

Special Report

Confronting the Reality of Climate Change

The business community and the military are joining forces with state and local governments to combat it. Will it be enough?



INTRODUCTION

Confronting the Reality of Climate Change

In 2014, President Barack Obama famously said, "We are the first generation to feel the effect of climate change and the last generation who can do something about it." Four years later, as Wharton's Initiative for Global Environmental Leadership (IGEL) convened its 11th annual conference, the growing sense of urgency was palpable. The title of the conference said it all: "The End of the World as We Know It: The Consequences of Extreme Climate Disruption for Business and Democracy." Throughout the day, speakers reviewed the scientific evidence of human-caused climate change, catalogued the dire consequences of insufficient action and examined the ways in which the business community, the military and government at all levels are responding, and failing to respond, to the challenge.



CONTENTS

The Science of Climate Change 1

The evidence for anthropogenic climate change began accumulating more than 100 years ago. Today, armed with eons of global climate data and unprecedented computing power, scientists now express their conclusions with statistical precision. The chances that devastating weather events will increase in frequency and intensity lies in the narrow zone of certainty between 95% and 100%. The increasingly urgent question scientists now face is, why do so many Americans doubt the science?

Climate Change and Government: State and Local Step Up in a Federal Vacuum 4

Nine months after President Obama signed the historic Paris Agreement, his successor announced the country's withdrawal from the climate accords. It was the beginning of a radical policy reversal that left vital work languishing. But as the federal government retreated, state and local governments have stepped into the breach. Mayors have taken action and many states have organized themselves into compacts and passed unilateral regulation. Partnerships between cities and private industry are also proving important.

Managing Business Risk in the Age of Climate Change 7

Faced with a future of unprecedented climate risks, many businesses are taking steps to help mitigate the harm. Relatively few are actively preparing themselves for effects that are now all but certain to impact their operations, sales and supply chains. Investors are pushing companies to assess the business risks they face and develop plans for managing them. Recognizing both the challenges and the opportunities, the most enlightened businesses are working actively on both mitigation and adaptation.

The U.S. Military's Response to a Warming Planet 10

The devastating effects of climate change increase the likelihood of armed conflict between nations, while at the same time compromising the effectiveness of the U.S. military. Many facilities are threatened by extreme weather and troops are compromised by their reliance on fossil fuel supplies. The Department of Defense recognizes these threats to its mission and is responding "by taking a proactive, flexible approach to assessment, analysis and adaptation." Despite the federal government's stonewalling on climate change, the military has said it will "keep pace with a changing climate, minimize its impacts on our missions, and continue to protect our national security."

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The Science of Climate Change

LIKE 98% OF SCIENTISTS, IRINA MARINOV KNOWS THAT CLIMATE CHANGE IS REAL and is being caused by human activity. As a professor of earth and environmental science at the University of Pennsylvania, what she finds baffling is why so many non-scientists in this country doubt this well-established fact.

According to a report from the National Surveys on Energy and Environment, 27% of Americans either do not believe the science or seriously doubt it. Even more alarming, 37% of Americans believe that natural causes, rather than human activity, are partially or wholly behind the rapid climactic changes of the past century.

Speaking at “The End of the World as We Know It,” a conference on extreme climate disruption sponsored by Wharton’s Initiative for Global Environmental Leadership (IGEL), Marinov asked, “What are we doing wrong? How do we get people to trust us?”

The evidence stretches back more than 100 years.

Svante Arrhenius, Sweden’s first Nobel Prize winner, was the first to calculate how levels of atmospheric carbon dioxide (CO₂) affect the earth’s average temperature. He published his findings in 1896, after collecting the meager data then available and performing what he called “tedious calculations.” His conclusion — that if CO₂ levels doubled, the earth’s surface temperature would rise about 5°C to 6°C — was a surprisingly accurate first attempt. (Scientists now say 2°C to 3°C is more likely.)

Arrhenius, who couldn’t have foreseen the rapid growth of internal-combustion automobiles, was the first to realize that burning coal would increase CO₂ levels and warm the planet, although his timetable was wildly off target. He estimated it would take 3,000 years for CO₂ levels to rise 50%, when, in fact, the average global temperature rose 30% in the 20th century alone. He also anticipated the warming trend would benefit humankind, enabling our distant descendants to “live under a milder sky and in less-barren surroundings than is our lot at present.”

Over the years, scientists confirmed that the world’s increasing reliance on fossil fuels was indeed pumping large amounts of CO₂ into the atmosphere, but like Arrhenius, they remained optimistic about the outcome. Earth’s oceans, said the experts, would absorb much of the gas and the small amount left in the atmosphere would help nourish plant life, leading to increasingly lush vegetation.

In her closing keynote at the IGEL conference, Margaret Leinen, vice chancellor and current director of the Scripps Institution of Oceanography at the University of California, San Diego, described how this sanguine view began to unravel in 1952 with the publication of a paper by Roger Revelle, then director of Scripps, and chemist Hans Suess. Their groundbreaking study showed that the oceans were absorbing only 25% of the atmospheric CO₂ generated by the use of fossil fuel. That same year, Revelle hired Charles David Keeling, then a post-doctoral fellow at Caltech, to take detailed measurements of CO₂ levels. The result, said Leinen, is “the iconic Keeling Curve of climate change,” which charts the steadily rising concentrations of atmospheric CO₂ from 1952 to the present.

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Since then, scientists have taken ice core samples allowing them to measure atmospheric CO₂ over hundreds of thousands of years, as the earth has cycled through ice ages and warm periods. The current CO₂ level, 410 parts per million, does not break any world records, said Marinov (it was equally high 23 million years ago, during the Oligocene Epoch, when seas were 100 feet higher than they are today). What is unique is the speed with which the greenhouse gas is being added. According to Marinov,

scientists have been unable to find any time in the geologic history of the earth that CO2 levels have increased as much as they have in the past 100 years.

