



Implications for US National Security of Anticipated Climate Change

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In the Intelligence Community's (IC) analysis of the possible impacts of climate change on national security over the next 20 years, the IC takes as a scientific baseline the reports produced by the Intergovernmental Panel on Climate Change (IPCC), the international body responsible for assessing the science related to climate change. This memorandum does not assess effects on the homeland, nor does it evaluate the science of the IPCC reports.

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Key Points

Long-term changes in climate will produce more extreme weather events and put greater stress on critical Earth systems like oceans, freshwater, and biodiversity. These in turn will almost certainly have significant effects, both direct and indirect, across social, economic, political, and security realms during the next 20 years. These effects will be all the more pronounced as people continue to concentrate in climate-vulnerable locations, such as coastal areas, water-stressed regions, and ever-growing cities.

Effects of Climate Change on National Security: Possible Pathways

Climate change and its resulting effects are likely to pose wide-ranging national security challenges for the United States and other countries over the next 20 years through the following pathways:

- Threats to the stability of countries.
- Heightened social and political tensions.
- Adverse effects on food prices and availability.
- Increased risks to human health.
- Negative impacts on investments and economic competitiveness.
- Potential climate discontinuities and secondary surprises.

Effects of Climate Change on National Security: Possible Timeframes

The complexity of the climate, the uncertainties of modeling, and human choices make it difficult to project when and where specific severe weather events and other effects will affect national security most significantly. However, climate models do not diverge significantly on their estimates of future surface temperatures or on changes in other climate variables during the next 20 years, particularly when fluctuations in the climate system are considered (see chart on page 12).

- **Now**, the effects resulting from changing trends in extreme weather events suggest that climate-related disruptions are under way.
- Over the **next five years**, the security risks for the United States linked to climate change will arise primarily from distinct extreme weather events and from the exacerbation of currently strained conditions, like water shortages.
- Over the **next 20 years**, in addition to increasingly disruptive extreme weather events, the projected effects of climate change will play out in the combination of multiple weather disturbances with broader, systemic changes, including the effects of sea level rise.

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Climate change is projected to produce more intense and frequent extreme weather events, multiple weather disturbances, along with broader climatological effects, such as sea level rise. These are almost certain to have significant direct and indirect social, economic, political, and security implications during the next 20 years. These effects will be especially pronounced as populations continue to concentrate in climate-vulnerable locales such as coastal areas, water-stressed regions, and ever-growing cities. These effects are likely to pose significant national security challenges for the United States over the next two decades, though models forecast the most dramatic effects further into the future. While specific extreme weather events remain difficult to attribute entirely to climate change, unusual patterns of extreme and record-breaking weather events are likely to become more common, according to the Intergovernmental Panel on Climate Change (IPCC).

- Extreme weather events, such as heavy rainfalls, floods, droughts, cyclones, and heatwaves, will disrupt critical human and natural systems. They could trigger crop failures, wildfires, energy blackouts, infrastructure breakdown, or infectious disease outbreaks. The frequency and magnitude of such events are increasing as the climate changes, according to the IPCC.
- Moreover, multiple weather disturbances—when several extreme weather events occur within a small region or short time—compound their impact while undercutting efforts by people and governments to cope. Clusters or rapid sequences of relatively modest weather events may cause more damage than very powerful single events.
- Global climatological stresses—such as sea-level rise, ocean acidification, permafrost and glacial melt, air quality degradation, changes in cloud cover, and sustained shifts in temperature and precipitation—could substantially alter broader natural and manmade systems involving where and how humans live and patterns of infectious disease outbreaks, as well as critical ecosystems.

The following table lays out the IPCC baseline for likely increases in extreme weather events in the decades ahead. Such events may occur at different rates of frequency, intensity, and location compared to historical patterns, and lack of preparedness for those changes—such as weather-related disasters, drought, famine, supply chain breakdown, or damage to infrastructure—may prove a primary cause of disruption.

According to the National Oceanic and Atmospheric Administration, *weather* reflects short-term conditions of the atmosphere in a particular region while *climate* encompasses the averages, variability, and other statistics of weather over longer periods of time. *Weather* includes very hot or cold or rainy days, while *extreme weather events* include extended droughts, floods, heatwaves, coldwaves, and intense tropical storms. *Climate change* reflects nonrandom change in climate measured over several decades or longer. *Climate variability* reflects the way that climate fluctuates above or below long-term average values.

