gas account for 43.3%, 36.4% and 20.3%, respectively, of U.S. greenhouse gas generation. Transportation generates 33% of U.S. CO₂ emissions from burning fossil fuels. If we could average 40 miles per gallon, gasoline use would halve.

Methane contributes about one-third of the greenhouse effect of CO₂, in spite of vastly smaller quantities in the atmosphere, by absorbing more infrared energy per molecule. It comes from landfills, natural gas, coal mining, animal waste and decaying plants.

Ancient methane levels ranged from 300 – 700 parts per billion (ppb) and persisted at 700 ppb through year 1750. By 1998 levels had risen to 1745 and since 2006 have been rising about 25 ppb per year. Scientists worry that melting arctic ice will release a huge amount of methane from exposed, decayed, Arctic plants.

Methane directly harms health only by displacing oxygen in air – too little oxygen and we asphyxiate, but that really only happens in coal mines. Methane's most common adverse health effects result from its contribution to global warming.

Oxides of nitrogen (NOX) and volatile organic compounds, mixed with heat and water vapor, generate

ozone, another greenhouse gas. Each has health consequences separate from their effect on climate change. See *Death by Car* in an upcoming DrG'sMediSense issue for more details.

Storms: We've always had weather cycles and storms, but now climatologists believe that increasing frequency and ferocity result from climate change. They fear that it will continue to whip up more devastating disasters.

Since warm air retains more moisture than cooler air, the warming atmosphere holds more water vapor, another greenhouse gas. The air can hold onto that water, inducing drought, or dump huge amounts of rain in hurricanes and monsoons. Rainfall over the past 15 years has decreased in eastern and SW Australia, a large region of equatorial and southern Africa, Eastern Europe, Asia and parts of Peru and Bolivia, often to the point of cropland failure.

Other areas, including Canada in which the usual snow has turned to rain, are seeing more rain. Increasingly heavy rains in China since 1961 have caused heavy flooding, recently killing at least 1100 people. Closer to home, Hurricane Katrina killed 1836 people. Iowa is now flooding from heavy rains, fortunately with a very low immediate death toll. Record-breaking monsoons (12 inches in one 36 hour period) led to floods in Pakistan, which have killed 1,600 people so far. Flooding threatens millions more with disease from unprocessed sewage and starvation from destroyed cropland.

Infectious diseases: With more flooding and warmer temperatures, mosquitoes and the diseases they carry will flourish. The mosquito that transmits malaria requires water to lay eggs and temperatures above 61°F to complete the life cycle. We can expect previously 'tropical' diseases to move into usually temperate climates like the U.S. as those areas become warmer and wetter. This has already happened with malaria in Northern Africa.

Cholera follows natural water disasters. A few Hurricane Katrina victims died of it. Many more died of cholera after the Asian tsunami. The flood in Pakistan is just starting to generate cholera cases.

Cases of yellow fever, another tropical, mosquito-borne disease, surged in the 1990's due to a perfect storm of climate change, deforestation, urbanization and declining population immunity.

West Nile virus infections flourish in times of drought, because the birds carrying the virus meet up with the mosquitoes which carry it to people at scarce water holes.

Waterborne diseases surge in any condition that prevents adequate sewage processing. A drought limits the ability to process sewage. Flooding carries sewage into streets and houses, exposing people to dangerous bacteria and parasites. Kenya's epidemic of cholera followed severe drought. Milwaukee's cryptosporidium outbreak accompanied heavy rains.

The World Health Organization predicts that diarrheal illness of all causes, particularly in children, will increase by 10% by 2030. Childhood diarrhea leads to malnutrition, which in children impairs brain growth and ability to learn. A sick, uneducated populace retards the progress of a whole society.

Communities disappear: An ice sheet up to two miles thick covers 80% of Greenland, which is warming twice as fast as the rest of the world. The ice sheet holds 7% of all the earth's fresh water, but melts by 50 cubic miles per year. Scientists estimate that 450 parts per million (ppm) CO₂ would raise temperatures enough to melt all of Greenland, the largest freshwater reservoir in the world. When that happens, the world's oceans would rise by 24 feet, wiping out every port city in the world.

