Ahead of the Herd Newsletter - 2018 Issue Twenty Eight

Saturday June 23rd

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Telling you things everyone else doesn't already know.

Climate Armageddon – Part 5

As a general rule, the most successful man in life is the man who has the best information

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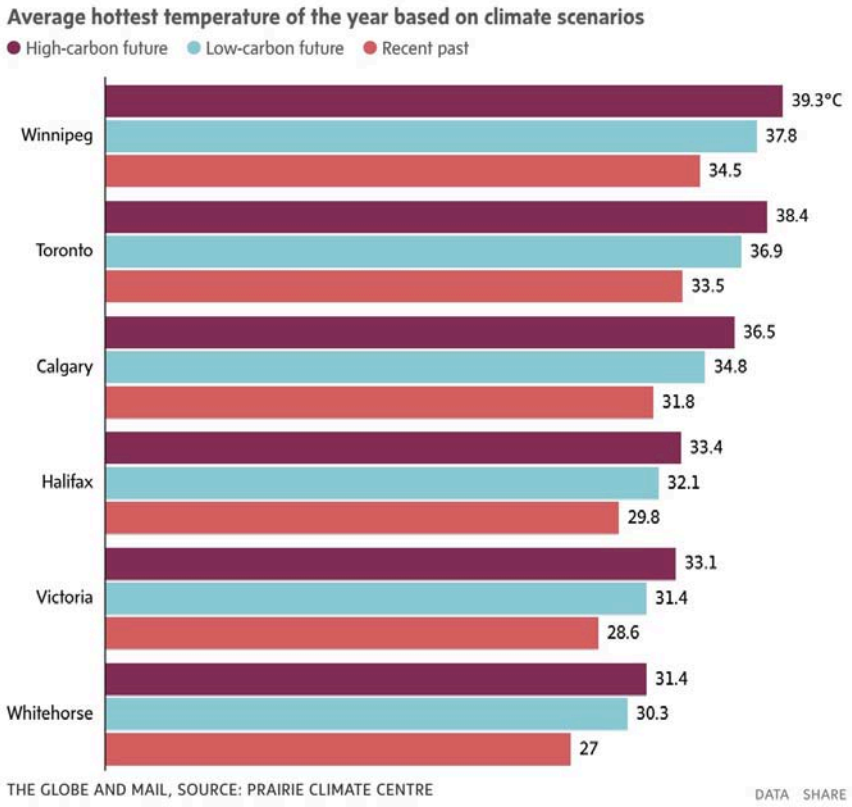
In Winnipeg, the hottest day of the year, on average, is nearly 40 degrees Celsius, while in Whitehorse, the mercury blasts past 31.4. A moderating coastal climate means little to Victoria, which averages 33.1 degrees, and Toronto, the most humid city in Canada, becomes even less bearable, with the temperature climbing to a sweltering 38.4.

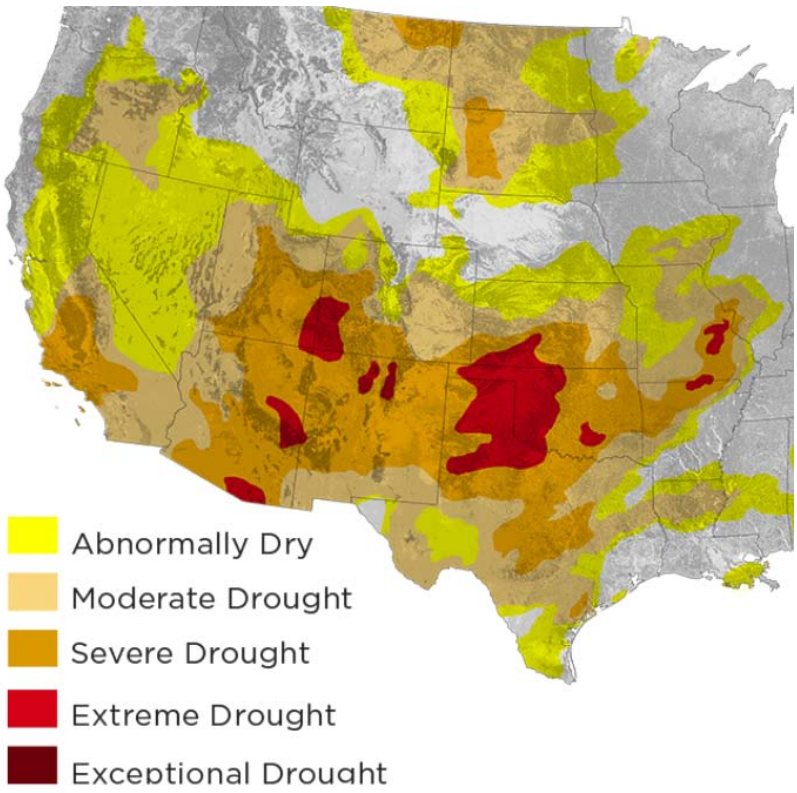
These are the average hottest temperatures of the year in the new Canada, based on a higher-carbon atmosphere, one of three scenarios put together by The Prairie Climate Centre and graphed by The Globe and Mail in April. For Winnipeg, better known in summer for black flies than sun burns, that's 4.8 degrees higher than the recent past, 4.5 degrees hotter in Victoria, and 4.9 degrees steamier in Toronto.

