

Ten Key Facts: Climate Change

William Fassuliotis

The facts about climate change are clear: the earth is warming, man-made emissions are causing the warming, and the effects will get worse over time.

For the 5th time since it was chartered by the UN in 1988 to review and assess the science of climate change, the Intergovernmental Panel on Climate Change (IPCC) has released a series of reports in 2013-2014 detailing the state of knowledge on climate change, including its impacts and efforts to both mitigate and adapt to it.

The basics of climate change, therefore, are solidly established. The political discourse on the issue is very different than the scientific arguments.

In order to clearly show the basics that policymakers need to know, this paper lays out 10 essential facts about climate change.

These are facts and are not in dispute.

The Earth is Warming

The Climate has always Changed - but never this rapidly in human history

Today's Warming is Due to Emissions from Fossil Fuels

Sea Levels Are Rising

The Arctic is Melting

The Oceans are Becoming More Acidic

Weather Events are Becoming more Intense

Seemingly Small Changes in Temperature have Immense Consequences

Climate Change Presents National Security Threats

The Effects of Climate Change Will Make Life Difficult for People

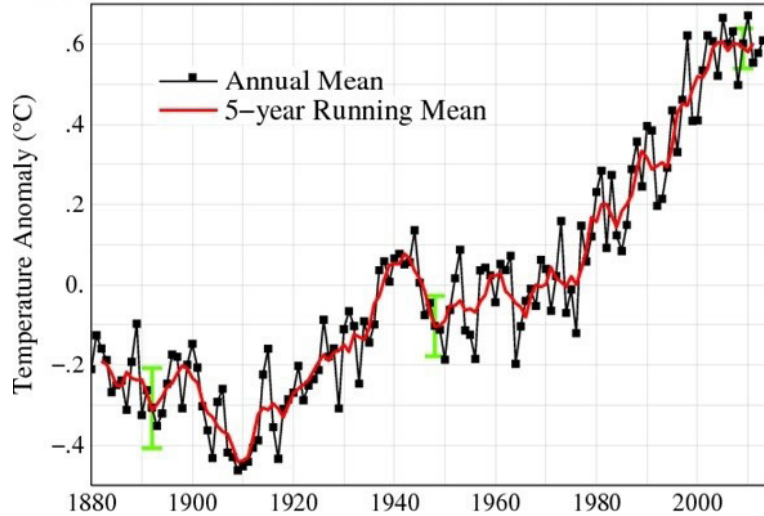


CLIMATE SECURITY

The Evidence of Climate Change

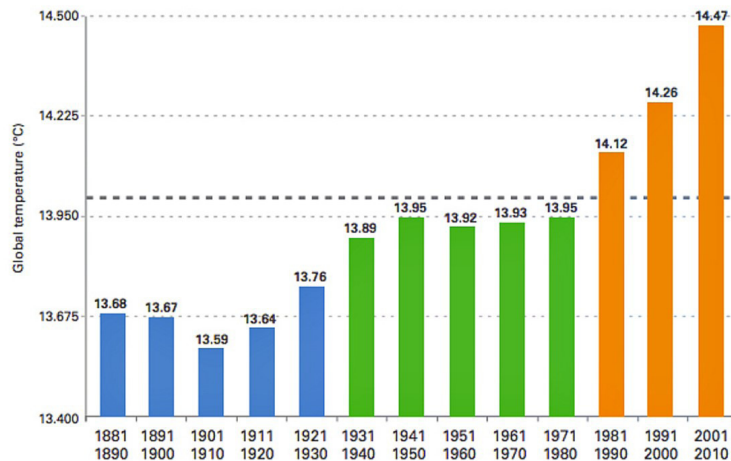
1) The Earth is Warming

- Average surface air temperatures have warmed 1.4°F since the beginning of the 20th century, with most of that warming since the 1970s.



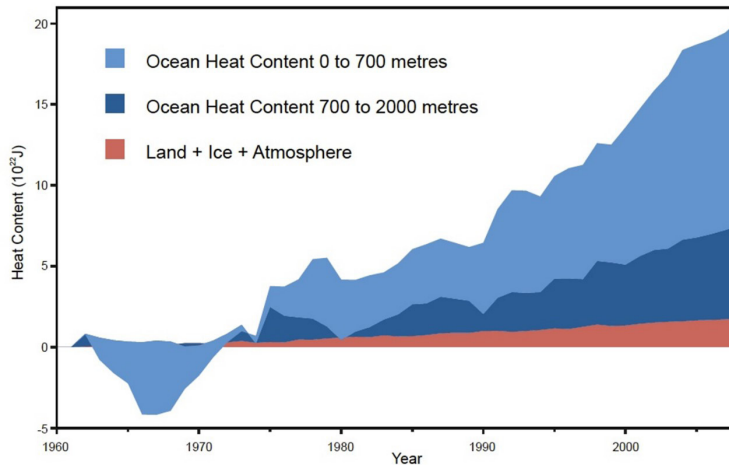
Changes in global surface temperatures since 1880¹

- The warmest decade on record was the 2000's, with each of the three decades before that warmer than the one before.