There has been amazing progress since Arrhenius' time in measuring climate change. Scientists now have access to vast amounts of real-time data from ships, submarines, buoys, weather stations, balloons, satellites and radar installations around the world. Armed with computing power the 19th century scientist could not have imagined, today's researchers have incorporated the data into climate models that have been tested and refined over the years, based on their ability to accurately account for past climate variations. Scientists are now convinced that climate change is caused by human activity. In fact, according to Leinen, the science is so well established that the upcoming report of the Intergovernmental Panel on Climate Change will be the first to include predictions of future extreme weather events based on statistical probabilities.

A severe 2010 heat wave in Russia left nearly 56,000 dead, and a 2003 heat wave in Europe claimed the lives of almost 70,000 people.

Forecasting “the end of the world as we know it.” In his opening remarks at the climate conference, Eric Orts, Wharton professor of legal studies and business ethics and faculty director of IGEL, pointed out that with hurricanes Harvey, Irma and Maria battering the southeast and wildfires sweeping through California, 2017 was America's costliest year yet in terms of natural disasters.

And it's only going to get worse, Leinen explained. Scientists can now say with virtual certainty (meaning a better than 99% chance) that the frequency and intensity of extreme high temperature events will continue to increase. The likelihood that extreme precipitation events will also increase in frequency and intensity is only slightly less certain (90% to 99%). The toll from such events is already staggering. Hurricanes and flooding make the headlines, but a severe 2010 heat wave in Russia left nearly 56,000 dead, and a 2003 heat wave in Europe claimed the lives of almost 70,000 people. In California, 99% of the deaths from heat waves have been in poorer regions, raising what Leinen called “an environmental justice issue.”

The food supply is also threatened by climate change. In the developed world, the greatest agricultural losses to date have been due to extreme weather events, especially rain and floods, and across the major farm regions of the U.S., decreasing soil moisture poses a growing

threat to crop yields. Of equal concern in today's global economy, 22% of the losses due to natural disasters in the developing world affect agriculture, according to a 2017 report by the Food and Agriculture Organization of the United Nations.

“Extreme weather events are uncovering new kinds of catastrophic losses, as well,” said Anthony Wagar, executive vice president of environmental practice at Willis Towers Watson. A featured speaker at the conference, Wagar recounted experiences from his insurance work — flooding that carried industrial pollution into previously uncontaminated areas and toxic mold that grew in the aftermath of major storms. In some areas, flood waters overwhelmed water treatment plants, sending untreated sewage into nearby waterways. Outside of Houston, Hurricane Harvey knocked out critical cooling systems at a chemical plant, which led to a massive explosion.

The cumulative effect of all this scientific and anecdotal evidence is setting off alarms at the highest levels of society. “Doomsday predictions can no longer be met with irony or disdain,” said Pope Francis in his 2015 encyclical. “The pace of consumption, waste and environmental change has so stretched the planet's capacity that our contemporary lifestyle, unsustainable as it is, can only precipitate catastrophes, such as those which even now periodically occur in different areas of the world.”

The man who convinced the pope to focus his encyclical on climate change is Veerabhadran Ramanathan, professor of atmospheric and climate sciences at Scripps. According to Ramanathan, there is an even chance that the earth's temperature will rise more than 2°C in the next 35 years, and as a result, there is a 5% chance of what he calls catastrophic changes, ranging from deadly heat and widespread drought to overwhelming sea level rise and an explosion of vector-borne diseases such as dengue and chikungunya. To put this in perspective, Leinen asked conference attendees if they would get on a plane that had a 5% chance of crashing (the actual probability of a plane crash is one in 5.4 million).

So why do so many Americans doubt climate change?

Despite rock-solid science, the near certainty of devastating changes and a 5% chance of catastrophic change, millions remain unconvinced of the need to mitigate or adapt to climate change. Neither the pope's encyclical nor the Paris Agreement, an international commitment signed by 174 countries, has appreciably changed anyone's mind. In fact, according to a recent Gallup poll, the number of Americans who believe, disbelieve or remain uncertain about climate change has remained remarkably stable over the past two decades.

Colby Manwaring, CEO of Innovyze, a global provider of business analytics software for water-related

infrastructure, offered a possible explanation during his morning keynote address at the climate conference. He suggested that people react to climate change disasters as they do to any traumatic event, moving from denial to anger and bargaining before finally coming to terms with the reality of their loss. Denial was rampant after 2012's superstorm Sandy, said Manwaring, who quoted one resident of a flooded New York neighborhood as saying, "I don't want to live in a high-risk flood zone, but I don't want to move."

Others, he said, have reacted with anger, blaming big business or corrupt politicians or even duplicitous scientists for the problem. And one instance of bargaining he mentioned bordered on the ludicrous, with New York City officials negotiating with FEMA to change the contours of flood maps because the new scientifically determined flood zones would be unpopular with residents.

Howard Kunreuther, co-director of the Wharton Risk Management and Decision Processes Center, offered another possible explanation. Kunreuther and Robert Meyer (also co-director of the risk management center), focused their recent book, *The Ostrich Paradox: Why We Underprepare for Disasters*, on confronting the cognitive biases they believe influence people's thinking about climate change.

Calling on the pioneering work of Nobel laureate Daniel Kahneman, Kunreuther and Meyer outline six biases rooted in what Kahneman calls "system one thinking" (fast, intuitive and emotional), as distinguished from "system two thinking" (slower, more deliberative, and more logical): (1) myopia (focusing on the short-term); (2) amnesia (forgetting the lessons of the past); (3) optimism (underestimating the likelihood of extreme events); (4) inertia (a bias toward the status quo); (5) simplification (attending to just a few factors); and (6) herding (basing choices on others' actions).

"We are not going to change these biases," said Kunreuther. "They are part of the way we deal with the world." But he said there are ways to mitigate their influence. One key strategy, he suggested, is to stretch people's time horizons. If the upfront cost of a solar installation deters people from investing in its long-term benefits (myopia), create financing programs that stretch the upfront cost over the life of the system. If people underestimate the risk posed by extreme weather events (optimism), don't tell them there's a one in a hundred chance of a flood or hurricane next year, tell them there's at least a one in five chance of disastrous weather occurring more than once in the next 25 years.

