

The 2017 Social Enterprise Leadership Forum: The Near-term Impacts of Climate Change on Investors



Featured Speakers

In order of agenda

Peter deMenocal

Thomas Alva Edison / Con Edison Professor of Earth and Environmental Sciences;
and Director, Center for Climate and Life
Lamont-Doherty Earth Observatory;
Dean of Science, Faculty of Arts and Sciences

Ken Mehlman

Global Head of Public Affairs
KKR

Peter Huybers

Professor of Earth and Planetary Sciences and Environmental Science and Engineering;
Co-director
Harvard University Center for the Environment

Christopher Mayer

Paul Milstein Professor of Real Estate
Columbia Business School

Adam Sobel

Professor, Department of Applied Physics and Applied Mathematics and
Department of Earth and Environmental Sciences
Lamont-Doherty Earth Observatory and the Fu Foundation School of Engineering and Applied Science

Stephen Weinstein

Senior Vice President, Chief Compliance Officer, Group General Counsel and Corporate Secretary
RenaissanceRe Holdings Ltd.

Lila Preston

Partner
Generation Investment Management

Wolfram Schlenker

Associate Professor
School of International and Public Affairs
Columbia University



Richard Seager

Palisades Geophysical Institute / Lamont Research Professor
Lamont-Doherty Earth Observatory

Geoffrey Heal

Donald C. Waite III Professor of Social Enterprise
Columbia Business School

Lucas White

Portfolio Manager
GMO

Kent Daniel

William von Mueffling Professor of Business
Columbia Business School;
Former Co-Chief Investment Officer and Head of Equity
Research, Quantitative Investment Strategies
Goldman Sachs Asset Management

Mary Jane McQuillen

Managing Director, Portfolio Manager, Head of Environmental,
Social and Governance Investment
ClearBridge Investments

Ashley Schulten

Portfolio Manager, BlackRock's Green Bond Mandates
BlackRock

Damon Phillips

Lambert Family Professor of Social Enterprise
Co-director of the Tamer Center for Social Enterprise
Columbia Business School

Bruce Usher

Elizabeth B. Strickler '86 and Mark T. Gallogly '86 Faculty
Director
Co-director of the Tamer Center for Social Enterprise
Columbia Business School

Written by Justin Doom

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Introduction

By Jeremy Grantham, Co-founder and Chief Investment Strategist, GMO
and Lucas White, Portfolio Manager, GMO

We believe the problems and risks associated with climate change are much worse than the average investor or business person realizes. Failing to understand the investment implications of climate science exposes professional investors to risks that must be understood in order to maintain fiduciary duty. Investors should be thinking hard about stranded asset risk for fossil fuel companies and disruption risk in the energy, utility, and transportation sectors. Attention must also be paid to energy-intensive industries, such as industrials, mining, and agriculture, in addition to the obvious risks to coastal real estate, both commercial and residential.

An understanding of the state of technology is also critically important for investors. We think of the dilemma posed by climate change as “the race of our lives.” On the one side, the environment is becoming increasingly unstable. Carbon dioxide concentrations and temperatures, both land and ocean, have been accelerating upwards. Glaciers have melted at an alarming rate, leading sea levels to rise at an increasing rate as well. Floods, droughts, wildfires, and other natural disasters have been increasing in both frequency and severity. On the other side, we’ve had tremendous progress in clean energy technology. Over the past few years, costs for renewables and storage have dropped by 70 to 85%, and costs are expected to drop considerably from here. This is critical because we’re reaching an inflection point where clean energy solutions are becoming the cheapest alternatives even without subsidies. Yet, we can’t wait for the natural replacement cycle of our existing electricity generation, transportation, and grid assets. We need to proactively replace our existing energy infrastructure. While it will cost trillions to transition to a clean energy world, the costs of inaction are far higher.

Climate change is already impacting the world, and it will continue to get worse, regardless of how quickly we move to address it. Scientists, investors, and policymakers must work together to address the impacts of climate change, most notably the implications for our food and water supplies. Agricultural productivity is expected to suffer greatly as temperatures continue to rise, leading to more extremely hot days, droughts, floods, and heavy downpours that lead to soil erosion. Water supplies will also be threatened by changing precipitation patterns and distribution; enhancing water infrastructure will be critical. Addressing these challenges will largely determine the shape of society itself in the decades to come.

The stakes in this race are unthinkable high, and business as usual won’t cut it. We need investment, science, technology, and policymaking to come together in an unprecedented, coordinated global effort in order to have a chance to win. The “The Near-term Impacts of Climate Change on Investors” forum and this related report represent a critical step in this direction. The forum captured a rare collaboration between the scientific community and the investment industry. Sponsored by the Tamer Center for Social Enterprise at Columbia Business School and the Lamont-Doherty Earth Observatory, this event brought the world’s best scientists into a conversation with the world’s best investment professionals while setting aside the politics of climate change. Policymaking is critically important, but we also need to focus on solutions to climate change irrespective of the particular politics of the day. Getting some of the world’s smartest scientists and investors into the same room to share their knowledge is an important step, and we hope that the forum will be the first of many such occasions.

How Will Climate Change Alter Investment and Business Opportunities in the Near Future?

As the 2017 Social Enterprise Leadership Forum drew to a close, Damon Phillips stepped to the podium for a few final words.

“There are plenty of discussions on climate change, but the opportunity to bring in the world’s best scientists with the world’s best investment professionals is a unique opportunity,” said Phillips, co-director of the Tamer Center for Social Enterprise and a professor at Columbia Business School. “We’re privileged that we’re a leader in this space, and hopefully other universities will pick up on this as well.”

Honest discussions of climate change are often hijacked by politics, which can render purely scientific explanations ineffective or, at best, inefficient. But explaining the issues in terms of dollars gained or dollars lost, as was often the case during “The Near-term Impacts of Climate Change on Investors,” held in early May at KKR’s Midtown Manhattan headquarters and sponsored by the Tamer Center for Social Enterprise and the Lamont-Doherty Earth Observatory, provides incontrovertible evidence to those who may still need convincing. For those who may have their doubts about the science behind explaining climate change, they’re much less likely to doubt the billions, if not trillions, of dollars that are being invested to mitigate and prevent it. Recent advances in climate science are informing and guiding myriad investment decisions throughout the global economy, and smart asset managers see plenty of opportunities to improve their risk-adjusted returns while also helping the planet. In short, many of the best investors over the next 10 or 20 or 50 years will be the ones who best understand climate science.

