



II. CURRENT ISSUES

Climate Change and National Security

by Peter C. Oleson

According to the National Oceanic and Atmospheric Administration (NOAA), 2016 was the warmest year on record, continuing a trend of the past several years. Carbon dioxide (CO₂) concentrations increased by the largest amount in the 58 years on record and are at a peak exceeding that extrapolated from ice core measurements of the past 800,000 years. The NOAA report¹ noted that global surface temperatures are the highest ever recorded, sea levels have risen for the past six years, storm cycles are more extreme, the Arctic is warming more quickly than the rest of the planet, and Antarctic sea ice levels are the lowest recorded.

What are the national security considerations of climate change? When considering this topic, one has to define “national security” broadly – it’s not just security from hostile adversaries or terrorists. It has to include economic security and the population’s health and welfare. Why? Because scientists now project that climate change will affect not only sea rise but weather patterns and severity, heat indexes, air pollution, drought and fresh water availability, ocean acidification, food availability and diseases.

More and more is being written about the implications of climate change. The language of scientists often is specialized and difficult to decipher. Scientists also tend to be conservative in their expressions to avoid peer criticism. One observer has noted that climate “denialism” has made scientists cautious in offering speculative warnings.² Scientists also tend

to stay within their specialties, but climate change is a broad topic encompassing many fields of scientific endeavor. This author has tried to consolidate some of the latest available information to give an overview of climate change and its implications.



TEMPERATURE AND SEA LEVEL RISE

Sea level rise is the most written-about aspect of our warming planet. A recent study noted “warming beyond 3.6 degrees Fahrenheit, or 2 degrees Celsius, is viewed as the ‘tipping point’ at which the effects of climate change become more extreme.”³ Some researchers project that even if all greenhouse gas emissions ceased today the Earth would still heat up by another 2 degrees Fahrenheit by the year 2100, and if emissions continue for another 15 years, by 3 degrees Fahrenheit.

Ice melt is the major cause of sea rise, and melting in the Arctic is dramatic, as observed by NASA and European satellites. At the December 2017 meeting of the American Geophysical Union, Jeremy Mattis, Director of NOAA’s Arctic Research Program, reported that the rate of Arctic warming is “double the rest of the planet” and the decline of ice is “unprecedented in the past 1,450 years.” By comparison, “[i]n 2017, ‘multi-year ice,’ which is older and lasts through the summer melt season, made up just 21 percent of total Arctic ice... In 1985, it was 45 percent.”⁴

“The Greenland Ice Sheet, spanning 660,000 square miles (an area almost as big as Alaska) and with

1. <https://www.climate.gov>. See also http://www.politico.com/story/2017/08/10/2016-broke-global-temperature-records-again-241486?wpmm=1&wpisrc=nl_daily202.

2. David Wallace-Wells, “When Will the Planet Be Too Hot for Humans? Much, Much Sooner Than You Imagine,” *New York* magazine, July 10, 2017. (<http://nymag.com/daily/intelligencer/2017/07/climate-change-earth-too-hot-for-humans.html>). Wallace-Wells interviewed numerous climate scientists. Many were more outspoken and pessimistic when speaking anonymously than when writing publicly.

3. See Sean Duffy, “Research on Climate Change Becomes Grimmer and Grimmer,” Courthouse News Website, August 1, 2017, <https://www.courthousenews.com/research-global-warming-gets-grimmer-grimmer/> citing the journal *Nature Climate Change* (http://www.nature.com/nclimate/current_issue.html#section-articles).

4. Chris Mooney, “Warming of the Arctic is ‘unprecedented’ over the last 1,500 years, scientists say,” *Washington Post*, December 12, 2017. https://www.washingtonpost.com/news/energy-environment/wp/2017/12/12/federal-scientists-call-the-warming-of-the-arctic-unprecedented-over-the-last-1500-years/?utm_term=.c071f44fa4ea.

a thickness at its highest point of almost 2 miles, has the potential to raise the world's oceans by more than 20 feet.... Greenland fell out of balance in the 1990s, and is now shedding more and more ice in the summer than it gains back in the winter.”⁵

Though Antarctica's contribution to sea level rise is still minimal, over the past decade and a half, experts have started to warn about more rapid melting in the upcoming century.⁶ The West Antarctic Ice Sheet's melting could raise sea levels by 10 feet. And “the collapse of several major glaciers flowing into the Amundsen Sea is now unstoppable,” according to National Geographic. Melting glaciers worldwide (including Antarctica, Greenland, the Himalayas, and the tropical glaciers in Peru) could raise sea levels 3 to 7 feet by 2100.⁷

