Science and the International Politics of Climate Change

by Idean Salehyan and Cullen S. Hendrix

World leaders met in December of 2009 in Copenhagen, Denmark to discuss ways to mitigate climate change through meaningful cuts to greenhouse gas emissions. Leading up to the conference, there was a high degree of scientific consensus that climate change is a very real phenomenon, that human activity contributes to the process, and unless significant steps are taken to reduce the amount of carbon in the atmosphere the impact on the environment could be catastrophic. In addition, there was a growing recognition that some degree of climate change is inevitable, and so, humanity must devise strategies to adapt to this reality. Armed with evidence compiled by the Intergovernmental Panel on Climate Change (IPCC), scientists from a wide array of disciplines constituted a strong epistemic community,[1]—a network of experts who share a common view on a particular issue—and urged policymakers to take bold action at Copenhagen. Specifically, scientists and environmental activists called for limiting the level of greenhouse gasses in the atmosphere to below approximately 450 parts per million, in order to keep average global temperatures from rising more than 2ºC.[2]

World leaders at Copenhagen underscored the importance of the issue. In his speech at the conference, US President Barack Obama declared, "unchecked, climate change will pose unacceptable risks to our security, our economies, and our planet."[3] Noting the high degree of scientific consensus, former British Prime Minister Tony Blair remarked, "what is beyond debate, however, is that there is a huge amount of scientific support for the view that the climate is changing as a result of human activity."[4] Even developing countries agreed in principle that something must be done to curb climate change. As India's environmental minister, Jairam Ramesh remarked, "India is already and will be even more profoundly impacted by climate change…We have a tremendous obligation to our own people by way of both adaptation and mitigation policies and programs."[5]

Despite the large body of scientific research on climate change and calls to action by heads of state, environmental ministers, and non-governmental organizations, among others, Copenhagen failed to produce a set of binding

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agreements to curb CO_2 emissions. In this article, we seek to understand this gap between a broad scientific consensus on the hazards of climate change and limited action on the part of policymakers. Given that climate change poses a severe threat to ecosystems and to humanity, and that there is widespread scientific agreement about the problem, why has there not been more cooperation in crafting a comprehensive deal? In what follows, we will first discuss the current research on climate change, noting both the impacts to the physical environment and to human communities. Then, we will discuss the reasons for the failure at Copenhagen, and the political obstacles to future action on this issue. Finally, we will outline a number of policy recommendations that may help to bridge the gap between scientific knowledge and policy outputs.

The Science of Climate Change

Current political debates over an international response to climate change are rooted in forecasts of the future impacts on the physical environment, but more importantly, on the human impacts of these changes. The consensus regarding physical impacts is broad and well-grounded in peer-reviewed science. Forecasts about the human impact of climate change, however, are less certain. This uncertainty has become politicized as those on the left and the right of the issue selectively use evidence to make their case.

Physical Impacts

The current consensus position on the physical impacts of climate change is embodied in the IPCC 4th Assessment Report, issued in 2007. IPCC assessment reports are based on peer-reviewed scholarly research and subject to peer review themselves before submission for review and comment by member governments. The IPCC, by its very nature, is a broadly representative intergovernmental organization. It was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP), both specialized agencies of the United Nations, and as such, all UN member countries are eligible for membership and participation in the drafting of the reports. The IPCC Summaries for Policymakers—non-technical reports of key findings—represent the consensus position of scientists and government officials representing over 130 countries, and are only adopted after line-by-line discussion in plenary session.[6]