Average temperature by decade since the 1880s²

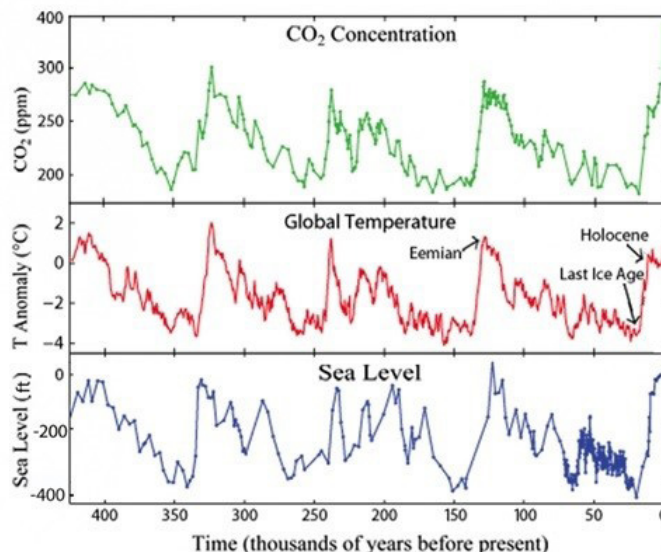
- However, measures of the increases in air temperature understate the amount of excess heat absorbed by the earth because they leave out water temperatures. The oceans, since the mid-1970s, have absorbed much of the heat (chart 3).



Accumulation of Global Excess Heat Since 1960³

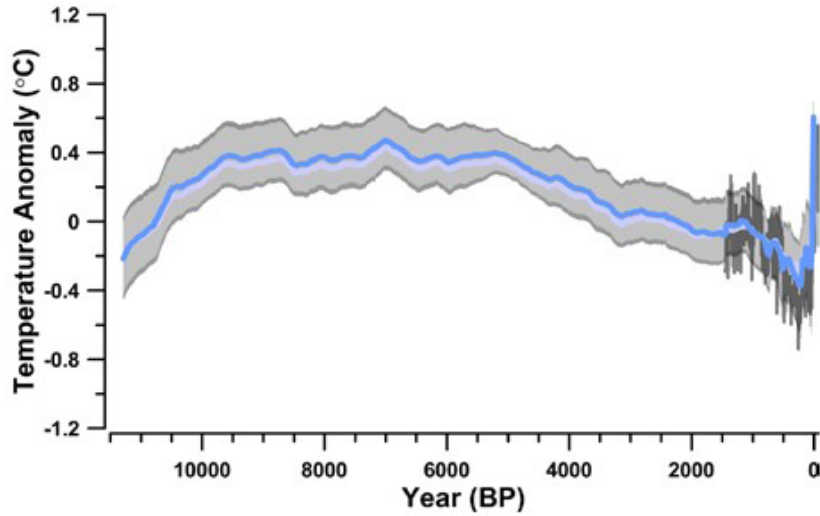
2) The Climate has always Changed - but never this rapidly in human history

- The Earth's climate has always changed; that is not in dispute. Carbon dioxide concentration, global temperatures, and sea level have naturally varied, in close correlation with each other, over the last 400,000 years.



