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Rhetorical Research: Methods for Teaching Multiple Purposes for Texts

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Global Warming's Terrifying New Math

Three simple numbers that add up to global catastrophe - and that make clear who the real enemy is

by: Bill McKibben

If the pictures of those towering wildfires in Colorado haven't convinced you, or the size of your AC bill this summer, here are some hard numbers about climate change: June broke or tied 3,215 high-temperature records across the United States. That followed the warmest May on record for the Northern Hemisphere – the 327th consecutive month in which the temperature of the entire globe exceeded the 20th-century average, the odds of which occurring by simple chance were 3.7 x 10-99, a number considerably larger than the number of stars in the universe.

Meteorologists reported that this spring was the warmest ever recorded for our nation – in fact, it crushed the old record by so much that it represented the "largest temperature departure from average of any season on record." The same week, Saudi authorities reported that it had rained in Mecca despite a temperature of 109 degrees, the hottest downpour in the planet's history.

Not that our leaders seemed to notice. Last month the world's nations, meeting in Rio for the 20th-anniversary reprise of a massive 1992 environmental summit, accomplished nothing. Unlike George H.W. Bush, who flew in for the first conclave, Barack Obama didn't even attend. It was "a ghost of the glad, confident meeting 20 years ago," the British journalist George Monbiot wrote; no one paid it much attention, footsteps echoing through the halls "once thronged by multitudes." Since I wrote one of the first books for a general audience about global warming way back in 1989, and since I've spent the intervening decades working ineffectively to slow that warming, I can say with some confidence that we're losing the fight, badly and quickly – losing it because, most of all, we remain in denial about the peril that human civilization is in.

When we think about global warming at all, the arguments tend to be ideological, theological and economic. But to grasp the seriousness of our predicament, you just need to do a little math. For the past year, an easy and powerful bit of arithmetical analysis first published by financial analysts in the U.K, has been making the rounds of environmental conferences and journals, but it hasn't yet broken through to the larger public. This analysis upends most of the conventional political thinking about climate change. And it allows us to understand our precarious – our almost-but-not-quite-finally hopeless – position with three simple numbers.

The First Number: 2° Celsius

If the movie had ended in Hollywood fashion, the Copenhagen climate conference in 2009 would have marked the culmination of the global fight to slow a changing climate. The world's nations had gathered in the December gloom of the Danish capital for what a leading climate economist, Sir Nicholas Stern of Britain, called the "most important gathering since the Second World War, given what is at stake." As Danish energy minister Connie Hedegaard, who presided over the conference, declared at the time: "This
is our chance. If we miss it, it could take years before we get a new and better one. If ever."

In the event, of course, we missed it. Copenhagen failed spectacularly. Neither China nor the United States, which between them are responsible for 40 percent of global carbon emissions, was prepared to offer dramatic concessions, and so the conference drifted aimlessly for two weeks until world leaders jetted in for the final day. Amid considerable chaos, President Obama took the lead in drafting a face-saving "Copenhagen Accord" that fooled very few. Its purely voluntary agreements committed no one to anything, and even if countries signaled their intentions to cut carbon emissions, there was no enforcement mechanism. "Copenhagen is a crime scene tonight," an angry Greenpeace official declared, "with the guilty men and women fleeing to the airport." Headline writers were equally brutal: COPENHAGEN: THE MUNICH OF OUR TIMES? asked one.

The accord did contain one important number, however. In Paragraph 1, it formally recognized "the scientific view that the increase in global temperature should be below two degrees Celsius." And in the very next paragraph, it declared that "we agree that deep cuts in global emissions are required... so as to hold the increase in global temperature below two degrees Celsius." By insisting on two degrees -- about 3.6 degrees Fahrenheit -- the accord ratified positions taken earlier in 2009 by the G8, and the so-called Major Economies Forum. It was as conventional as conventional wisdom gets. The number first gained prominence, in fact, at a 1995 climate conference chaired by Angela Merkel, then the German minister of the environment and now the center-right chancellor of the nation.

Some context: So far, we've raised the average temperature of the planet just under 0.8 degrees Celsius, and that has caused far more damage than most scientists expected. (A third of summer sea ice in the Arctic is gone, the oceans are 30 percent more acidic, and since warm air holds more water vapor than cold, the atmosphere over the oceans is a shocking five percent wetter, loading the dice for devastating floods.) Given those impacts, in fact, many scientists have come to think that two degrees is far too lenient a target. "Any number much above one degree involves a gamble," writes Kerry Emanuel of MIT, a leading authority on hurricanes, "and the odds become less and less favorable as the temperature goes up." Thomas Lovejoy, once the World Bank's chief biodiversity adviser, puts it like this: "If we're seeing what we're seeing today at 0.8 degrees Celsius, two degrees is simply too much." NASA scientist James Hansen, the planet's most prominent climatologist, is even blunter: "The target that has been talked about in international negotiations for two degrees of warming is actually a prescription for long-term disaster." At the Copenhagen summit, a spokesman for small island nations warned that many would not survive a two-degree rise: "Some countries will flat-out disappear." When delegates from developing nations were warned that two degrees would represent a "suicide pact" for drought-stricken Africa, many of them started chanting, "One degree, one Africa."

Despite such well-founded misgivings, political realism bested scientific data, and the world settled on the two-degree target -- indeed, it's fair to say that it's the only thing about climate change the world has settled on. All told, 167 countries responsible for more than 87 percent of the world's carbon emissions have signed on to the Copenhagen Accord, endorsing the two-degree target. Only a few dozen countries have rejected it, including Kuwait, Nicaragua and Venezuela. Even the United Arab Emirates, which makes most of its money exporting oil and gas, signed on. The official position of planet Earth at the moment is that we can't raise the temperature more than two degrees Celsius -- it's become the bottomest of bottom lines. Two degrees.

The Second Number: 565 Gigatons

Scientists estimate that humans can pour roughly 565 more gigatons of carbon dioxide into the atmosphere by midcentury and still have some reasonable hope of staying below two degrees. ("Reasonable," in this case, means four chances in five, or somewhat worse odds than playing Russian roulette with a six-shooter.)

This idea of a global "carbon budget" emerged about a decade ago, as scientists began to calculate how much oil, coal and gas could still safely be burned. Since we've increased the Earth's temperature by 0.8 degrees so far, we're currently less than halfway to the target. But, in fact, computer models calculate that even if we stopped increasing CO2 now, the temperature would likely still rise another 0.8 degrees, as previously released carbon continues to overheat the atmosphere. That means we're already three-quarters of the way to the two-degree target.

How good are these numbers? No one is insisting that they're exact, but few dispute that they're generally right. The 565-gigaton figure was derived from one of the most sophisticated computer-simulation models that have been built by climate scientists around the world over the past few decades. And the number is being further confirmed by the latest climate-simulation models currently being finalized in advance of the next report by the Intergovernmental Panel on Climate Change. "Looking at them as they come in, they hardly differ at all," says Tom Wigley, an Australian climatologist at the National Center for Atmospheric Research. "There's maybe 40 models in the data set now, compared with 20 before. But so far the numbers are pretty much the same. We're just fine-tuning things. I don't think much has changed over the last decade." William Collins, a senior climate scientist at the Lawrence Berkeley National Laboratory, agrees. "I think the results of this round of simulations will be quite similar," he says. "We're not getting any free lunch from additional understanding of the climate system."

We're not getting any free lunch from the world's economies, either. With only a single year's lull in 2009 at the height of the financial crisis, we've continued to pour record amounts of carbon into the atmosphere, year after year. In late May, the International Energy Agency published its latest figures -- CO2 emissions last year rose to 31.6 gigatons, up 3.2 percent from the year before. America had a warm winter and converted more coal-fired power plants to natural gas, so its emissions fell slightly; China kept booming, so its carbon output (which recently surpassed the U.S.) rose 9.3 percent; the Japanese shut down their fleet of nukes post-Fukushima, so their emissions edged up 2.4 percent. "There have been efforts to use more renewable energy and improve energy efficiency," said Corinne Le Quéré, who runs England's Tyndall Centre for Climate Change Research. "But what this shows is that so far the effects..."
have been marginal." In fact, study after study predicts that carbon emissions will keep growing by roughly three percent a year – and at that rate, we'll blow through our 565-gigaton allowance in 16 years, around the time today's preschoolers will be graduating from high school. "The new data provide further evidence that the door to a two-degree trajectory is about to close," said Fatih Birol, the IEA's chief economist. In fact, he continued, "When I look at this data, the trend is perfectly in line with a temperature increase of about six degrees." That's almost 11 degrees Fahrenheit, which would create a planet straight out of science fiction.

So, new data in hand, everyone at the Rio conference renewed their ritual calls for serious international action to move us back to a two-degree trajectory. The charade will continue in November, when the next Conference of the Parties (COP) of the U.N. Framework Convention on Climate Change convenes in Qatar. This will be COP 18 – COP 1 was held in Berlin in 1995, and since then the process has accomplished essentially nothing. Even scientists, who are notoriously reluctant to speak out, are slowly overcoming their natural preference to simply provide data. "The message has been consistent for close to 30 years now," Collins says with a wry laugh, "and we have the instrumentation and the computer power required to present the evidence in detail. If we choose to continue on our present course of action, it should be done with a full evaluation of the evidence the scientific community has presented." He pauses, suddenly conscious of being on the record. "I should say, a fuller evaluation of the evidence."

So far, though, such calls have had little effect. We're in the same position we've been in for a quarter-century: scientific warning followed by political inaction. Among scientists speaking off the record, disgusted candor is the rule. One senior scientist told me, "You know those new cigarette packs, where governments make them put a picture of someone with a hole in their throats? Gas pumps should have something like that."

The Third Number: 2,795 Gigatons

This number is the scariest of all – one that, for the first time, meshes the political and scientific dimensions of our dilemma. It was highlighted last summer by the Carbon Tracker Initiative, a team of London financial analysts and environmentalists who published a report in an effort to educate investors about the possible risks that climate change poses to their stock portfolios. The number describes the amount of carbon already contained in the proven coal and oil and gas reserves of the fossil-fuel companies, and the countries (think Venezuela or Kuwait) that act like fossil-fuel companies. In short, it's the fossil fuel we're currently planning to burn. And the key point is that this new number – 2,795 – is higher than 565. Five times higher.

The Carbon Tracker Initiative – led by James Leaton, an environmentalist who served as an adviser at the accounting giant PricewaterhouseCoopers – combed through proprietary databases to figure out how much oil, gas and coal the world's major energy companies hold in reserve. The numbers aren't perfect – they don't fully reflect the recent surge in unconventional energy sources like shale gas, and they don't accurately reflect coal reserves, which are subject to less stringent reporting requirements than oil and gas. But for the biggest companies, the figures are quite exact: If you burned everything in the inventories of Russia's Lukoil and America's ExxonMobil, for instance, which lead the list of oil and gas companies, each would release more than 40 gigatons of carbon dioxide into the atmosphere.

