

## Chapter 7: The Future of Climate Change Law and Policy: Risks and Possibilities

Chapter 7: The Future of Climate Change Law and Policy: Risks and Possibilities.....	1
A. Scenario One: Inadequate Mitigation Leads to Major Impacts and Adaptation .....	1
1. Maintaining Carbon Dioxide Levels Below Critical Thresholds .....	2
2. Environmental Justice Dimensions of Major Climate Change .....	7
3. Climate Change Refugees .....	12
4. National Security Concerns .....	18
B. Scenario Two: Efforts to Reverse Climate Change through Geoengineering .....	21
1. The State of the Science and Technology .....	21
2. Legal Dilemmas.....	30
3. The Possibilities and Risks of a Technological Fix.....	41
C. Choosing Our Future.....	47
1. The Economics, Politics, and Governance Challenges of Mitigating Adequately.....	47
2. A Vision for Effective Climate Change Law .....	54

The concluding chapter looks to the future of climate change law and policy. In so doing, it engages a question that has been lurking below the surface of the preceding chapters: What if we fail to mitigate adequately? The book up to this point has looked at international, national, subnational, and nongovernmental efforts to address climate change, but it is clear that none of these efforts are coming close to what scientists say are needed to minimize the risks of major climate change. Although the 2011 Durban climate change negotiations resulted in breakthroughs on a universal agreement and on a second Kyoto Protocol commitment period, these laudable steps forward will not significantly change the emissions scenarios over the next few years.

Given that troubling reality, this chapter explores the potential pathways that remain if we do not start to mitigate more aggressively soon. It considers two risky and potentially intertwined future scenarios and the role that law might play in each of them. In the first scenario, which looks likely to be our path if mitigation efforts continue on their current course, major climate change transforms the globe, and leaders must contemplate significant relocation and reconstitution of law and society in response. In the second scenario, which also seems possible given our tendency to look for technological solutions to problems, the nations of the world decide to try to reverse climate change through geoengineering. These scenarios could happen together and also in some combination with current mitigation approaches. They might be proposed and decided upon in a relatively deliberate way, or they might be undertaken as part of a hastier and more desperate response to major climate change.

The primary way to avoid these two risky scenarios is through adequate mitigation that results in relatively limited climate change and accompanying adaptation. The book concludes by exploring how future lawyers and policymakers interested in this problem can work towards adequate mitigation and adaptation most effectively while preparing for this chapter's riskier scenarios.

### A. Scenario One: Inadequate Mitigation Leads to Major Impacts and Adaptation

Climate change already has begun to impact Arctic, low-lying coastal, and desert communities significantly. If we continue on our current emissions trajectory or even a slightly reduced one, climate change will likely affect an ever-greater swath of humanity. Moreover, the impacts of climate change are not distributed equally. Those who are most physically vulnerable are often in the places least able to adapt.

This reality raises not only profound justice questions, but also geopolitical, national security, and economic ones. As places become unlivable, climate change refugees will increase, as will the risk of armed conflict in some of the most impacted areas. This Section engages those concerns, and considers the difficult human and legal issues that major climate change would raise.

### 1. Maintaining Carbon Dioxide Levels Below Critical Thresholds

Leading climate scientists claim that we must keep carbon dioxide below threshold levels in order to avoid the risk of major climate change. These scientists indicate that the safest approach is to keep carbon dioxide concentrations below 350 parts per million. However, we have already exceeded that threshold significantly—carbon dioxide concentrations were at 390 parts per million at the Mauna Loa observation site, <http://www.esrl.noaa.gov/gmd/ccgg/trends/>, as of November 2011—and are moving rapidly towards the riskier 450 parts per million.

The following excerpt from an article by a number of these scientists written just before the Copenhagen negotiations explains why the 350 parts per million threshold is important. It describes the rising risks as we exceed that concentration and have a greater risk of an over 2 °C rise in temperature from pre-industrial levels.