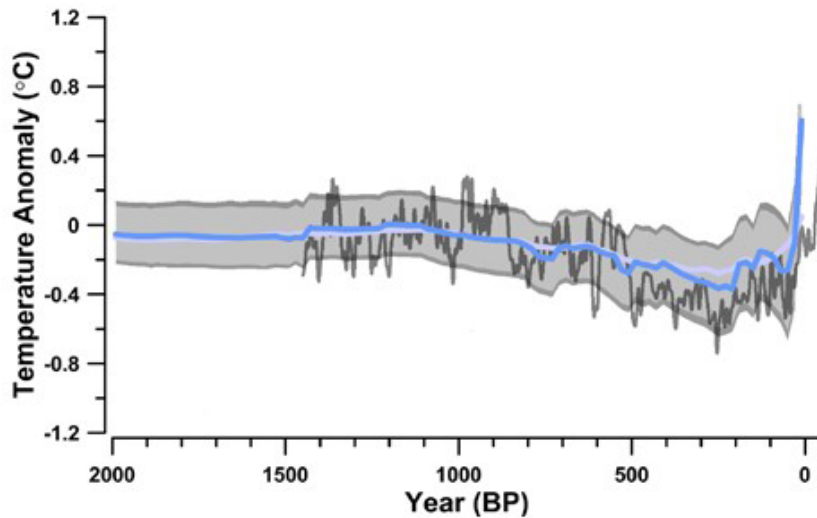
Carbon Dioxide Concentration, Temperature Change, and Sea Level for 450,000 years⁴

- The last 10,000 years, however, have demonstrated remarkable stability, with a slight downward trend.



Global Temperature Changes Since 10,000 BC⁵

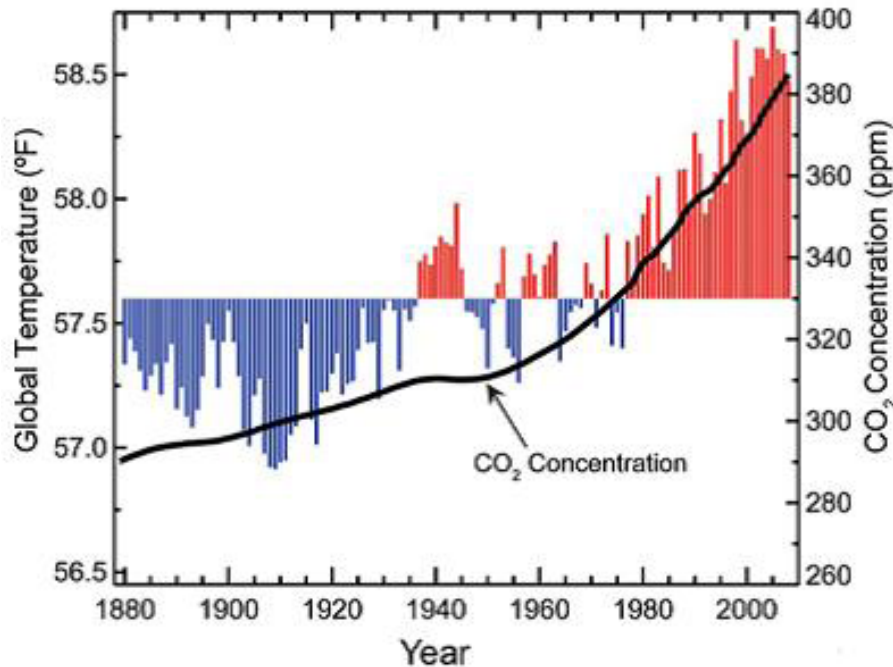
- The past century has seen an abrupt shift. Temperatures are no longer stable and have increased suddenly



Global Temperature Changes the last 2000 years

3) Today's Warming is Due to Emissions from Fossil Fuels

- Greenhouse gases (including carbon dioxide) are necessary to life as we know it; without them, the earth would lose all the sun's heat into space.
- With an increase, more of the sun's heat is retained. As concentrations of heat-trapping gases increase, the natural greenhouse effect is enhanced, causing average global temperatures to increase.
- The atmospheric concentrations of greenhouse gases have increased over the past two centuries as a result of human activities, particularly the burning of fossil fuels, but also through land-use changes (clearing forests for farming) and livestock breeding.
- These rising levels of greenhouse gases are directly linked to man-made emissions – and those emissions are largely responsible for the changes in climate.