The report states unequivocally that human activity—specifically the emission of greenhouse gases (CO_2, methane, and nitrous oxide) resulting from fossil fuel use, agriculture, and land use change—is a major contributor to global climate change. The atmospheric concentration of CO_2 in May 2010 was 389.8 parts per million (ppm) and has been above 350 ppm since 1988—well outside the natural range of 180 to 300 ppm for the last 650,000 years.[7] While the annual growth rate in atmospheric CO_2 has accelerated steadily from 1959 to present, growth in CO_2

emissions has ramped up since 2000: while the average annual growth rate was 1.3 percent from 1959 to 1999, it has been 1.97 percent since 2000.[8] The causes of this accelerating trend in CO_2 emissions are rooted in the rapid growth of developing countries such as Brazil, China, and India. However, while developing countries accounted for 73 percent of the growth in CO_2 emissions from 2000 to 2004, these economies, which are home to 80 percent of the world's population, are responsible for only 23 percent of total CO_2 emissions since the Industrial Revolution.[9] The United States, the European Union, Japan, and the former Soviet Union, by comparison, account for the vast majority of total CO_2 emissions despite constituting less than 20 percent of the world's population.[10]

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The forecasts of future effects of climate change on global temperature, sea level rise, changing rainfall patterns, and extreme weather events are stark. The 18 general circulation models—complex computer programs that simulate the Earth's atmosphere—that inform the IPCC predict an increase in air temperature of between 1.8 and 4.0ºC from the 1980–1999 average by 2099, resulting from at least a doubling of atmospheric CO_2 through the 21st century. Even if atmospheric CO_2 levels could be capped at the year 2000 level, the models still forecast a 0.6ºC increase in global temperature. Over the same time period, sea levels are forecast to rise from 0.18 m to 0.59 m, though these estimates do not take into account increases in sea levels due to rapidly melting ice sheets in Greenland and Antarctica. More recent forecasts that include ice sheet melt, presented at the International Scientific Congress on Climate Change in Copenhagen, suggest a rise of more than 1 meter by 2100; even the lower range predictions would dramatically affect the lives of some 600 million people that live in low-lying coastal areas.[11]

Increasing global temperatures will affect patterns of rainfall and extreme weather events such as drought, flooding, and tropical cyclones. The IPCC forecasts dramatic decreases (>20 percent) in rainfall across broad swaths of North Africa and the Middle East, Meso- and Central America and the Caribbean, Southern Africa, the eastern Amazon basin, and Western Australia, leading to an average water availability decrease of 10–30 percent. In addition, dramatic rainfall increases (>20 percent) are forecast for the higher latitudes of the Northern hemisphere and the Horn of Africa.[12] The IPCC also forecasts a 90 percent likelihood that variability in rainfall will increase, leading to more numerous heat waves and dry spells but also heavy precipitation events and flooding. An increase in areas affected by drought is viewed as likely, as is the forecast that future tropical cyclones, such as hurricanes and typhoons, will become more intense and destructive. Moreover, the IPCC forecasts a similar likelihood of an increase in extreme sea level events, such as storm surges and abnormally high tides that will inundate coastal areas.

It bears mentioning that these forecasts represent the relatively conservative, consensus positions of the scientific community and government-appointed

representatives to the IPCC. Recently, there has been some controversy over the scientific basis for climate change estimates. Leaked emails by researchers at the University of East Anglia—sometimes termed the "climategate" scandal—have led to accusations that some scientists may have deliberately suppressed research findings that do not conform to the consensus view, even as the broader scientific community rallied to support the IPCC's position.[13] In addition, some elements of the IPCC reports, such as an erroneous statement about the forecasted date of the disappearance of the Himalayan glacier, have further shaken public confidence in the science. These events notwithstanding, thousands of researchers from many academic disciplines have contributed to a collective body of evidence on climate change and the vast majority of scientists stand firm in their conclusion that climate change is occurring and has been accelerated by human activity.

Human Impacts

While there is broad scientific consensus on the future physical impacts of climate change, the human impacts are more difficult to anticipate. Niels Bohr, the Nobel Prize-winning physicist, famously opined, "Prediction is very difficult, especially if it's about the future." Bohr had the luxury of studying the atom—a particle whose complexity is dwarfed by that of human communities, the environment, and the interactions between them.