Projected Trends in Extreme Weather Events

Phenomenon	Likelihood of Changes in 2016-2035	Likelihood of Changes by 2080-2100
Warmer days and nights	Likely	Virtually certain (99-100%)
More hot days and nights	Likely	Virtually certain
More warm spells and heatwaves	Likely	Very likely (90-100%)
More heavy precipitation events	Likely	Very likely
More droughts	More likely than not	Likely (66-100%)
More intense tropical cyclones	More likely than not	More likely than not (33-66%)
More extreme sea levels	Likely	Very likely

Source: Intergovernmental Panel on Climate Change, Fifth Assessment Report, September 2013

Effects of Climate Change on National Security: Possible Pathways

Climate and weather have long affected the national security of countries worldwide, although most often as a contributing factor that might be recognized only in retrospect. Sometimes the effects are dramatic—such as the brutal Russian winter that contributed to Hitler’s failed invasion in World War II—but more often weather and climate exert indirect effects that shape underlying social, political, and economic conditions. Academic research on the impacts of climate on political and security outcomes is still sparse, but we judge that climate will affect US national security interests over the next 20 years through the following pathways.

Threats to the Stability of Countries

Many countries will encounter climate-induced disruptions—such as weather-related disasters, drought, famine, or damage to infrastructure—that stress their capacity to respond, cope with, or adapt. Climate-related impacts will also contribute to increased migration, which can be particularly disruptive if, for example, demand for food and shelter outstrips the resources available to assist those in need.

When climate-related effects overwhelm a state’s capacity to respond or recover, its authority can be so undermined as to lead to large-scale political instability. Countries with weak political institutions, poor economic conditions, or where other risk factors for political strife are already present will be the most vulnerable to climate-linked instability. In the most dramatic cases, state authority may collapse partially or entirely. Climate-related instability is likely to create strong pressure for foreign aid, disaster assistance, or military responses. Even if climate-related disruptions do not undermine stability, however, some

governments could be so preoccupied with managing the effects that they have little time or energy left to engage on broader foreign policy issues.

- Fueled by unusually warm Arabian Sea waters, two separate tropical cyclones hit Yemen in 2015 in the span of just 10 days, including the first hurricane-strength storm to hit the country in recorded history. Already suffering a humanitarian crisis from war and water shortages, Yemen was unable to provide adequate relief for its citizenry. Heavy rains have since fueled the breeding of an unusually large population of desert locusts that threaten to devastate Yemen's agriculture, and efforts to eradicate the locusts have been stymied both by the difficult security situation and by fear of killing bees, a crucial pollinator for the region's honey and crop production.

Heightened Social and Political Tensions

Decreases in water and disputes over access to arable land will increase the risk of conflict between people who share river basins, aquifers, or land areas. Although historically water disputes between states have led to more water-sharing agreements than violent conflicts, according to academic studies, we judge that this trend could change over the next 20 years as water scarcity and variability intensify, possibly leading to disputes that pose greater challenges to security. Although environmental stress is rarely the sole cause, disputes between groups within countries over land and water resources are increasingly common as triggers for social violence and internal conflict, particularly when social and political tensions already exist.

- In 2014, citizens in a village on the outskirts of Mexico City, already water-stressed by drought, battled anti-riot police during a protest over the diversion of spring water to a new development nearby. More than 100 police were injured, many seriously.
- In 2014, farmers and herdsman in Nigeria clashed over access to grazing land and dwindling well water. Then President Goodluck Jonathan ordered military operations to reduce the violence.
- In 2012, mass protests and violence erupted over water shortages in Nouakchott, Mauritania. More than 70,000 refugees had migrated to Mauritania by July that year because of deteriorating conditions in neighboring Mali, putting additional pressure on Mauritania's water and soil resources, already strained by drought and desertification.

Even if climate-induced environmental stresses do not lead to conflict, they are likely to contribute to migrations that exacerbate social and political tensions, some of which could overwhelm host governments and populations. Sudden extreme weather—such as from floods, droughts, and severe tropical storms—almost certainly will increase the number of displaced people, particularly in regions that are unaccustomed to or unprepared for such events. Rising sea levels and unexpectedly large storm surges could threaten small island states and low-lying coastal regions—including many megacities—with flooding and saltwater contamination of freshwater. Over 20 years, the net effects of climate change on the patterns of global human movement and statelessness could be dramatic, perhaps unprecedented. If unanticipated, they could overwhelm government infrastructure and resources, and threaten the social fabric of communities.