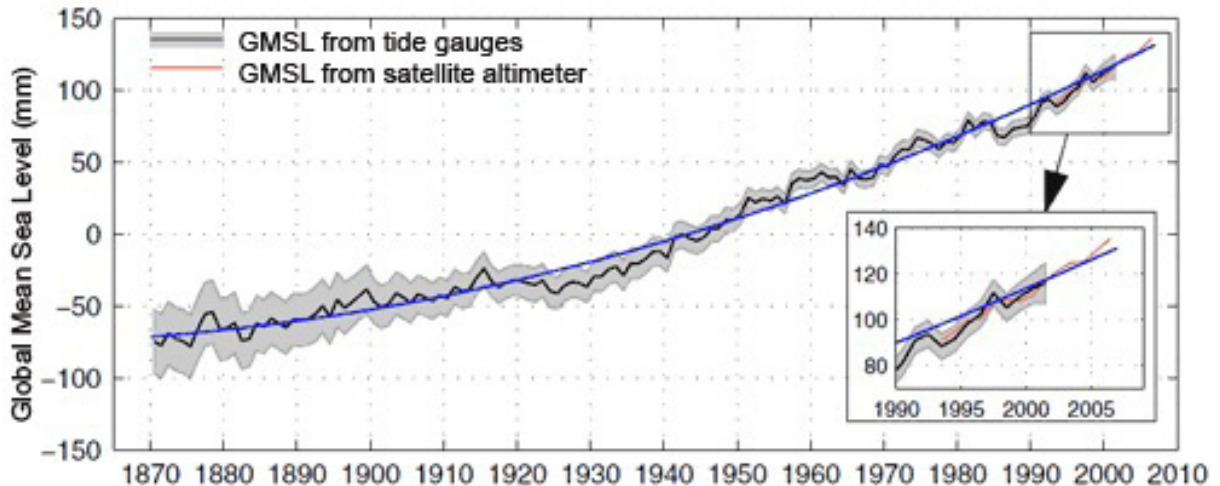


Global Average Temperatures vs. Atmospheric CO₂

Effects of Climate Change

4) Sea Levels Are Rising

- The global average sea level has increased 8-10 inches since 1870. This trend is projected to increase. By the end of the century (2100), sea levels worldwide could rise 2-3 feet or more, depending on the melting of ice sheets in Greenland and Antarctica.

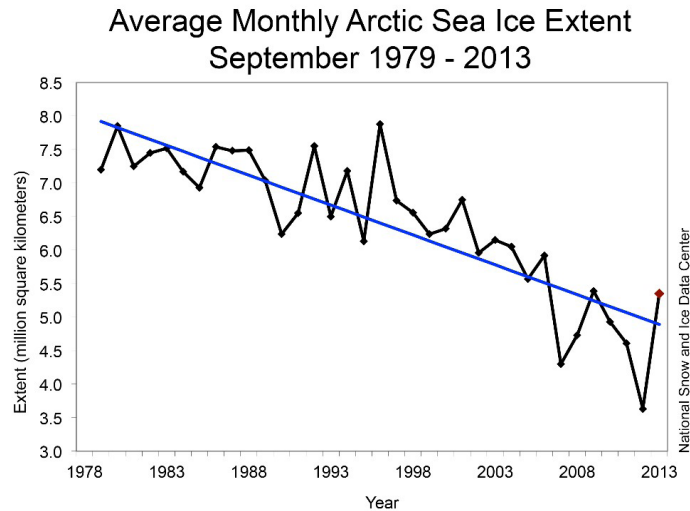


Global Average Sea Level since 1870⁶

- Rising sea levels will have effects on societies around the world.
- Almost 50% of the U.S. population lives within 50 miles of the coastline and 39% of the total population lives in counties directly on the shoreline, while an estimated 16% of total U.S. property value is located in coastal counties.⁷ This places much of the populace at greater risk of storm surges and prolonged flooding.
- These effects are dwarfed by small island countries like Nauru and archipelagoes like Indonesia and others throughout the Pacific and Oceania, threatened with the complete submersion of their country.⁸
- Freshwater aquifers and groundwater supplies on coasts around the world are at risk of becoming salinated, creating further restraints on freshwater consumption.⁹

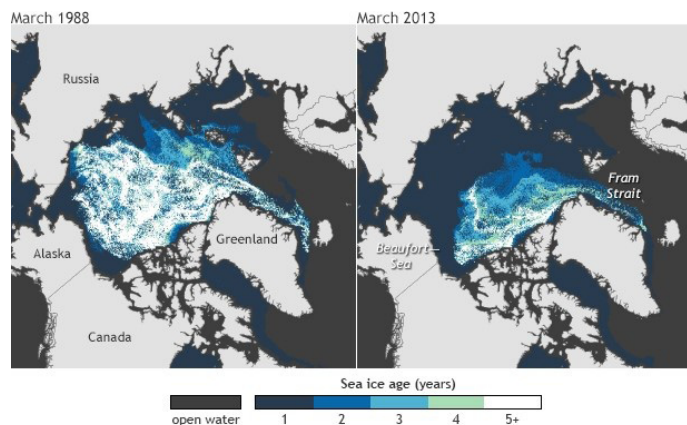
5) The Arctic is Melting

- Arctic Ice Coverage (surface area) and Arctic Sea Ice Volume have shrunk precipitously in the past decades. While ice coverage has always varied, it has dramatically decreased in a short period.