Marinov herself suggested a third explanation for the disconnect between science and public opinion when she

pointed out that Americans' beliefs about climate change are determined more by political affiliation than by science, a fact confirmed more than once by polling data. This partisan divide has nothing to do with educational level. In fact, a Gallup poll from 2015 showed that the more education Democrats and Republicans have, the more their beliefs about climate change diverge.

According to an analysis published in *The New York Times*, this counter-intuitive relationship between education and partisan beliefs holds true for just a handful of complex issues. "On these kinds of matters, many Americans don't necessarily have their own views, so they look to adopt those of political elites," reports the *Times*. And when political elites disagree, "their views tend to be adopted first by higher-educated partisans on both sides, who become more divided as they acquire more information." And partisan beliefs are inherently resistant to rational persuasion. According to a 2010 study, "committed participants" clung tenaciously to misperceptions even when shown accurate corrections. "Even worse," noted the researchers, the corrections "actually strengthen misperceptions among ideological subgroups in several cases."

Rather than taking on people's surface attitudes directly, ... the goal of Jiu Jitsu persuasion is to identify the underlying motivation, and then to tailor the message so that it aligns with that motivation.

—*American Psychologist*

A recent article in *American Psychologist* suggests using what the authors call "psychological Jiu Jitsu" to overcome such resistance. "Rather than taking on people's surface attitudes directly (which causes people to tune out or rebel), the goal of Jiu Jitsu persuasion is to identify the underlying motivation, and then to tailor the message so that it aligns with that motivation." Other researchers have found, for example, that Republicans become less likely to deny climate change when presented with free-market solutions more in keeping with their core beliefs.

It remains to be seen whether any or all of these strategies can help persuade a majority of Americans to accept the reality of anthropogenic climate change. Whatever the solution, "the window for action is closing," said Leinen at the conference. "What we do this decade will determine the degree of suffering, versus mitigation and adaptation, we will experience."



Climate Change and Government: State and Local Step Up in a Federal Vacuum

ERIC ORTS, FACULTY DIRECTOR OF WHARTON'S INITIATIVE FOR GLOBAL ENVIRONMENTAL LEADERSHIP (IGEL), opened the center's conference this year with a set of ominous questions. Given the increasing likelihood that climate change will lead to catastrophic consequences, "how can we best prepare for the possibility of coming catastrophes? How can we best preserve our foundational institutions of free enterprise, democratic government and basic human rights in a radically changing world? In a word, how can we preserve civilization?"

Orts, who is also a Wharton professor of legal studies and business ethics, noted the timeliness of the conference theme, "The End of the World as We Know It: The Consequences of Extreme Climate Disruption for Business and Democracy."

"With each year of inaction, climate damage is increasing and increasingly likely to be more severe in the future."

—Eric Orts, faculty director of Wharton's Initiative for Global Environmental Leadership (IGEL)

"The timing for this conference is critical given the unfortunate political situation in the United States," Orts said. "A major party has reversed course from policy positions that had previously endorsed market-based approaches to climate regulation — including cap-and-trade and carbon fee options — to a complete and irrational denial of science and scientific warnings. With each year of inaction, climate damage is increasing and increasingly likely to be more severe in the future. It is

incumbent on academics and business leaders to prepare for long-term extreme risks."

A radical change in direction. Three years before signing the Paris Agreement in 2016, the most ambitious climate change accords in history, President Barack Obama introduced his Climate Action Plan. It accepted the scientifically proven reality of climate change and called for decisive action to help prevent a warming planet's most devastating effects. The Obama plan targeted a 17% reduction in greenhouse gas emissions by 2020, encouraged and incentivized renewable energy, and enacted far-reaching curbs on carbon dioxide from tailpipes, power plants and other sources.

Nine months later, President Donald Trump announced that the country was withdrawing from the Paris Agreement. Today, climate denial is official federal policy. Scott Pruitt, the first Environmental Protection Agency (EPA) administrator appointed by Trump, circulated this view: "Human activity impacts our changing climate in some manner. The ability to measure with precision the degree and extent of that impact, and what to do about it, are subject to continuing debate and dialogue." Pruitt also did not agree that carbon dioxide was a "primary contributor" to climate change, and asserted that the human race has mainly profited from warming trends.

Pruitt has left office, but the department did not change course under acting EPA Administrator Andrew Wheeler. The EPA has removed many references to planetary warming from its website. Christine Todd Whitman, who headed the EPA under President George W. Bush, said the culling of online scientific data on climate change is "to such an extreme degree that [it] undermines the credibility of the site."

The inevitable result of this radical shift in federal policy will be intense, varied and catastrophic climate effects. "It will become more and more apparent that global

climate change is the most significant challenge that human civilization will face in the 21st century,” said Orts. “Formerly verdant parts of the world will likely become overburdened and uninhabitable. Migrations and environmental refugee flows will likely multiply exponentially. Tropical diseases will likely spread. Many species will likely continue to die off.”

State and local municipalities step up. In the vacuum created by federal stonewalling on climate change, mayors have taken action and many states have organized themselves into compacts and passed unilateral regulation. Perhaps the strongest position was taken by California’s state legislature, which in August 2018 voted that 60% of its electricity generation would come from renewable sources by 2030, and 100% by 2045. “This is a pivotal moment for California, for the country and the world,” stated Michael Brune, the Sierra Club’s executive director.

Nine Northeastern and Mid-Atlantic states have joined together in the Regional Greenhouse Gas Initiative (RGGI). The states together represent the world’s sixth largest economy, with a combined GDP of \$2.8 trillion in 2017. The states formed their own cap-and-trade system, and pledged to reduce power plant emissions by 3% each year over the previous year, resulting in emissions in 2030 that will be 65% lower than in 2009, the first year of RGGI.