That’s why getting some of the world’s leading scientists and investors in the same room to share their wisdom is hopefully just the first of many such occasions. At the forum, in both quick-paced lecture pairings and discussion groups, and in individual presentations, experts from both fields presented their latest findings, complementing and complimenting each other’s efforts.

Peter deMenocal, Dean of Science and a professor at the Lamont-Doherty Earth Observatory, began the day with a framing that was echoed throughout by several of the speakers: “It’s critically important that the climate science community engages in the business and finance community as we advance knowledge. The private sector is where the rubber meets the road in turning knowledge to action, so it’s important that we work together closely.”

Many in the business community have already begun putting their money, so to speak, where the scientists’ mouths are. Many of the world’s largest firms, in just one example, are divesting from fossil fuel-based ventures and pouring money into renewables. The private companies with the most at stake need the best information possible to make their most important decisions. The best information comes from the best scientists, including deMenocal.

“A motivating factor for this meeting is to invite some of the best climate scientists in the world to share what they know with private sector stakeholders who care deeply about these outcomes,” deMenocal said. “Climate change affects financial investments, and climate is now changing faster than any other time in recorded human history—there’s a lot at stake.”

DeMenocal wants to build the climate science equivalent of the Manhattan Project—assuming he’s able to fund it. Risks to the planet have increased, but science funding in the U.S. has decreased and is constantly under threat. In addition to a proposed federal budget that could gut the National Institutes of Health, the Centers for Disease Control, the Environmental

Protection Agency, the National Oceanic and Atmospheric Administration, and NASA, among others, President Donald Trump has vowed that the U.S. will abandon the Paris climate agreement, the landmark 2015 accord joined by Barack Obama. Lloyd Blankfein, the CEO of Goldman Sachs, tweeted on the day of Trump's announcement: "Today's decision is a setback for the environment and for the U.S.' leadership position in the world." Elon Musk, the founder of Tesla, and Disney CEO Robert Iger abruptly resigned from Trump's panel of business advisers in protest. The European Union rejected the U.S. president's offer to renegotiate a pact already agreed to by almost 200 nations, as other countries and states and cities worldwide are scrambling to pick up the slack. Former New York City mayor Michael Bloomberg pledged \$15 million to help defray the costs of reducing carbon emissions.

"A climate innovation gap has emerged between an increasing need for scientific understanding about our future on one hand, and the sharply decreasing federal investment in basic research on the other," deMenocal said, a few minutes before he began introducing the next few speakers. Turning toward many of the individuals representing the private sector, he added, "Your bottom line is to not lose money. Our bottom line is to make sure you have the best knowledge to make those decisions. That relationship has never really been formally forged. Climate change poses very real threats to the things we care deeply about, and there is a lot of investment risk and opportunity attached to this."

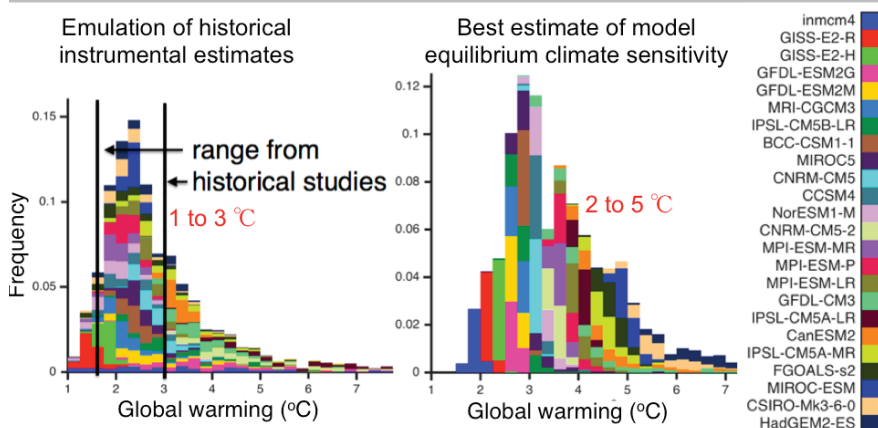
Sea Level Rise and What That Means for Real Estate

Peter Huybers, a professor of earth and planetary science, environmental science, and engineering; and the co-director of Harvard University's Center for the Environment, addressed the audience at the forum shortly after deMenocal. He used a series of charts to explain potential sea level rise outcomes. Among Huybers' conclusions was the fact that not only have sea levels risen over the last century, but that the rise has accelerated and could accelerate further. Temperature predictions of one to three degrees Celsius may in fact be closer to two to five degrees Celsius.

"If you were to follow this linear line out to 2100," he said, gesturing toward a graph, "what you get is about 30 centimeters of sea level rise. If you take this accelerating trend out to 2100, you get about 60 centimeters of sea level rise. I wouldn't rule out that it's a good deal higher than that. We have deep uncertainty about how rapidly ice will flow into the ocean; it's the major unknown for the 2100 sea level problem."

For many people, a phrase such as "the 2100 sea level problem," and how the planet ends up facing that problem, wouldn't elicit much of a response. But many people aren't investors. And investors, and by and large many companies, will have an unprecedented opportunity to make

Applying linear versus curved heat-radiation relationships accounts for discrepant estimates



Harvard's Peter Huybers explained the vast difference between historical projections of temperature increases and those demonstrated by new models.