Sea Ice Annual Minimum Extent Since 1979¹⁰

- Notably, this means that there is little of the thick, multi-year ice remaining every year. So, even though the Arctic refreezes every winter, there is less thick ice remaining in the summer. This has contributed to a “death spiral” of Arctic Sea ice.

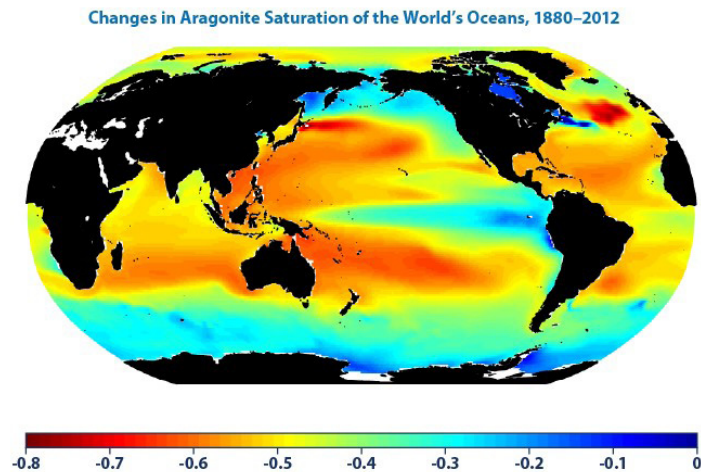


Decline in multi-year sea ice, 1988-2013¹¹

- For all of human history, the Arctic Ocean has been inhospitable and unnavigable, until now. The Northwest Passage, sought by explorers for centuries is now opening as ice in the northern region of Canada has melted enough to allow commercial shipping and military vessels through. The Northern Sea Route through Russia’s territory is even more navigable.

6) The Oceans are Becoming More Acidic

- The ocean absorbs an estimated 25-50% of manmade carbon emissions. The chemical interactions between CO_2 and seawater create bicarbonate molecules, an acid which lowers pH, making seawater more acidic.
- Changes in ocean chemistry are apparent with changes in Aragonite concentration – a compound used to build seashells.

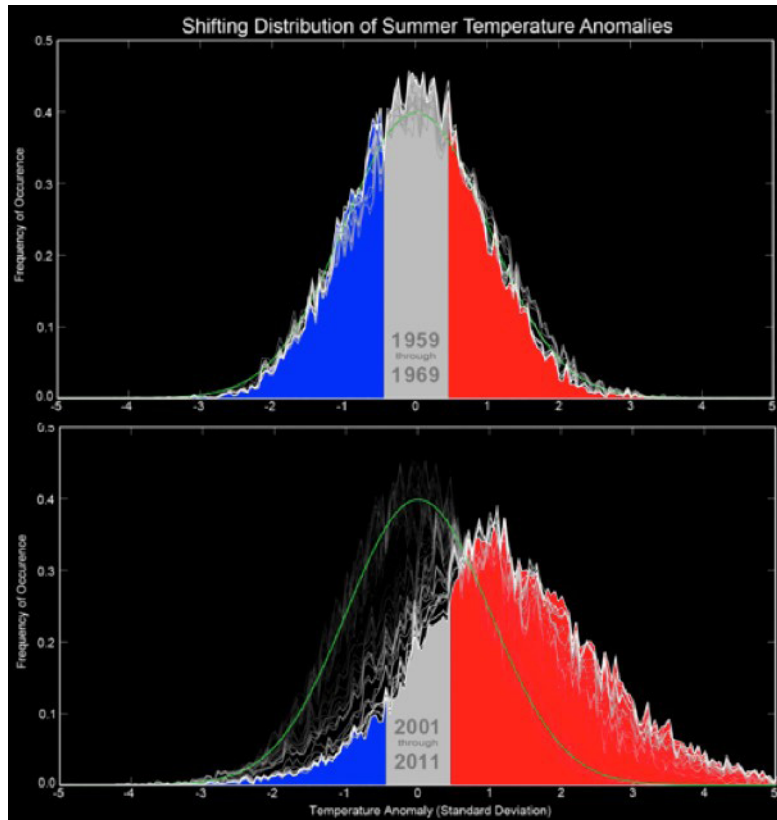


Change in Aragonite Saturation since 1880¹²

- Without greater acidity, certain sea life will be unable to build the shells needed to grow, potentially changing the entire ocean ecosystem.
- Changes to ocean chemistry are irreversible for thousands of years.
- Changes in acidity disrupt the life cycle and resource gathering of many marine species at the bottom of the food chain, like plankton, sea snails, and coral separate from the effects of warming. As the basis for food for many larger marine animals, their decreased numbers could harm populations of species further up on the food chain that humans use as a source of food.