The Arctic region is warming twice as fast as the rest of the planet, transforming rapidly, according to the National Oceanic and Atmospheric Administration. The resulting retreat of sea ice is creating new possibilities for resource extraction, tourism, fishing, and shipping routes between the Atlantic and Pacific. Unpredictable ice floes, remoteness, and harsh conditions will limit operations in the Arctic over the coming decade, but disputes over unresolved maritime boundary claims, military posturing, and economic activity could increase as the Arctic opens.

- Contention over Russia's claim to 1.2 million square kilometers of Arctic shelf, which Moscow submitted to the UN in August 2015, could increase friction with rival claimants, including Denmark and Canada.
- Opening waterways have encouraged a Western cruise line to plan the first month-long cruise through the Northwest Passage this summer, carrying more than 1,000 passengers. Maritime authorities have cautioned that the voyage is high-risk in terms of navigational security and because of limited search and rescue capabilities.
- Significant thawing of Arctic and sub-Arctic permafrost could rupture the China–Russia crude oil pipeline—an important shared resource between the two countries—and could threaten the integrity of other Russian pipelines, according to recent scientific studies.

Political disputes could arise over climate change responses and policies. Some adversely affected countries may seek relief through international judicial mechanisms. Countries not meeting their pledges to reduce carbon emissions may face heightened political pressure and eventually punitive actions—such as sanctions or pricing carbon into trade—even though the pledges now are voluntary, with no current enforcement mechanism.

Unilateral efforts by countries or groups to test or deploy **geoengineering**—a largely theoretical field exploring how the climate might be modified intentionally through methods such as injecting aerosols into the stratosphere or chemically changing the reflectivity of clouds—would almost certainly heighten regional or international tensions, especially in the absence of multilateral frameworks or institutions to govern such activities. Some forms of geoengineering experimentation are probably within the financial and technical capacity of some major powers and individuals, although there are fundamental scientific uncertainties about the efficacy and possible unintended consequences of such methods.

- If, for example, geoengineering methods suppressed global temperatures below the point assumed to bring dangerous climate change, such efforts would almost certainly need to be sustained and probably would alter global weather patterns, benefitting some regions at the expense of others, according to the National Academies of Science.

Adverse Effects on Food Prices or Availability

More frequent extreme weather events, ranging from droughts to extreme rainfall, would significantly threaten agricultural production. Moreover, long-term climate trends—such as more very hot days, changing precipitation patterns, and poleward shifts of tropical clouds—along with constraints on land, water, and energy also put upward pressure on food prices. We judge that in countries with weak political

institutions, climate-induced threats to food security sharpen the risk of social disruption, migration, or large-scale political instability.

- The terrorist group Al-Shabaab exploited the 2011-13 famine in Somalia to coerce and tax international aid agencies, and it withheld food from those it deemed uncooperative, according to Human Rights Watch.
- In 2015, insurgent groups in northern Mali exploited deepening desertification, worsened by persistent drought, to enlist locals in a “food for jihad” arrangement.

Heatwaves threaten livestock directly and also reduce fertility, decrease milk production, and make them more vulnerable to disease. Droughts, wildfires, and extended periods of reduced precipitation threaten pasture and food supplies, indirectly threatening livestock.

- In Australia, the world’s third-largest beef exporter, the direct and indirect impacts of heatwaves have contributed heavily to a decline in cattle stocks to the lowest levels in 20 years.

Increased ocean temperatures and more frequent and more intense storms will increasingly threaten fisheries, many of which are already under stress from overfishing and pollution, according to the UN Food and Agriculture Organization. As oceans become more acidic as they absorb atmospheric carbon dioxide, ecosystems on which fish and other sea life depend are further jeopardized.

- Warm ocean temperatures have helped fuel an unprecedented, ongoing bloom of toxic red algae along the southern coastline of Chile since early May 2016. The damage to Chile’s important aquaculture industry has sparked protests from fishermen, who have blocked access to ports over what they view as inadequate governmental compensation for their losses.