Which is exactly why this new number, 2,795 gigatons, is such a big deal. Think of two degrees Celsius as the legal drinking limit – equivalent to the 0.08 blood-alcohol level below which you might get away with driving home. The 565 gigatons is how many drinks you could have and still stay below that limit – the six beers, say, you might consume in an evening. And the 2,795 gigatons? That's the 33-12-packs the fossil-fuel industry has on the table, already opened and ready to pour.

We have five times as much oil and coal and gas on the books as climate scientists think is safe to burn. We'd have to keep 80 percent of those reserves locked away underground to avoid that fate. Before we knew those numbers, our fate had been likely. Now, barring some massive intervention, it seems certain.

Yes, this coal and gas and oil is still technically in the soil. But it's already economically aboveground – it's figured into share prices, companies are borrowing money against it, nations are basing their budgets on the presumed returns from their patrimony. It explains why the big fossil-fuel companies have fought so hard to prevent the regulation of carbon dioxide – those reserves are their primary asset, the holding that gives their companies their value. It's why they've worked so hard these past years to figure out how to unlock the oil in Canada's tar sands, or how to drill miles beneath the sea, or how to frack the Appalachians.

If you told Exxon or Lukoil that, in order to avoid wrecking the climate, they couldn't pump out their reserves, the value of their companies would plummet. John Fullerton, a former managing director at JP Morgan who now runs the Capital Institute, calculates that at today's market value, those 2,795 gigatons of carbon emissions are worth about $27 trillion. Which is to say, if you paid attention to the scientists and kept 80 percent of it underground, you'd be writing off $20 trillion in assets. The numbers aren't exact, of course, but that carbon bubble makes the housing bubble look small by comparison. It won't necessarily burst – we might well burn all that carbon, in which case investors will do fine. But if we do, the planet will crater. You can have a healthy fossil-fuel balance sheet, or a relatively healthy planet – but now that we know the numbers, it looks like you can't have both. Do the math: 2,795 is five times 565. That's how the story ends.

So far, as I said at the start, environmental efforts to tackle global warming have failed. The planet's emissions of carbon dioxide continue to soar, especially as developing countries emulate (and supplant) the industries of the West. Even in rich countries, small reductions in emissions offer no sign of the real break with the status quo we'd need to upend the iron logic of these three numbers. Germany is one of the only big countries that has actually tried hard to change its energy mix; on one sunny Saturday in late May, that northern-latitude nation generated nearly half its power from solar panels within its borders. That's a small miracle – and it demonstrates that we have the technology to solve our problems. But we lack the will. So far, Germany's the exception; the
rule is ever more carbon.

This record of failure means we know a lot about what strategies don't work. Green groups, for instance, have spent a lot of time trying to change individual lifestyles: the iconic twisty light bulb has been installed by the millions, but so have a new generation of energy-sucking flatscreen TVs. Most of us are fundamentally ambivalent about going green: We like cheap flights to warm places, and we're certainly not going to give them up if everyone else is still taking them. Since all of us are in some way the beneficiaries of cheap fossil fuel, tackling climate change has been like trying to build a movement against yourself – it's as if the gay-rights movement had to be constructed entirely from evangelical preachers, or the abolition movement from slaveholders.

People perceive – correctly – that their individual actions will not make a decisive difference in the atmospheric concentration of CO2; by 2010, a poll found that "while recycling is widespread in America and 73 percent of those polled are paying bills online in order to save paper," only four percent had reduced their utility use and only three percent had purchased hybrid cars. Given a hundred years, you could conceivably change lifestyles enough to matter – but time is precisely what we lack.

A more efficient method, of course, would be to work through the political system, and environmentalists have tried that, too, with the same limited success. They've patiently lobbied leaders, trying to convince them of our peril and assuming that politicians would heed the warnings. Sometimes it has seemed to work. Barack Obama, for instance, campaigned more aggressively about climate change than any president before him – the night he won the nomination, he told supporters that his election would mark the moment "the rise of the oceans began to slow and the planet began to heal." And he has achieved one significant change: a steady increase in the fuel efficiency mandated for automobiles. It's the kind of measure, adopted a quarter-century ago, that would have helped enormously. But in light of the numbers I've just described, it's obviously a very small start indeed.

At this point, effective action would require actually keeping most of the carbon the fossil-fuel industry wants to burn safely in the soil, not just changing slightly the speed at which it's burned. And there the president, apparently haunted by the still-echoing cry of "Drill, baby, drill," has gone out of his way to frack and mine. His secretary of interior, for instance, opened up a huge swath of the Powder River Basin in Wyoming for coal extraction: The total basin contains some 67.5 gigatons worth of carbon (or more than 10 percent of the available atmospheric space). He's doing the same thing with Arctic and offshore drilling; in fact, as he explained on the stump in March, "You have my word that we will keep drilling everywhere we can... That's a commitment that I make." The next day, in a yard full of oil pipe in Cushing, Oklahoma, the president promised to work on wind and solar energy but, at the same time, to speed up fossil-fuel development: "Producing more oil and gas here at home has been, and will continue to be, a critical part of an all-of-the-above energy strategy." That is, he's committed to finding even more stock to add to the 2,795-gigaton inventory of unburned carbon.

Sometimes the irony is almost Borat-scale obvious: In early June, Secretary of State Hillary Clinton traveled on a Norwegian research trawler to see firsthand the growing damage from climate change. "Many of the predictions about warming in the Arctic are being surpassed by the actual data," she said, describing the sight as "sobering." But the discussions she traveled to Scandinavia to

The same kind of hypocrisy applies across the ideological board: In his speech to the Copenhagen conference, Venezuela's Hugo Chavez quoted Rosa Luxemburg, Jean-Jacques Rousseau and "Christ the Redeemer," insisting that "climate change is undoubtedly the most devastating environmental problem of this century." But the next spring, in the Simon Bolivar Hall of the state-run oil company, he signed an agreement with a consortium of international players to develop the vast Orinoco tar sands as "the most significant engine for a comprehensive development of the entire territory and Venezuelan population." The Orinoco deposits are larger than Alberta's – taken together, they'd fill up the whole available atmospheric space.

S o: the paths we have tried to tackle global warming have so far produced only gradual, halting shifts. A rapid, transformative change would require building a movement, and movements require enemies. As John F. Kennedy put it, "The civil rights movement should thank God for Bull Connor. He's helped it as much as Abraham Lincoln." And enemies are what climate change has lacked.

But what all these climate numbers make painfully, usefully clear is that the planet does indeed have an enemy – one far more committed to action than governments or individuals. Given this hard math, we need to view the fossil-fuel industry in a new light. It has become a rogue industry, reckless like no other force on Earth. It is Public Enemy Number One to the survival of our planetary civilization. "Lots of companies do rotten things in the course of their business – pay terrible wages, make people work in sweatshops – and we pressure them to change those practices," says veteran anti-corporate leader Naomi Klein, who is at work on a book about the climate crisis. "But these numbers make clear that with the fossil-fuel industry, wrecking the planet is their business model. It's what they do."
According to the Carbon Tracker report, if Exxon burns its current reserves, it would use up more than seven percent of the available atmospheric space between us and the risk of two degrees. BP is just behind, followed by the Russian firm Gazprom, then Chevron, ConocoPhillips and Shell, each of which would fill between three and four percent. Taken together, just these six firms, of the 200 listed in the Carbon Tracker report, would use up more than a quarter of the remaining two-degree budget. Several, the Russian mining giant, leads the list of coal companies, followed by firms like BHP Billiton and Peabody. The numbers are simply staggering – this industry, and this industry alone, holds the power to change the physics and chemistry of our planet, and they're planning to use it.

They're clearly cognizant of global warming – they employ some of the world's best scientists, after all, and they're bidding on all those oil leases made possible by the staggering melt of Arctic ice. And yet they relentlessly search for more hydrocarbons – in early March, Exxon CEO Rex Tillerson told Wall Street analysts that the company plans to spend $37 billion a year through 2016 (about $100 million a day) searching for yet more oil and gas.

There's not a more reckless man on the planet than Tillerson. Late last month, on the same day the Colorado fires reached their height, he told a New York audience that global warming is real, but dismissed it as an "engineering problem" that has "engineering solutions." Such as? "Changes to weather patterns that move crop-production areas around – we'll adapt to that." This in a week when Kentucky farmers were reporting that corn kernels were "aborting" in record heat, threatening a spike in global food prices. "The fear factor that people want to throw out there to say, 'We just have to stop this,' I do not accept," Tillerson said. Of course not – if he did accept it, he'd have to keep his reserves in the ground. Which would cost him money. It's not an engineering problem, in other words – it's a greed problem.

You could argue that this is simply in the nature of these companies – that having found a profitable vein, they're compelled to keep mining it, more like efficient automatons than people with free will. But as the Supreme Court has made clear, they are people of a sort. In fact, thanks to the size of its bankroll, the fossil-fuel industry has far more free will than the rest of us. These companies don't simply exist in a world whose hungers they fulfill – they help create the boundaries of that world.

Left to our own devices, citizens might decide to regulate carbon and stop short of the brink; according to a recent poll, nearly two-thirds of Americans would back an international agreement that cut carbon emissions 90 percent by 2050. But we aren't left to our own devices. The Koch brothers, for instance, have a combined wealth of $50 billion, meaning they trail only Bill Gates on the list of richest Americans. They've made most of their money in hydrocarbons, they know any system to regulate carbon would cut those profits, and they reportedly plan to lavish as much as $200 million on this year's elections. In 2009, for the first time, the U.S. Chamber of Commerce surpassed both the Republican and Democratic National Committees on political spending; the following year, more than 90 percent of the Chamber's cash went to GOP candidates, many of whom deny the existence of global warming.

Not long ago, the Chamber even filed a brief with the EPA urging the agency not to regulate carbon – should the world's scientists turn out to be right and the planet heats up, the Chamber advised, "populations can acclimate to warmer climates via a range of behavioral, physiological and technological adaptations." As radical goes, demanding that we change our physiology seems right up there.

Environmentalists, understandably, have been loath to make the fossil-fuel industry their enemy, respecting its political power and hoping instead to convince these giants that they should turn away from coal, oil and gas and transform themselves more broadly. "The fear factor that people want to throw out there to say, 'We just have to stop this,' I do not accept," Tillerson said. Of course not – if he did accept it, he'd have to keep his reserves in the ground. Which would cost him money. It's not an engineering problem, in other words – it's a greed problem.

Environmentalists' strategy: try to make fossil fuel industries go green

Strategies for responding to the fossil fuel industry

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Environmentalists, understandably, have been loath to make the fossil-fuel industry their enemy, respecting its political power and hoping instead to convince these giants that they should turn away from coal, oil and gas and transform themselves more broadly into "energy companies." Sometimes that strategy appeared to be working – emphasis on appeared. Around the turn of the century, for instance, BP made a brief attempt to restyle itself as "Beyond Petroleum," adapting a logo that looked like the sun and sticking the economic playing field would now be a level one for nonpolluting energy sources. And you

Much of that profit stems from a single historical accident: Alone among businesses, the fossil-fuel industry is allowed to dump its main waste, carbon dioxide, for free. Nobody else gets that break – if you own a restaurant, you have to pay someone to cart away your trash, since piling it in the street would breed rats. But the fossil-fuel industry is different, and for sound historical reasons: Until a quarter-century ago, almost no one knew that CO2 was dangerous. But now that we understand that carbon is heating the planet and acidifying the oceans, its price becomes the central issue.