If climate change doesn't stop, Hogtown (Toronto) will see over 100 days of searing-hot weather, according to the University of Winnipeg's Prairie Climate Institute, which assembled the projected temperatures for

Canadian cities as part of an interactive website that allows Canadians to see the likely impact of global warming on where they live. In the graph below, recent past means 1976-2005, while the future, both lower- and higher-carbon, refers to the years 2051-80.



An audit by the federal Environment Commissioner done in March showed that while most provinces have ambitious plans to reduce carbon emissions, few have any idea as to how they would reach those goals - despite the Canadian government's commitment to cut emissions by at least 30% from 2005 levels by 2030. Canada has already abandoned a previous target to bring emissions 17% below 2005 levels by 2020, knowing there is no hope of meeting it.



South of the border, continuing drought conditions in the Great Plains, combined with late spring planting, means a record low for hard red winter wheat acreage, which has commodity analysts predicting an explosion in wheat prices, when combined with dry conditions in Canada and Argentina.

On a scale of 1 to 500, the condition of this year's US wheat crop is 293 versus the five-year average of 318, as of May 20, High Plains Journal reported.

Last year the drought in California caused the worst forest fire season in the state's history, with over 9,000 fires costing $13 billion in damage. According to US Drought Monitor, in February 2018, 38.4% of the US was in a drought situation, the highest percentage since 2014 when it was 40%. The unusually warm winter weather caused rain to fall instead of snow, leading to record-low snowpacks. In the Colorado Basin, a 17-year run of dry years has left reservoirs at alarmingly low levels, USA Today reported.

Over the past few weeks, Ahead of the Herd has run a series of articles on

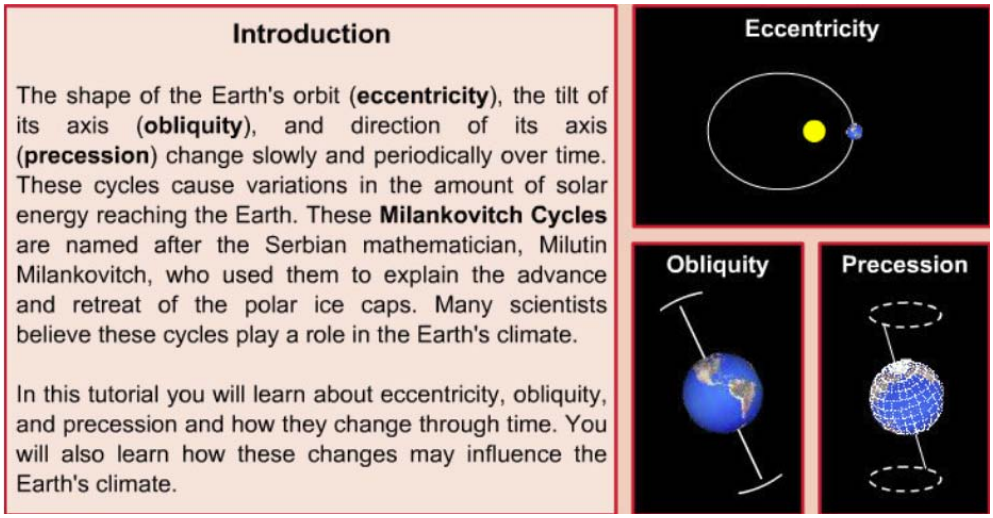
climate change. We have covered the whole range of global warming causes and effects - from the threat to the North Atlantic Current, polar vortices, melting ice and rising seas, to the mass extinction of land and ocean species, and the rapid reduction of the world's freshwater supply. In this wrap-up article, we pull all the elements of climate change together. In doing so, the overall picture you are about to see is sobering, alarming, and it is not a stretch to say, apocalyptic. Despite the promises of politicians and certain business leaders who claim to have the answers to stop climate change, the truth is it is unstoppable. The inescapable conclusion? The world will keep warming, until it starts cooling. We are all on an upward global warming escalator that has no down option. The only question is, how fast will the escalator move?