7) Weather Events are Becoming more Intense

- It is difficult to link individual weather events with climate change, but changes in climate do mean that overall weather events are expected, overall, to be more intense and volatile than historically.
- As temperatures rise, more water evaporates, and warmer air is capable of carrying more precipitation, increasing the potential for intense storms.



The Distribution of Weather Events Become More Extreme¹³

- The effects of climate change are not uniform across the globe.
 - Some regions will become more prone to drought, such as the American West Coast and the Middle East.¹⁴ Droughts will be more frequent and longer in duration, putting areas already prone to wildfires even more at risk.

8) Seemingly Small Changes in Temperature have Immense Consequences

- Depending on the level of future greenhouse gas emissions, climate change models predict global warming to increase average global temperatures by 2°F to 11.5°F by the year 2100, depending on greenhouse gas emissions and the atmosphere sensitivity.¹⁵
- These changes will have consequences:
 - 1) An increase of 3.8°F would cause a catastrophic decrease in plant and animal life in the Arctic region.
 - 2) An increase of 5.4°F would decrease yields for all major cereal crops in all major regions of production. At low latitudes, some crops could see a yield decrease of over 20%.¹⁶
 - 3) An increase of 7.2°F would double the frequency of drought events across southern Africa, South East Asia, and the Mediterranean basin.¹⁷
 - 4) Increases of 7.2°F would cause sea levels to rise as much as 31 inches by the end of the century.¹⁸

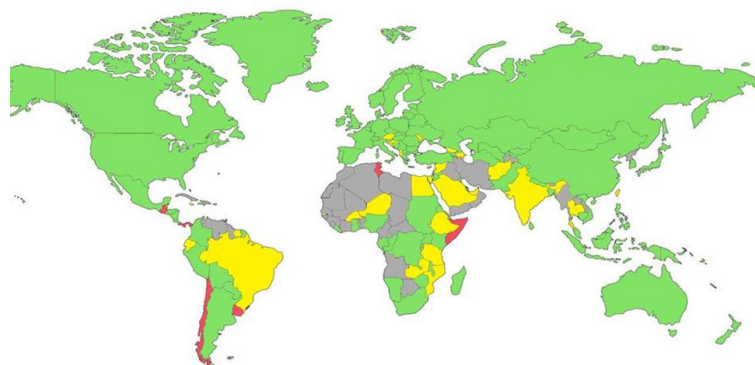
9) The Effects of Climate Change Will Make Life Difficult for People

- Climate change is not an intangible abstraction that only polar bears have to worry about. It already threatens existing livelihoods and lifestyles around the world:
 - 1) Mass displacement of populations, especially of inhabitants of coastal cities and famine stricken regions.
 - 2) An estimated 150 million more people per year would experience flooding in 2075 if sea level are to rise an average 21 inches.¹⁹
 - 3) Disruption of transportation and energy infrastructure from extreme weather.
 - 4) Food insecurity from increased warming and more varied and extreme precipitation like droughts and flooding.
 - 5) Less access to drinking and irrigation water.

10) Climate Change Presents National Security Threats

- Global warming brings unique and previously unaccounted for national security problems. Climate change is an “accelerant of stability” and a “threat multiplier.” By itself, climate change is not likely to cause war, but it contributes to the conditions that do lead to conflict.
- Possible vectors through which climate change will impact national security include:
 - Declining food productivity
 - Decreased fresh water availability
 - Greater mass migrations and refugees
 - Changing political borders
 - Dangers to human livelihoods from extreme weather
- These changes need not cause societies to fall into conflict.
- With reasonable foresight, countries can adapt to the effects of climate change and militaries can intervene before a problem becomes a war. On the other hand, in a world that already has many threats to security and stability, climate change will make the threats that much more dangerous and unpredictable.
- The threats to global security from these effects of climate change have raised the alarm among militaries and governments around the world.
- At least 110 nations have identified climate change as a threat to national security.²⁰

Level of Concern about how Climate Change Threatens Security



Green – Climate is a national security threat
Yellow – Climate is an environmental issue
Red – Climate is not a defined concern
Grey – No information available

About the Authors:

Andrew Holland is the American Security Project's Senior Fellow for Energy and Climate. He is a Washington-based expert on energy, climate change, and infrastructure policy.

