

The Anthropocene Has Arrived

By David Mayne Reid



“Anthropocene: The era of geological time during which human activity is considered to be the dominant influence on the environment, climate, and ecology of the earth.” *Oxford English Dictionary*

Four billion years of Earth's history shows that climates have always been variable. Ice ages interspersed by warm interglacial periods are good examples. Such events have been triggered by alterations in the quantity of solar radiation, meteorite collisions, plate tectonics, volcanic activity and global changes in ecosystems

Now a new factor is forcing climate change, humans. We are transforming the planet's geology. Humans have irreversibly modified the global biosphere, poisoned the oceans, increased soil erosion and salinity, decreased soil fertility, turned grasslands into deserts, and destroyed forests. Species diversity is rapidly declining and we are now in the midst of what Elizabeth Kolbert and others term the “Sixth Extinction.” Over 30 percent of all species likely will be extinct by mid-century. These are planet-wide events. Human activities such as burning fossil fuels and deforestation have pushed us into the Anthropocene geological period. While some geologists object to the name Anthropocene, it is indisputable the planet has been altered on a huge scale and in a horrifyingly short period. Barring unexpected volcanic eruptions, a visiting meteor or some lunatic starting a nuclear war we are now in a sustained period of global warming.

The air above us, land beneath and vast

seas are all warming. While this warming doesn't mean that every year is necessarily warmer than the preceding one, the upward trend is unambiguous. Warming began soon after the industrial revolution triggered increases in human population, overfishing, deforestation for agriculture, and increased pollution on a vast scale. The invention of machines to exploit coal, oil and gas allowed us to bend more of the planet to our will with increasing and terrifying efficiency.

Why are we getting hotter? What are the consequences? Why do climate change deniers say there is no problem? What must we do?

Why are we getting hotter?

Atmospheric concentrations of water vapor, CO₂, nitrous oxide and methane are rapidly rising. These are called greenhouse gases (GHG) because they trap the heat in sunlight, analogous (not identical) to a hot greenhouse sitting in the sun. Some solar energy is absorbed by land and open water and re-emitted as warming infrared (IR). IR is trapped by GHG, where it heats the lower atmosphere, land, and sea. This is global warming. To convince yourself that there is considerable potential heat energy in sunlight, hold your bare bum against the paint of a black car that has been in the sun for two hours. After you

get your bum burns tended by the doctor, you won't repeat the experiment.

Increases in atmospheric water vapor have not caused recent warming. Furthermore, excess water vapor tends to condense out of the atmosphere as precipitation. If warming increased atmospheric water content this could produce more clouds which trap heat causing warming, but clouds reflect sunlight, resulting in cooling. These effects may cancel each other out.

There is however an excellent positive correlation between rising quantities of other GHG and rising global temperatures. CO₂ concentrations and temperature track together extremely well. There are parallel and large global increases in methane and N₂O. Since other factors also affect temperature the correlations are not perfect due to: variations in the amount of solar energy, volcanoes spewing dust, aerosols and sulfur dioxide (SO₂), which block sunlight, leading to cooling. The Mt. Pinatubo eruption is a good example. However, volcanoes also emit CO₂ that would promote warming. In spite of these confounding influences, it is still clear that the rise of GHG is driving increased global warming.

A little GHG is a good thing and vital for life on Earth. Without a dash of GHG acting as a nice warm atmospheric blan-

ket, Earth would be an uninhabitable ball of ice. CO₂ constitutes only 4 of every 10,000 molecules in the atmosphere, but excess GHG cause over-heating. We need just the right amount. If the percentage of carbon dioxide in the Earth's atmosphere rose to one percent from today's 0.04 percent - all other things being equal – the Earth's surface temperature would be lethally hot to most forms of life.

Normally the global CO₂ level is partially controlled by biological processes, balancing uptake by land plants and marine photosynthesizers with re-emission by soil microbes, animals, and wild fires. Some carbon also dissolves in the oceans and is used in the formation of shells of marine organisms that eventually sink to the sea bottom forming limestone. There are similar cycles with methane and N₂O and such cycles are the historical norm. Unfortunately humans are upsetting this delicate balance, pushing extra GHG into the atmosphere.

CO₂ concentration is now higher than it has been for 700,000 years and the industrial revolution is responsible for the recent rapid rise. In 1972, when I began research on the effects of CO₂ on plants, normal atmospheric CO₂ concentration was 340 parts per million (ppm). Now it is 400 ppm. The excess CO₂ largely comes from burning the oil, natural gas, wood, and coal we use in transport, manufacturing, and heating.

Together with increased emissions, we have less CO₂ sequestration because human activities have globally reduced the number of plants that absorb CO₂. Deforestation continues at alarming rates, tree diseases/pests such as the pine bark beetle are increasing, and we continue to convert wild lands and forests to agriculture. Unfortunately agricultural ecosystems trap less CO₂ than wild ecosystems.