Sea rise will not stop in 2100. When the Earth was slightly warmer 125,000 years ago, sea levels were 20-30 feet higher than today. Three million years ago, when CO₂ was as high as today, sea levels were 70 feet higher.⁸

“The Arctic has traditionally been the refrigerator of the planet,” [NOAA's] Mattis said, “but the door to that refrigerator has been left open.”⁹

What is the impact of such sea rise? The Geology.com website has a useful interactive tool allowing one to visualize the rise in sea levels (<http://geology.com/sea-level-rise/>). If sea levels rise by 1 meter (3 feet), the impact on the US is minimal – however, large sections of the Mississippi River delta flood and many Chesapeake Bay islands are submerged. If the rise is 2 meters (6 feet), JFK Airport is inundated, Battery Park and the lower west side of Manhattan are underwater, as are large portions of the Norfolk Naval Base.¹⁰ A sea rise of 20 feet would be catastrophic: a quarter of Brooklyn would disappear, Wall Street would be waterfront, New Orleans would be gone, as would most of southwest Florida and the Keys. The Sacramento River valley would flood, making Stockton a seaport. South Seattle would be under water. In Washington, DC, Ronald Reagan National Airport would be inundated as would be southwest DC, the Pentagon's parking lots, and the central part of the Mall. Internationally,

the impact would be devastating – half of the Netherlands would be under the sea; Venice would disappear, as would the Italian coastline as far south as Ravenna; Kolkata, India, and one-third of Bangladesh and large portions of Tokyo would be flooded. The list is endless.

In his book, *The Ends of the World*, science writer Peter Brannen points out that oceans were hundreds of feet higher when the Earth was 4 degrees warmer.¹¹



HEAT

Some reports indicate that global warming since 1998 has occurred more than twice as fast as scientists had thought.¹² The UN Intergovernmental Panel on Climate Change (IPCC) projects the Earth could warm by 4 degrees by 2100. “The ‘likely’ warming expectation, for the worst warming scenario presented by the IPCC in 2013, is 2.6 to 4.8 degrees Celsius for the 2081-2100 period.” David Wallace-Wells believes temperatures could increase as much as 8 degrees.¹³

With significant temperature rise, portions of the Earth may become uninhabitable. The metric for uninhabitability is “wet-bulb temperature” (TW). A recent study explains:

“The increase in TW reduces the differential between human body skin temperature and the inner temperature of the human body, which reduces the human

5. <https://www.nasa.gov/feature/goddard/warming-seas-and-melting-ice-sheets>.

6. Ibid.

7. Douglas Fox, “Crisis on the Ice,” *National Geographic* magazine, July 2017: 30-49.

8. Ibid.

9. Mooney, “Warming of the Arctic...”

10. As many as 128 US military bases will be affected. Discussion by John Kerry, former Secretary of State, at the Carnegie Endowment on Twitter (December 20, 2017): <https://twitter.com/attn/status/94351938321636864>.

11. Peter Brannen, *The Ends of the World: Volcanic Apocalypses, Lethal Oceans, and Our Quest to Understand Earth's Past Mass Extinctions*, New York: Harper-Collins, 2017.

12. Wallace-Wells.

13. Some scientists challenge Wallace-Wells' 8 degree figure. Wallace-Wells did not specify whether his figures were Fahrenheit or Celsius, causing some confusion. His interview methodology has also drawn criticism as it sidesteps normal peer review. Chris Mooney, “Scientists challenge magazine story about ‘uninhabitable Earth’,” *Washington Post*, July 12, 2017. https://www.washingtonpost.com/news/energy-environment/wp/2017/07/12/scientists-challenge-magazine-story-about-uninhabitable-earth/?utm_term=.d8ff3c78dd8b. Scientific projections, of course, are highly dependent upon the assumptions made. One cannot expect unanimity among the scientific community.

body's ability to cool itself. Because normal human body temperature is maintained within a very narrow limit of $\pm 1^{\circ}\text{C}$, disruption of the body's ability to regulate temperature can immediately impair physical and cognitive functions. If ambient air TW exceeds 35°C (typical human body skin temperature under warm conditions), metabolic heat can no longer be dissipated. Human exposure to TW of around 35°C for even a few hours will result in death even for the fittest of humans under shaded, well-ventilated conditions. While TW well below 35°C can pose dangerous conditions for most humans, 35°C can be considered an upper limit on human survivability in a natural (not air-conditioned) environment."¹⁴

"[W]here humidity routinely tops 90 percent, simply moving around outside when it's over 105 degrees Fahrenheit [40 degrees Celsius] would be lethal. And the effect would be fast: Within a few hours, a human body would be cooked to death from both inside and out."¹⁵

Most regions of the globe today reach a TW of 26 to 27 degrees Celsius.