Following President Trump’s decision to abandon the Paris Agreement, a group of 36 U.S. mayors signed the 2017 Chicago Charter, agreeing to abide by the principles of the international pact. “We’re all going to get to the same destination in our own individual way,” said Chicago Mayor Rahm Emmanuel. “It’s designed in such a way that it is measurable.” In 2018, the so-called “Climate Mayors” had more than 400 U.S. cities, representing 70 million Americans, pledge to meet the provisions of the Paris Agreement.

One of those cities is Orlando, Fla., which under the leadership of Mayor Buddy Dyer, has installed 20 megawatts of solar power (through the municipal utility), testing systems to trap carbon dioxide from its power plants, and looking at closing plants that burn coal.

Globally, the London-based C40 Cities Climate Leadership Group, founded in 2005, has signed on 90 cities (including in the U.S. Austin, Tex., Boston, Portland, Ore., Chicago, Houston, Los Angeles, New York, Philadelphia, San Francisco, Seattle and Washington, D.C.). The 90 cities represent more than 650 million people and a quarter of the international economy. C40 is focused both on reducing urban emissions and reducing risks to cities from a dramatically warming world.

The current C40 chairperson, succeeding former New

York Mayor Michael Bloomberg, is Anne Hidalgo, mayor of Paris, who made a major climate commitment in the French capital by pledging to ban diesel vehicles by 2024, and internal-combustion vehicles of all types by 2030. Further, France has said that, under the Paris climate accords, it will end the sale of all diesel and gas-powered cars by 2040.

“Our methods and plans need to be dynamic, not static, and we can’t pretend that new data won’t emerge over time.”

—Colby Manwaring, CEO, Innovyze

Adapting to climate change. It’s too late to escape significant global warming impacts. States and cities are recognizing the inevitability that they will “feel the heat” from climate change, and the Wharton conference highlighted some of the ways they are making preparations. Or, in some cases, resisting them.

Colby Manwaring, the CEO of Innovyze, a global provider of business analytics software for water-related infrastructure, said at the conference that outdated flood maps with misleading 100-year-storm data have given coastal residents false assurances about their likelihood of experiencing catastrophic events. In the wake of superstorm Sandy, the Federal Emergency Management Agency (FEMA) used big data analytics to draw new flood maps that take into account higher variability in the weather. Manwaring emphasized the importance of these statistically sophisticated maps, and noted that the effort must be ongoing. “Our methods and plans need to be dynamic, not static, and we can’t pretend that new data won’t emerge over time,” he said.

But simply having accurate data won’t guarantee that elected officials will respect the message contained in it. The new FEMA flood maps for New York City were rejected by some city officials, because they would reduce property values and force thousands of people to buy flood insurance.

Other cities, like New Orleans, are taking more realistic approaches, said Elinor Haider, vice president for market development at Veolia North America, which applies sustainable solutions to energy, water and waste issues. “The old model,” she said at the conference, “is to run infrastructure to failure, then look to government to bail us out.” With the federal government in climate-denial, this strategy has failed dramatically.

Haider pointed to Puerto Rico, which at the time of the conference still had 100,000 people without power because of Hurricane Maria in 2017, and grappling with \$9 billion in related debt. “The future is in sustainable infrastructure,” Haider said. “The island has a strong incentive to privatize its utility system and invest in microgrid technology. Every dollar invested can save \$6 in costs.” She defined microgrids as “interconnected systems of distributed generating sources and controllable consumption loads.” The model of these small, decentralized power plants she cited combine solar, battery back-up, and combined heat-and-power units (CHP).

“We have a responsibility to produce chemicals safely and operate reliably.”

—Erica Campo, global sustainability strategy manager, The Dow Chemical Company

According to Haider, those business complexes, campuses and hospitals with microgrids were able to keep the power on when they were hit by Sandy (which caused \$70 billion in damage). Because of its Washington Square microgrid, she said, New York University’s campus had electricity, heat and hot water during the storm, while nearby NYU Langone Medical Center went dark at a critical time. (Since the storm, Langone installed an 11-megawatt CHP plant and microgrid that Haider said “will be state-of-the-art and keep the power on during the next storm.”)

In part because of the state’s Sandy experience, New York’s Public Service Commission in 2014 ordered utility Con Edison “to enhance system reliability, to achieve a higher level of storm hardening and resiliency in the face of

anticipated climate change and sea level rise.” Specifically, Con Ed was told to invest in distributed generation as an alternative to its existing power plants. Other New York utilities were also told to build predicted climate impacts into their planning.

Private industry can help when local and state governments get overwhelmed, added Erica Campo, global sustainability strategy manager at The Dow Chemical Company. “The chemical industry in Texas employs nearly 79,000 people,” she said. “We have a responsibility to produce chemicals safely and operate reliably.” Campo also pointed to Gulf-area plants that were shut down without toxic releases, or allowed to continue running at adjusted levels.

According to Campo, Dow has made contributions to recovery efforts, provided interest-free loans to homeowners so they could rebuild, and has become a large investor in renewable energy, installing 150 megawatts of it. “A huge value chain depends on our reliability,” Campo said. “The areas directly affected by Hurricane Harvey account for \$155 billion in shipments.” She quoted climate scientist John Holdren, an advisor to President Obama: “We have three choices: mitigation, adaptation and suffering. We’re going to do some of each; the question is what the mix is going to be.”

Anthony Wagar, executive vice president for environmental practice at Willis Towers Watson, agreed that business will have to work with government, and step up with comprehensive adaptation plans. “We’re seeing non-traditional liability exposure as a result of extreme weather events,” he said. “We need to be proactive about this, and ask questions: Is that plant close to the shoreline properly situated? Risk management has to be in place, and acted upon. Fortunately, we’re seeing companies be more transparent with environmental disclosure, and the impacts they’re facing.”