**Johan Rockström, Will Steffen, Kevin Noone, Åsa Persson, F. Stuart Chapin, III, Eric F. Lambin, Timothy M. Lenton, Marten Scheffer, Carl Folke, Hans Joachim Schellnhuber, Björn Nykvist, Cynthia A. de Wit, Terry Hughes, Sander van der Leeuw, Henning Rodhe, Sverker Sörlin, Peter K. Snyder, Robert Costanza, Uno Svedin, Malin Falkenmark, Louise Karlberg, Robert W. Corell, Victoria J. Fabry, James Hansen, Brian Walker, Diana Liverman, Katherine Richardson, Paul Crutzen, Jonathan A. Foley, *A Safe Operating Space for Humanity*, 461 NATURE 472, Sept. 24, 2009.**

#### Climate Change

Anthropogenic climate change is now beyond dispute, and ... the international discussions on targets for climate mitigation have intensified. There is a growing convergence towards a '2 °C guardrail' approach, that is, containing the rise in global mean temperature to no more than 2 °C above the pre-industrial level.

Our proposed climate boundary is based on two critical thresholds that separate qualitatively different climate-system states. It has two parameters: atmospheric concentration of carbon dioxide and radiative forcing (the rate of energy change per unit area of the globe as measured at the top of the atmosphere). We propose that human changes to atmospheric CO<sub>2</sub> concentrations should not exceed 350 parts per million by volume [p.p.m.v], and that radiative forcing should not exceed 1 watt per square metre above pre-industrial levels.

Transgressing these boundaries will increase the risk of irreversible climate change, such as the loss of major ice sheets, accelerated sealevel rise and abrupt shifts in forest and agricultural systems. Current CO<sub>2</sub> concentration stands at 387 p.p.m.v. and the change in radiative forcing is 1.5 W m<sup>-2</sup> [watts per square meter].

There are at least three reasons for our proposed climate boundary. First, current climate models may significantly underestimate the severity of long-term climate change for a given concentration of greenhouse gases. Most models suggest that a doubling in atmospheric CO<sub>2</sub> concentration will lead to a global temperature rise of about 3 °C (with a probable uncertainty range of 2–4.5 °C) once the climate has regained equilibrium. But these models do not include long-term reinforcing feedback processes that further warm the climate, such as decreases in the surface area of ice cover or changes in the distribution of vegetation. If these slow feedbacks are included, doubling CO<sub>2</sub> levels gives an eventual temperature increase of 6 °C (with a probable uncertainty range of 4–8 °C). This would threaten the ecological life-support systems that have developed in the late Quaternary environment, and would severely challenge the viability of contemporary human societies.

The second consideration is the stability of the large polar ice sheets. Palaeo climate data from the past 100 million years show that CO<sub>2</sub> concentrations were a major factor in the long-term cooling of the past 50 million years. Moreover, the planet was largely ice-free until CO<sub>2</sub> concentrations fell below 450 p.p.m.v. ( $\pm 100$  p.p.m.v.), suggesting that there is a critical threshold between 350 and 550 p.p.m.v. Our boundary of 350 p.p.m.v. aims to ensure the continued existence of the large polar ice sheets.

Third, we are beginning to see evidence that some of Earth's subsystems are already moving outside their stable Holocene state. This includes the rapid retreat of the summer sea ice in the Arctic ocean, the retreat of mountain glaciers around the world, the loss of mass from the Greenland and West Antarctic ice sheets and the accelerating rates of sealevel rise during the past 10–15 years.

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Adequate mitigation means staying below this destabilizing threshold. The more we continue to exceed it, the greater the risks of major climate change impacts become. Organizations like 350.org have formed around trying to keep concentrations in that range and are exploring what measures are needed to do so.

The following excerpt from Professor Mary Wood explains in human and biological terms the importance of keeping carbon dioxide below destabilizing concentrations. It explores what the role of law could be in assisting needed transformation.

|| **Mary Christina Wood, “You Can’t Negotiate with a Beetle”: *Environmental Law for a New Ecological Age* 50 NAT. RESOURCES J. 167 (2010).** ||

#### IV. CLIMATE EMERGENCY AND THE BIG ADAPTATION

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 The crisis that eclipses all others today is climate change, a situation that creates enormous stakes for virtually every human being on Earth. In June 2007, a team of leading climate scientists warned that carbon dioxide and other greenhouse gas emissions have put Earth in “imminent peril”--literally on the verge of runaway climate heating that would impose

catastrophic conditions on generations to come. Runaway heating threatens to melt the polar ice sheets and Greenland, kill the coral reefs, and turn the Amazon rainforest into savannah. It would bring floods, hurricanes, killer heat waves, fires, disease, crop losses, food shortages, and droughts of a caliber that is unimaginable to many. If unchecked, it will cause rising sea levels and inundation of coastal areas worldwide. Biologists warn that climate change could wipe out 40 percent to 70 percent of the world's species, triggering the kind of mass extinction that has not occurred on Earth for 55 million years. In the words of NASA Goddard Institute for Space Studies director, Jim Hansen, our continued carbon pollution will “transform the planet.”