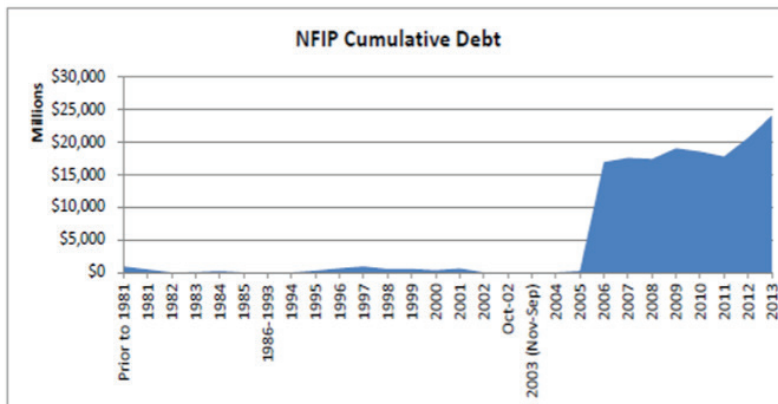
decisions that, in their own way, help explain science to a greater audience. If investors, not just the larger banks and investment shops but even citizens planning their own retirements, see more and more headlines about significant money from respected people or institutions flowing into climate mitigation strategies, or pulled from investments that generate huge carbon outputs, others may follow suit. It's not unlike a chain reaction that may result from owners of coastal property who see an increasing number of for-sale signs in their neighborhoods.

"Much of what we need to do around issues of climate," Huybers continued, "is understand how to leverage our understanding of global climate to identify and meet challenges at the local level."

The US Flood Insurance Program

RenaissanceRe

National Flood Insurance Program - Cumulative Debt



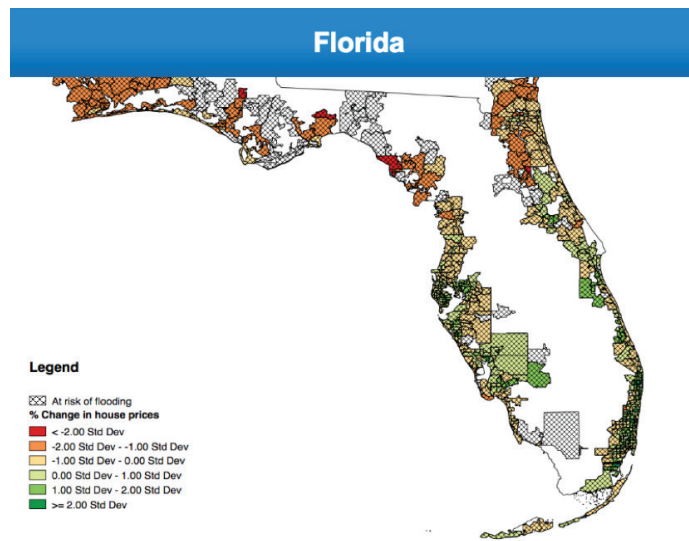
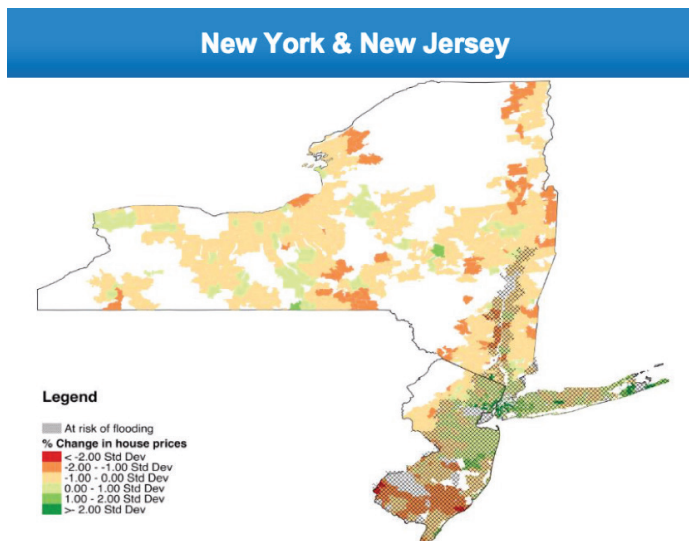
The U.S. Flood Insurance Program was about \$25 billion in debt in 2016.

coastal properties have begun paying closer attention to rising sea levels, as illustrated in a recent *New York Times* story highlighting properties along the East Coast, many other at-risk areas, including Miami; Seattle; and Portland, Oregon have generally experienced increasing prices in flood-prone areas.

Mayer contends that because of government-subsidized flood insurance, real-estate markets aren't operating at anything close to optimum efficiency. In other words, until enough people lose enough money by buying these types of properties and suffer flood damage that they actually have to pay for, their behavior won't change and the markets won't reflect where prices actually should be.

Local and federal governments' arguing over flood zones also sends mixed signals on the true risks of living in certain areas. Politicians don't want to scare off potential developers or impose additional costs on voters, especially those at the lower end of the income spectrum, and so far, due largely to storms such as Hurricanes Katrina and Superstorm Sandy, U.S. taxpayers over the last five decades have picked up the tab. The National Flood Insurance Program is about \$25 billion in debt.

"Many people believe that the government is going to rebuild their homes when they get flooded and that they don't have to insure." Mayer said. "There's a bunch of Latin American money that's looking for safety in the U.S." by buying Florida property, he added. "They may be safe from their local governments here, but they may or may not be safe relative to rising waters. Hamptons prices are rising quite a bit. There are properties in the Hamptons that need to be renovated



Above, real estate markets up and down the East Coast could be devastated by rising sea levels. Source: NOAA and Zillow.

already as a result of rising waters.”

Homeowners may or may not be able to gamble on when the value of protecting a vacation home will equal the cost, but even those with only a primary residence are ignoring scientific findings at their potential peril. “Even in places that saw significant amounts of flooding” during past storms, “we haven’t seen consistent changes in prices that reflect people saying, ‘These are places I’m worried about living,’” Mayer concluded. “There’s a little bit of, ‘People won’t believe rising sea levels until it happens.’”

Extreme Climate Events, Prediction Models, and Reinsurance

It’s impossible to ignore catastrophic weather events. It will be even harder as the oceans creep farther up shorelines.