Causes

If you listen to mainstream media, climate change has only one antecedent: human-caused emissions of carbon dioxide and other gases (methane, water vapor, nitrous oxide) that have been spewing into the skies since the Industrial Revolution; these greenhouse gases have caused heat to become trapped within the lower atmosphere. While human-caused pollution is certainly causing the degregation of our soil, water and air, this theory does not take into account the natural cycles of cooling and warming that have driven climate change for billions of years.

Milankovitch's Theory states that as the Earth travels through space around the sun, cyclical variations of three elements combine to produce variations in the amount of solar energy that reaches us. These three elements are:

- Variations in the Earth's orbital eccentricity - the shape of the orbit around the sun, a 100,000-year cycle.
- Changes in obliquity or tilt of the earth's axis - changes in the angle that Earth's axis makes with the plane of Earth's orbit, a 41,000-year cycle.
- Precession - the change in the direction of the Earth's axis of rotation, a 19,000 to 23,000-year cycle.



Milankovitch theory

These orbital processes are thought to be the most significant drivers of ice ages and, when combined, are known as Milankovitch Cycles. The last ice age, the Glacial Maximum, occurred between 27,000 and 24,000 years ago. But we know from geological records - studies of Danish and Swedish bogs and lakes, for example - that as the Earth has warmed and cooled over the centuries, the warmer periods are getting longer and the colder periods shorter. In order words, spread out over an extremely long time sequence, the Earth is gradually getting hotter even as it warms and cools in cycles.

The most dramatic of these cooling trends is known as the Younger Dryas - the most recent and longest of three “stadials” that took place over the last 16,000 years. During the Younger Dryas, which lasted about 200 years, temperatures on Earth very quickly dropped 2 to 6 degrees Celsius, which led to an advance of glaciers, mostly in northern Europe. The reason for the sudden change is not decisively known. One theory is that a large lake in the interior of North America collapsed, spilling freshwater into the Atlantic Ocean.

This caused a change in the North Atlantic Current, discussed in a previous article, which moves warm tropical waters from the Gulf Stream like a giant conveyor belt to northern latitudes and eventually the Arctic Ocean.

Could Earth be entering the end of a warming period and the start of a cooling period? While all the models show that warming is likely to continue for a couple thousand more years, scientists are giving more credence to the “sudden deep freeze” hypothesis. Science magazine reported earlier this month that a newly discovered sequence of rocks in Ethiopia supports a “Snowball Event” 717 million years ago, when the Earth cooled in “only” thousands of years - the equivalent of a cold snap in geologic terms. The rocks in Ethiopia dated to about the same time as the Stuartian glaciation. The big question is, could a catastrophic event like the stoppage of the North Atlantic Current, trigger the next ice age, like the Younger Dryas or the Snowball Event?

Climate is also affected by changes occurring within the sun, thus shifting the intensity of sunlight that reaches the Earth’s surface. These changes in intensity can cause either warming - stronger solar intensity - or cooling when solar intensity is weaker.

Irreversible effects

The effects of climate change are many and we have discussed them all in this comprehensive series. In summary:

- We can say with certainty that the temperature on Earth is rising. According to NASA's Goddard Institute for Space Studies (GISS), the average global temperature on Earth has increased by about 0.8° Celsius (1.4° Fahrenheit) since 1880. Current climate models predict that Earth's average temperature will keep rising.

- The polar vortex is a seasonal atmospheric phenomenon whereby high winds swirl around an extremely cold pocket of Arctic or Antarctic air. The winds are like a barrier that contains the cold air, but when the vortex weakens, the cold air "escapes" from the vortex and travels south, bringing with it a cold blast of Arctic weather. If the polar vortices collapse, it would mean a total disruption of normal atmospheric warming and cooling. Without halos of swirling Arctic and Antarctic winds serving to cool the poles, they would be left to heat up, accelerating global warming.

- Climate scientists have been raising concerns that rising temperatures could throw a wrench into the conveyor-like currents system. The volume of water moving northward has been sluggish. The amount of water surging through the Atlantic Meridional Overturning Circulation (AMOC), which exchanges warm water from the equator with cold water from the Arctic, transporting warm and cold water to the North and South Poles, has slowed to a 1,000-year low. The disruption of the North Atlantic Current formed the plot line of the movie *The Day After Tomorrow*, where the current stopped and resulted in an ice age.