The implications for humanity, and the world's children, are unthinkable. If runaway heating comes to pass, it could mean death for millions or even billions of Earth's citizens. Even under the present heating scenarios, the United Nations estimates that the numbers of environmental refugees will climb to 50 million by 2010, and then to 1 billion by 2050. Desperate mass human migrations will pose unending threats to world security. Legal institutions that collapse under such stress will no longer provide stability, and many predict that a much hotter world would trigger the breakdown of civilization as we know it.

The global warming crisis has mind-blowing urgency, because of what scientists call the “tipping point.” This is a climate tripwire, so to speak, a point at which humanity's carbon pollution kicks in dangerous natural feedback loops that could unravel the planet's climate system, despite any subsequent carbon reductions achieved by humanity. Due to carbon in the atmosphere from past releases, Earth is now precariously close to triggering these lethal feedbacks that would threaten civilization as we know it.

Some feedbacks are already underway. First, vast areas of permafrost are now melting, releasing carbon and methane. Scientists fear that such melting permafrost could release a billion tons of carbon dioxide a year to the atmosphere, creating what one science writer calls an “atmospheric tsunami.” Second, as the polar ice caps melt, they, in turn, cause more planetary heating, because the ice, which reflects heat, turns to water, which absorbs heat--a phenomenon known as the “albedo flip.” Third, the natural “sinks,” such as oceans and forests, that have historically absorbed society's carbon pollution, have reached their limits and are now failing. Vast swaths of forest are dying and burning, both releasing carbon and eliminating carbon absorption capacity. Even the Amazon rainforest--the lungs of the planet--is now a significant source of carbon pollution. Finally, the oceans are so saturated with carbon that they are acidifying, creating conditions that are lethal to shellfish. These and other alarming feedbacks caused scientists to warn in 2007: “Recent greenhouse gas (GHG) emissions place the Earth perilously close to dramatic climate change that could run out of our control, with great dangers for humans and other creatures.”

The world has only a narrow window of time to slash global emissions of carbon before the planet passes the tipping point. While just two years ago scientists believed the tipping point would be triggered at 450 parts per million of carbon in the atmosphere, some now believe the tipping point is below 350 parts per million. Present levels are at 387 parts per million. Analysts now repeatedly warn in the clearest terms possible that Earth is in a danger zone --a state of planetary emergency. Yet, following an aimless “business as usual” course, humanity continues to emit enormous amounts of carbon dioxide. Until the economic collapse of 2008, the yearly average increase in emissions was between 2 and 3 percent. As James Speth concludes, “[If we] keep doing exactly what we are doing today, [even] with no growth in the human population or the world economy . . . the world in the latter part of this century won't be fit to live in.”

Even if humanity manages to prevent runaway heating, the natural world is already locked into extreme change. Due to the persistence of carbon already in the atmosphere, the world is projected to heat, at the very least, approximately 2.6 degrees Fahrenheit further. This is known as the heating “in the pipeline.” In other words, this heating will occur despite cuts in GHG pollution. Projected effects from such irrevocable heating include increased storm intensity, a rise in sea levels, between 20 and 30 percent species loss, forest die-offs, drought, fire, crop loss, and a myriad of other harmful or deadly consequences.

The climate challenge boils down to two Herculean tasks, both of which put environmental law at the forefront of humanity's response. In climate circles, these tasks are tagged by the rather uninspiring terms “mitigation” and “adaptation.” The first, “mitigation,” means that humanity has to slash carbon emissions enough to prevent runaway heating. This is a huge challenge, since fossil fuels are the engine of modern industrial society and support virtually every aspect of human activity, including transportation, construction, food systems, and electricity use. The second term, “adaptation,” means that humanity must figure out how to survive the heating that it can no longer avoid. No one really knows what the additional 2.6 degrees Fahrenheit will mean for daily living conditions, but it is certain to create radical change, given that the 1.6 degree Fahrenheit average temperature increase experienced so far is enough to prompt scientific predictions that the summer ice caps at the poles will vanish by 2012. The dual necessity of mitigation and adaptation is perhaps best captured by Thomas Friedman when he says: “Avoid the unmanageable and manage the unavoidable.”