Twenty four feet is a lot. Between 60 and 70% of the world's population lives within 37 miles of a coast. Two thirds of the world's megacities are located on a coast. With rising seas and powerful storms, coastal erosion undermines human communities and natural habitat. Using current projections, whole island nations will drown by 2050. The highest point on the Maldives is only 7.8 feet above sea level. They have already experienced serious flooding - In 1987 unexplained ocean high waves covered two thirds of the capitol city with water.

Sea-level also rises as ocean water warms. New evidence suggests that more than 90 percent of heat trapped by greenhouse gases over the past 50 years has been absorbed into the oceans. Because water expands as it warms, the added ocean heat is contributing to sea level rise. A warmer ocean is less able to buffer warm air, so it further contributes to warming.

Not only is Greenland ice doing a disappearing act. Arctic and Antarctic ice is melting. Very old, thick Arctic ice, that normally buffers summer heat and keeps temperatures cool, has thinned by 57% in just 4 years, from 2004 to 2008. Scientists predict that Glacier National Park will have no glaciers by 2030.

Coastal Arctic communities built on ice pack watch as large hunks of their "ground" break off into the sea. This is what endangers the polar bear - not having ice flows big enough for habitat and to break up long swims when looking for food.

A 100 square-mile chunk of glacier just broke off from the Peterman Glacier in Greenland. If it floats south, there is no way to stop it from crashing into oil rigs further south along Greenland's coast. The ensuing oil dump would make the Deepwater Horizon Gulf spill look small. Greenland's fishing economy would wither, leaving Greenlanders destitute.

Drought: Though Peru has the largest number of tropical glaciers in the world, most of the melt slides toward the Atlantic, leaving only 2% for the arid Pacific coast, where 70% of Peru's population lives. Those glaciers have lost a third of their surface area since the 1970's. Three rivers originating in the Andes glaciers supply water to the capital Lima's eight million people, which is built on a desert and continually has a large deficit between water demand and supply. When that glacier goes dry, people will most likely die.

Lima, Peru is not alone in its dependence on glacial melt for water. As glaciers disappear, millions of people will be without water.

Famine: Food crops also need water. Changing rainfall patterns can turn previously fertile farms to dust, starving the people who depend on them. Farmland is disappearing in Australia as they suffer the highest temperatures and worst drought ever. Bushfires burned tens of thousands of acres of farmland. What land didn't burn didn't have enough water to grow crops.

The same is happening in newly arid areas of Africa, where they experience more frequent and longer droughts due to unpredictable rainfall. There they have less money to import food.

Heat: In Europe in 2003 record heat waves caused at least 35,000 deaths, more than 14,000 in France alone.

Currently, an unprecedented heat wave has scorched Moscow. For the first time in history Moscow temperatures topped 100, a trifle for Sacramento, but significant in an area accustomed to low-to mid-70's summer temperatures. People don't have air conditioners and they die from heat prostration. They also die from attempting to cool off - 2000 (some drunk) having drowned so far in unguarded rivers.

They die from fire and smoke. Heat ignited fires in dessicated peat bogs and dried up underground marshes, starting over 500 wildfires covering more than 465,000 acres. More than 50 people died directly from fire. An untold number have died of heart and lung disease from the smoke, which raised the carbon monoxide level to six times the maximum safe level. Fine particulate matter penetrated every corner of the city, stinging eyes and

irritating lungs. At one point, the daily mortality rate in Moscow topped 700, more than double the usual.

What to do: Get serious about massive change. It took multiple generations to get us into this mess, but we only have time for a couple of generations to stop it. Ending sprawl and smart community planning would go a long way to easing the problem

We are horrified by pictures of climate induced destruction and death, but how much are we willing to change to keep it from happening to us? How long will we believe it just won't happen to us?

Urge your governmental representatives to vote for reduced emission standards. Demand clean buildings and support environmentally sound businesses (See the LEED Building article in an upcoming DrG'sMediSense issue).

Move close to work, so you don't have to drive. Vote for higher gasoline taxes, to disincentivize driving and pay for the true cost of burning fuel. Leave your car in the garage and walk or cycle instead. Support and use public transit, and fight funding cuts. Change to fluorescent lights, then turn them off. Reduce tree destruction by using recycled paper and alternative building materials. Buy local produce, trucked in from a near-by farm, rather than packaged food that has traveled many miles before it reaches your lips. Don't fight windmills. Use solar energy, a white roof, good insulation and energy efficient appliances.

Calculate your climate carbon footprint at www.nature.org/climatecalculator, then work to generate carbon far below the average.