“Sea level rise is really the big elephant in the room—it’s the bigger factor” compared to an overall temperature rise, explained Adam Sobel, a professor of applied physics, applied mathematics, and environmental sciences at the Lamont-Doherty Earth Observatory and the Fu Foundation School of Engineering at Columbia University. “A little bit of sea level rise—just starting the sea at a higher level before the storm surge comes—is the equivalent of a big change in the storm intensity. And although storm intensity is probably going up, it’s doing so slowly, and the sea level rise is much faster, for the purpose of coastal flood risk. That’s the big thing to worry about. There will be little storms that never would have done stuff, but now they will.”

That means a sea level rise of about three feet could potentially turn the storm surge due to a Category 3 hurricane into the equivalent of that from a Category 4, or a Category 4 into a 5, Sobel said, explaining the nuances of risk-assessment modeling. That could have devastating consequences.

A city such as Mumbai, despite not being a constant target for hurricanes as southern Florida is, could be in serious trouble if confronted with a historically bad storm. While models built by most insurance firms tend to focus on areas with more insured property, such as the U.S. Atlantic Coast, different areas will require different, but equally as important, models, Sobel said.

“It’s a city with a lot of people, a lot of value,” Sobel added. “Hurricanes are very rare in the

Arabian sea. They have not had a serious one in the modern history of the city, but the chance is not zero. It's incredibly low-lying and vulnerable. It's a bunch of islands where land was filled in, and if they were to get a big one, it would be tremendously catastrophic. We're trying to understand that risk, and we need models like this to do it."

Understanding those kinds of risks is something most reinsurance companies have been doing for quite some time. It's yet another example of an overwhelming financial incentive to properly understand the risks tied to extreme weather events. Stephen Weinstein, a senior vice president at RenaissanceRe Holdings Ltd. who spoke in conjunction with Sobel, also understands the human cost.

"We spend a lot of time at meetings like this talking about financing risk, and whether we can reform the subsidies we provide for moral hazard" Weinstein said. "But we spend almost no time talking about the number of Americans who are literally in harm's way in respect of risks that are increasing all the time. We've lost more Americans at home in the United States since 9/11 to climate-related disasters than we have to terrorism."

Experts, both private and public, are feverishly working on models that can predict storms not just as bad as Katrina or Sandy but potentially worse than anything in the historical record. Some of the best models are likely to be the product of collaborations between private insurers and academic experts. Giving companies like RenaissanceRe more of an opportunity to cover at-risk regions, which sends clearer signals to the market, could lead to better overall outcomes, Weinstein added. Gauging such enormous risks is never easy, but it's vital, and he told the gathered crowd that, ultimately, he remains optimistic.

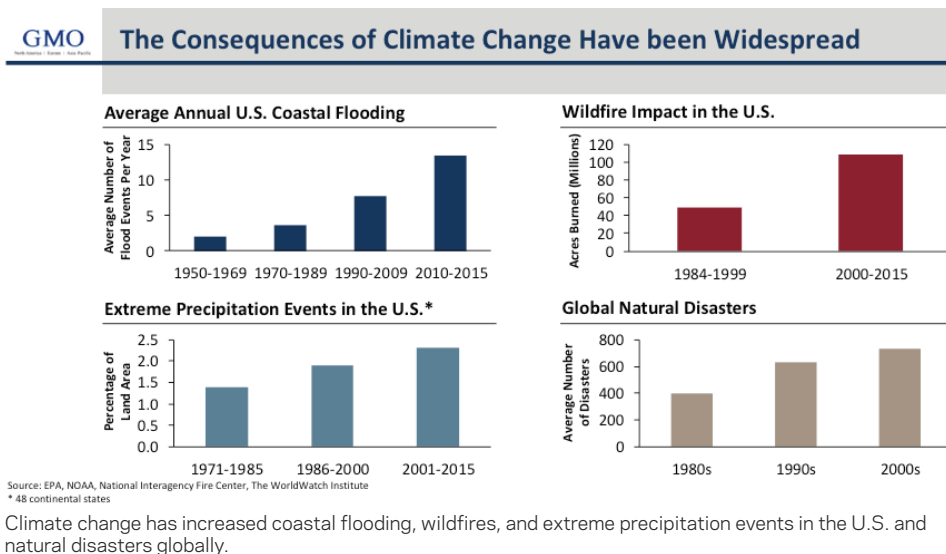
"Climate change is happening. It's accelerating and increasing the risks of storms, making them more severe and potentially more frequent," he said. "The problem with risk is that it's happening but you can't always see it."

Weinstein also urged attendees to be mindful of the special life safety needs of lower income Americans. "We tell people to stay in place and go to the Superdome. We did that for Katrina, we did that for Sandy, we did it for the floods in Louisiana last year. Right now, we're going to do it for the next Sandy. But we can fix this."

Increased Temperatures and Less Water Means Less Food

Ensuring food supplies may require another large "fix." Rising temperatures and extreme weather events could threaten millions with hunger.

Both directly and indirectly, corn, wheat, rice, and soybeans are responsible for about three-quarters of all calories consumed by humans, Wolfram Schlenker, a professor at the School of



International and Public Affairs at Columbia University, explained during his presentation at the forum. The U.S. produces about a quarter of all of those calories, both through exporting the crops and feeding the crops to animals, many of which also are later exported.

"A lot of people think Saudi Arabia is big for oil," Schlenker said. "It's much smaller than the U.S. share for basic food calories. Any weather event we have in the Midwest has the potential to have lasting impacts on the world."

Up to a certain point, higher temperatures in certain areas such as North America can extend growing seasons and slightly increase yields. But after a period of sustained higher temperatures, at least when it comes to corn, yields decline about 10 times as quickly as they previously increased. It's a very slippery slope, with potentially dire consequences.

"With climate change, and this is something we should emphasize, there are always good and bad things," Schlenker said, explaining how climate ranges—roughly speaking in terms of crops—from too cold to moderate / optimal to too hot. "The good thing is that when some of the cold temperatures shift to the optimal moderate range, you see an increase in yields. At the same time, currently moderate temperatures become too hot, which gives you a huge reduction. It turns out that because the damaging effect of the latter is 10 times in size as the beneficial effects of the former, on net, you see potentially very, very large losses."