Methane and N₂O come from various sources: industry and microbiological generation in cattle, rice paddies, fertilized and warmed soils. All of these have increased compared to the days before the industrial revolution.

Humans have significantly altered the composition of the global atmosphere in an astonishingly short time.

The consequences

Who is worried about climate change? To mention only a few; 97 percent of scientists working in the climate science field, the Pentagon, the CIA, many insurance companies, the Royal Society (UK), the Australian Academy of Sciences, the Royal Society of Canada, the American Association for the Advancement of Science (AAAS), NASA, NOAA and last but not least, the UN Intergovernmental Panel on Climate Change (IPCC).

Then there are moral and ethical beacons such as the Dalai Lama and Pope Francis. Although they are not scientists, they are men who think deeply about matters of global concern. Both urge governments to take immediate action on climate change. They join those mentioned above in recognizing that humans are significant drivers of this global warming which will lead to the following:

- Sea level increases, caused by melting of Arctic ice, glaciers, and ice caps (West Antarctic, Greenland) and thermal water expansion. Add to this we have increased intensity (and perhaps frequency) of extreme weather events, such as stronger hurricanes, and bigger tidal surges. Thus we get more coastal flooding. As much of the world's population lives on coasts this is serious.
- In coastal areas salt water is entering drinking water supplies and harming agriculture.
- Longer periods of severe drought, more wild fires burning forests and crops. Flash flooding inland will increase risks to homes, farms, infrastructure, and people. Food shortages and rising food prices are likely too.
- Species, including warm area pests, move into what were more temperate climes. The diseases they carry impact humans, wildlife, forests, and agri-

culture (ie. pine bark beetle, malaria, Lyme disease, diseases in muskox, Dengue fever)

- All these events will increase the likelihood of more hunger, more poverty, uncontrolled population movements, political unrest, terrorism, and war.
- Even if Earth were not warming, there is the enormous problem of CO₂-induced ocean acidification. Ocean acidity results from more CO₂ dissolving in seawater. This impairs the ability of marine organisms (plankton, shell fish, corals) to form carbonate structures. It will damage coral reefs, marine food chains and fisheries. Hundreds of millions of humans depend upon the ocean for food.

These consequences could get much worse, much faster

Polar icecaps are melting, and sea levels are rising, more rapidly than predicted, possibly due to "positive feedbacks." One example of a feedback is Arctic ice melt. Normally white ice and snow reflect sunlight back into space keeping us cool (the albedo effect), but when snow/ice melts, the darker water absorbs (not reflects) light, heats up, and yet more ice melts, causing accelerated polar heating.

Another example of a positive or reinforcing feedback is when warming tundra soils stimulate bacteria to produce methane. This GHG, more than 40 times more potent than CO₂ in the short term, traps yet more heat and liberates even more methane. Additional heat is trapped in this positive feedback loop.

Warming of the Arctic sea also will release methane from frozen methane hydrates, leading to another feedback. When such processes spiral out of control we may reach a "tipping point," rapid change where we would see a sudden jump from a cooler stable environment to a stable but hotter climate. Such new conditions would be exceptionally difficult to reverse.

The Climate Change Deniers

The Deniers have a disingenuous and selective approach towards scientific information. They accept the science that cures their diseases and is the foundation of computer technology, but reject the science showing that humans are the primary cause of recent climate warming. Many of The Deniers want to ignore the melting glaciers and ice caps. They argue the seas are not acidifying, nor are they rising, yet an immense amount of recent data shows the opposite. They are blind to the effects of massive changes in the chemical composition of our planet's atmosphere.

The Deniers cherry pick climate data. They embrace what they like and ignore that which confounds their beliefs. They exaggerate small inconsistencies whilst ignoring the vast bulk of growing evidence showing that we have a gigantic human-caused problem.

Over the years some of the denier groups have benefited from hundreds of millions of dollars of funding from the likes of ExxonMobil, Talisman, and the Koch brothers. They read climate science very selectively, possibly because it either contradicts their faith or may threaten the bottom line of their sponsors. They seem unprepared to accept the view of a "radical" organization such as the U.S. Department of Defense that climate change effects "are threat multipliers that will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions – conditions that can enable terrorist activity and other forms of violence."

By the way, on "belief", most scientists don't "believe" human activities are causing climate change. "*Belief*" – since it may be irrational – has nothing to do with it. Scientists look at the *facts* and come to *rational conclusions* based on that information: in this case the facts are clear, human or anthropogenic activities cause recent global warming.

Some deniers say illogical things like "the climate is always changing so this

current change can't be human caused."