Increased Risks to Human Health

Extreme heat increasingly will contribute directly to deaths from cardiovascular and respiratory disease across the globe, particularly among the elderly, according to the US National Institutes of Health. High temperatures also raise the level of ozone and other air pollutants that exacerbate cardiovascular and respiratory disease. Rising sea levels and severe weather events will increasingly threaten medical infrastructure and other essential services, according to the UN World Health Organization.

- The 2003 heatwave in Europe fueled their hottest summer on record since at least 1540, and contributed to more than 70,000 deaths, according to a peer-reviewed study by the French Institute of Health and Medical Research. Western Russia’s most extreme heatwave in recorded history was in 2010, causing more than 11,000 deaths in Moscow alone, according to scientists.
- Heatwave-related deaths in South Asia in 2015 numbered 2,500 in India and more than 100 in Pakistan. Another intense heatwave beginning in April 2016 produced India’s highest temperature ever recorded (124°F) and has caused more than 400 deaths so far.

Higher temperature and, in some regions, more rainfall and flooding are likely to increase the frequency of water-borne diseases and diseases transmitted by insects, snails, and other cold-blooded animals in

those areas. Extended transmission seasons of important vector-borne diseases are expected across a potentially larger geographic range, according to the National Institutes of Health.

- For instance, the mosquito *Aedes albopictus*, which is capable of transmitting a broad range of viruses to humans, is likely to live longer in Western and Central Europe in the next few decades because of increasing temperatures, according to academic research. In contrast, projected changes on the Mediterranean coast of Spain are likely to diminish mosquito survival in that region.
- The *Vibrio cholerae* bacterium, which causes cholera, thrives in warm, salty waters. Higher surface-water temperatures and rising sea levels could introduce cholera to previously unaffected areas.

Stress on Military Operations and Basing

Globally, more frequent and intense natural disasters will strain the capacity of US and allied armed forces to deliver humanitarian assistance and disaster relief. The US military may be called upon more frequently to respond to foreign crises if its counterparts in affected countries are overstretched, unable to handle their own crises or those in their neighborhood.

We also judge that rising sea levels, flooding, droughts, higher temperatures, and more frequent extreme weather events will increasingly threaten military capabilities and facilities on both US and foreign territory, including military bases and training ranges.

- Continued reduction of sea ice will increase the importance of the Arctic as a domain for military access and operations, although the environment there will remain challenging and unpredictable.

Implications for Investments and Economic Competitiveness

Past and anticipated extreme weather events may discourage investment in regions deemed particularly vulnerable. Infrastructure will be increasingly threatened by more extreme conditions in the near future, and freshwater from aquifers will be increasingly jeopardized by saltwater intrusion. Expectations of future losses will almost certainly increase insurance premiums and payouts, and insurance rates may increase well before real effects are felt in regions deemed vulnerable.

- The chairman of Lloyd's of London, one of the world's largest and most influential insurance markets, has stated that climate change is its primary concern. Allianz, Europe's largest insurer, has said that climate-change-driven losses from extreme events could increase by 37 percent within a decade.

The financial burden of responding to emergent climate trends and severe weather events, including the cost of efforts to mitigate greenhouse gas emissions, will reduce financing available for other investments, except in cases where those climate investments lead to green-growth opportunities. Increasing heat stress is likely to adversely affect agriculture, manufacturing, and other sectors requiring physical labor and could significantly contribute to GDP loss.

- Low-income countries are less equipped to rebound from the economic setbacks caused by extreme weather events, and an increase in the frequency of these events could contribute to or even push some people into poverty.

Potential Climate Discontinuities and Secondary Surprises

While current climate models project long-term increases in global average surface temperatures, climate scientists warn that more sudden, dramatic shifts could be possible, given the complexity of the system and analogs in the climate record. Looking back over the past 100,000 years, the earth's climate periodically has undergone extreme shifts, sometimes in as little as a decade. Such abrupt swings can occur in complex systems when seemingly small shifts in the forces in play suddenly trigger dramatic nonlinear change, such as when a slight drop in temperature can suddenly turn water into ice. A body of scientific research indicates that the current rate of increase of carbon dioxide in the atmosphere is the highest in perhaps as long as 66 million years, sea levels are rising faster than in the past 2,700 years, and the oceans are acidifying more rapidly than in the past 56 million years.