Those production losses can result in massive price swings. A five percent change in yields may

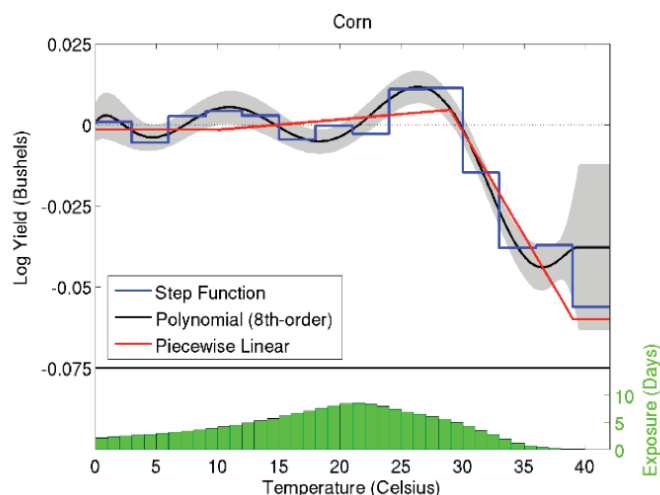
bump up prices 20 to 30 percent, Schlenker explained. Such a result, not unlike when food prices spiked in the mid-2000s, could have huge impacts on not only the full supply chain for agriculture but also on the insurance market that backs up that supply chain. An additional problem, similar to the mixed signals sent by flood insurance for homeowners, is that because crop insurance is potentially so lucrative for so many farmers, some may not feel incentivized to improve on bad yields, which would cause a ripple effect across the globe.

The potential combination of food shortages and billions of refugees

fleeing rising coastlines could prove a staggering challenge. And governments, in addition to investors and climatologists, will have a huge role to play, said Richard Seager, a professor at the Lamont-Doherty Earth Observatory who presented at the SELF conference on how climate change affects water supplies. Ensuring a livable climate for all will take an effort comparable to the New Deal, World War II, or the Space Race, he said in a later interview.

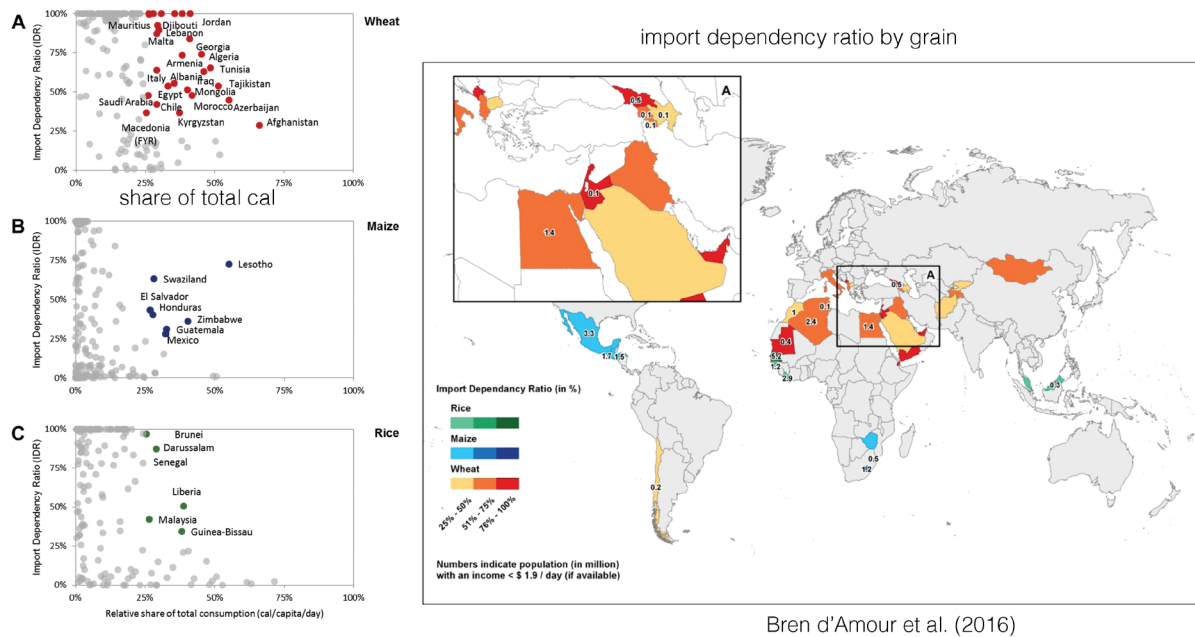
"Climate science has become politicized not because of the science, which cannot be denied, but because of an aversion of those who subscribe to free markets and oppose all regulations and government involvement in the economy to the proposed solutions," Seager said. "The way we solve that is in a tried and true American way: a public-private partnership to steer the U.S. to an economy for the 21st century." He added, "It's an exciting journey to work out how we, as

Corn Yields: Importance of Extreme Heat



Rising temperatures can slightly increase yields, but after a certain point, production will plummet and threaten global food supplies. Source: Schlenker & Roberts (PNAS, 2009).

Many middle income and poor countries are highly dependent on grain imports (often of a single grain), creating vulnerability to remote crop production disruptions



Bren d'Amour et al. (2016)

Depicted above, countries that import grain may be hit especially hard if prices for food staples skyrocket.

a species, can live on this planet in harmony with nature while also ensuring life, liberty, and happiness for all. We need to fire up and take on the biggest challenge humanity has faced. Young people can be thrilled by this."