Or, "warming is primarily caused by the sun." Obviously the sun warms Earth, but there is no evidence that recent *changes* in solar radiation affecting Earth constitute the most significant driver of *recent* warming.

Then there was this claim: "Mann's graph (the famous hockey stick graph used by the Intergovernmental Panel on Climate Change in 2001) showing rapid warming over the last 150 years comes from falsified data."

Not so; Mann's work has been rechecked, and extended by many independent scientists. His original conclusions are correct. In fact, recent studies published in *Nature Science* and *Science* offer the most powerful support yet for Mann's pioneering work.

Another focus of The Deniers is the claim that "more CO₂ is a good thing. It is a plant food and bigger plants will absorb the excess CO₂." I'm afraid this thinking illustrates that a little knowledge may be a dangerous thing. True... CO₂ is plant food, photosynthesis absorbs enormous quantities of CO₂, and normally global CO₂ levels are controlled. But we all know a little food is good, but too much is bad. Actually very high levels of CO₂ are toxic and while a little more CO₂ promotes plant growth, the effect is short lived. Faster growing plants run out of other resources (water and minerals). Also, high concentrations of CO₂ reduce the ability of plants to absorb yet more CO₂. Some types of photosynthesis don't respond positively to more CO₂. The fertilizing effect of CO₂ is limited.

Also, when The Deniers talk about CO₂ benefits, they tend to ignore the complex reality. In a warmer world some areas will be drier. My research with Mirwais Qaderi shows that a combination of heat PLUS drought reduces a plant's ability to protect itself against further environmental stress and, even worse for the climate, stressed plants emit methane. We don't need more GHG production.

Scientists search for truth and base their

conclusions on evidence. The Deniers could learn much from them.

What must we do?

Promote a different type of democratic politics. Elect politicians who think beyond their next election. Governments must stop subsidizing Big Energy; our systems of party and election financing must change to eliminate donations from industry. Governments must stop muzzling civil servants who dare to speak about scientific information that clashes with the governing party's partisan tune.

Get off our addiction to oil, natural gas and coal. Legislate increased fuel-efficiency in vehicles and greener buildings. Promote and use public transport. Only buy small cars with low fuel consumption.

Promote renewable energy – if a leading oil-producing state like Texas can promote renewables shouldn't they be a significant part of Alberta's energy future? Ignore the self-interested arguments of Big Energy and Government when they say: "We can't do this yet. It is too expensive. The technology is not ready." This is not true. Solar panels should be installed on rooftops. The technology is available NOW. It can be done. *Bloomberg Businessweek* reported that, in the first half of 2014, Germany generated 27 percent of its electricity from renewables (excluding hydro). Promote installation of tide and wave electrical generators on our coasts. Develop hydrogen (which burns to form non-polluting water) as a clean energy source. Spend research dollars on artificial photosynthesis producing hydrogen and electricity from water. We have the drilling technology for more use of geothermal energy.

Yes, alternative energy will impact the fossil fuel industry, but that industry has a limited life-span. With their money, technology and resources they should lead the way reinventing themselves as suppliers of green sustainable energy.

Promote large-scale reforestation. Don't cut down forests and use the cleared land for biofuel or cattle production. A forest is much more use to humanity than ag-

riculture that produces cattle or biofuels. Capture CO₂ by increasing the area under forests, wild lands and grasslands. Photosynthesis has been efficiently capturing CO₂ for 3 billion years. It is suicidal to reduce this essential global service by willfully destroying grasslands and forests.

A growing human population adds to the pressure on resources and the environment. Our numbers must be controlled and reduced. The rich world must also downsize, since we produce 40 times more pollution (per capita) than those in underdeveloped countries. Here, the provincial government estimates that Alberta's population could nearly double from 4 to 7.3 million by 2041. Alberta's landscapes can't sustain that population.

When estimating the costs of developments like Alberta's oil sands, the accounting should include full long-term environmental costs. The loss of environmental services associated with this development is not adequately accounted for.

We must redesign our economic system to one where profit and the environmental sustainability are complementary, not contradictory. The longer we procrastinate the more costly it will be to make that transition. The assumption that a finite world can indefinitely sustain ever-increasing population, rising consumption and more pollution is mistaken and threatens our future on this planet. We must all act and it's imperative we act soon.

I don't enjoy concluding that humans are

the greatest threat to the planet's ecosystems but my scientific education and training tell me that is today's reality. We had better deal with it now and stop sticking our heads in the increasingly hot sand. 🐻

David was professor in the Dept. of Biological Sciences at the University of Calgary until retirement in 2007 and was Head of Department 1999-2005. He came to specialize in plant ecophysiology and published over 170 refereed publications on subjects such as how plants survive environmentally stressful conditions.

Connie Beattie - Featured Artist



The Bear Necessities, 36" x 40", Acrylic on Gallery Canvas