Managing Business Risk in the Age of Climate Change

CLIMATE CHANGE IS UNIQUE AMONG BUSINESS RISKS. It is directly responsible for three of the top five risks facing companies today, according to the World Economic Forum's latest "Global Risk Report." It is also, in the language of the military, a 'force multiplier.' "Climate change raises the complexity and interdependence of risk," said Sanjay Patnaik, professor of strategic management and public policy at George Washington University. "It will worsen many of the risks firms face on a regular basis and on a scale we have never experienced before."

Speaking at a conference on climate disruption sponsored by Wharton's Initiative for Global Environmental Leadership (IGEL), Patnaik emphasized that the uncertainty of many climate-induced threats makes planning for them much more difficult. Companies develop continuity plans for dangers they have experienced in the past, like power outages and fire, said Colby Manwaring, CEO of Innovyze, a global provider of business analytics software for water-related infrastructure. But many firms today fail to account for less predictable but increasingly likely risks, such as new areas of flooding and storms of unprecedented intensity, he explained during his opening keynote at the conference.

Beyond damaging a company's facilities, extreme weather events can disrupt supply chains with disastrous results. When Hurricane Maria knocked out power and blocked roads in Puerto Rico, it incapacitated one of the largest centers of pharmaceutical manufacturing in the world. Almost overnight, hospitals throughout the U.S. lost their source, in some cases their only source, for a range of critical drugs and medical devices, including critical drugs for treating cancer, heart disease, diabetes and HIV.

Regulatory and political risks are also dramatically increased by climate change. According to Patnaik, 80 different jurisdictions around the world, at all levels of government, have already placed a game-changing price on

carbon and more are sure to follow. "And when you look at the 2015 refugee crisis in Europe, that's probably nothing compared to what we can expect in the future with the displacement of people from the Middle East and Africa," said Patnaik.

Many firms have yet to confront climate risks. According to the 2017 KPMG "Survey of Corporate Responsibility Reporting," three-quarters of companies worldwide do not acknowledge climate change as a financial risk. The 250 largest companies do better, but more than half are still climate-change deniers when it comes to confronting potential financial losses, the report said. Even among those that do acknowledge climate risks, it added, "very few are currently quantifying the potential impact of those risks in financial terms or modeling it using scenario analysis or other methodologies as the Task Force on Climate-related Financial Disclosures (TCFD) recommends."

Climate change "will worsen many of the risks firms face on a regular basis and on a scale we have never experienced before."

—Sanjay Patnaik, professor of strategic management and public policy, George Washington University

Investors are increasingly dissatisfied with companies' refusal to confront the dangers that lie ahead. Vanguard, the world's-largest mutual fund company, is now pushing businesses to disclose the risks climate change poses to them. So are a number of hedge fund managers and investor groups, including a coalition of institutional investors managing more than \$1 trillion in assets. According to the *Financial Times*, the group sent letters to 60 of the world's largest banks demanding more

information about their exposures to climate-related risks. Even Exxon Mobil agreed to disclose the risks climate change poses to its business, after losing a landmark shareholder vote in 2017.

Mitigation is a priority in the business community.

The need for mitigation efforts is irrefutable. According to Nigel Arnell, a climate scientist at the University of Reading in the U.K. and lead author of a recent report on climate change impacts, between 60% and 95% of the adverse effects of climate change might be avoided if the increase in global temperature was held to 1.5°C, the target of the COP21 agreement. Achieving this goal will require herculean effort, including substantial emissions reductions over the next few decades and near-zero emissions of CO2 and other long-lived greenhouse gases by the end of the century, according to the U.N.'s Intergovernmental Panel on Climate Change (IPCC).

Global manufacturer Mars Inc., for one, is willing to shoulder its share of the work, setting ambitious goals based on the best-available science. According to Lisa Manley, Mars' senior director of sustainability engagement and partnerships, the company aims to reduce absolute greenhouse gas (GHG) emissions throughout its entire value chain by about two-thirds by 2050 and eliminate 100% from direct operations all around the world by 2040. Mars is also taking steps to end deforestation through pioneering work in agroforestry and by sourcing key raw materials only from suppliers that comply with the company's deforestation policy.

governance is not a sideshow," they wrote, "but one way to bypass government gridlock and achieve major emissions reductions over the next decade."

Such independent initiative is commendable and clearly necessary, but it is far from sufficient, cautioned Margaret Leinen, vice chancellor and current director of the Scripps Institution of Oceanography at the University of California, San Diego. "This sense that the private sector can just go on and do it themselves is a myth," she said during her closing keynote at the IGEL conference. "Business has to actively engage with government because too much of your risk profile is out of your control."

Government agencies set regulations, draw flood maps that influence insurance rates and control the electric grid. Everything from water rights to the rules governing genetic modification of plants is determined by legislators and influenced by politicians. "So although we have the sense that business can adapt on its own, your hands are tied," Leinen said. To free business to innovate, she urged companies and business schools like Wharton to use their influence to change laws and regulations that inhibit progress and encourage those that stimulate innovation.

Other speakers at the IGEL conference echoed Leinen's plea. Manwaring asked businesses to advocate for realistic assumptions and policies. "Homeowners have a voice, but businesses sometimes have more of voice with local municipalities," he said. And Manley added that advocacy for climate action, from the highest levels of Mars to the company's lobbying on Capitol Hill, was a major focus of its climate strategy.

"Private climate governance is not a sideshow, but one way to bypass government gridlock and achieve major emissions reductions over the next decade."

— Beyond Politics

Business needs to work with government, and vice versa.