An Evolving Power Structure

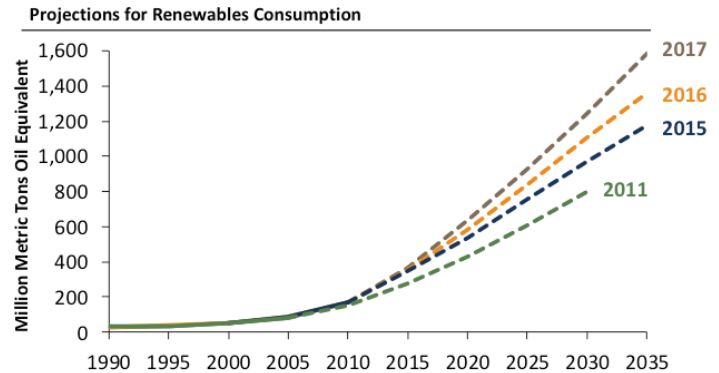
Many young people already are thrilled about the increased use of renewable power, which was discussed at length by Geoffrey Heal, a professor at Columbia Business School and a keynote speaker at the event. Arguably, the biggest reason switching from fossil fuel-based generating plants to those powered by solar and wind hasn't been faster is that those sources simply aren't as reliable. Wind speeds change. The sun goes down. But if power providers could store electricity as it's generated and provide it on demand, rather than switching on natural gas-powered peaking plants to account for sudden spikes, that would go a long way to reducing global carbon emissions. These peaking power plants, or "peakers," are most frequently used in the morning or after-work hours when people are going to work or just home from work and using the most electricity. Improved battery technologies will change all of that.

Musk, a billionaire co-founder of PayPal, is betting on just that. Cars and rockets and solar panels all produced by his companies—Tesla Motors, SpaceX, and SolarCity, which Tesla recently purchased—all may benefit from and, perhaps equally as important, illustrate the immense benefits of, cheaper batteries.

"The cost of energy storage has come down massively in the last decade or so," Heal told the audience. "Mr. Musk and his Tesla company are paying something like \$250 a kilowatt hour for the batteries they buy for their Model S cars. A couple of years ago, that would have cost \$500 a kilowatt hour, and a decade ago, that would have cost \$1,000 a kilowatt hour. It's remarkable

progress.”

Last year, about two-thirds of utility-scale electricity in the U.S. was generated by burning coal and natural gas, compared with just 15 percent from renewables, including hydroelectric power, according to data compiled by the Energy Information Administration. But that’s more than double the percentage of generation compared with 15 years earlier, in 2001, due mostly to enormous gains in solar and wind, EIA data show. A recent report by the National Renewable Energy Laboratory showed that the U.S. realistically could be targeting 80 percent by 2050. Heal, during his presentation, advocated for an even larger number.



As of 2/2017
Source: BP

The consumption of renewable energy already has been revised upward several times.

“The generation of electric power has obviously been dominated by fossil fuels historically, but if we’re going to solve the climate problem, or at least mitigate the climate problem substantially, we’re going to have to move fully away from fossil fuels by the middle to second half of this century,” Heal said. “That’s a radical transformation of power generation.”

And it could be radically expensive—especially for companies that don’t transform quickly enough. In addition to the capital required for all of the new infrastructure required to connect solar, wind, and other renewable sources to the electric grid, Bloomberg News reported last year, citing a Barclays analyst, that fossil fuel producers are risking more than \$30 trillion in so-called stranded assets—coal, oil, and natural gas that will have to be left in the ground to meet climate targets. The flip side to that coin, however, according to another Bloomberg news item from this March, which referenced a report the International Renewable Energy Agency prepared for the German government, estimates that by 2050 investments in clean energy and energy efficiency may boost global GDP by 0.8 percent. The investors with the best understanding of the underlying science will snag the biggest chunk of that.

One reason power remains so expensive in so many places, and an obvious example of capital that could be better allocated, is the natural gas-powered peaker plants, Heal continued. About 20 percent of U.S. generating capacity is used less than 100 hours a year—only to cover massive demand spikes. “You’ve got billions and billions of dollars of generating capacity sitting there doing nothing for most of the year,” he added. A diet of 100 percent renewables, where power could be bought and used on demand, could eliminate the need for baseload power and “be good for the efficiency of the system and the efficiency of the use of capital equipment long term.”

Utilities in Europe, especially in Germany, where nuclear power is being phased out by 2022, that still must maintain baseload supplies have seen shares plummeting as more renewables have come online. A big reason why, Heal said, is that running a clean-energy facility doesn’t require the same inputs.

“A key feature of renewables is that their marginal cost is essentially zero,” he said. “If I’m running

a wind farm or a solar farm and I want to bid aggressively for business, I can bid at really low prices because my operating cost is zero and still make positive cashflows on two, three, or four cents a kilowatt hour."

Companies bidding on power contracts are driving down spot electricity prices so low that traditional utilities, including those that receive nuclear generation, can't compete. In the U.S., utilities and homeowners with solar panels who want to sell excess power back into the grid, or have the grid as a backup for their panels, can't agree on pricing mechanisms. Different states have different regulations, but many homeowners who bought systems on the promise they could sell back power at the same rate they paid for it aren't happy to learn that such a model is unsustainable. If a power company that pays a huge producer five cents for a kilowatt hour and resells it for 15 cents, it can't very well pay 15 cents to a customer for that same power. Utilities, Heal explained, will have to find a way to price grid access separately from usage, and customers will need to realize current pricing structures are untenable.

"Utilities make money by selling power. The more power they sell, the more fossil fuels they use, the more the climate changes. That's not a very good model for us," Heal said. "We'd rather have a situation where utilities get remunerated by selling less power and encouraging people to be energy efficient and cut back on power use." Revenues and power sales are now "decoupled" for utilities in California, which are now required to build storage alongside more traditional infrastructure.

How Are Investors Reacting to Climate Change?

Battery storage is but one area of investment that excites Lucas White, a portfolio manager on GMO's Focused Equity team. The way GMO, founded in 1977, considers investments related to climate change is to place each idea into one of two buckets. The first bucket is more focused on mitigation, which includes investing in firms focused on clean energy, battery storage, and energy efficiency. The other bucket pertains more to operations that are helping the world adapt to climate change by, for example, working to increase agricultural yields or maintaining access to clean water supplies. Companies focused on climate change mitigation and adaptation may end up being excellent investments, White said in an interview after the SELF forum, with significant returns both financial and environmental.