If you put a price on carbon, through a direct tax or other methods, it would enlist markets in the fight against global warming. Once Exxon has to pay for the damage its carbon is doing to the atmosphere, the price of its products would rise. Consumers would get a strong signal to use less fossil fuel – every time they stopped at the pump, they'd be reminded that you don't need a semimilitary vehicle to go to the grocery store. The economic playing field would now be a level one for nonpolluting energy sources. And you could do it all without bankrupting citizens – a so-called "fee-and-dividend" scheme would put a hefty tax on coal and gas and oil, then simply divide up the proceeds, sending everyone in the country a check each month for their share of the added costs of carbon. By switching to cleaner energy sources, most people would actually come out ahead.

There's only one problem: Putting a price on carbon would reduce the profitability of the fossil-fuel industry. After all, the answer to the question "How high should the price of carbon be?" is "High enough to keep those carbon reserves that would take us past two degrees safely in the ground." The higher the price on carbon, the more of those reserves would be worthless. The fight, in the end, is about whether the industry will succeed in its fight to keep its special pollution break alive past the point of climate catastrophe, or

economic strategy: carbon tax to enlist markets in the fight against global warming

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whether, in the economists' parlance, we'll make them internalize those externalities.

It's not clear, of course, that the power of the fossil-fuel industry can be broken. **The U.K. analysts who wrote the Carbon Tracker report** and drew attention to these numbers had a relatively modest goal – they simply wanted to remind investors that climate change poses a very real risk to the stock prices of energy companies. Say something so big finally happens (a giant hurricane swamps Manhattan, a megadrought wipes out Midwest agriculture) that even the political power of the industry is inadequate to restrain legislators, who manage to regulate carbon. Suddenly those Chevron reserves would be a lot less valuable, and the stock would tank. Given that risk, the Carbon Tracker report warned investors to lessen their exposure, hedge it with some big plays in alternative energy.

"The regular process of economic evolution is that businesses are left with stranded assets all the time," says Nick Robins, who runs HSBC's Climate Change Centre. "Think of film cameras, or typewriters. The question is not whether this will happen. It will. Pension systems have been hit by the dot-com and credit crunch. They'll be hit by this." Still, it hasn't been easy to convince investors, who have shared in the oil industry's record profits. "The reason you get bubbles," sighs Leaton, "is that everyone thinks they're the best analyst – that they'll go to the edge of the cliff and then jump back when everyone else goes over."

So pure self-interest probably won't spark a transformative challenge to fossil fuel. But moral outrage just might – and that's the real meaning of this new math. It could, plausibly, give rise to a real movement.

Once, in recent corporate history, anger forced an industry to make basic changes. That was the campaign in the 1980s demanding divestment from companies doing business in South Africa. It rose first on college campuses and then spread to municipal and state governments; 155 campuses eventually divested, and by the end of the decade, more than 80 cities, 25 states and 19 counties had taken some form of binding economic action against companies connected to the apartheid regime. "The end of apartheid stands as one of the crowning accomplishments of the past century," as Archbishop Desmond Tutu put it, "but we would not have succeeded without the help of international pressure," especially from "the divestment movement of the 1980s."

Movements rarely have predictable outcomes. But any campaign that weakens the fossil-fuel industry's political standing clearly increases the chances of retiring its special breaks. Consider President Obama's signal achievement in the climate fight, the large increase he won in mileage requirements for cars. Scientists, environmentalists and engineers had advocated such policies for decades, but until Detroit came under severe financial pressure, it was politically powerful enough to fend them off. If people come to understand the cold, mathematical truth – that the fossil-fuel industry is systematically undermining the planet's physical systems – it might weaken it enough to matter politically. Exxon and their ilk might drop their opposition to a fee-and-dividend solution; they might even decide to become true energy companies, this time for real.

Even if such a campaign is possible, however, we may have waited too long to start it. To make a real difference – to keep us under a temperature increase of two degrees – you'd need to change carbon pricing in Washington, and then use that victory to leverage similar shifts around the world. At this point, what happens in the U.S. is most important for how it will influence China and India, where emissions are growing fastest. (In early June, researchers concluded that China has probably under-reported its emissions by up to 20 percent.) The three numbers I've described are daunting – they may define an essentially impossible future. But at least they provide intellectual clarity about the greatest challenge humans have ever faced. We know how much we can burn, and we know who's planning to burn more. Climate change operates on a geological scale and time frame, but it's not an impersonal force of nature; the more carefully you do the math, the more thoroughly you realize that this is, at bottom, a moral issue; we have met the enemy and they is Shell.

Meanwhile the tide of numbers continues. The week after the Rio conference limped to its conclusion, Arctic sea ice hit the lowest level ever recorded for that date. Last month, on a single weekend, Tropical Storm Debby dumped more than 20 inches of rain in Florida – the earliest the season's fourth-named cyclone has ever arrived. At the same time, the largest fire in New Mexico history burned on, and the most destructive fire in Colorado's annals claimed 346 homes in Colorado Springs – breaking a record set the week before in Fort Collins. This month, scientists issued a new study concluding that global warming has dramatically increased the likelihood of severe heat and drought – days after a heat wave across the Plains and Midwest broke records that had stood since the Dust Bowl, threatening this year's harvest. You want a big number? In the course of this month, a quadrillion kernels of corn need to pollinate across the grain belt, something they can't do if temperatures remain off the charts. Just like us, our crops are adapted to the Holocene, the 11,000-year period of climatic stability we're now leaving... in the dust.

*This story is from the August 2nd, 2012 issue of Rolling Stone.*

Related
Appendix 1

A biobank is a place where human tissue samples are stored. DNA is gathered from these samples and linked to other health information about the donors, their families and past generations. The linked information becomes a biobank resource that may help researchers identify the genetic causes of human diseases. It is hoped that biobank resources will lead to cures for a wide range of conditions, including diabetes, heart disease and cancer.

Biobanks are required by law to obtain permission from participants to use their samples and to link them with other health information. They are also required by law to ensure confidentiality. Biobank resources are expected to be kept secure, so that insurers, employers and others cannot access them. Bearing all of this information in mind, I would now like to ask you about your thoughts on biobanks. Using a scale from 0 to 10, where 0 means ‘do not trust at all’, and 10 means ‘trust a great deal’, please indicate how much you trust the following biobanks.
likely to be met with an absence of opposition rather than with active support.\textsuperscript{11} In addition, willingness to implement measures that decrease GHG emissions is mostly limited to measures that are easily undertaken, can be done at home and are not costly.\textsuperscript{17} The reasons given for changing behaviour were mostly financial and health reasons, rather than a genuine concern for the detrimental effects of climate change.\textsuperscript{10} To date, social research has mostly focused on climate change as an ecological concern rather than as a threat to human health. Some studies have skimmed over the subject of perceptions of the health effects of climate change (e.g. the perception that climate change lowers standard of living and aggravates water shortages).\textsuperscript{x,11,12} Only few studies have considered the level of knowledge of the direct health effects (e.g. the knowledge that climate change increases the frequency and intensity of heat waves that in turn can affect health by leading to dehydration or heat stroke) as well as the indirect health effects of climate change (e.g. that climate change worsens air quality).

This study, which examines the Maltese public perception of climate change, gives particular attention to public perceptions and knowledge of the health effects of climate change. Health-related items that had already been used in other studies (e.g. perceptions that people are dying or becoming ill because of climate change) were replicated in the questionnaire used in this study. A new item on knowledge about the human health effects of climate change was introduced.

Risk perception and knowledge of the human health effects of climate change were in turn analysed together with knowledge about the contributors of climate change, willingness to adopt climate change mitigation behaviour and support for climate change mitigation policy.

**Background**

Malta is a small archipelago in the centre of the Mediterranean. The two larger islands—Malta and Gozo—together cover an area of 316 km$^2$. The island state, which has been a member of the European Union since May 2004, has a resident population of 413,609 (as at end 2008) and a very high-population density (1309 persons/km$^2$ as at end 2008).\textsuperscript{15}

Over the last decades, Malta has experienced overall all year round warmer temperatures with particularly pronounced warmer temperatures during the summer months. This was accompanied by an increase in the frequency and intensity of heat waves. Rainfall precipitation was observed to have increased in the wetter months (between October and February) and decreased in the drier months (between March and September). Monthly projections indicate that the period from October to February may experience an increase in precipitation by as much as 22%.\textsuperscript{16} This implies a shift of precipitation to shorter time windows, which is problematic for a country with limited water reservoirs and which may further contribute to more frequent flooding events.

As in other countries, diarrhoeal disease caused by *Salmonella* spp. is projected to increase owing to the close relationship between the incidence of *Salmonella* spp. and higher temperatures.\textsuperscript{17} Local surveillance of vector-borne diseases shows a general decline overall; however, the introduction of new vector species due to climate change is a concern. *Aedes albopictus*, also known as the tiger mosquito, a major vector for Chikungunya fever and a secondary Dengue vector, was detected locally in September 2009.\textsuperscript{18,19}

**Methods**

The target population was the Maltese resident population over the age of 18 years ($N = 310,819$ as at end December 2008).\textsuperscript{15} The population is distributed over Malta and Gozo and both islands were included in the study. The study was conducted by means of a telephone survey. A representative random sample of 800 participants, stratified by gender, age and district, was taken from the March 2008 Electoral Register. Telephone and mobile-phone numbers of these participants were obtained from the two main telephone online directories.

The research tool was formulated through a multi-step process, which included the adaptation (with permission) of a similar tool from another study.\textsuperscript{12} The tool was then modified to meet the objectives of this particular study, adapted to a telephone-survey methodology and adjusted to be more sensitive to the Maltese islands’ scenario. The modification process included continuous peer review and a focus group. The focus group consisted of 10 people, three males and seven females with an age range of 22–60 years (mean age: 43 years) and with different educational backgrounds. They held different occupations ranging from staff support, receptionist and data-entry operator to research officer and administrator. None worked with the subject or had a particular interest in climate change and health. The formulation and categorization of the new questions regarding the human health effects of climate change was based on the feedback from the focus group.

The questionnaire was translated into the Maltese language with back translation into English in order to ensure that the Maltese version corresponded in meaning with the English version. A pilot study was conducted between the 17 and the 28 November 2008 on an original sample of 50 individuals. Of these, 26 were traceable and 22 successfully answered the questionnaire. Following the pilot study, the sampling frame for the study was changed and minor modifications were made to the research tool.

The main telephone survey was carried out over a 7-week period between 12 January and 28 February 2009. Interviews were carried out by the author of the study and a trained interviewer. As per pilot study, significant differences between interviewers were sought and there were none. Informed consent was obtained over the telephone prior to the interview. Participants were contacted during days and times that were most convenient for them. After five failed attempts to contact participants on different days and times of day, the household was considered ‘empty’ and the participant considered untraceable.