Mars is hardly alone. Increasingly concerned about climate risks and frustrated by inaction at the federal level, a growing number of U.S. companies are taking steps that would normally be handled by the public sector. In their recent book, *Beyond Politics: The Private Governance Response to Climate Change*, Michael P. Vandenbergh and Jonathan M. Gilligan call the efforts of companies like Mars and Walmart, "private climate governance." They see such private sector action as a way around the paralysis of America's hyper-polarized government. "Private climate

Adaptation efforts are lagging badly. According to a leaked draft of the upcoming IPCC "Special Report on Global Warming of 1.5°C," even with coordinated efforts "there is very high risk that ... global warming will exceed 1.5° C above pre-industrial levels," based on the current pace of warming and existing national plans to limit greenhouse gas emissions. The World Food Program (WFP), among others, agrees. "It is now increasingly unlikely that we will be able to limit global warming to this 'safe' warming threshold," noted the WFP. "As a result, decision-makers need to plan to adapt to a world with higher levels of global warming."

While many companies are actively working to mitigate the worst effects of climate change, most are neglecting to plan for consequences that are now unavoidable. DNV GL, a global quality assurance and risk management company, recently surveyed more than 1,200 professionals in Europe, Asia and the Americas about their adaptation plans. While nearly all the companies mentioned at least one climate-related hazard they think will have a direct or indirect impact on their business, only 25% said they were

currently engaged in adaptation or resilience measures. Large companies were further ahead, with 40% taking steps, but that still leaves 60% of major firms unprepared for the all but inevitable impacts of climate change.

It's not that companies don't understand the urgency of the challenge. About 88% of those surveyed said they expected serious impacts — primarily from heat waves, storms and floods — within 10 years, and more than 25% said that one area of their value chain had already been impacted.

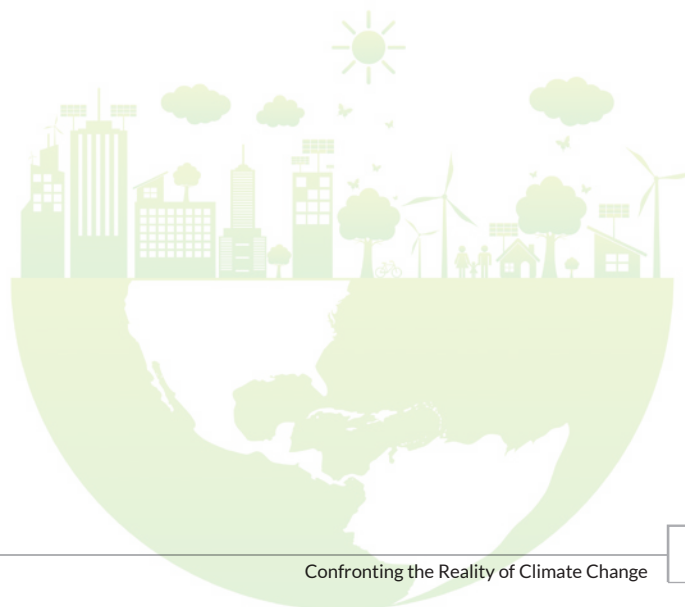
One reason for the disconnect seems to be a confusion over mitigation and adaptation, with more than 43% of the surveyed companies listing mitigation efforts as part of their planning for adaptation. It's a dangerous mistake. "Mitigation efforts are crucial to reduce greenhouse gas emissions, but these will not help a company adapt to climate change or build resilience," said Luca Crisciotti, CEO of DNV GL Business Assurance.

Many of the companies that are starting to adapt are motivated by external forces. Forty-three percent say pressure from customers is behind their adaptation efforts, and 50% say their actions are driven by laws and regulations rather than their own concerns about climate risks. They may not be planning for increasing floods, but a growing number of companies are planning for the increasing likelihood of carbon pricing. (Emissions trading schemes and carbon taxes have nearly doubled since 2012, according to the World Bank.) Some 400 firms have established an internal price on carbon, giving their managers a chance to learn how carbon pricing works and start managing the risk before actual regulations are implemented. Such adaptive action will give these firms a distinct competitive advantage in the future, according to Patnaik.

This ability to identify opportunity as well as risk in adaptation efforts is a hallmark of the companies in the forefront of adaptation. Among the small group identified as leaders in the DNV GL survey, about half are convinced that preparing for climate change now will put them ahead of competitors in the future. Thirty-five percent expect their preparations will increase the value of their companies. It's a sentiment increasingly shared by successful companies around the world. According to the Science-Based Targets Initiative, whose 476 members include many of the world's largest corporations, "Adapting to climate impacts offers many benefits to the private sector, such as improving operations and competitiveness, leveraging new business opportunities, building corporate reputation and protecting value chains."

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Indeed, the level of disruption posed by climate change is unique, but there is reason for modest optimism. If companies are willing to confront climate risks, gain the support of government and focus on adaptation and resiliency as well as mitigation, the business community is well positioned to help meet the challenge.





The U.S. Military's Response to a Warming Planet

“THE ENVIRONMENTAL PROTECTION AGENCY IS TOUTING ITS DEREGULATORY EFFORTS ON CLIMATE, but the Defense Department has recognized the reality of planetary warming and is planning for it,” said Sarah Light, professor of legal studies and business ethics at Wharton, during the 11th annual conference of Wharton’s Initiative for Global Environmental Leadership (IGEL). The topic: “The End of the World as We Know It: The Consequences of Extreme Climate Disruption for Business and Democracy.”

“The military has the potential to make an enormous impact on climate change policy, especially in its stimulation of strategies to reduce energy demand and encourage the development of renewables.”

—Sarah Light, professor of legal studies and business ethics at the Wharton School

Light moderated a panel that looked closely at the military’s practical adaptation to climate change, a response that extends from the battlefield to supply logistics. In a *Boston College Law Review* article, “The Military-Environmental Complex,” she wrote, “The military has the potential to make an enormous impact on climate change policy, especially in its stimulation of strategies to reduce energy demand and encourage the development of renewables.”