Scientists project that even if we meet the Paris goal of only 2 degrees Celsius warming, cities like Karachi and Kolkata will become close to uninhabitable.¹⁶ South Asia (Pakistan, India, Nepal, Bangladesh, and Sri Lanka), where one-fifth of the world's population lives, will be most susceptible to increases in temperature. Other susceptible areas include parts of China, the Persian Gulf area, and the Arabian Peninsula. Also, the urban heat island effect may increase the risk to inhabitants elsewhere, especially those in poor living conditions.¹⁷ Even before reaching life-threatening levels, heat increases contribute to human irritability and crime. "At wet-bulb temperatures exceeding 33°C , about an hour of vigorous, shaded activity leads to skin temperatures of 100°F and core body temperatures of 104°F – the threshold for heatstroke."¹⁸

INTENSE STORMS

The latest National Climate Assessment identifies the changes in weather resulting from the increases



in CO_2 and temperature.¹⁹ Projections are for more intense storms (hurricanes, tornadoes, and thunderstorms with hail) that are more destructive. Tropical storms draw their energy from the heat of the oceans. Wallace-Wells somewhat hyperbolically claims, "in a six degree-warmer world, the Earth's ecosystem will boil with so many natural disasters that we will just start calling them 'weather'.... The strongest hurricanes will come more often, and we'll have to invent new categories" for the Saffir-Simpson Scale.²⁰

At the American Geophysical Union meeting, several papers were presented on the relationship of storms and global warming. Computer simulations suggested that the three-day rainfall from Hurricane Harvey, which inundated Houston (50 inches were recorded in one place), was three times more likely due to the warming of the Gulf of Mexico, the waters of which were at record levels.²¹

A recent study cited in *Science* magazine states that, in recent years, climate change has affected the timing of river floods in Europe: coming earlier in the season and adversely affecting planting season for farmers.²² River flooding is one of the most widespread, destructive, and costly of all adverse weather events.

14. Eun-Soon Im, Jeremy S. Pal, and Elfatih A. B. Eltahir, "Deadly heat waves projected in the densely populated agricultural regions of South Asia," *Science Advances* 3 (8), 2 August 2017. This article was a cooperative research project between scholars at the Hong Kong University of Science and Technology, Loyola Marymount University in Los Angeles, and the Massachusetts Institute of Technology.

15. Wallace-Wells.

16. Ibid.

17. Im, Elfatih, Eltahir.

18. Mooney.

19. <http://nca2014.globalchange.gov/report>.

20. Wallace-Wells. The Saffir-Simpson Scale is for hurricane wind strength. Category 1 winds are between 74 and 95 mph, Category 2 – 96 to 110 mph, Category 3 – 111 to 130 mph, Category 4 – 131 to 155 mph, and Category 5 – greater than 155 mph.

21. Seth Borenstein, "Studies: Warming made Harvey's deluge 3 times more likely, AP, Dec. 14, 2017. http://www.chron.com/news/texas/article/Studies-Warming-made-Harvey-s-deluge-3-times-12426948.php?wpmm=1&wpisrc=nL_daily202. Related papers were presented by the Royal Netherlands Meteorological Institute, the Lawrence Berkeley National Laboratory, the National Center for Atmospheric Research, and Massachusetts Institute of Technology.

22. The *Science* cited study was led by Guenter Bloeschl of Vienna's Technical University and reported by Frank Jordans of AP, August 10, 2017.



DROUGHT AND FOOD SHORTAGES

One projected consequence of a warming planet is drought. Some scientists believe “[d]rought might be an even bigger problem than heat, with some of the world’s most arable land turning quickly to desert.²³ Precipitation is notoriously hard to model, yet predictions for later this century are basically unanimous: unprecedented droughts nearly everywhere food is produced today. Syria may be an early example. Drought resulted in the destruction of 60 percent of Syrian farmland and precipitated a migration of over 1,500,000 people to the cities, overwhelming the government. This led to a social explosion, civil war, and a massive refugee migration to Europe with significant political impact in many countries.²⁴

By 2080, without dramatic reductions in emissions, southern Europe will be in permanent extreme drought, much worse than the American dust bowl ever was. The same will be true in Iraq and Syria and much of the rest of the Middle East; some of the most densely populated parts of Australia, Africa, and South America; and the breadbasket regions of China.”²⁵

“Climates differ and plants vary, but the basic rule for staple cereal crops²⁶ grown at optimal temperature is that for every degree of warming, yields decline by 10 percent. Some estimates run as high as 15 or even 17 percent. Which means that if the planet is five degrees warmer at the end of the century, we may have as many as 50 percent more people [given population growth projections²⁷] to feed and 50 percent less grain to give them.”²⁸

23. A desert is defined as receiving less than 250 mm (9.8 inches) of rain per year. Approximately, one-third of the Earth is classified as “arid,” meaning desert or near-desert.