Individuals who were not listed in the telephone directory, did not own a telephone or a mobile phone, or were untraceable by telephone for other reasons were excluded from the study. Persons who formed part of the selected sample but were hard of hearing, suffering from dementia or mental disability, on long-term hospitalization, living abroad long term or had passed away during the study period, were also excluded from the study.

Data input, validation and analysis was performed using 'Microsoft Excel 2007' and 'SPSS 16.0'. Indices were constructed for sets of items in order to summarize data and analyse it. As defined by Babbie, indices are efficient data reduction devices that summarize a respondent’s answers to different questions measuring different dimensions of the same complex concept in a single score.\textsuperscript{20} The idea of constructing indices was taken from other studies, including studies on climate change; however, most of the indices were constructed afresh on variables that were unique to this study.

Internal reliability testing of indices was carried out using Cronbach’s $\alpha$ or Gutman’s $\lambda_2$ to give a measure of the strength of the indices. Cronbach’s $\alpha$ was used for reliability testing of items using Likert scales. Gutman’s $\lambda_2$ was used for items with a Boolean or binary (‘yes’ or ‘no’) response. The latter is more complex than Cronbach’s $\alpha$ and preferred by certain researchers, though less commonly used.\textsuperscript{21} It is better adapted for binary variables.

In total, five indices were constructed: the ‘Knowledge of Contributors of Climate Change Index’, the ‘Risk Perception Index’, the ‘Knowledge of Health Effects of Climate Change Index’, the ‘Support for Policy Index’ and the ‘Willingness to Act Index’. Single variables were also used in the analysis. These variables are ‘people dying’ and ‘people becoming ill’, and refer to the perception that people are dying and people becoming ill due to climate change, respectively.

As shown in Appendix tables A1–A7, ‘Knowledge about Contributors of Climate Change Index’ is a construct of eight items related to knowledge about the contributors of climate change. ‘Risk Perception Index’ is a construct of six items related to the perception that climate change will have an impact on people’s standard of living, water shortages and increased rates of serious disease in 50 years time, both world wide and locally. ‘Knowledge of Health Effects of Climate Change Index’ is a
construct of seven items related to knowledge about the direct human health effects of climate change. 'Support for Policy Index' is a construct of six items related to willingness to support national climate change mitigation policy. 'Willingness to Act Index' is a construct of six items related to willingness to adopt a set of 'climate change friendly' measures.

Results

Response rate

Out of a total sample of 800 individuals, 586 (73.3%) were eligible to participate in the study. According to the set criteria, 192 (24.0%) individuals could not be traced and 22 (2.8%) were excluded. Among 586 eligible participants, 543 (92.7%) successfully answered the questionnaire, which is not significantly different from the study population for gender (P = 0.977), age (P = 0.767) and district (P = 0.812), and was appreciably similar to the study population by education, occupation and labour status.

Out of 543 participants, 455 (83.8%) were aware of the terms ‘climate change’ or ‘global warming’. The rest (16.2%) were not aware of these terms and for this reason could not answer the rest of the questionnaire.

Table 1 describes the relationships between different variables and indices using Spearman correlation analysis. As shown in this table, 'Risk Perception Index' correlates very strongly with all the variables and indices including 'People dying', 'People becoming ill', 'Knowledge of Health Effects of Climate Change', 'Support for Policy' and 'Willingness to Act', except 'Knowledge about Contributors of Climate Change Index'. Furthermore, the 'Willingness to Act Index' correlates very strongly with the 'Support for Policy Index', both of which in turn correlate very strongly with the 'Risk Perception Index' and to a lesser extent with the variables 'People dying' and 'People becoming ill'. 'Knowledge of Health Effects of Climate Change Index' is also significantly correlated with the 'Willingness to Act Index' but seems to be most strongly correlated with the variables 'People dying' and 'People becoming ill' and with the 'Risk Perception Index'. The 'Knowledge of Contributors of Climate Change Index' is not significantly correlated to any of the variables and indices except for 'People dying' in which case, it is negatively correlated.

Since 'Risk Perception Index' was found to have the strongest correlation with 'Support for Policy Index' and 'Willingness to Act Index', multi-variate analysis for the correlations between 'Risk Perception Index' and 'Support for Policy Index', and 'Risk Perception Index' and the 'Willingness to Act Index', was carried out to test for confounding with age, gender and education. The correlation between the 'Risk Perception Index' and the 'Support for Policy Index' was not found to be significantly confounded by age, gender or education. The correlation between 'Risk Perception Index' and 'Willingness to Act' was found to be significantly confounded by age and gender, but not by education. Nevertheless, the confounding effect of age and gender, though present, was minimal and the strength of the relationship between the 'Risk Perception Index' and the 'Willingness to Act Index' was retained even when age and gender were inserted in the model (table 3).

Table 1 Internal reliability testing

<table>
<thead>
<tr>
<th>Index</th>
<th>Guttman ρ2</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about Contributors of Climate Change Index</td>
<td>0.602a</td>
<td></td>
</tr>
<tr>
<td>Risk Perception Index</td>
<td>0.797b</td>
<td></td>
</tr>
<tr>
<td>Knowledge of Health Effects of Climate Change Index</td>
<td>0.605a</td>
<td></td>
</tr>
<tr>
<td>Support for Policy Index</td>
<td>0.452c</td>
<td></td>
</tr>
<tr>
<td>Willingness to Act Index</td>
<td>0.538c</td>
<td></td>
</tr>
</tbody>
</table>

a: Good for exploratory purposes
b: Good reliability
c: Poor reliability

Table 2 Correlation matrix between indices and variables

<table>
<thead>
<tr>
<th>Knowledge about contributors of Climate Change Index</th>
<th>People dying</th>
<th>People becoming ill</th>
<th>Risk Perception Index</th>
<th>Knowledge of health effects of Climate Change Index</th>
<th>Support for Policy Index</th>
<th>Willingness to Act Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about contributors of Climate Change Index</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>People dying</td>
<td>-0.119a</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>People becoming ill</td>
<td>-0.062</td>
<td>0.450b</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk Perception Index</td>
<td>-0.077</td>
<td>0.319a</td>
<td>0.346b</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge of Health Effects of Climate Change Index</td>
<td>0.002</td>
<td>0.199b</td>
<td>0.186b</td>
<td>0.276b</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Support for Policy Index</td>
<td>-0.009</td>
<td>0.154c</td>
<td>0.119a</td>
<td>0.220b</td>
<td>0.067</td>
<td>1.000</td>
</tr>
<tr>
<td>Willingness to Act Index</td>
<td>-0.068</td>
<td>0.136d</td>
<td>0.165e</td>
<td>0.268b</td>
<td>0.108f</td>
<td>0.282g</td>
</tr>
</tbody>
</table>

a: Correlation is significant at the 0.05 level (2 tailed)
b: Correlation is significant at the 0.0001 level (2 tailed)
c: Correlation is significant at the 0.01 level (2 tailed)

Table 3 Models for willingness to act as predicted by Risk Perception Index

<table>
<thead>
<tr>
<th>Model</th>
<th>B</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.0687</td>
<td>0.1494</td>
</tr>
<tr>
<td>2</td>
<td>3.4638</td>
<td>0.3734</td>
</tr>
<tr>
<td>3</td>
<td>3.6737</td>
<td>0.3857</td>
</tr>
<tr>
<td>4</td>
<td>0.2899</td>
<td>0.0499</td>
</tr>
<tr>
<td>5</td>
<td>-0.1194</td>
<td>0.0282</td>
</tr>
<tr>
<td>6</td>
<td>-0.0035</td>
<td>0.0017</td>
</tr>
</tbody>
</table>

Bold in this table is being used to highlight figures that are referred to in the text.
Discussion

This study demonstrates that the perception among the Maltese public that climate change poses a risk to one’s health (increased disease, water shortages) and general well-being (impact on standard of living) may be the strongest driver behind support for climate change mitigation policy and a willingness to take measures to mitigate climate change. This correlation is also supported by the strong relationship between a perception that people die or become ill because of climate change, and support for climate change mitigation policy and a willingness to act.

Interestingly, the broad perception that climate change somehow influences health and well-being was a much stronger predictor of support for policy and a willingness to act than a correct knowledge about the human health effects of climate change. Therefore, for example, it was unimportant whether the Maltese public perceived climate change as influencing health due to an increase in the frequency of heat waves which would precipitate more cardio-respiratory events; or whether it incorrectly perceived climate change as a cause of cancer. As long as climate change was perceived as a threat to public health and general well-being, both locally and abroad, the public demonstrated a stronger willingness to act on the issue. This relationship still held strong in multi-variante analysis. The finding that the relationship between risk perception and a willingness to act was confounded by age and gender could imply that independently of risk perception, age and gender were also independent predictors of a willingness to act.

Despite the stronger link between risk perception and a support for policy, and willingness to act, correct knowledge about the human health effects of climate change was found to correlate very strongly with the perception that climate change negatively affects health and well-being. This may imply that people who are better informed about the human-health effects are more likely to have an image of climate change as a threat to public health. Conversely, it could also mean that people who perceive climate change as a threat to health are more likely to seek information about ways by which climate change affects health.

However, irrespective of the strong relationship between knowledge and perception, the study shows that it is the perception of climate change as a threat to health and well-being that drives behaviour and not knowledge. This is consistent with studies conducted in the USA and in Australia by Leiserowitz, Bulkeley and Bord, who have argued at length about the importance of imagery, affect and risk perception as a means of influencing behaviour and garnering support for policy, and about the inadequacy of only providing scientifically sound information to educate the public.1,11,12,22 This study in addition shows that providing knowledge about the human-health effects of climate change may help influence perceptions about climate change as a risk to human health and well-being, which will in turn drive behaviour in support of climate change mitigation.

Knowledge about the contributors of climate change was not found to relate significantly to risk perception, knowledge about the health effects of climate change, support for policy or willingness to act. It correlated significantly with the perception that people can die because of climate change, although negatively. This is rather surprising as some studies in the United States have identified knowledge about the causes of climate change as an independent predictor of support for policy.8,23 This study shows that among the Maltese public, knowledge about the contributors of climate change is unimportant as a motivator for behavioural change and support for policy. Unlike knowledge about the human health effects of climate change, knowledge about the contributors of climate change does not even correlate with risk perception. This may reflect the poor knowledge about the science of climate change among the Maltese public. However, it may also mean that knowledge about the science of climate change is unimportant in influencing the public’s perception of climate change as a social issue which requires action. Correct knowledge about the human-health effects of climate change, on the other hand, may help build an image of climate change as a threat to one’s health.

Since climate change is most likely to be the result of human behaviour and activity,6 a strategy to mitigate climate change should engage the public into becoming more energy efficient by using energy from renewable sources and shifting the use of carbon intensive to less carbon intensive fossil fuels such as gas. This implies that climate change mitigation policy should address lifestyle issues and facilitate climate-friendly choices such as choosing walking or cycling as a means of transport, public transport over private car use, car pooling and investing in sources of renewable energy such as solar water heaters or photovoltaic technology. For this to be possible, a number of barriers (real or perceived), which have been described in depth by Lorenzoni et al., must be addressed. These barriers include physical barriers (e.g. lack of showers on the workplace, unsafe roads for walking or cycling), systematic barriers (e.g. a lack of an efficient public-transport system) and financial barriers (e.g. capital outlay to buy energy efficient equipment). Nonetheless, literature shows that climate change lacks issue salience among the general public and this lack of issue salience has been repeatedly documented in the literature as being a major deterrent to engagement of the public in the climate change issue.