In keeping with the forum's theme of collaboration between climate scientists and the investment community, White implored the scientific community to not be overly conservative at this critical time. With sea level and temperature estimates rising, "if there were ever a time to not be conservative and err on the side of caution, this is it," he added. "If you keep saying the sea levels may rise two feet, but they actually rise 11 feet, that's a substantial difference."

"Take the world population," White said, referring to how it's increased more than sevenfold since just 1800. "It exploded from a few hundred million to 7.5 billion. Can you imagine the stresses we're putting on the world, even if you didn't know about the carbon emissions? It would be more surprising if something weren't going haywire in the environment."

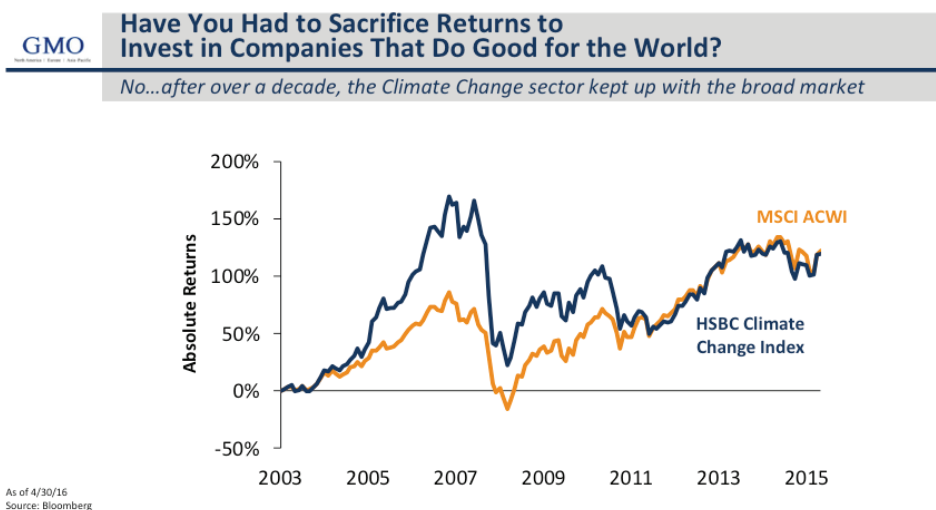
Given the grave concerns about the environment, public policy changes in the United States may seem particularly disconcerting. "The negative spin is that Trump has already killed the Clean Power Plan, and they're talking about pulling out of the Paris Agreement, which could cause other countries to waver on their commitments," he said a few days before Trump announced the United States' withdrawal from the Paris Agreement. "But there's a positive spin. The president is very focused on creating jobs. The renewables industry has grown at eight

times the rate of the broad job market over the last few years, and it's expected to add another several hundred thousand over the next few years. It's hard to see him getting in the way of that." Now, Mr. Trump himself is talking about putting solar panels on his proposed wall at the U.S.-Mexico border!

"The bullish take is that any one administration can't really do too much to what is a freight train heading toward the issue" of climate change, White said. "Even if we move a little slower for a few years, then we'll just have to move faster in a few years when the technology is better and the costs are lower. There are some concerns there, but in the big picture, I think the world will move more aggressively to address climate change."

Some investors are less certain. Global investment in clean energy in 2016 plummeted 18 percent to \$287.5 billion after reaching a record \$348.5 billion in 2015, according to Bloomberg New Energy Finance. BNEF, the renewable energy news and data provider owned by Bloomberg LP, also noted that investments in 2014 were about \$315 billion, still higher than last year. BNEF expects figures for this year to be similar to last year's, but also in part because equipment costs for solar and wind systems should continue to decline, definitely

an encouraging long-term prospect. Those data points vary wildly in different regions, some of which had a bit of a head start and made large early investments. Although large-scale spending declined in China and Japan—two nations that had been spearheading clean energy installations—almost \$30 billion was invested in offshore wind projects, a year-over-year increase of 40 percent.



Investments in renewable energy already have demonstrated returns in line with the broader market.

It's also important to remember that those figures primarily represent dollars spent funding non-fossil-fuel power generation. It doesn't account for the billions spent insuring or reinsuring property in coastal areas that could be smashed by the next catastrophic storm. It doesn't account for all of the investment in improving crop yields by using less water as temperatures rise. It doesn't account for buying a car that uses less gasoline or runs completely on electricity, and it doesn't even begin to consider the burgeoning market in energy efficiency and storage.

'We're All on the Same Side'

"It's nearly impossible to divorce the idea of investing money from how it will affect the planet," and those long-term effects, deMenocal said in a later interview, extend far beyond politics. "The biggest obstacle is getting us to understand that we're all on the same side," he said. "The planet is in transition, and it will affect all of us regardless of our political affiliation. A way forward is for us to find issues that we care about deeply that connect to this larger climate challenge."

"Although we're two different tribes, we share a common interest," he said, referring to investors. "We can mitigate economic risk and uncertainty by using science to understand how climate

impacts things people genuinely care about—their security of food, water, shelter, energy, and health. I was impressed to see so many big funds active in this area, such as Generation Investment Management and BlackRock, and I was also impressed to see the diverse ways in which the private sector is adjusting. In truth, we have a long way to go, but it's not hard to see a path that integrates our knowledge of future climate impacts with shifting investment strategies. It's clear that we can't do this alone. A climate science and business partnership is needed to prepare for, and build, the future. Repowering the planet and adapting to and mitigating against climate impacts represents a multigenerational investment opportunity."

Seager, a lifelong academic, agreed with deMenocal and said he appreciated how serious the private sector representatives at the forum were when it came to committing resources to benefitting the environment. "It was not all about protecting the bottom line, but a strong agenda to take action to move the global economy to sustainability," he said. "I was impressed by that."

More and more companies, especially those publicly held, are beginning to come around. By 2100, damage related to climate change could reduce global Gross Domestic Product by five to 20 percent, according to a September report by Blackrock, citing the 2006 Stern Review prepared for the UK government. "The economic impacts are not just in the distant future," the report stated. "More frequent—and more intense—extreme weather events such as hurricanes, flooding, and droughts are already affecting assets and economies."