William Fassuliotis is a research assistant and intern at the American Security Project. He is an undergraduate student at the College of William and Mary studying Government and Biology.

Further Reading:

www.NationalSecurityandClimateChange.org

[Climate Security Report](#)

[Protecting the Homeland – The Rising Costs of Inaction on Climate Change](#)

[Critical Security Challenges in the Arctic](#)

[The Global Security Defense Index on Climate Change](#)

[Pay Now, Pay Later, ASP's Report on the 50-state impact of Climate Change](#)

Endnotes

1. NASA Goddard Institute for Space Studies, “GISS Surface Temperature Analysis.” Available at: http://data.giss.nasa.gov/gis-temp/graphs_v3/ (accessed April 11, 2014).
2. World Meteorological Organization, “A Decade of Climate Extremes, Summary Report” 2013. Available at: http://library.wmo.int/pmb_ged/wmo_1119_en.pdf (accessed April 11, 2014).
3. Nuccitelli et al. “Comment on Ocean Heat Content and Earth’s Radiation Imbalance” *Physics Letters A*, Volume 376, Issue 45, 1 October 2012, Pages 3466–3468. Available at: <http://www.sciencedirect.com/science/article/pii/S0375960112010389> (accessed April 11, 2014).
4. Hansen and Sato, “Paleoclimate Implications for Human-Made Climate Change” NASA Goddard Institute for Space Studies and Columbia University Earth Institute, New York. Available at: http://www.columbia.edu/~jeh1/mailings/2011/20110118_MilankovicPaper.pdf (accessed April 11, 2014).
5. Marcott et al. “A Reconstruction of Regional and Global Temperature for the Past 11,300 Years” *Science* 339, 1198 (2013). Available at: <http://www.sciencemag.org/content/suppl/2013/03/07/339.6124.1198.DC1/Marcott.SM.pdf> (accessed April 11, 2014).
6. Church et al. “Understanding global sea levels: past, present and future” *Sustainable Science*, (2008) 3:9–22. Available at: http://academics.eckerd.edu/instructor/hastindw/MS1410-001_FA08/handouts/2008SLRSustain.pdf (accessed April 11, 2014).
7. Chin, Kareem. “Climate Change’s Threats to the United States – Lessons from the Netherlands” American Security Project (2013). Available at: <http://americansecurityproject.org/featured-items/2013/climate-changes-threats-to-the-united-states-lessons-from-the-netherlands/> (accessed April 11, 2014).
8. Lister, Tim, CNN. “Rising Sea Level Pus Island Nations like Nauru at Risk” December 5, 2012. Available at: <http://www.cnn.com/2012/12/04/world/asia/nauru-ocean-danger/> (accessed April 11, 2014).
9. IPCC, Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability. Available at: http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch6s6-4-2.html (accessed April 11, 2014).
10. Sea Ice Index, National Snow & Ice Data Center. Available at: <http://nsidc.org/data/g02135> (accessed April 11, 2014).
11. NOAA, “2013 Arctic Report Card: Only 7 percent of the ice cover at the end of winter 2013 was old, thick ice.” December 9, 2013. Available at: <http://www.climate.gov/news-features/featured-images/2013-arctic-report-card-only-7-percent-ice-cover-end-winter-2013-was> (accessed April 16, 2014).
12. Environmental Protection Agency “Climate Change Indicators in the United States.” Available at www.epa.gov/climatechange/indicators (accessed April 11, 2014).
13. Hansen et al. “Perception of Climate Change” *Proceedings of the National Academy of Science*, March 2012. Available at <http://www.pnas.org/content/early/2012/07/30/1205276109> (accessed April 11, 2014).
14. Fassuliotis, “California, Drought, and Climate Change.” American Security Project, February 20, 2014. Available at: <http://americansecurityproject.org/blog/2014/california-drought-and-climate-change/> (accessed April 11, 2014).
15. IPCC, Climate Change 2007: Working Group I: The Physical Science Basis, Mean Temperature. 2007. Available at: http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch10s10-es-I-mean-temperature.html (accessed April 11, 2014).
16. UK Met Office, “4 Degree Interactive Map” Available at: <http://www.metoffice.gov.uk/climate-guide/climate-change/impacts/four-degree-rise/map> (accessed April 11, 2014).
17. Ibid.
18. Ibid.
19. Ibid.
20. Holland and Vagg, “Global Security Defense Index on Climate Change” March, 2013. Available at: <http://americansecurityproject.org/featured-items/2013/the-global-security-defense-index-on-climate-change-%EF%BF%BCpreliminary-results/> (accessed April 11, 2014).