To the Maltese public, the perception that climate change may claim lives, cause disease, worsen standards of living and cause water shortages appears to be more important than knowledge of ‘how’ climate change will affect human health in predicting support for policy and a willingness to take measures to mitigate climate change. Framing climate change as a public health issue, in order to make climate change salient and to steer a movement towards a low carbon lifestyle, may prove more important and fundamental than educating and providing the public with information about the mechanisms by which climate change occurs and affects health. This does not mean that educating the public about climate change is unnecessary. Education and information provision are important but only secondary to presenting climate change as a public health issue.

The study encountered a number of limitations including those arising from a telephone survey methodology. This method effectively excluded ~16% of the Maltese public from participating in the survey mostly because these were untraceable by phone. Despite this, the respondent sample was ultimately very similar to the target population. Internal reliability testing of the indices also showed that it would have been desirable if some indices, especially the ‘Support for Policy index’, were stronger.

This study shows that policy makers should endeavour to change the face of climate change to one that includes health. Policy makers need to ensure that, apart from providing scientific information on climate change and bringing about the wider structural changes that are needed to facilitate lifestyle choices that mitigate climate change, the public must learn to appreciate that climate change is a public health issue which affects peoples’ health and well-being. Re-framing climate change as a threat to human health can be the principal catalyst for people to change their behaviour and increase their support for climate change mitigation (and adaptation) policies.

Conflicts of interest: None declared.

Key point

- To the Maltese public, the perception that climate change may claim lives, cause disease, worsen standards of living and cause water shortages appears to be more important than knowledge of ‘how’ climate change will affect human health, in predicting support for policy and a willingness to take measures to mitigate climate change.
References
12 Leiserowitz A. Climate change risk perceptions and policy preferences: the role of affect, imagery and values. Climatic Change 2006;77:45–72.

Appendix 1
The Appendix 1 shows some of the variables that were used in the questionnaire together with a description of how indices were constructed from their respective variables.

<table>
<thead>
<tr>
<th>Table A1 Knowledge about contributors of Climate Change Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question: I am going to mention a list of things which may or may not contribute to climate change. In Malta, which of the following contributes to climate change? (ticked boxes represent correct answers)</td>
</tr>
<tr>
<td>1 ‘Power stations’</td>
</tr>
<tr>
<td>2 ‘Cars’ and other transport vehicles</td>
</tr>
<tr>
<td>3 Aerosol ‘spray cans’</td>
</tr>
<tr>
<td>4 ‘Pesticides’</td>
</tr>
<tr>
<td>5 The production and consumption of ‘potable water’</td>
</tr>
<tr>
<td>6 The use of ‘electrical appliances’ such as freezers, televisions, air conditioners, Toasters</td>
</tr>
<tr>
<td>7 The ‘ozone hole’</td>
</tr>
<tr>
<td>8 ‘Mobile phones’</td>
</tr>
</tbody>
</table>

Construction of index: one point was awarded for a correct answer, one point was deducted for an incorrect answer, no points were awarded or deducted for ‘Don’t Know’ answers.

<table>
<thead>
<tr>
<th>Table A2 Risk Perception Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question: How likely do you think it is that each of the following will occur during the next 50 years due to climate change?</td>
</tr>
<tr>
<td>Very unlikely</td>
</tr>
<tr>
<td>(a) ‘World wide’, many people’s ‘standard of living’ will decrease due to climate change.</td>
</tr>
<tr>
<td>(b) ‘World wide’, ‘water shortages’ will occur due to climate change.</td>
</tr>
<tr>
<td>(c) Increased rates of ‘serious disease’ ‘world wide’ due to climate change.</td>
</tr>
<tr>
<td>(d) ‘You or your family’s’ ‘standard of living’ will decrease due to climate change.</td>
</tr>
<tr>
<td>(e) ‘Water shortages’ will occur ‘in Malta’ due to climate change.</td>
</tr>
<tr>
<td>(f) The chance of ‘you or your family’ getting a ‘serious disease’ will increase due to climate change.</td>
</tr>
</tbody>
</table>

Construction of index: the index is an average of the Likert scales of six items. ‘Don’t Know’ answers were not excluded from the average but given a mid-point score on the Likert scale of 2.5.
Table A3 Knowledge of health effects of Climate Change Index

Question: The following list contains items, some of which are affected by climate change while others are not. Which of the following is affected by climate change? (ticked boxes represent correct answers)

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
<th>No</th>
<th>Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Infectious diseases such as malaria</td>
<td>☑️</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2 Asthma and respiratory conditions</td>
<td>☑️</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>3 Allergies</td>
<td>☐</td>
<td>☑️</td>
<td>☐</td>
</tr>
<tr>
<td>4 Cardiovascular conditions</td>
<td>☑️</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>5 Infections which can cause diarrhoea</td>
<td>☑️</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>6 Skin cancer</td>
<td>☑️</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>7 Heat waves</td>
<td>☑️</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Construction of index: One point was awarded for a correct answer, one point was deducted for an incorrect answer, no points were awarded or deducted for 'Don't Know' answers.

Table A4 Support for Policy Index

Question: The Maltese government has an important role in ensuring that Malta reduces its impact on the climate. To what extent would you agree or disagree with the following measures?

<table>
<thead>
<tr>
<th>Measure</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
<th>Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Money is spent on 'clean energy projects' such as wind farms so that Malta satisfies part of its energy demands from the wind and the sun.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(b) Money is spent on 'more information' provision and 'better education' of the Maltese public about climate change.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(c) Money is spent to 'increase subsidies on things like solar panels'.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(d) ‘Petrol and diesel are taxed’ so that people use their cars less.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(e) The introduction of a ‘tax on those businesses and companies’ that use energy inefficiently. This could raise the cost of some products that we buy.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(f) Money is spent on a ‘public transport system to make it more efficient’ so that people use their cars less.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
</tbody>
</table>

Construction of index: the index is an average of the Likert scales of six items. ‘Don’t Know’ answers were not excluded from the average but given a mid-point score on the Likert scale of 2.5.

Table A5 Willingness to Act Index

Question: To what extent are you willing to do some of the following?

<table>
<thead>
<tr>
<th>Measure</th>
<th>Definitely not apply</th>
<th>Probably not apply</th>
<th>Probably yes</th>
<th>Definitely yes</th>
<th>Does not apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Buy more ‘energy-efficient’ light bulbs, appliances, or motor vehicles</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(b) Use ‘less air-conditioning’ during the Summer months</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(c) ‘Purchase solar panels’</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(d) ‘Car pool’ at least a couple of days a week</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(e) Use ‘public transport’ at least twice a week</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(f) ‘Walk or cycle’ to work, to go shopping or other places</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
</tbody>
</table>

Construction of index: The index is an average of the Likert scales of six items. ‘Don’t Know’ answers were not excluded from the average but given a mid-point score on the Likert scale of 2.5.

Table A6 Variable: people dying

(a) Do you think ‘people can die’ because of climate change? | Yes | No | Future | Don’t Know |
|----------------------------------------------------------|-----|----|--------|------------|
(b) If yes, worldwide, do you think that this is already happening, or is it something which will happen in the future? | Now | | | |

Two points were given for respondents who answered yes and now, one point was given for respondents who answered yes and in the future, zero points were given for respondents who answered no.

Table A7 Variable: people becoming ill

(a) Do you think ‘people can become ill’ because of climate change? | Yes | No | Future | Don’t Know |
|-------------------------------------------------------------|-----|----|--------|------------|
(b) If yes, worldwide, do you think that this is already happening, or is it something which will happen in the future? | Now | | | |

Two points were given for respondents who answered yes and now, one point was given for respondents who answered yes and in the future, zero points were given for respondents who answered no.
Karen Bloomquist, Luther, and the Challenge of Climate Justice

Cynthia Moe-Lobeda
Professor of Christian Ethics, School of Theology and Ministry, Seattle University

One does not often encounter such a stunning mixture of intellectual acumen and ability to read the signs of the times, pull diverse people into fruitful collaborative work, cross cultural and geographical boundaries with grace and apparent ease, wed social analysis to theological reflection, and do all that with a sense of humanity, humility and humor. Mix it all together and the result is Karen Bloomquist, a woman of the church, at home also in the academy and the world of social justice activism. Her art is applying the best of Christian intellectual, moral and liturgical traditions to bring the gospel to bear on issues of burning moral import in our world today.

What can one write to honor the person and work of Karen Bloomquist? I propose exploring and using her own wisdom to further a purpose to which she dedicates her life: promoting justice in the world through the life of the church. Herein I do so by identifying four defining threads woven throughout Karen’s work that are grounded in her heritage as a Lutheran theologian and ethicist, and then applying those threads to the central question that she poses in one of her recent projects for The Lutheran World Federation. It is God, Creation, and Climate Change, and the series of gatherings culminating in that volume. Karen poses perhaps the paramount question facing the church of our day in that volume, “How do we participate in the redemption of creation to which Scripture testifies, and embody hope for the future rather than succumbing to despair?”

Karen is an eminently Lutheran theologian. This statement bears many connotations. Here, I mean that she is profoundly shaped by central aspects of Martin Luther’s theological methodology and claims. In this essay, I identify four of them as gifts that a Luther-an take on Lutheran traditions might offer to the quest for answers to the aforementioned question. We consider each of the four in sequence, noting its roots in Luther and its presence in Bloomquist’s work, and then—to varying degrees—building constructively on it in response to the question at hand.

Theology arises from the life of the church… Confronts what obscures the gospel?

Luther’s genius was, in part, his keen ability to hone in on whatever human construct was obscuring the gospel in his time and place. He cut to the quick of what held people in bondage, preventing them from opening their arms to receive


2. Karen’s recent work with the LWF, a four-volume series titled Theology in the Life of the Church, exemplifies this commitment.

Meta-Exploration: Description of Method

Situate the question

Re-state the method based on the question
and trust God's love, and to live in accord with it. If this meant unmasking evil that parades as good, then such was the work of theology. He was convinced that theology worthy of that name “calls a thing what it actually is” even if doing so is dangerous or socially costly. “A theologian of glory calls evil good and good evil. A theologian of the cross calls the thing what it actually is.”

Luther was also a master of the dialectic between theological continuity and reform. He claimed ancient Christian truths, holding them up in evangelical defiance against religious beliefs and practices that blocked people's trust in God's love. His God was a living God who did not say the same thing—or call humans to say the same thing—in every context. Listening to the Spirit of this God rendered radical and controversial reform in theology, church practice and ways of life.