Many climate scientists warn that the risk of abrupt climate change—currently low—will increase over the next several decades and beyond. **We judge that the possibility of abrupt climate change cannot be discounted over any timeframe because research has not identified indicators to forecast potential tipping points and other thresholds.** Even if sudden shifts in the climate do not materialize, gradual shifts in climate could nonetheless spark surprising secondary effects—such as a massive release of gases from melting permafrost, persistent megadroughts, extreme shifts in critical ecosystems, emerging reservoirs of new pathogens, or the sudden breakup of immense ice sheets. The national security implications of such changes could be severe.

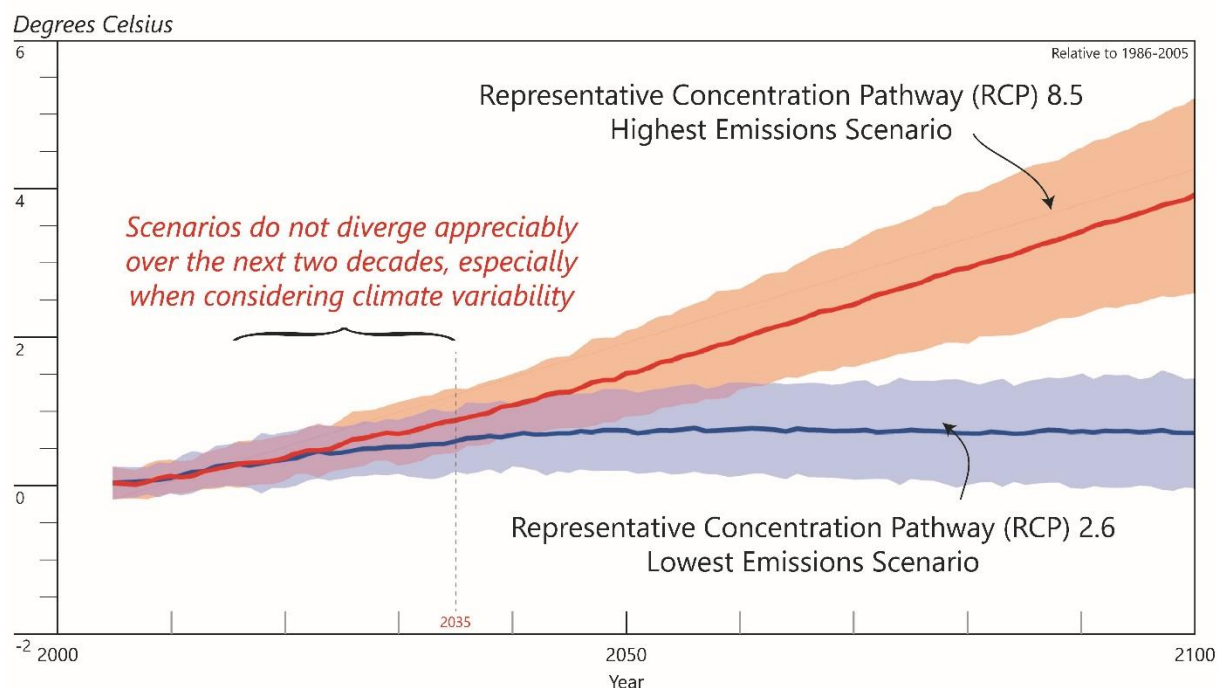
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Effects of Climate Change on US National Security: Possible Timeframes

The major forces driving climate are understood well enough for models to forecast climate trends for general regions, but complex interactions in the climate system, modeling uncertainties, and human choices make it difficult to project when and where specific weather and climate effects will most significantly affect national security. Most scientists expect that climate change generally will exacerbate current conditions—for example, making hot, dry places hotter and drier.

Future climate conditions could be altered significantly by government policies, industrial practices, or consumer behavior regarding greenhouse gas emissions. That said, IPCC scenario modeling suggests that aggressive environmental policies would not begin to slow the growth of global average surface temperatures for another 15-20 years because of the lag time for complex global climate systems to respond to changes in human behavior (see chart below).