There are several reasons why our understanding of the human impact of climate change lags behind our understanding of the physical impact. First, forecasting human impacts requires scientists to move out of comparatively deterministic hard sciences like physics, chemistry, and biology, and into the murkier waters of the social sciences: sociology, economics, political science, and anthropology. We have yet to develop models that accurately predict future economic growth or where wars are likely to occur, for example. People are complicated, and as a result, the interactions between them are more highly variable, historically contingent, and context-specific than their counterparts in the physical world.

Second, humans are notoriously bad at anticipating the technological solutions we devise to overcome the problems posed by our physical environment. Paul Ehrlich's *The Population Bomb*, published in 1968, predicted that India was headed for mass starvation at about the same time that Norman Borlaug was introducing high-yield strains of wheat and rice to the subcontinent, sparking the Green Revolution and helping India to become self-sufficient in the production of cereal grains by the mid-1970s.[14] Our present forecasts about the human effects of climate change are inherently limited by our inability to imagine the future fruits of human ingenuity.[15]

Third, because climate change mitigation and adaptation will be costly and create winners and losers, projecting the human impacts of climate change is a highly politicized enterprise. Environmental advocates and proponents of the status quo have incentives to overstate and understate, respectively, the case for human impacts of climate change in order to press political agendas and defend their economic

interests.

The securitization of climate change—viewing the effects of climate change through the prism of national security policy and arguing that climate change is a cause of conflict[16]—has certainly raised the profile of climate change research. For instance, UN Secretary General Ban Ki Moon's A Climate Culprit in Darfur,[17] explicitly linked the Darfur conflict to climatic conditions and received a significant amount of attention in the press. But such statements have been dismissed as hyperbole, with little grounding in scholarly research.[18] Alternately, when Senator James Inhofe (R-Okla.), the ranking minority member of Committee on Environment and Public Works, asks rhetorically, "could it be that man-made global warming is the greatest hoax ever perpetrated on the American people? It sure sounds like it," it must be acknowledged that Inhofe represents a constituency that is heavily dependent on the exploitation of oil and natural gas—two of the biggest contributors to atmospheric CO_2.[19]

Despite these limitations, there is some important work being done on the future impacts of climate change on human communities. These effects include, but are not limited to: changes in regional agricultural productivity, water and food insecurity, migration, and the potential for violent conflict. Of these four, the IPCC considered the first three to be likely (>66 percent chance in next 100 years), while the IPCC did not reach consensus on the prospect of climate-related violent conflict.

Changing levels and patterns of rainfall and decreased snowpack and runoff, will affect patterns of agricultural productivity worldwide, with countries in higher latitudes generally seeing an increase in water and agricultural productivity, while countries in middle latitudes experience a general decrease. The IPCC forecasts that 75 to 250 million people in Africa will be exposed to increased water stress as a result of climate change and that agricultural yields in some African countries—many of which are dependent on rain-fed agriculture—may be reduced by up to 50 percent by 2020.[20] Drier regions of Latin America are expected to see desertification of agricultural land, and Southern Europe is projected to see higher temperatures, more frequent droughts, and decreases in water availability, agricultural productivity, and summer tourism.[21]

Rising sea levels, reduced agricultural productivity, and water stress are likely to result in large-scale human migration, though the IPCC makes no specific predictions about the number and destination (internal or international) of climate-induced migrants. Other researchers have been more willing to make pointed predictions. Projected sea level rise will have direct impacts on countries located in coastal and river flood plains, such as Bangladesh, where the World Bank has calculated that a 1.5 m increase in sea level would inundate 15 percent of Bangladesh's 160 million people, forcing them to migrate.[22] In 1995, Norman Myers and Jennifer Kent predicted that as many as 200 million people would be put at risk of displacement if current climate forecasts were to come true by 2025. In later calculations, Myers revised that number to 204 million, of which 144 million were inhabitants of low-lying regions in developing countries.[23] These calculations,

however, do not enjoy the same consensus as those made by the IPCC.