BOARD OF DIRECTORS



The Honorable Gary Hart, Chairman

Senator Hart served the State of Colorado in the U.S. Senate and was a member of the Committee on Armed Services during his tenure.



Norman R. Augustine

Mr. Augustine was Chairman and Principal Officer of the American Red Cross for nine years and Chairman of the Council of the National Academy of Engineering.



The Hon. Donald Beyer

The Hon. Donald Beyer is the former United States Ambassador to Switzerland and Liechtenstein, as well as a former Lieutenant Governor and President of the Senate of Virginia.



Lieutenant General John Castellaw, USMC (Ret.)

John Castellaw is President of the Crockett Policy Institute (CPI), a non-partisan policy and research organization headquartered in Tennessee.



Brigadier General Stephen A. Cheney, USMC (Ret.)

Brigadier General Cheney is the Chief Executive Officer of ASP.



Lieutenant General Daniel Christman, USA (Ret.)

Lieutenant General Christman is Senior Vice President for International Affairs at the United States Chamber of Commerce.



Robert B. Crowe

Robert B. Crowe is a Partner of Nelson Mullins Riley & Scarborough in its Boston and Washington, DC offices. He is co-chair of the firm's Government Relations practice.



Lee Cullum

Lee Cullum, at one time a commentator on the PBS NewsHour and "All Things Considered" on NPR, currently contributes to the Dallas Morning News and hosts "CEO."



Nelson W. Cunningham

Nelson Cunningham is President of McLarty Associates.



Admiral William Fallon, USN (Ret.)

Admiral Fallon has led U.S. and Allied forces and played a leadership role in military and diplomatic matters at the highest levels of the U.S. government.



Raj Fernando

Raj Fernando is CEO and founder of Chopper Trading, a technology based trading firm headquartered in Chicago.



Vice Admiral Lee Gunn, USN (Ret.)

Vice Admiral Gunn is the President of the Institute of Public Research at the CNA Corporation, a non-profit corporation in Virginia.



Lieutenant General Claudia Kennedy, USA (Ret.)

Lieutenant General Kennedy was the first woman to achieve the rank of three-star general in the United States Army.



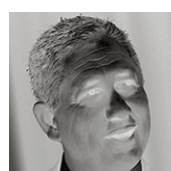
General Lester L. Lyles, USAF (Ret.)

General Lyles retired from the United States Air Force after a distinguished 35 year career. He is presently Chairman of USAA, a member of the Defense Science Board, and a member of the President's Intelligence Advisory Board.



Dennis Mehiel

Dennis Mehiel is the Principal Shareholder and Chairman of U.S. Corrugated, Inc.



Stuart Piltch

Stuart Piltch is the Co-Founder and Managing Director of Cambridge Advisory Group, an actuarial and benefits consulting firm based in Philadelphia.



Ed Reilly

Edward Reilly is CEO of Americas of FDI International Limited, a leading global communications consultancy that is part of FTI Consulting, Inc.



Governor Christine Todd Whitman

Christine Todd Whitman is the President of the Whitman Strategy Group, a consulting firm that specializes in energy and environmental issues.

The American Security Project (ASP) is a nonpartisan organization created to educate the American public and the world about the changing nature of national security in the 21st Century.

Gone are the days when a nation's security could be measured by bombers and battleships. Security in this new era requires harnessing all of America's strengths: the force of our diplomacy; the might of our military; the vigor and competitiveness of our economy; and the power of our ideals.

We believe that America must lead in the pursuit of our common goals and shared security. We must confront international challenges with our partners and with all the tools at our disposal and address emerging problems before they become security crises. And to do this we must forge a bipartisan consensus here at home.

ASP brings together prominent American business leaders, former members of Congress, retired military flag officers, and prominent former government officials. ASP conducts research on a broad range of issues and engages and empowers the American public by taking its findings directly to them via events, traditional & new media, meetings, and publications.

We live in a time when the threats to our security are as complex and diverse as terrorism, nuclear proliferation, climate change, energy challenges, and our economic wellbeing. Partisan bickering and age old solutions simply won't solve our problems. America – and the world - needs an honest dialogue about security that is as robust as it is realistic.

ASP exists to promote that dialogue, to forge that consensus, and to spur constructive action so that America meets the challenges to its security while seizing the opportunities that abound.



American Security Project

www.americansecurityproject.org