- The warming of the Earth's surface has caused a widespread retreat of the glaciers at both poles. According to NASA between 2002 and 2006 Greenland lost 60 cubic miles of ice; in Antarctica it was 36 cubic miles from

2002-05. All of this melting ice has caused sea levels to rise, from between seven and eight inches over the last 117 years, NASA states, with the most rise occurring since 1993. The expansion of ocean water as it warms also causes higher sea levels. The latest International Panel on Climate Change report predicts sea levels rising between 52 and 98 centimeters by 2100 if nothing is done to stop rising temperatures. An increase of 65 centimeters, or roughly two feet, is expected to cause significant flooding in coastal cities.

- Desertification is human-caused degradation of land, including unsustainable farming, overgrazing, clear-cutting, mis-use of water and industrial activities. Climate change accelerates desertification because warmer temperatures dry out once-fertile land, which then makes the area even hotter. Removing plants from the ground also increases greenhouse gas emissions, since they can no longer serve as carbon sinks. As we strip away the amount of available land for food production, we are literally depriving ourselves of the means to survive. Eventually this will lead to the destruction of human civilization.

- According to the World Wildlife Fund and the Zoological Society of London, over the past 40 years the number of wild animals living on Earth has been cut in half. Marine populations have also suffered badly, with sea-based creatures crashing by 40%.

- Climate change is throwing a wrench into the seasonal migrational patterns of birds. The early onset of spring means some bird species can adapt by arriving earlier, but those who can't are having problems. They are missing the chance to find good nesting spots or to feed on insects.

- Due to warming, bees are not migrating to cooler areas to establish new hives. Bees are finding a mismatch between when the pollen arrives and when they feed on pollen. Even a mismatch of three days can make bees

less likely to reproduce and less resistant to predators or parasites. Less healthy bees make them more susceptible to infections. Insecticides are also killing off bee populations.

- Insect losses are said to be compounded by global warming, which causes habitat destruction. A recent analysis found that when the temperature warmed up to a certain point, some regions could no longer support certain species. Climate change could make nearly half of insect habitat unsuitable by 2100.

- There is a "perfect storm" occurring in the oceans due to overfishing and climate change. The result could mean a dramatic decline in fish stocks, with the most serious affect being malnutrition in poor countries in tropical climates that depend on fishing as a protein staple.

- In 2015 ocean temperatures were the warmest in 136 years. Warmer temperatures and overfishing are pushing temperate species towards the poles where they face greater competition for food with polar animals. Warmer ocean temperatures also cause acidification, which stunts the growth of corals and shell-based creatures like oysters. The destruction of coral reefs is a major problem resulting from climate change, since they provide critical habitat and food for so many species in the reef ecosystem.

- The result of rising surface ocean temperatures is a reduction in the numbers of phytoplankton. Since 1950, phytoplankton numbers have declined globally by about 40%. The decline in phytoplankton could make the problem of over-fishing even worse, since phytoplankton are eaten by zooplankton, which is consumed by fish further up the food chain.

- Half of the world's oxygen comes from phytoplankton. They are vital in maintaining the earth's atmosphere and the oxygen we need to survive. For a long time there has been an extremely small, but constant, decline in the

oxygen content of our atmosphere. It's possible that the loss of phytoplankton could be a factor. Phytoplankton also absorb a huge amount of carbon dioxide each year.

Effects that scientists had predicted in the past would result from global climate change are now occurring: loss of sea ice, accelerated sea level rise and longer, more intense heat waves.

In the next several decades, storm surges and high tides could combine with sea level rise and land subsidence to further increase flooding in many regions. Sea level rise will continue past 2100 because the oceans take a very long time to respond to warmer conditions at the Earth's surface. Ocean waters will therefore continue to warm and sea level will continue to rise for many centuries at rates equal to or higher than those of the current century.

The Arctic Ocean is expected to become essentially ice free in summer before mid-century. - NASA

Much of the discussion about global warming surrounds the amount of warming before Earth reaches a "tipping point" where we can no longer return to normal climate patterns and conditions will worsen. Most scientists agree this number is an increase of 2 degrees C. Signatories to the Paris Agreement of 2015 agreed to limit global warming to 1.5 degrees C. However only eight months after the target was set, scientists observed, in 2016, that temperatures were already close to pushing past 1.5 degrees.