Contemporary theology, then, in the mode of Martin Luther, arises from people's struggles to trust the boundless grace of the God revealed in Jesus Christ and to live in accord with it in response to their contextual circumstances. A particular focus of Lutheran theological inquiry will be to identify, disclose, and confront dominant institutions, beliefs, or social forces that obscure the gospel, this being a crucial aspect of proclamation. Where evil wears the guise of good, theology will “call a thing what it actually is,” freeing people from deception and distraction that impede their hearing of the word. The tools of that evangelical defiance are traditional faith claims, brought into each new context to assist the church in seeing what God is doing in that context so that the church, “empowered by the

Holy Spirit,” may fulfill its call to “bear witness to God's creative, redeeming, and sanctifying activity in the world...to participate in God's mission....” This entails a necessary and fruitful tension between consistency with historical interpretations of doctrines and “re-forming” them in order that their truth may be heard in each new time and place.

However, to claim that theology arises from the life and struggles of the church begs a question, so often ignored until recent decades: which parts of the church and which people within it? The North Atlantic church is slowly realizing that limiting theological interpretation to the lenses of the Global North has diminished our capacity to hear and heed the word of God, and hence to participate in God's work on earth. In this movement, Karen has been a moving force. She has pushed the Lutheran church worldwide to heed especially the voices of people historically overlooked in the shaping of Lutheran theology. In 1998, she called for Lutheran Christian traditions to be interpreted, articulated and shaped by the perspectives of people who traditionally have been “othered” by those at the center of power and privilege in society and in formal theology. She then proceeded to enact that call through her work with the LWF.

Theology and the work of the church, thus understood, entail vast expanses of moral ambiguity. Evil and good are intertwined. With vexing frequency, it is unclear which aspects of “a thing” are good and which are evil.

Karen's work has unfolded along these lines. These tendencies inherited from Luther characterize her contributions as director of the LWF's Department of Theology and Studies and before that as Director of Studies for the Evangelical Lutheran

4. Ibid.

5. Constitutions, Bylaws, and Continuing Resolutions of the Evangelical Lutheran Church in America”, 4.01-02.
Church in America. Her work reveals her steadfast commitment to theology arising from the life of the church—as a global communion—in order to serve the church and the world. She draws upon ancient Christian faith claims, holding them up to a double hermeneutic of critique and profound trust in order to bear fruit in the face of vexing current struggles. Persistently, she prioritizes the authority of voices from the Global South. With keen insight, she poses questions that will free people individually and as church from social forces and arrangements that would blind them to the profound power of God’s gracious love. And she insists that what it means to embody God’s astounding, confronting, healing, and liberating love in contexts of moral ambiguity and complexity is often more a question than a certainty.

Karen’s work related to climate change exemplifies these Lutheran proclivities. Global climate change poses an unprecedented and dire threat to the lives and well-being of many people in the Global South. Indicators of that threat are too many to name here. The Intergovernmental Panel on Climate Change (IPCC) predicts 150 million environmental refugees by the year 2050. Rising sea levels will have dire consequences for low-lying islands in the Pacific. Many of Asia’s most densely populated areas and productive lands are on or near coastal areas under risk of flooding.

In other words, the millions of environmental refugees will disproportionately be people who are economically impoverished and not white. So, too, the people who starve as climate change diminishes crop yields of rice, wheat, corn, beans, and potatoes—staples for millions of people and major food crops in Africa....rice may disappear because of higher temperatures in the tropics.”

6. Intergovernmental Panel on Climate

are inextricably linked with climate.”

Drought and its impact on food production “especially in semi-arid and subhumid region” in particular, is life threatening to those already on the margins of power and privilege the world over. In short, people

United States society generally accepts as a “good life” patterns of consumption, production and acquisition that threaten the earth’s capacity to sustain life as we know it.

who are colored white and have relative economic wealth stand a greater chance of protection from the impacts of climate change and toxic waste than do many of the earth’s people.

The terrible irony for Christians in the United States is that we are primary causes of this deadly disaster, while our “neighbors” in impoverished parts of the

Change, IPCC Fourth Assessment Report: Climate Change 2007: Working Group II: Impacts, Adaption and Vulnerability, 10.2.2.3 (505).

7. Ibid., 10.2.1.1. (495).

8. Ibid.
world will “die first.” United States society generally accepts as a “good life” patterns of consumption, production and acquisition that threaten the earth’s capacity to sustain life as we know it. In general—but not exclusively—we demonstrate effective allegiance to ways of living that endanger the earth’s life-systems, and the lives of global “neighbors” far less responsible for climate change. Tactically agreeing to continue with life as we know it, we acquiesce to destruction parading as good despite the consequences.

This reality is, I contend, a monumental obstacle to the proclamation and hearing of the gospel today. How do “economically privileged” Christians in the United States speak of God’s love to and with people whose lives we are unrepentantly destroying? What does it mean to be in communion with someone whose child we are killing? How do we proclaim the word among ourselves knowing that we are killing and doing little to stop it?

True to form, Karen Bloomquist recognized this situation as a central struggle arising from the life of the church, especially in the Global South. Seeing this reality as contrary to the message of God’s love, she called upon voices from the Global South and North to guide the church in responding faithfully to it. Moreover, she insists that climate change and our (the church of the Global North’s) responsibility for it must be addressed theologically.

The people of God are to address reality theologically

Climate change presents theological challenges never before encountered. Consider four of them. One pertains to the claim held in common by the monotheistic traditions, that God creates the earth and its bounty. The first great treatise against “heresy” was against the very notion that the earth itself is not created by the God of all that is, the God of Jesus Christ. In the late second century, Irenaeus of Lyons set out to refute the claim, prevalent in some branches of the emerging church, that the God of Jesus Christ, and revealed in Jesus Christ, was not the God who had created the heavens and the earth. Between that creator and the true high God, asserted this “heresy,” was a vast, unbridgeable separation. The creator god was a lesser god, a fallen god, a demiurge. “Orthodox” Christianity—theological perspectives and practices considered “true” in relationship to stands deemed incompatible with that truth—emerged in response to this very claim. Irenaeus coined the term gnostikoi, those capable of learning, to identify various schools making this claim, some of whom also claimed certain other perspectives, including docetism (Christ appeared to have been human with a human body and to have died on the cross); a tri-fold hierarchical theological anthropology in which humans fell into the classes of pneumatic (spiritual), psychic (ensouled), or hylic (material); and a spiritualized soteriology that denied the resurrection of the body and assured salvation for the pneumatics alone. Groups labeled “gnostic” were far too varied to be lumped together. The common thread it seems was rejecting the creator God of the Hebrew Scriptures as the high god of Jesus Christ and of all creation. This is all to say


10. Note that neither orthodox Christianity nor the strands labeled gnostic and deemed heretical were univocal...both were diverse and highly varied. Those labeled heresy were in fact “survivals of opinions which, prior to the declaration of heresy, had been fully at home and widely held within the mainstream Christian community.” Dennis Minns, Irenaeus of Lyons, 11.
that, from the earliest times, the church has held that the God revealed in Jesus Christ created and creates the cosmos.

Indeed, God created a planet that spawsns and supports life with a complexity and generosity beyond human ken. Fundamental to Christian and Jewish faith is the claim that it is “good” (Gen 1). According to the first creation story in Genesis, “God saw that it was good.” The Hebrew tob, while often translated as “good,” also means “life furthering.” It is that very “tob,” life-generating capacity that we are undoing, uncreating. We—or rather, some of us—have become the “uncreators.” Herein lies an unprecedented theological challenge. Never before has humankind played this role.

A second theological dilemma arises from the affirmation, central to Christian faith, that God reveals Godself. Christian traditions hold not only that God created and is creating a life regenerating and good creation, but also that God reveals Godself in that creation; it is the “first book of revelation.” Humankind is destroying central features of the “first book of revelation.” If to do and be as God would have us, we must receive God’s self-revelation, then God’s self-revelation is necessary for the life of faith. What do we make of destroying its first source?

Thirdly, Christians claim that human beings are the creatures created “in the image of God.” However, as Catholic moral theologian, Dan Maguire, asserts, climate change if unchecked renders us “an endangered species.” How do we make sense of a human trajectory now aimed at destroying the creatures crafted “in the image of God”?

These three unprecedented theological challenges are accompanied by a fourth that is far more familiar. Two millennia of Christians and the Hebrew people before them claimed that God calls God’s people to receive God’s love, and then “to love the Lord your God with all your heart, with all your soul, and with all your strength” (Deut 6:5); and “to love your neighbour as yourself” (Lev 19:18). This is our lifework, to be empowered by God to receive God’s love, and to live that justice making mysterious and marvelous love into the world. Life was breathed into us for a purpose. We are here to let God work through us, in us, and among us to bring healing from all forms of sin and brokenness that would thwart God’s gift of abundant life for all. We are to participate in what God is doing on earth. This, according to one widespread understanding of the Christian story, is the human vocation. In a particular way, it is the vocation of the community of communities spanning centuries, continents and cultures that understands itself to be Christ’s body on earth.11

Christian academic and ecclesial circles, for the most part, affirm that “love” is, from a biblical perspective, the primary moral norm for human life.12 Loving “neighbour” as self—or loving neighbour as

11. This theological moral anthropology is contestable, as are all theological claims. Here is not the place to argue it. Suffice it to say that this understanding of human moral being and vocation has been held by many throughout the two millennia of Christian history, has been expressed in multiple ways, and is widely accepted today.

12. The norm, of course, is derived (in large part, but not exclusively) from the statement attributed to Jesus by the authors of Matthew and Mark, and drawn by Jesus from Torah: “You shall love your neighbor as yourself” (Matt 22:40; Mark 12:31). According to the author of Matthew, Jesus goes on to declare that “everything in the law and the prophets hangs on” this commandment and the commandment to love God (Matt 22:40). Mark’s record of Jesus words is similar: “There is no other commandment greater than these” (Mark 12:31). According to Paul, “the whole law is summed up in love” (Rom 13:10).
God loves—along with loving God, commonly is seen as the essence of morality. “It is the biblical view that being moral is loving well.”13 “In fact, the whole thrust of biblical religion is toward the recovery of the broken human capacity to love.”14

With this claim, all consensus and certainty cease; what “love” implies for contemporary life is a matter of debate. The moral weight of neighbor-love depends on what is meant by the term.15

Countless volumes have explored that question. Here we note just two characteristics of love as a biblical norm. Love implies active commitment to the well-being of who or what is loved. And, where systemic injustice causes unnecessary suffering, seeking the well-being or good of who or what is loved inherently entails seeking to undo injustice. That is, the norm of neighbor-love includes the norm of justice. Because doing justice necessarily means active engagement in challenging social structures that enable injustice, neighbor-love implies that engagement.

Where systemic injustice exists, neighbor-love entails seeing that injustice, unmasking it; resisting it; envisioning alternatives more resonant with faith; and living toward them.16

The implication is shaking: If Christians fail to repent of the climate injustice that we are committing against neighbour, are we not defying the call to love? Can we claim to be serving the well-being of people in need by contributing to relief and development efforts both here and abroad, if we continue to live in ways that will flood some of those people out of their homelands or destroy their water, fish, or grain supplies? Multitudes of people will die as a result of climate change. Can we claim to be one in Christ with the people we are killing?

Karen Bloomquist, reflecting her roots in Martin Luther, urges the church to address reality theologically. Here we have considered four theological challenges posed for people of the Global North by the contemporary reality of climate change. They are the problems of becoming “uncreators,” destroying central features of God’s “first book of revelation,” endangering the species that claims to be the image of God, and transgressing the call to love. These are manifestations of structural sin.