Finally, there is concern that climate change, operating indirectly through dwindling resources and migration, will lead to armed conflict. The 2007 IPCC report is muted on the subject, with specific references to conflict appearing most often in Working Group 2's chapter on Africa (which covers impacts, adaptation, and vulnerability).[24] The chapter notes "climate change may become a contributing factor to conflicts in the future, particularly those concerning resource scarcity, for example, scarcity of water."[25] While there is some academic literature to suggest that warming and an increased incidence of natural disasters will lead to an increase in armed conflict, consensus around the future impacts of climate change on conflict has yet to emerge.[26]

The previous discussion has served to highlight three points. First, the scientific evidence of human-induced climate change is clear and presents the international community with potentially dire consequences of inaction. Second, there is a considerable gulf between our understanding of the physical and human impacts of climate change, and this gulf introduces uncertainty into policy discussions about the problems that present and future generations will face. Finally, and perhaps most importantly, many of the most threatening aspects of climate change—sea level rise, loss of water resources, increasing incidence of drought, and an increase in extreme weather events and natural disasters—are projected to dramatically impact the less-developed countries of Africa and Central and South Asia.[27] That is, the direst consequences are projected for those countries with the fewest resources available to invest in mitigation and adaptation. Climate change threatens most those countries that have contributed least to the buildup of atmospheric CO_2 since the Industrial Revolution.

Explaining the Lack of Action

Despite the presence of a strong consensus about the science of climate change and its physical impacts, recognition of the problem by world leaders, and a significant amount of popular activism, CO_2 emissions continue to rise and little progress has been made on reaching an international agreement. The Copenhagen Climate Change Conference promised much, but resulted in a relatively modest accord.[28] First, there was a vague commitment to limit global warming to 2ºC and to make necessary emissions cuts, although there was no binding enforcement mechanism for doing so. Second, developed countries pledged to offer resources—$30 billion USD in the next three years, rising to $100 billion by 2020—to help the poorest countries adapt to climate change.[29] Third, governments would publically announce non-binding targets and plans to limit carbon emissions. Finally, the accord stated that steps should be taken to limit deforestation, but offered few details for doing so. In

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the end, those hoping for an ambitious plan of action to reduce CO_2 emissions were dismayed by the overall weakness of the Copenhagen Accord.

Why didn't the agreement do more to address the challenge of climate change? Moving forward, what are the key obstacles that hinder progress on an international agreement and deep, meaningful action by states? First, we note that while there has been a considerable degree of scientific consensus on the physical process of climate change, there are still doubters who question whether or not global warming is actually occurring,[30] and those who remain skeptical that human activity is a major contributing factor. While these voices are a minority, their hand was strengthened by the recent "climategate" scandal and a few factual errors in the IPCC report, such as incorrect estimates of Himalayan glacier melt.[31] This has exacerbated a long-standing disconnect between scientific knowledge and public opinion on the issue. A Gallup Poll reported in March 2010 revealed that 41 percent of the American public viewed the seriousness of global warming as "exaggerated"—the highest percentage since the question was first asked. Self-identified Republicans were even more skeptical, with 66 percent claiming that the threat was exaggerated. Moreover, the American public is nearly evenly split between those who believe that climate change is caused by human activity and those who doubt that this is the case.[32] European respondents are more likely to be concerned with climate change, although opinion there has softened as well.[33] Despite recent challenges to some of the details of research, most scientific experts continue to believe that climate change is real and that human activity has contributed to it. Nonetheless, one's political ideology often determines the degree to which one believes in the science and the extent that publicized scientific controversies—even relatively minor ones—undermine confidence in the overall balance of evidence.