Specific actions already taken by military branches in response to environmental imperatives are far-reaching:

- Former Secretary of the U.S. Navy Ray Mabus set a goal that the Navy and Marine Corps would derive at least 50% of their energy from alternative sources by 2020. In 2016, the Navy began equipping Arleigh Burke-class destroyers with gas-electric hybrid engines. Contractor L3 Technologies won a \$119 million contract in 2013.
- According to Gen. James T. Conway, Marine Corps commandant in 2010, a gallon of gasoline or diesel fuel delivered to troops in Afghanistan can cost \$400. That’s one reason the U.S. Army and General Motors have jointly developed a hydrogen-powered fuel-cell pickup truck. Other alternative fuel vehicles tested by the military include a parallel hybrid tactical truck, a medium-sized utility hauler using hydraulic hybrid power and a variety of battery electrics.
- According to Reuters, the U.S. military between 2011 and 2015 nearly doubled renewable power generation, including solar, to 10,534 billion British thermal units (BTUs) — enough to power 286,000 average American homes. The military’s use of oil fell 20% between 2007 and 2015.
- In 2007, the Air Force declared that all new construction projects should be “green” enough to merit the U.S. Green Building Council’s LEED Silver rating. Achieving that rating is likely to include a variety of energy-saving measures, and use of renewable power is encouraged. Consideration of environmental factors in new construction is official military policy. A DoD “Unified Facilities Criteria Revision Summary Sheet” from 2016 lists “consideration of resiliency for energy, water and climate change, related to mission execution” among the requirements.

- The Marine Corps uses solar blankets at forward bases to lessen dependence on fossil fuels. The Marines have also been carrying solar panels into the field since 2009 to supply energy for GPS, night goggles and communications equipment.

Light makes clear why the armed forces have put a proverbial stake in the ground. Global warming, she said, “is likely to carry significant and destabilizing geopolitical impacts, contributing to poverty and food and water scarcity, and thereby increasing the likelihood of armed confrontations between nations over access to resources.”

Sanjay Patnaik, professor of strategic management and public policy at George Washington University, agreed on the unique challenges imposed on the U.S. military’s mission. He said the armed forces are “increasingly recognizing the threat climate change presents to operational capabilities, the readiness of military bases around the world and the stability of different world regions.” He added, “The assessment of climate risks for military commanders is gaining importance, as is reflected by orders issued by the U.S. military in 2016 to improve climate resilience across the military.”

Preparing for uncertainty. Rear Admiral Ann C. Phillips spent 30 years on active duty, serving in every warfare group in the surface Navy, and retired in 2014. By creating environmental refugees, she said at the Wharton conference, climate change exacerbates conflicts worldwide.

Phillips cited Syria’s worst drought in modern history, between 2006 and 2009, as helping set the stage for the war there. And according to Edward L. Rubin, a professor of law and political science at Vanderbilt University, who also spoke at the conference, Syria has produced five million refugees, a million of whom reached the western world, leading to anti-immigrant rallies in Europe and aggravated tensions that can be exploited by populist politicians and result in armed conflicts.

Climate disruption is widespread. “Cape Town, South Africa is experiencing a severe drought,” Phillips said. “Lake Chad was 13,000 acres, but now it’s 1,300 acres. People are losing the ability to grow crops, and that’s led to more and more migration of people and the breakdown of law and order.”

Phillips recommended that the military identify the top facilities and places under threat from climate change, and come up with a plan to address the most serious issues. Patnaik told conference attendees that once climate threats have been identified, they need to be assessed, then integrated into the risk analysis that is part of any strategic planning.

Mapping the threats. “Our armed forces must prepare for a future with a wide spectrum of possible threats, weighing risks and probabilities to ensure that we will continue to keep our country secure,” the Pentagon said in its 2014 Climate Change Adaptation Road Map. “By taking a proactive, flexible approach to assessment, analysis and adaptation, the Defense Department will keep pace with a changing climate, minimize its impacts on our missions, and continue to protect our national security.”

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— Pentagon

The Department of Defense (DoD) itself describes its work as “developing policies and plans to manage and respond to the effects of climate change on DOD missions, assets, and the operational environment.” It also states, “Because the performance of DOD systems and platforms are influenced by environmental conditions, understanding the variability of the Earth’s environment and the potential for change is of great interest to the Department.”

The Department of Defense response to climate change dates back years. The Energy Policy Act of 2005, the Energy Independence Security Act of 2007 and a 2015 executive order from then-President Barack Obama, “Planning for Federal Sustainability in the Next Decade,” prodded the Pentagon to “lead by example” in making environmentally informed construction, design and operating decisions.

In the DoD’s 2014 climate change road map, the U.S. defense strategy refers to climate change as a “threat multiplier,” because “it has the potential to exacerbate many of the challenges we are dealing with today — from infectious disease to terrorism. We are already beginning to see some of these impacts.” The report added, “Politics or ideology must not get in the way of sound planning.”

Mark Patrick Nevitt is a former tactical jet aviator and U.S. Navy attorney who’s now a teaching fellow at the University of Pennsylvania Law School. He pointed out at the Wharton conference that the military’s role “is to plan for the unknown,” and that having that culture in place is helpful in preparing for climate change and adaptation. He

said that the military added climate change provisions to its mission during the Obama presidency, and that those mandates are still in place.

Phillips told a U.S. House committee in 2017, “I believe climate change has a significant and intensifying impact on our national security, and [we] continue to work at the local, regional, and national level to foster action across the whole of government and community to both address and build resilience to this threat.”

At the Wharton conference, Phillips added, “A dozen Defense officials have acknowledged that they believe climate change is real, and that action has to be taken. DoD tries to steer clear of the political aspects of it, and just address what needs to be done to operate in extreme temperatures and climates.”

Fear of flooding. Phillips said that the armed forces “take the sea-level projections for Norfolk, Va. by 2050 seriously. Fifty percent of the military facilities at Hampton Roads acknowledge they have a problem. DoD understands it can’t handle climate change by itself, and that decisions have to be made based on science, on what can be expected in the context of resilience. The DoD knows it has to do more, but it’s hard to quantify what needs to be done.”