USA Today reported in 2017 that the effects of climate change on human health are already noticeable, and likely irreversible. Quoting from the respected medical journal *The Lancet*, USA Today said that warming is exacerbating the spread of Dengue fever; a record 175 million people were exposed to heat waves in 2015; rising temperatures have cut labor productivity and taken nearly 100,000 people out of the workforce; and dangerous levels of air pollution have increased by 11.2% since 1990.

Feedback loops

The warming of the planet could occur at a much faster rate when “feedback loops” are slotted into climate equations. What is a feedback loop? This is what happens when one change causes another change to occur, worsening the first change. NASA states that climate feedbacks could double the amount of warming caused by carbon dioxide alone. The space agency points to snow and ice, water vapor, clouds and the carbon cycle as the main climate feedbacks. A well-known feedback loop is the disappearance of snow and ice at the poles. This exposes dark ocean to sunlight, warming the oceans. When ice covers the poles, the sunlight is reflected back to the atmosphere, keeping the oceans cool. As the planet keeps warming, more ice disappears, exposing more water, further raising ocean temperatures, and sea levels.

The carbon cycle is another dangerous feedback loop. NASA estimates that the oceans and land ecosystems (plants, trees) absorb around half of emissions released through the burning of biomass and fossil fuels. But when the oceans warm, they absorb less carbon, meaning more goes into the atmosphere. The poles are warming at a much faster rate than the rest of Earth. This means the most dramatic effects of climate change are being felt in the Arctic and Antarctic. One of the most potent examples of this is melting permafrost. As the Arctic tundra thaws, it exposes methane, a greenhouse gas that is about 30 times more powerful than CO2, in terms of its ability to trap heat. States NASA:

The impact of climate change on the land carbon cycle is extremely complex, but on balance, land carbon sinks will become less efficient as plants reach saturation, where they can no longer take up additional carbon dioxide, and other limitations on growth occur, and as land starts to add more carbon to the atmosphere from warming soil, fires, and insect infestations. This will result in a faster increase in atmospheric carbon dioxide and more rapid global warming.

NASA climate scientist James Hanson has warned of a “Venus effect” where a warming Earth turns it into an uninhabitable desert. Less dramatic is Tim Lenton

at the University of East Anglia in England, who came up with nine “tipping points” as reported by Scientific American. They are:

- Monsoons and hurricanes grow in force and intensity, but come less frequently. Examples include the 2011 flood in Pakistan and the 2017 deluge in Houston.

- Even worse would be if the monsoons suddenly shut down, putting a billion people in India at risk of starvation, and a a humanitarian crisis of unprecedented proportions as people flock to large cities. A similar situation could occur if monsoons stop in West Africa.

- The thinning of Arctic sea ice. We may have already reached this tipping point, with much of the ice disappearing during the summer, providing ice-free passage for ships. As described above, the open water will absorb summer sunlight, warming the ocean. Lenton says a year-round ice free pole “would be like heating Greenland on a skillet.”

- Greenland’s glaciers hold the equivalent of 20 feet of water should they melt into the ocean. While the Intergovernmental Panel on Climate Change predicts it will take a thousand years for all the ice to melt, Lenton says it could happen in 300.

- The fifth tipping point is the one that could plunge the planet into an ice age. Lenton predicts the melting of Greenland would effect the North Atlantic Current and the Atlantic Meridional Overturning Circulation. The amount of freshwater pouring into the ocean from glacial melt could effectively stop the normal circulation of water round the globe, causing a sudden deep freeze. Sea levels could rise up to seven meters, inundating big cities like New York, Los Angeles, San Francisco, London, Tokyo, Hong Kong, the entire state of Florida and vast swaths of Indochina.

- The melting of the Antarctic ice sheet is even scarier, with Lenton predicting it could also happen within three centuries. That would cause a sea rise of 80 meters, or up to five meters in the next 100 years if the West Antarctic Ice Sheet starts calving.

- On land, Lenton's tipping point is the Amazon rain forest. As logging deforests the Amazon, dry seasons get drier and last longer. This causes fauna to dry out and catch fire. The drought of 2010 saw 12,000 forest fires in the Amazon; burning trees and brush let carbon into the atmosphere.

- A similar die-off could occur in Canada's boreal forests, which would release up to 100 billion tons of carbon currently trapped in the permafrost.

- Lenton's last tipping point is more frequent occurrences of El Nino and La Nina. While they currently alternate every five years, scientists say they are seeing a more erratic pattern, which could have a detrimental effect on carbon sinks and sources of moist air like the Amazon.