While consensus regarding the physical impact of climate change is relatively firm, there is more disagreement about the human impact, as we discussed above. This introduces more uncertainty in the debate. Given the difficulty of forecasting social behavior, we do not have firm predictions about how climate change will affect livelihoods, settlement patterns, or human security. For example, human beings may devise geo-engineering solutions that forestall climate disaster;[34] simple adaptation measures and alternative livelihoods may be sufficient to cope with modest temperature increases; and some areas may indeed be net beneficiaries of climate change.[35] How technology and human ingenuity play out in the future is unknown. As such, political leaders, eager to avoid costly action on climate change, can use scientific uncertainty as leverage in their debates over policy, claiming that the problem—at least in human terms—is not as bad as it is often made out to be. In addition, shifting away from a carbon-fueled global economy will require significant, well-known, sacrifices in order to forestall uncertain social consequences in the future.[36] Those who stand to lose economically or politically from changes in economic production and consumption patterns point to scientific disagreement—and often exaggerate such disagreement—as a tactic to argue against sweeping changes.

In addition to uncertainty related to the physical and human impacts of climate change, collective action problems have stalled the creation of a global climate change treaty. The atmosphere is a common pool resource from which we all benefit, but no single actor owns or is able to prevent others from using (or abusing) it.[37] This leads to a "tragedy of the commons" problem in which decisions that are individually rational, such as continuing dirty means of production, can destroy the resource if everyone engages in the same behavior. Despite recognition of the problem, no country has an incentive to make cuts to greenhouse gas emissions and forgo economic gains as long as others continue to pollute.

To state the problem another way, preserving the environment may be understood as a global public good in that a clean atmosphere is non-excludable (all benefit from it) and non-rival (one's enjoyment of it does not diminish that of others).[38] As with other public goods, efforts to combat climate change suffer from the free-rider problem. Collectively, all countries would be better off if they contributed to the good and adhered to environmental protection agreements. Individually, however, each country has an incentive to defect from the deal, to avoid costly changes to their economy, and to reap the benefits of continued levels of production under current, dirty practices. Since no one country's contribution to climate change is likely to be decisive (except perhaps for the largest polluters), and none can be excluded from the public good of clean air, each country has an incentive to free-ride on the actions of others. Since all countries are faced with similar incentives and no global actor can enforce emissions standards, agreements are likely to break down as actors cheat on the deal; even those that are sincerely concerned with climate change will be reluctant to act for fear of free-riding by others.

Third, agreements have been hampered by disputes between countries with very different sets of interests. In Copenhagen, there were at least three distinct sets of countries with very different views on the subject. There were the developed countries of North America, Europe and others, whose past industrial practices have contributed the most to the problem of climate change. Then, there were the relatively poor but rapidly industrializing countries such as India, China, Brazil, South Africa and others, who are just now becoming major CO_2 emitters, and currently see no practical, green alternative to carbon emissions as a means to fuel economic growth.[39] Finally, the poorest countries—especially in Sub-Saharan Africa—will not be major emitters in the near future, and have the least capacity to adapt to climate change. While wealthy countries pressed hard to reach a comprehensive deal at Copenhagen, India and China, along with a handful of other rapidly developing countries were more reluctant to agree to sweeping changes.[40] Although their cooperation is likely to be vital in crafting a global agreement, these countries view development and poverty alleviation as a more pressing goal. They argue that while they account for most of the current growth in CO_2 emissions, they still emit far less per capita than North America or Europe and should be able to reach levels of consumption rivaling those enjoyed by rich countries. Yet, countries such as the US

find it hard to agree to deep cuts so long as these states' emissions continue to sharply rise.[41] The poorest and most vulnerable states, moreover, argue that more should be done to help them adapt to climate change—including generous aid packages—given that they are hapless victims of rich country pollution.[42]