The threats to the military operations and its institutions are clear. Much of Hampton Roads is only eight feet above sea level. “It’s hard to imagine one of the world’s biggest military bases becoming Atlantis, or becoming an island, but that’s where we’re headed,” Phillips said in an opinion column written for *The Hill*.

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—Rear Admiral Ann C. Phillips, U.S. Navy

The 2003 Hurricane Isabel was devastating to the Langley Air Force Base in Hampton, Va., causing an estimated \$166 million in damage, flooding more than 200 mechanical systems, damaging 22% of the base’s aircraft engines and 35% of its buildings.

Although global warming does not itself cause hurricanes, by warming the water it intensifies them, with major consequences for military installations and personnel. Confounding for military planners, it’s also

very unpredictable. According to Patnaik, “Climate change is a unique environmental problem that poses an unprecedented challenge to human civilization. It raises the complexity and interdependency of a variety of different risk factors and introduces very high levels of uncertainty along several concurrent dimensions into the decision making process of business, government and military leaders around the world.”

Climate change also contributes to rising oceans. The Center for Climate and Security (CCS) reported in 2016 that sea-level rise could flood military bases on both the East and Gulf coasts for as much as three months of the year by 2050. The world’s largest naval base, Norfolk in Portsmouth, Va., already floods 10 times a year. Sea level there has risen 18 inches since 1917, when the base was built.

Naval Station Norfolk sits on flat land in a region that is home to 17 other major military sites, collectively known as Hampton Roads. Colby Manwaring, the CEO of Innovyze, a global provider of business analytics software for water-related infrastructure, said at the conference that flood mapping needs to be updated to account for increased variability in the weather, and more frequent flooding. “We can’t change the climate for the better, so we have to adapt to the changes and get on with it.”

The huge Marine training base at Parris Island, S.C. is also very low-lying, Phillips said, and especially threatened is the \$1 billion Kwajalein Atoll radar project in the Marshall Islands, which was built to track space debris without rising oceans as a consideration. The Pacific atoll is also home to the Ronald Reagan Ballistic Missile Defense Test Site. “In 20 to 25 years these sites could become almost unusable because of sea-level rise,” Phillips said.

It’s not only coastal installations that are at risk. The Earth Institute’s Water Center is working with the Department of Defense to study flood risks at military bases and facilities in the Ohio River Valley over the next 50 to 100 years.

The tether of fuel — and the consequences of burning it. Nevitt pointed out at the Wharton conference that the U.S. military is the world’s largest institutional fossil fuel user at 14 million gallons a day, consuming more energy annually than 100 nations. He said it also produces “an enormous amount of emissions — as much as the country of Sweden. The military’s ability to respond to conflicts around the world is leashed to the tether of fuel.”

The current defense secretary, Jim Mattis, first expressed a desire to free the military from “the tether of fuel” in 2003, after seeing, as a Marine commander, how vulnerable diesel convoys were to attack in Afghanistan

and Iraq. The Navy's Mabus made the same point. He said that one Marine is killed in every 50 fuel convoys, and that guarding fuel is distracting from the military's mission. "The big reason we're doing this is to make us better fighters," he said.

According to the Army, the military's three major fuel consumers are aircraft, ground vehicles and power generators. The problem is exacerbated on the ground, because the heavily armored mine-resistant tactical vehicles deployed on the front lines consume 200% more fuel than standard trucks. And at forward bases, according to a report from the Tactical Fuels Manager Defense system, nearly half the fuel is consumed by generators. These facts help explain the military's growing interest in alternative sources of energy, particularly solar.

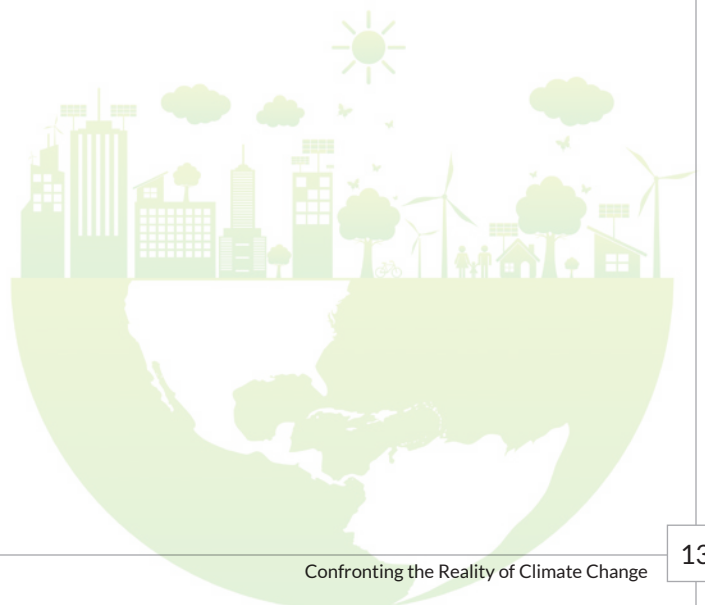
An Army study determined that a 1% improvement in energy efficiency would mean that troops in Iraq would have had to serve on 6,444 fewer missions.

It's not just fuel. In a report by the Brookings Institution titled "Fueling the 'Balance,'" military bases use 30 million

megawatt-hours of electricity annually, at a cost of \$2 billion. Almost all of that electricity is bought on the civilian market, "which also makes our bases highly susceptible to the increasing spate of large-scale outages (caused by accidents and over-demand, as well as cyber-attack)."

A 1% improvement in energy efficiency would mean that troops in Iraq would have had to serve on 6,444 fewer missions.

Brookings' report called on the DoD to reduce its baseline consumption of energy 20% by 2025, and to be a net-zero energy consumer at its bases and facilities by 2030. The report concluded, "It is high time we address the long-standing irony of fueling our national defense from a source that threatens our nation's security." To which Nevitt added, "We need all hands on deck to solve this problem."



Special Report

Confronting the Reality of Climate Change

The business community and the military are joining forces with state and local governments to combat it. Will it be enough?

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