**Hope and moral authority lie in God’s promises**

Karen Bloomquist prods the church with

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15. Volumes could be written about the different and conflicting construals of neighbor-love and its moral implications throughout the histories of Christian and Jewish traditions.

16. These four dimensions of seeking justice cohere with Walter Brueggemann’s articulation of “doing justice” according to the Hebrew Scriptures. See Walter Brueggemann, “Voices of the Night—Against Justice,” chap. in Walter Brueggemann, Thomas H. Groome, and Sharon Parks, *To Act Justly, Love Tenderly, Walk Humbly* (New York and Mahwah: Paulist Press, 1986). He writes: Doing justice implies “relentless critique of injustice” (7); “envisions a changed social system” (10); and works toward “nothing less than the dismantling of the presently known world for the sake of an alternative world not yet embodied” (11). More specifically, Brueggemann argues, doing justice, biblically understood, includes “sorting out what belongs to whom and returning it to them. Such an understanding implies that there is a right distribution of goods and access to the sources of life. There are certain entitlements that cannot be mocked” (5).
and its theologies to face and take seriously realities that—if honestly faced—defy hope. Hope and a sense of moral agency are likely casualties if one were to take seriously climate change and its probable consequences, especially if one simultaneously faces squarely the power of contemporary empire and the forces lined up against those who challenge it. In theological terms, it is a matter of facing up not only to the pernicious presence of sin—which seems rather easy for Lutherans—but to the pervasive presence and demonic power of “structural sin.”

In part because our hope and moral agency might be dashed, we evade admitting in the depths of our beings the kinds of ecological and human brutality that our lives have helped to cause. Needed, if we are to do so, are a sense of hope and a will to act that can withstand the awful message of the earth’s distress and countless people who have died and will die as a consequence of the ways of life we assume to be normal. Herein lies, I believe, an incredible gift of Lutheran theology that is consistently offered by Karen in her work. Our hope and power to act, she insists, rest neither in logical likelihood of success nor in our own ability always to act justly; hope rests in “what God has done, is doing, and promises to bring about.” This theological claim—also a faith claim—quietly pervades her work. “Our hope is in the justice that God will bring about.”

The Latin root of the English word, “authority” (auctor), means inventor, creator, or that which authorizes, grants power, brings something about, makes something happen. That which brings something about or makes it happen—our fundamental moral authority—is that which grants hope and a sense of moral power.

The church is called to confess in word and deed who God is, what God has done and is doing, and what God promises to bring about. The church is called to discern where God is active in the world, working to fulfill the promise of abundant life for all of creation, and to participate in that work. This is what constitutes the moral life of the church. In her writing, Karen Bloomquist consistently reminds that our source of hope and power to heed our call—that is, our moral authority—is indeed “what God has done, is doing, and promises to bring about.”

Some warn that utter trust in God to fulfill God’s promise grants freedom to desist from human efforts toward justice,
including climate justice. To the contrary, this trust grants quite the opposite: freedom to engage fully in those efforts. God, as understood by Luther and also by Karen Bloomquist, works through human beings to fulfill God’s promise.

**God’s abiding power and presence working through human relationships and all of creation**

I was confronted recently by a dear friend who heard me responding to a question of whether or not I had hope for humankind given the realities of ecological devastation we now face. I asserted hope in knowing that “the end of the story” (whatever it might look like) was in “God’s hands.” “But, Cynthia,” responded this friend, “you must emphasize not only that God’s promise is trustworthy but also that God is at work in the world to fulfill those ends.” Therein too lies our hope and moral power.

**Martin Luther, Lutherans readily assert, was an incarnational theologian.** The implications are manifold. One is that God is at work in the world, using fallible and finite earthlings to bring about God’s purposes. We are, Luther asserts, God’s hands and feet. In sermon after sermon, he proclaims the power of the Holy Spirit, working in the lives of believers, enabling us to serve the common good, despite our inevitable shortcomings in doing so. At times, Luther emphasizes, God is working not only in human creatures but also in other creatures and elements.

**Karen Bloomquist is an incarnational theologian in much the same way.** God’s power and presence working through the communion of believers and all of creation is an abiding theme in her work. It is explicit in her writing and implicit in her unavering commitment to bring the call to “love neighbor as self” and the Spirit’s presence to bear on the “defining realities and struggles of our time.”

**In closing**

In her recent work, Karen Bloomquist has called the church to face theologically and practically an unprecedented moral challenge confronting humankind, and in particular the Global North. We have constructed ways of living that threaten the earth’s capacity to be what God created: a life-furthering world. We are “uncreating.” In this context, Bloomquist asks, How is the church to “participate in the redemption of all creation to which Scripture testifies, and embody hope for the future rather than succumbing to despair”? The question warrants the church’s full attention. Valid responses will emerge through the “communal” work of the *communio*, its many parts informing, challenging, and nurturing each other. As one small contribution to that multivalent and multivocal effort, here we have considered four defining aspects of Martin Luther’s theological method and claims that also are central in Karen Bloomquist’s work.

Together, these four shed light on what the church may offer to the “great work” of humankind today: to forge sustainable earth-human relations that are marked by compassion and justice within and among human societies. May the church be thankful that God called and equipped Karen Bloomquist to help the it participate in God’s work on this splendid and suffering planetary home. May we be thankful, too, that she has heeded that call.

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20. Ibid.

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There has been some modest progress over the past 12 months in the international negotiations over climate change, but there is still an insufficient understanding of the urgency with which the science indicates we should be dealing with this challenge. We have seen the intense build-up to the 15th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), COP15, in Copenhagen in December 2009 and the deep disappointment in the outcome; the mid-term elections in the United States of November 2010, which have essentially removed the possibility of strong federal climate legislation for the foreseeable future; and the publication in October 2010 of the outline of China’s 12th five-year plan (for the period 2011-15), which appears to set a clear route towards low-carbon growth. Now that COP16, the UNFCCC conference following Copenhagen, has taken place in Cancún, Mexico—constructive both in atmosphere and outcome—where do we stand on prospects for international and national action on climate change?

Assault on Climate Science

The attack on climate science has in many ways been scurrilous and dishonest. It has worked in large part in three ways: by deliberately confusing the uncertainty over the potential magnitude of climate change with uncertainty over the presence of the phenomenon; by grossly magnifying the significance of a few errors in a report of the Intergovernmental Panel on Climate Change (IPCC); and by occasional innuendo and character assassination. First, climate change is all about risk. We cannot predict exactly the climate consequences of any particular emissions path. But science has shown that the greenhouse effect is real and that the risks are potentially very large. In doing so, it builds upon sound theory and compelling evidence, beginning with the work of the great French physicist and mathematician Joseph Fourier in the 1820s. The basic physics and chemistry of how greenhouse gases prevent the escape of energy...
Many models, emissions are growing faster than we thought, and many impacts, including the melting of Arctic sea ice and ice sheets and damages to ecosystems, are happening faster than we thought.

**Economic Duress and Opportunity**

The world economic slow-down and recession has no doubt diverted attention away from climate change in some rich countries, while temporarily slowing the growth of emissions in those countries. At a time of economic crisis, if you ask citizens about their priorities, they are very likely to put the crisis first. But the slow-down should have been seen, and in some countries has been seen, as an opportunity.

The time to invest in change is when economic activity is slower and the competition for natural and human resources is less. The best time to insulate homes, factories, and offices is when there are unemployed builders. The best way to respond to a crisis for growth is to lay the foundations for sound sustainable growth in the activities that have a bright future: in other words, to invest in the low-carbon economy. That has been the path of Korea and China, and they and other countries that recognize the way forward will lead the “green race,” which has already begun. Those that deliberately opt out may find their exports taxed as “dirty” a decade or so from now.

The crisis has seen the G20 take over from the G8 as the world’s principal economic forum. The centrality of the main emerging market countries (including Brazil, Mexico, China, India, and South Africa) to the G20 is a great advance on the G8 structure. The G20 includes all of the countries (Brazil, India, China, South Africa, the United States) that authored
the Copenhagen Accord. At the meeting of the G20 in Korea in November 2010, climate issues, including climate finance, were brought to the table. This in itself was an advance as hitherto some countries, including China and Brazil, had argued that the UNFCCC was the only appropriate forum. I hope the G20 will increasingly take climate change into account; it is a fundamentally economic and political policy issue. Both action and inaction have profound implications across the global economy. Primarily an economic forum, at least at the moment, the G20 can advance the work on climate finance. Indeed it has asked its ministers of finance to do so by taking forward a report prepared by an advisory group on climate change financing, of which I was a member, established by the UN Secretary General after COP15 in Copenhagen.

At the G20 in Korea, we also saw the initiative of the Business Summit for CEOs and chairs of major companies, for which I moderated sessions focusing on the central theme of “green growth.” In many ways, the business world is ahead of government on action to manage the risks of climate change. Businesses recognize the scale of change required in the future by an ever-tightening carbon constraint. They also see the opportunities that will be presented by the transition to the low-carbon economy, and the new energy-industrial revolution has begun. However, businesses also seek credible government policies at the national and international levels, in order to ensure that this revolution is efficient, rapid, and sufficient in scale. I should note that the language of the new energy-industrial revolution is more appropriate in conveying the scale and dynamics of change than the somewhat cuddly “green growth.” We have to divide global emissions per unit of output by around eight in the next 40 years—surely an industrial revolution by anyone’s standards, and one likely to be very attractive.

**Action and Promise**

Among the good news of the last two years are the rapid pace of technological development and the growing recognition of the potential of this new energy-industrial revolution. Everywhere we look, be it agriculture, building, transport, new materials, renewables, or smart grids, the ideas are coming. Not only do we see new ideas, we also see action. Who would have thought a few years ago that General Motors would make an electric vehicle, that Texas would be a leader in wind farms, that China would be the biggest manufacturer of solar photovoltaic panels, or that algae would begin to look promising as a new source of fuel? Not all ideas will work, as with any process of creation and innovation. But there are so many new ideas now that we can be confident that many will.

An understanding of the history of industrial revolutions should spur the change. That history tells us that they bring two, three, or more decades of innovative and creative growth and investment, as Carlota Perez describes in her excellent book *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*. That history also shows that investment flows to the pioneers of the revolutions. More and more companies and countries are recognizing the opportunities from the new industrial revolution and the risks in being left behind or excluded from markets.

The positions of many countries have shifted over the last two years, but in different ways. Political change in the United States looks to have stymied federal action, at least on cap-and-trade. But China has moved in a particularly decisive fashion to embrace low-carbon growth, notably in its refliationary package of 2008-2009 but also, and more importantly, in its outline for the 12th Five-Year Plan. This plan sets strong targets, and China has often achieved more than the targets it has set in previous Five-Year Plans. This plan will likely be no exception.