These disagreements are fundamentally about distributional and ethical issues.[43] Who should pay for mitigating climate change? What responsibilities do countries have in responding to this threat? What is the proper balance between economic development and environmental protection? Wealthy countries with strong environmental movements are most concerned with protecting the environment and combating climate change. Developing countries argue that they have a right to seek growth and increased consumption, and that wealthy countries should bear most of the costs of mitigating climate change. The poorest countries argue, moreover, that they were not responsible for the problem and should receive compensation for harms done. There is some agreement that developing countries should "leap frog" over older, dirty technologies such as coal-fired power plants and adopt new, green technologies. However, these technologies are often more expensive than their dirty counterparts and intellectual property rights protections may impose additional constraints on their adoption.[44] These debates are not easy to resolve, since they hinge on differential rights and responsibilities. How the burden of providing the public good of environmental protection should be distributed across these distinct sets of countries, at least in the short run, is a question the leaders of the world lack political will to address.

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The final obstacle to a comprehensive deal on climate change is the problem of time-inconsistency. Such problems arise when there is a disjuncture between what is valued currently and what is valued in the future.[45] Climate change is a long-term threat, and the most severe effects have yet to be realized. However, efforts to mitigate climate change and adopt adaptation strategies are costly in the short-term. Politicians, particularly in democratic societies with short electoral cycles, are often reluctant to make short-term sacrifices for long-term gains. Deep emission cuts are likely to be immediately opposed by the most polluting industries and by people employed in such firms; changes to the way we heat our homes and fuel our cars also impose significant costs. Politicians will find it difficult to take bold measures to limit CO_2 emissions given that these may harm their immediate re-election prospects. Even if there is agreement that climate change will be a serious problem for future generations, people are often unwilling to change current behavior for long-term rewards. For this reason, it is difficult for many countries to achieve deep emission

cuts, particularly if leaders are sensitive to immediate political pressures, as in democracies. Unelected autocrats are not necessarily better environmentalists, however, as authoritarian states like Myanmar and North Korea demonstrate a similar lack of regard for environmental responsibility.

Policy Measures

We have argued that the global public good of a sustainable climate is undermined by four interrelated problems: 1) inability of countries to commit to lowering CO_2 emissions in the presence of free-riders, 2) entrenched domestic actors that have economic interests in opposing action on climate change, 3) time inconsistency problems, which are especially acute for democratically-elected governments, and finally 4) a disconnect between scientific consensus and public opinion. We conclude by proposing the establishment of an international institutional framework to help resolve these collective action problems, as well as more conscious efforts by scientists to communicate their findings to the public. The former addresses the problems associated with countries tackling problems that reach beyond any individual country's borders and capacity to solve. The latter addresses the political will that will be necessary to do so.

Addressing climate change will likely require the creation of a new international institutional framework. A useful analogy can be made to free trade. Most governments have decided that free trade offers significant long-term benefits, but these same governments are sensitive to political opposition from groups that lose out from trade in the short term. Governments, therefore, face time-inconsistency problems in implementing liberalizing policies. Moreover, open markets may be considered a global public good, and thus face potential free-rider problems at the international level, as governments have incentives to defect from established rules from time to time.

International institutions can help to overcome free-rider and time-inconsistency problems by lengthening time-horizons, making binding public commitments, and establishing mechanisms for monitoring and enforcement.[46] The General Agreement on Tariff and Trade (GATT) and the World Trade Organization (WTO) represent successive attempts to institutionalize free trade at the international level by establishing clear rules that current and future governments are held accountable to; monitoring compliance; and creating dispute resolution and enforcement mechanisms. Moreover, international commitments can tie the hands of future governments, making it less likely that leaders in the future will defect from current agreements due to short-term political pressures. International agreements make it harder for politicians to reverse policies for short-term political gain and can give such leaders some degree of political cover for taking costly action.