Projected Average Surface Temperature Change



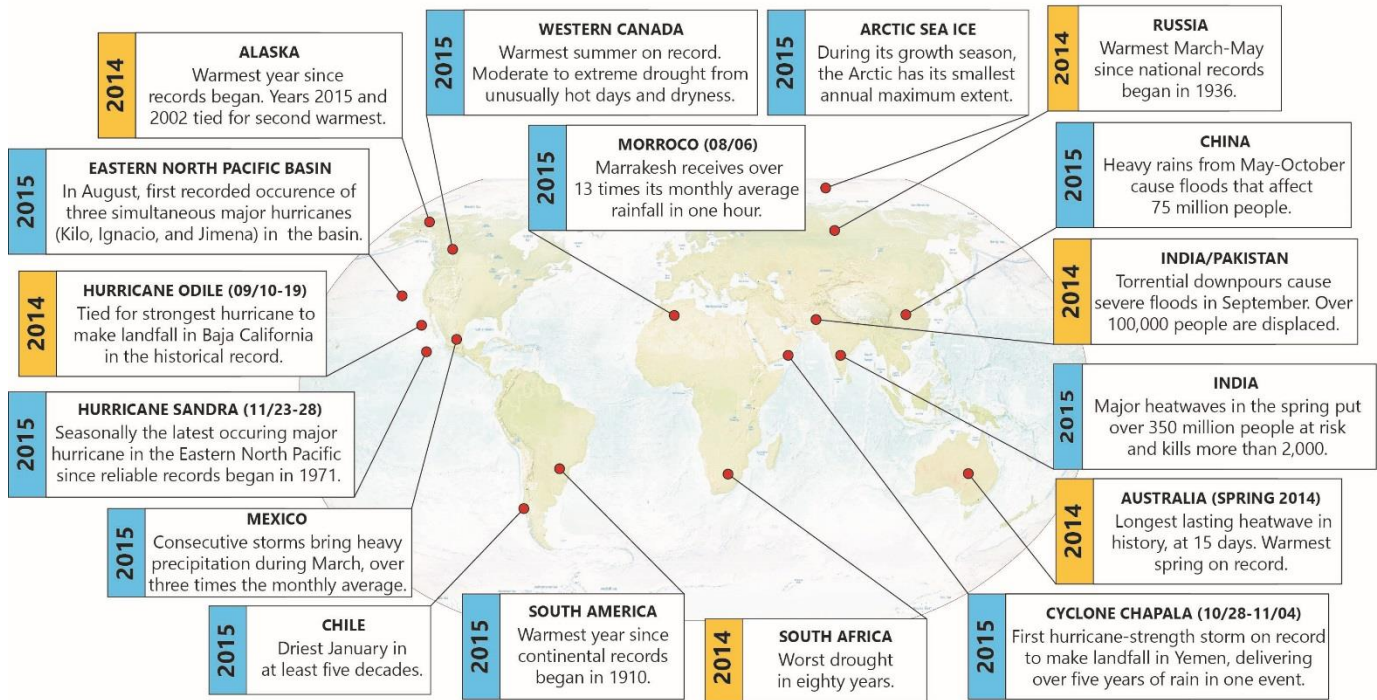
The bold curves represent averages in global surface temperatures determined from computer modeling, but the actual trajectory will have many peaks (higher than average) and valleys (lower than average). The peaks are qualitatively important because they likely represent snapshots of future average climate conditions.

Source: Intergovernmental Panel on Climate Change, Fifth Assessment Report, September 2013.

The long time horizon for climate change makes for different assessments of the national security implications for different periods. We make these assessments based on the IPCC's findings of projected climate change and our understanding of the possible pathways by which climate change affects national security.

At present, the growing implications for humans of extreme weather events suggest that **climate-change related disruptions are well underway** (see following map for illustrative examples of recent extreme weather events). Individual weather occurrences remain difficult to attribute entirely to climate change, however.

Selected Significant Extreme Weather Events, 2014-2015



Source: National Oceanic and Atmospheric Administration (NOAA), State of the Climate Reports, 2014, 2015.
Some events were influenced by an unusually large El Niño pattern that emerged in the last half of 2015.

Looking forward, we assess that during the next five years national security risks linked to climate change will arise mostly from distinct extreme weather events, especially in regions with weak governance, poor living conditions, or persistent conflict that limit the capacity of governments and societies to cope with additional stress. When extreme events occur where they have not before, that too will be disruptive, even for advanced industrial countries.

We assess that during the next 20 years—in addition to increasingly disruptive extreme weather events—climate change effects will play out in broader, systemic ways, such as more acidic oceans, degraded soil and air-quality, and rising sea levels, resulting in sustained direct and indirect effects on US national security. Weather events of modest severity will be disruptive when their impacts are compounded as part of a rapid sequence or in clusters.