Even for those "skeptical about the science of climate change, there is no escaping a swelling tide of climate-related regulation," the report continued. "Technological changes in areas such as renewables and batteries are already causing disruption, while pressures on companies and asset owners to support sustainability are increasing."

Even with projected gains in efficiency, global energy use may grow almost 50 percent by 2040, according to the EIA. One of the only sectors to outpace energy consumption may be food, where demand could nearly double by 2050. Feeding all of those people won't be easy, especially if temperature increases soar past two or three degrees Celsius, as many scientists fear.

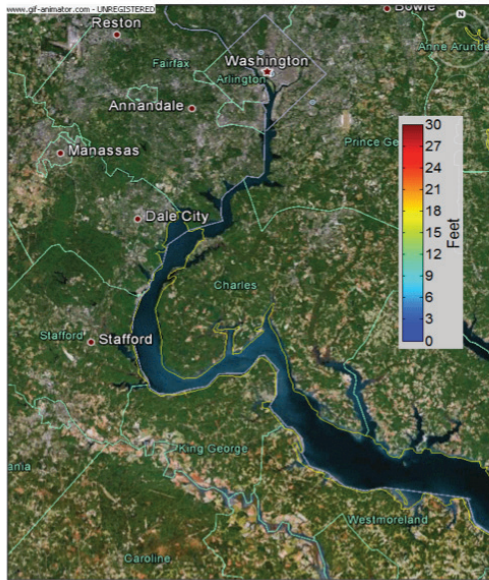
Planning for the Worst but Working Toward the Best

Stripping away all of the politics, it was easier to have meaningful discussions about the best path forward, Sobel added during a question-and-answer portion of the forum. "We sometimes hear 'Well, the science is uncertain,' so that's an excuse not to do anything. That makes no sense. People who work in the industries represented in this room understand that. The fact that something's uncertain means you have to worry about the worst-case scenario. You don't just say, 'Well it could be the best-case, maybe you guys are wrong and it'll be better than they say.' It might also be worse. The language of risk is how we have to think about and communicate this problem. We have to understand that uncertainty is a motivator for action, rather than the converse."

Hurricane season in the Atlantic has been remarkably active this year, as seen with Hurricane Irma, Hurricane Maria, Hurricane Jose, and Tropical Storm Katia, demonstrating that Superstorm Sandy and Hurricane Harvey are not singularly destructive flukes. The unique combination of intensity and frequency of these storms, as described in a recent *New York Times* article, is highly unusual, particularly when four of the seven hurricanes this year have reached or exceeded Category 3.

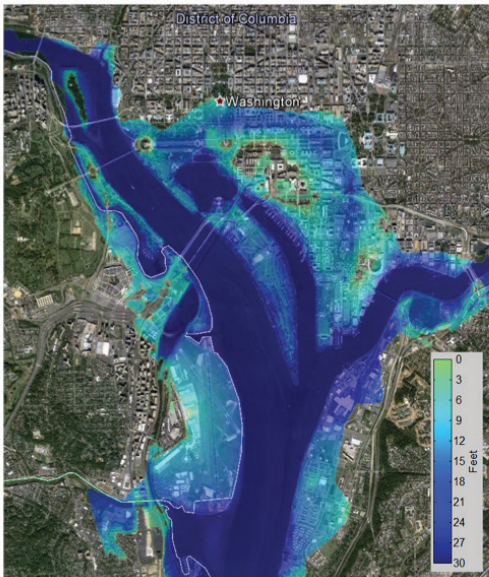
Storm Surge going through Potomac River...

RenaissanceRe



...Resulting inundation of our Nation's Capital...

RenaissanceRe



An extreme storm surge near the Potomac River could completely flood much of Washington D.C.

A repeat of Sandy slamming into D.C. instead of New York could entirely flood much of the capitol, shutting down government operations for days, if not weeks. Rising seas in Florida—or even just the perception of rising seas there—could destroy hundreds of billions in property values, far outpacing the real estate crash in the late 2000s.

Another drought on par with the recent one in Syria, the worst seen there in a millennium, could stretch dwindling freshwater supplies even further, ravage supply chains, and send food prices skyrocketing. Millions of refugees could become tens of millions, maybe hundreds of millions. “These problems are too important to be limited to one industry or one sector,” Sobel said. “Academia, universities, government, and scientists have a role to play here; the science is out there for everyone to use for any purpose.”

The forum purposely did not directly address the role governments will have to play in battling climate change. In

leaving that out, attendees were able to focus on facts, not politics. A few presenters made mention of their general frustration with the politicization of science, but all were committed to sharing their data and expertise in a way free of partisan rancor.

“We intentionally chose not to focus on policy, partly because, in my experience, there’s a lot of quicksand around that area,” Bruce Usher, co-director of the Tamer Center for Social Enterprise and a professor at Columbia Business School, said in a later interview. “The fact that science has become a partisan issue is unbelievable. Science is one of the few things that really shouldn’t be partisan, and communicating that is important.”

But separating politics from science doesn’t mean removing governments, Usher clarified. Because so much climate science research has time horizons measured in decades while so many business decisions are made not just quarterly but daily, reconciling those viewpoints may prove a useful task for elected leadership. “The government can step in and bridge that gap,” Usher said. “It’s very important for people to understand the value of science at a societal and

national level, as well as individual industries and companies.”

One huge benefit of hosting the first such event, of getting that ball rolling, Phillips added, is that more meetings among business and scientific professionals should begin to spring up organically so that businesses of all types—not solely investment-based ones—have their voices heard. These conversations will rise far above the naysayers who dismiss collaboration between business communities and scientists as Corporate Social Responsibility (CSR) chatter. “The next steps are more direct conversations,” Phillips said. “One of the outcomes is a real commitment to closer dialogue.” That could lead to other similar forums, perhaps with different but related focuses—conferences that would build on the first one and everything else exchanged in the interim. In the end, it’s about building a community where scientists and the leaders at top firms can share insights and make the best decisions.

“We’re going to continue to work in this space,” Phillips said, “and continue to determine the best ways of combining the insights of climate scientists with the insights of business professionals.”

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