An international institution for dealing with climate change would entail several key elements missing from existing global emissions agreements: binding caps on emissions, enforcement mechanisms to punish carbon free riders, transfers of green technology, and buy-in from major emitters. First, countries must make binding

commitments to keep global emissions below 450ppm. A global per capita emissions standard (taking into account population growth), rather than numerical cuts in CO_2 tonnage, would help avoid some of the complications inherent in determining individual country reductions. Although we leave the exact target—and mechanisms for reaching it—up to future negotiations, it should recognize that wealthy countries must significantly lower per capita emissions, while poor countries may see some manageable increase in emissions as their populations are allowed to consume more. Second, this institution must be tasked with monitoring emissions and imposing penalties, such as targeted trade sanctions, for violations of global standards. The power to punish free riders—countries that continue to emit above targeted levels—will be critical if such an institution is to be effective. Third, it must address issues dealing with intellectual property rights for the transfer of clean technology. As new technologies come on line, their diffusion—especially to poor countries—must be encouraged, without stifling innovation. A fund to compensate firms for their intellectual property and encourage green technology transfers would help in this regard. Finally, we encourage further funding and planning for climate change adaptation and disaster preparedness in developing countries.

The creation of a new international institution will be fraught with difficulty, as some states will be reluctant to go along with a global deal. Therefore, clear leadership by the US and a core group of states most interested in the problem will be critical to the establishment of a binding treaty. Thus far, the US has been a laggard with respect to global environmental agreements, but there are promising signs that this opposition is fading. Moreover, while a broadly multilateral agreement would be ideal, it is possible to strike an agreement among the major emitters, including the US, EU countries, Japan, China, India, and so on. Striking an agreement among a smaller set of countries and incrementally broadening the institution to include additional states is exactly the route that the WTO took in reducing global barriers to trade. However, incentives must be in place to act quickly, since the world cannot afford to wait for meaningful cuts in CO_2 emissions.

An Inconvenient Truth did what four generations of IPCC Assessment Reports had thus far failed to do: make the scientific understanding of the forces driving climate change intelligible to a wide audience.

In addition to the creation of a global institution, the scientific community must do a better job of communicating the scientific consensus on climate change. The IPCC reports—even the Summaries for Policymakers—read like documents prepared for a technically sophisticated audience. This has two practical implications. First, most people's impressions of the scientific consensus on climate change will be refracted through the lenses of popular journalism and political debate, two arenas in which the science can easily be mis-

communicated or lost in partisan position-taking. The IPCC shared the Nobel Peace Prize with Al Gore in 2007, largely because former Vice President Al Gore's *An Inconvenient Truth* did what four generations of IPCC Assessment Reports had thus far failed to do: make the scientific understanding of the forces driving climate change intelligible to a wide audience. It should not be left up to civil society alone to make the case for the science of climate change. The IPCC should be tasked with generating general reports that synthesize and summarize the extent of climate change science in as plain language as possible, and should enhance its outreach programs for addressing popular audiences.

Second, the science of climate change is not being effectively communicated to younger generations. For future generations, the political will to tackle the issue of climate change will have to come from a greater recognition of the role humans have played in causing the problem. To that end, the IPCC should devote resources to engage in educational outreach. This may include websites and educational software for students, teachers, and children—replete with interactive games, tips for teaching about hunger and the environment, and Facebook and Twitter pages—such as those maintained by the World Food Programme and the UN Environmental Programme.[47]

Finally, more research must be conducted on the physical and human impacts of climate change. Increased government funding for basic research can help to resolve some of the remaining gaps in our knowledge surrounding the physical process of climate change. Importantly, research on the social impacts of environmental degradation is still in its infancy and few firm conclusions have been reached. Funding interdisciplinary research and encouraging conversations between the natural and social sciences is critically needed to help us more thoroughly understand the challenges posed by climatic change. Funding for the social sciences and research has frequently come from government sources and should be significantly expanded.

In sum, global climate change represents a key challenge for humanity. Our scientific understanding of the problem has far exceeded our political will to act. Further inquiry is clearly necessary, but we believe that the existing research already suggests that decisive action is needed to avert a catastrophe. Although the road ahead is likely to be difficult, a global agreement to curb greenhouse gasses is possible.

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