There are two headline themes in the 12th Five-Year Plan: the rise of the Chinese consumer and the move towards low-carbon growth. In the 12th Plan outline, there are seven priority sectors, “the magic seven,” which are largely low-carbon, three of them explicitly so (energy saving, new energy, clean vehicles) and the others, including new materials and high-end manufacturing, involving strong movements in...
that direction. These seven sectors are slated to grow from 3 to 15 percent of the economy in the next decade. Given that an overall growth rate of 7 to 8 percent is likely to be planned and achieved, that will be a phenomenal expansion, involving hundreds of billions of dollars per annum of investment in those sectors during the decade. The learning in this period will be immense.

We are likely to see Europe continue its commitment to action on climate change and there is intense discussion about the possibility of raising targets for emissions reductions between 1990 and 2020 from 20 to 30 percent. It is important that any hesitation in Europe associated with the economic and financial crises is overcome and that its leadership in this area is rekindled. There is a real possibility that we shall see major advances in the new energy industrial revolution in both China and Europe in this decade. And we should also remember that many states, cities, and firms in the United States are already in the vanguard of the new industrial revolution. California, for example, is the hotbed of “clean invention,” and in November 2010 an attempt (Proposition 23) to undermine climate legislation was defeated and a climate-aware governor, Jerry Brown, was elected.

However, the arguments for ambitious climate change mitigation and for embracing the new energy-industrial revolution have not yet won, and remain the subject of vigorous discussion and battle around the world. In a recession there are those in particular who argue, erroneously as I have suggested, that the issue should be addressed “not now but later.” And there are powerful hydrocarbon vested interests. The nay-sayers will try to hide behind the flimsy and ludicrous cloak of science denial, often with a spurious pretence of simply “questioning.” There is little analytical or other virtue in refusing to recognize powerful evidence or in trying to imply that the presence of uncertainty allows us to confidently assume minimal damage from unmanaged climate change. The argument must be won with careful quantitative evidence and analyses of both the risks and potential benefits of the new energy-industrial revolution. Investments in the new ways of doing things will have to be large. The price of electricity and energy will rise for a while. The politics will not be easy, but we must show that the transition to the new economy will be dynamic and creative. It is the real growth story. The story of low-carbon growth, when achieved, will be more energy-secure, cleaner, quieter, safer, and more bio-diverse. The power of example will be crucially important: from firms, from consumers, and from countries. The examples are beginning to come.

Copenhagen: Discord and Disappointment

Cooperation across countries will be vital too, and the UNFCCC meeting in Copenhagen in December 2009 was a crucial missed opportunity to foster international agreement. The Copenhagen Accord, which emerged from the last days of COP15, was much less substantial than many of us would have hoped as an outcome of that crucial conference, and was much less than could have been achieved if the participants had carried themselves better, even allowing for all the constraints of the country-by-country politics. First, much of the developing world feared an “ambush,” in the sense that they would be presented with a draft agreement that had already been “cooked,” mostly by rich countries. Given that such a draft was indeed being prepared, their anxieties were understandable. It looked to them like the last vestiges of G8 power. Second, Europe presented a very fractured front—there was no clear and single European Union or European Commission leadership, and a number of European heads of government were seeking their own special role as “hero of Copenhagen.” Third, there was aggression and hostility to China, an approach that was bound to backfire. Fourth, there was division in the Indian delegation that prevented it from playing a harmonizing role, which its low emissions per capita, large population, and high diplomatic skills might have warranted. The resulting Accord was only “noted” by the UNFCCC. Copenhagen was cold, chaotic, and quarrelsome; indeed, the acrimony that it generated has been a damaging legacy of that event.

The Potential of the Accord

But the Accord is not empty, and even though it was a fragile platform for going forward, it has proved less fragile than we feared upon leaving Copenhagen in December 2009. It has twelve paragraphs and three pages and was crafted at a presidential and prime ministerial level, put together by a small group of key countries: Brazil, China, India, South Africa, and the United States. Its main points have now been incorporated into the UNFCCC process through the agreements that were reached in Cancún.

The Accord touched on the key issues of finance, forestry, technology, and measurement, although with different degrees of specificity. On climate objectives, it calls for a limit on average global temperature increases to no more than two degrees Celsius (relative to mid-19th century levels, the standard benchmark)—not only a clear objective, but also founded on a notion, suggested by scientists, of dangerous climate change. In practice, this objective means reducing annual emissions of greenhouse gases over the coming de-
cades such that they follow a path that limits the chances of exceeding the crucial two degrees Centigrade temperature increase to no more than 50 percent. Global average temperature is already about 0.8 degrees Centigrade above mid-19th century levels. Thus the two degrees goal has obvious implications for emissions paths, although the magnitude of the emissions reductions required has not been sufficiently recognized. The Accord also set a target of climate finance flows from developed to developing countries of US$100 billion per annum by 2020.

Of particular significance, it set a deadline of January 31, 2010 for all countries to submit plans for 2020 emissions. By the end of 2010, around 140 countries had associated themselves with the Accord and emissions plans for 2020 had been received from all major emitters. The submitted plans cover more than 85 percent of global emissions. If we take the higher end for reductions whose ranges are given in those plans, and if those plans are delivered, then overall emissions in 2020 would be similar to those in 2010. We would have stopped global emissions from rising, according to an international review group (including my colleagues at the Grantham Research Institute) whose conclusions were published by the UN Environment Program shortly before the summit in Cancún. No doubt these are big “ifs,” but that would represent real progress relative to business-as-usual (BAU)—delivery on the Accord would give global total emissions of around 48 or 49 billion metric tons of carbon-dioxide-equivalent (CO2e) per annum relative to BAU of around 56 billion metric tons. This would still leave the world four or five billion metric tons above the approximately 44 billion metric tons necessary for a two degree path. Nevertheless, reductions of approximately eight billion metric tons compared with the 12 billion necessary would be a great deal better than nothing. We should recognize that many of these country commitments emerged in the build-up to Copenhagen as a result of the ambition to achieve an agreement there.

During 2010, we also saw significant progress on measures and financing to cut deforestation, including a plan for a two-year moratorium on deforestation in Indonesia, ambitious plans from Brazil, including an 80 percent reduction in annual deforestation in the Amazon by 2016, and a few billion dollars on the table to assist in the financing of forest protection.

In early 2010, the UN Secretary General, Ban Ki-moon, established a high-level advisory group on climate change financing, which reported on November 5 with specific ideas and analysis on how the US$100 billion per annum by 2020 in financing could be generated, combining mostly carbon-related public revenues and measures to promote substantial private sector flows. Smaller but significant progress between Copenhagen and Cancún was made on other dimensions including technology and measurement. Thus, the meeting in Copenhagen in December 2009, while a serious setback, produced a modest platform from which modest progress has been made.

Progress in Cancún

We saw consolidation and small advances on Copenhagen in Cancún: reasonably broad acceptance of the principles and numbers outlined in the Copenhagen Accord and associated plans for emissions in 2020. Essentially, the Copenhagen Accord, prepared by only a few countries and only noted in Copenhagen, became part of the UNFCCC in Cancún. Further, there was recognition that there must be progress on the key building blocks of finance, forests, technology, and measurement, and specific UNFCCC processes were put in place to take these issues forward, including the establishment of a “Green Fund” and agreement on Reduction in Emissions from Deforestation and Degradation, including reforestation and afforestation (REDD+). It is increasingly understood that progress is so important that it cannot be blocked by small groups of small countries that are determined to be difficult. The Mexican presidency of the COP16 meeting drew on the lessons of the problems of Copenhagen. Many participants had been shocked by the often poor behavior at Copenhagen: there was a much stronger multilateral spirit and awareness of the importance of the dangers of delay from the inexorable flow of greenhouse gas emissions that ratchets up concentrations in the atmosphere.

Any agreement should be based on an inclusive understanding—we all have so much to gain from action, and so much to lose from inaction. But what really matters is the agreement and understanding of the big emitters. Progress will accelerate as experience accumulates and we can see the attractiveness of the new route to growth, and as mutual
confidence and credibility grows. It is this mutual confidence that is fundamental, rather than the formalities of a “legally binding” treaty. Of course, mutual confidence can underpin such a treaty and a treaty can boost mutual confidence. But basically what we have to create is the confidence in progress and that action will be large-scale. Countries will want to be reasonably confident they are part of a bigger story and that the markets for new technologies and their products will be strong. For example, the objectives of China’s 12th five-year plan are credible given the country’s record of delivery, and are clear and legal commitments to the Chinese people, but they are not part of an international legally binding treaty. The European Union’s climate legislation would also be part of any assessment of Europe’s credibility.

A world where global discussions of economics and growth take place in the G20 gives us some hope. This is a world that is not... dominated by a single country. It is a world where leadership does not necessarily have to come from the largest economy."

Challenges Ahead
There are some who argue that international cooperation is impossible and that everything can be done without much active policy, that it will be driven by private decisions and technological advance without unambiguous policy signals—in other words, that top-down is unachievable, but bottom-up will do the trick. That is a basic misunderstanding of economics and science. It ignores the fact that the problem arises from a massive market failure in the absence of a price for emissions, and that the science indicates a very powerful reason for urgency. And it ignores the counsel of those who will lead the investment process, the CEOs and chairs of major companies, who ask for clear, strong, and internationally consistent policies. “Top-down” and “bottom-up” support each other: to pretend that we can do without one or the other is just confusion.

The challenge will be to move forward at a pace which allows us to reduce emissions fast enough to make the risks manageable. We cannot yet be confident that we will do that, but we can be confident that we can see how it can be done and that we will learn rapidly along the way. We can see that it is a very attractive route to follow, in addition to providing the fundamental reduction in risk that we seek. A new energy industrial revolution can bring two or three decades of innovation, creativity, and growth. Low-carbon growth will be more energy-secure, cleaner, quieter, safer, and more biodiverse. We have to continue making the arguments and building on the examples. I am optimistic there is an exciting way forward that can allow us to respond effectively to the two defining challenges of our century: managing climate change and overcoming poverty. However, I do not know whether we will be collectively sensible enough to follow that route.

In the meantime, as we make these arguments, there is surely no doubt about the urgency required for adaptation. Global temperature is now 0.8 degrees Celsius higher than its mid-19th century level, and nine of the ten warmest years on record have all occurred since 2000. The risks of extreme weather events, such as heat waves, have increased, and sea levels are rising. Poor people will be hit earliest and hardest as they strive for development in a more hostile climate and struggle to defend themselves against catastrophic climate events. All of us, particularly those in rich countries, should recognize the responsibility to support investment and new technologies, and, inevitably, to accept and manage the movement of people that will be a central element in the process of adaptation. In doing so, we will see that development, mitigation, and adaptation are inextricably intertwined wherever we look, be it in agriculture, infrastructure, construction, transport, energy, and, of great importance, forest protection.

One reason why progress was made in Cancún was a growing understanding of the attractions of transition to the low-carbon economy and of the low-carbon economy itself. There was also understanding of the close complement between top-down and bottom-up processes: each process needs the other. There was a deep desire to avoid the acrimony of Copenhagen and work in a collaborative way on a truly global problem. As illustrated at the World Economic Forum in Davos, Switzerland in January 2011, the efforts are being led in many countries by far-sighted business people who not only recognize that the future is low-carbon, but are also acting on that assumption. There is still a long way to go before a strong global agreement or understanding can be established, but the world is moving in that direction.