"The real nightmare scenario is when all these changes begin to rein-force one another. The Arctic loses its summer sea ice, causing Greenland's ice to melt and encouraging the boreal forests to change as well. The freshwater runoff changes the thermohaline dynamics and affects the jet stream. The El Niño–Southern Oscillation and the Amazon interact in such a way as to reinforce one another, perhaps affecting the monsoon in India and Africa," says Lenton. "It wouldn't be such a silly thing to say that if you meddle with one, you might affect the other. Which direction the causality would go is not always obvious. We know it's connected, we know it's nonlinear, we know they somehow couple together. When you see one change, you see changes in the other."

"Then we start talking about domino dynamics. The worse case would be that kind of scenario in which you tip one thing and that encourages the tipping of another. You get these cascading effects."

Conclusion

The effects of climate change are already apparent. The planet is warming, affecting our weather, our oceans, our growing seasons, even our food, as crops fail, causing shortages and price hikes. Storms are becoming more frequent, and more intense, and droughts are lasting longer. Forest fires are an annual occurrence in Australia, California and British Columbia. In the United States and the Caribbean, people live in fear of the next hurricane that could literally turn their lives upside down. Most of us have watched videos of calving glaciers as huge chunks of ice break off millions-year-old ice sheets and tumble into the sea.

Is global warming a temporary phenomenon that we can stop through government policies in partnership with industry, like carbon taxes and cap and trade schemes? Unfortunately the truth is that climate change is more like a runaway train that is just reaching the crest of a hill, before it begins to accelerate, at break-neck speed. It is unstoppable. As we said at the top, the Earth will warm until it starts cooling. The proof is in the geologic record. All we can do is try to manage the effects as best we can.

What are the likely effects of climate change on humanity in the near term? The answer is most definitely the effect on freshwater, our most important resource, behind oil. According to the World Economic Forum's annual Global Risk Report, water crises rank among the global threats likely to cause the greatest impact, ahead of natural disasters, mass migrations and cyber-attacks. As reported by Japan Times, the UN's climate science panel concluded that for every degree of global warming, about 7% of the world's population will have 20% less freshwater. Recall that freshwater comprises less than 1% of the total water, including oceans, on the planet. Much of that water is locked up in glaciers and sea ice, leaving the rest in underground aquifers which are rapidly depleting due to over-use, and exacerbated by droughts (Ie. less rainfall to replenish them).

We believe that access to freshwater will be the most important conflict point over the next century. Warmer winters cause lower snowpacks, meaning less freshet

feeding lakes and streams, and less snow melt going into rechargeable aquifers. This process is made worse by melting glaciers. Once that permanent ice is gone, it's gone for good. In coastal areas, rising sea levels will pollute aquifers with salt water, rendering them useless for supplying freshwater to municipalities. Without access to a water supply, these people will move inland, putting more pressure on an already stretched water supply due to the reasons cited above. As the sea rises due to melting ice at the poles and Greenland, many coastal cities will be flooded out. Their inhabitants will all be forced to move inland, where drought conditions will persist. History shows us this is nothing new. The Akkadians, the Maya, ancient Egypt, the Khmer, and the Ming Dynasty, all collapsed due to severe drought. The major difference is that we have never seen a situation where most of the Earth is gripped by drought. Conflicts within nations and between nations, over water, are inevitable. The future of humanity will essentially be reduced to the carrying capacity of how much freshwater is left on the planet, after climate change has heated the planet to its breaking point.

Meanwhile, as the earth continues to warm, and greenhouse gases increase, with the final blow coming from the escape of methane, air quality (remember those declining oxygen levels) will get worse. The number of deaths from respiratory diseases will increase, despite the shift from a fossil fuel economy to an electric and renewable energy economy. Even the victors of the climate wars will not be able to escape from the environment that has become a heat and poisonous gas-absorbing death trap.

The Earth is going to continue to warm until it isn't. There is nothing we can do about it.

Climate change is already impacting you and the consequences you feel are going to intensify and multiply. Is Climate Armageddon on your radar screen?

Ahead of the Herd has put together a series of articles on climate change. We

covered the whole range of global warming causes and effects. Each article

endeavors to explain a facet of climate science that is not only extremely interesting, but also has investment implications.

Our changing climate - Part 1

Birds, bees and bugs: going going gone – Part 2

Gone Fishing – Part 3

The day they turned off the taps – Part 4

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