24. John Kerry, Carnegie Endowment, December 20, 2017.

25. Wallace-Wells.

26. Maize (corn), rice, wheat, barley, and sorghum are the five top cereal crops.

27. UN projections are for a worldwide population of between 9.5 and 10 billion humans by 2100.

28. Wallace-Wells.



AIR POLLUTION

CO₂ is increasing in the atmosphere. “Ancient air bubbles trapped in ice enable us to step back in time and see what Earth’s atmosphere, and climate, were like in the distant past. They tell us that levels of [CO₂] in the atmosphere are higher than they have been at any time in the past 400,000 years. During ice ages, CO₂ levels were around 200 parts per million (ppm), and during the warmer interglacial periods, they hovered around 280 ppm....”²⁹ A by-product of fossil fuel burning, CO₂ has increased today to greater than 400 parts per million and is a contributor to poor air quality. “[H]igh-end estimates extrapolating from current trends suggest it will hit 1,000 ppm by 2100. At that concentration, compared to the air we breathe now, human cognitive ability declines by 21 percent.”³⁰ Other pollutants include ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. These are the components of the Environmental Protection Agency’s Air Quality Index measure. “AQI as a yardstick... runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality.”³¹

“As climate change affects air pollutant concentrations, it can have a significant impact on health worldwide, adding to the millions of people who die from air pollution each year,” according to Jason West, an associate professor at UNC-Chapel Hill. Drier areas are especially affected due to less pollutant removal

29. NASA Website, 15 Aug 2017, https://climate.nasa.gov/climate_resources/24/.

30. Wallace-Wells.

31. Air Now Website, 31 August 2016, <https://airnow.gov/index.cfm?action=aqibasics.aqi>.

by rain, increased fires and windblown dust.³² “The Chinese ‘airpocalypse’ of 2013 peaked at what would have been an Air Quality Index of over 800. That year, smog was responsible for a third of all deaths in the country.”³³



OCEAN ACIDIFICATION AND IMPACT ON FISHING

At least one-quarter of the CO₂ in the atmosphere is absorbed in the oceans. “In the past 200 years alone, ocean water has become 30 percent more acidic – faster than any known change in ocean chemistry in the last 50 million years ... resulting in relatively rapidly dropping pH in surface waters.” “Overall, it’s expected to have dramatic and mostly negative impacts on ocean ecosystems.... Beyond lost biodiversity, acidification will affect fisheries and aquaculture, threatening food security for millions of people, as well as tourism and other sea-related economies.”³⁴ Coral bleaching, a consequence of rising sea temperatures, affects one-quarter of fish life in the oceans, which is a major food supply for half a billion people worldwide. Also noted by scientists are the increasing “dead zones” (areas of reduced oxygen (O₂), and which can produce toxic hydrogen sulfide (H₂S)) in the ocean, are on the rise. “They have doubled in frequency every 10 years since the 1960s.” “Temperature is perhaps the climate-related factor that most broadly affects dead zones,” according to Smithsonian researchers. “As temperatures increase, animals such as fish and crabs require more oxygen to survive. But with less oxygen available, ‘that could quickly cause stress and

mortality and, at larger scales, drive an ecosystem to collapse.”³⁵

In an article, Admiral James Stavridis, the former Supreme Allied Commander, Europe, and Johan Bergen as note the “escalating conflict over fishing.” “The decline in nearly half of the global fish stocks in recent decades is a growing and existential threat to roughly 1 billion people... who rely on seafood as their primary source of protein.” China is significantly affected and has used its coast guard ships as escorts for its fishing fleet “when illegally entering other countries’ fishing waters.” The authors predict conflict over fishing in many areas.³⁶



DISEASES

A warming planet means that tropical diseases, such as malaria and dengue fever, will become more prevalent as disease-carrying mosquitoes migrate and survive. The World Health Organization states “[m]alaria is of great public health concern, and seems likely to be the vector-borne disease most sensitive to long-term climate change.”³⁷ Other diseases of concern include HIV/AIDS, hantavirus, hepatitis C, Zika, and SARS. Some disease parasites reproduce more rapidly in warmer temperatures.

Some have speculated about ancient diseases trapped in the melting Arctic tundra, some of which

32. Sean Duffy.

33. Wallace-Wells.

34. National Museum of Natural History, Smithsonian Institution, 2016, <http://ocean.si.edu/ocean-acidification>.

35. Sarah Zielinski, “Ocean Dead Zones Are Getting Worse Globally Due to Climate Change,” Smithsonian Website, 10 November 2014, on a study conducted by Andrew Altieri of the Smithsonian Tropical Research Institute in Panama and Keryn Gedan of the University of Maryland, College Park, and the Smithsonian Environmental Research Center in Maryland. <http://www.smithsonianmag.com/science-nature/ocean-dead-zones-are-getting-worse-globally-due-climate-change-180953282/>.

36. James Stavridis and Johan Bergen as, “The Fishing Wars are Coming,” *Washington Post*, Sept. 13, 2017. https://www.washingtonpost.com/opinions/the-fishing-wars-are-coming...63b4_story.html?utm_term=.e00ec480923a&wpisrc=nl_opinions&wpmm=1.

37. <http://www.who.int/globalchange/environment/en/chapter6.pdf>.

may not be known to humans and for which there would be no immunity.³⁸

IMPLICATIONS

“Barring a radical reduction of emissions, we will see at least four feet of sea-level rise and possibly ten by the end of the century. A third of the world’s major cities are on the coast, not to mention ... power plants, ports, navy bases, farmlands, fisheries, river deltas, marshlands, and rice-padd[ies].... [E]ven those above ten feet will flood much more easily, and much more regularly, if the water gets that high.”³⁹

More than 600 million people live within 10 meters of sea level today. “The 10 countries with the most people in the low coastal areas are China, India, Bangladesh, Vietnam, Indonesia, Japan, Egypt, United States, Thailand, and the Philippines. The countries with the largest share of their populations living in low-elevation areas are Bahamas, Suriname, the Netherlands, Vietnam, Guyana, Bangladesh, Djibouti, Belize, Egypt, and Gambia.... Two-thirds of world’s largest cities – cities with more than five million people – are at least partially in these low areas.”⁴⁰ The consequence of urban area and rural lowland flooding will be mass migrations. How will India absorb potentially millions of displaced Bangladeshis? The most likely response will be conflict. Some researchers have attempted to “quantify some of the non-obvious relationships between temperature and violence: For every half-degree of warming, they say, societies will see between a 10 and 20 percent increase in the likelihood of armed conflict.”⁴¹ This, of course, has major implications for US foreign and military policy.

Drought and the need for fresh water are also likely to spawn conflict. In the Middle East, most of the major rivers rise in Turkey, which has been building dams. Syria and Iraq depend on the waters of the Tigris

and Euphrates Rivers. If flows diminish significantly, affecting agriculture and urban water supplies downstream, it is not difficult to predict conflict to ensure adequate water access. This scenario is also relevant to other areas of the globe – for example, India – Pakistan (Indus river), Egypt – Ethiopia (the Nile), and Southeast Asia (Mekong River).

Competition for resources in an increasingly unproductive sea, especially for those countries highly dependent on fishing (China, Indonesia, India, Vietnam, Japan, Philippines, Russia, Chile⁴²), is also a likely flash point, especially in the South China Sea and western Pacific Ocean and potentially the Arctic.

The above factors and the need to reconstruct vast amounts of flooded infrastructure (roads, railways, bridges, living space, etc.) will have an adverse economic impact on all countries. Humanitarian efforts are likely to be wholly inad-

equate.

“[M]ore than half of the carbon humanity has exhaled into the atmosphere in its entire history has been emitted in just the past three decades; since the end of World War II, the figure is 85 percent.... We are currently adding carbon [and other pollutants] to the atmosphere at a considerably faster rate [and that] rate is accelerating.”⁴³

Some have hypothesized that global warming is bringing us to the brink of planetary disaster. More conservative voices disagree. Nonetheless, recent studies underline Sean Duffy’s comment that “Research on Climate Change Becomes Grimmer and Grimmer.”⁴⁴

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42. <http://www.worldatlas.com/articles/leading-countries-in-fishing-and-aquaculture-output.html>.

43. Wallace-Wells.

38. Wallace-Wells.

39. Ibid.

40. A 2007 study by Deborah Balk, acting associate director of the Institute for Demographic Research at the City University of New York. <http://www.npr.org/templates/story/story.php?storyId=9162438>.

41. Wallace-Wells.