Mitigation and adaptation, together, create an imperative to protect natural resources immediately, across the board, for two basic reasons. First, doing so is the only means of avoiding the climate tipping point. Scientists make clear that we need to take urgent measures to draw down carbon pollution from currently dangerous levels. This not only means steep pollution reduction from obvious sources such as coal-fired power plants and cars, but also measures to preserve and enhance natural sinks such as forests and soils that can absorb carbon. In policy terms, this means a halt to much extractive old growth logging, wetland destruction, virgin land development, and industrial farming that damages soils.

Second, it is vital to protect the natural resources we still have in order to adapt to the irrevocable climate heating already underway and thereby maximize human survival. The Global Humanitarian Forum estimates that 300 million people--about 5 percent of the world's population--are already seriously impacted by climate change. Humanity now has to look at virtually all of its natural infrastructure in a different light, because many systems will fail, and as they do, natural resources will become ever more scarce. The reality is that humanity simply will not have all of the water, species, productive soils, and forests that it inherited from past generations. In the new world of climate heating, all remaining natural assets carry a premium for human survival and welfare.

For example, recent data show that the major rivers of the world are losing significant water due to climate change. Rivers across the United States are already over-appropriated, and 35 states in this country are engaged in water conflicts with their neighbors. In other parts of the world, such conflicts lead to war. As the glaciers melt due to global warming, the stable input into rivers disappears, and water sources collapse. Cities and farms in need of water will turn to other sources, including underground aquifers. But those sources may be contaminated due to pollution permitted under law by environmental agencies. Already in the United States, more than 700 chemicals have been detected in drinking water, and 129 of those are highly toxic. Any remaining uncontaminated water carries a premium of value to society.

Climate change also brings floods, pests, and temperature extremes, all of which are a blow to agricultural production. With global warming, food shortages are manifestly on the horizon. Already, 45 million people are chronically hungry due to climate change. According to the United Nations, by 2030 food prices will rise 20 percent and 75 percent of the world's population will be hungry. In just the past few years, Australia's extended drought has caused an 89 percent decline in rice production. The prospect of climate damage makes all of the remaining agricultural soils that much more valuable. But the valuable virgin soils are still gouged and paved over for strip malls, destination resorts, and subdivisions, all permitted under law by local land-use agencies.

Forests are part of the vital ecology of Earth. They provide vegetative cover for countless species and support the headwaters for major rivers and streams. The city of New York, for example, relies heavily on forests in the Catskills Mountains for its water supply. Portland, Oregon, and other cities in the Willamette Valley depend on the Bull Run watershed, which is encased by century-old trees. But due to climate heating, forests are dying at twice their normal rates, and mega-wild fires are devouring forestlands with unprecedented speed. Seemingly oblivious to the change, the U.S. Forest Service and state land agencies continue to allow harvests that shred the vegetative fabric supporting many crucial water sources.

One assumption seems solid: The more natural resources that are kept intact and functional, the more natural stock humans will be able to draw upon in the future, and the better odds humans will have to adapt to potentially devastating ecological change. Environmental management must incorporate a precautionary approach that places a premium on all remaining nature, for overlooked resources will undoubtedly host attributes that are crucial to future generations. The environmental law of the past was tailor-made for the transnational industrial age. Environmental law must be remade for what can be termed the "New Ecological Age." Agencies must significantly amplify the protection of vital resources, which means that they must strengthen their resistance to proposals for private profit that cause ecological damage.

Unfortunately, the dismal record of environmental law gives no basis for confidence that the approach of the past is suitable for the challenges ahead. Instead, a look at how environmental law operates reveals systemic dysfunction that permeates the entire structure. Operating with this dysfunction, agencies continue to authorize damage as if nature had unlimited abundance and capacity to heal--as if the end were not already in sight.

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## NOTES AND QUESTIONS

1. Professor Wood's article provides a pretty stark case for needed transformations in environmental law. If you were to design environmental law for the "New Ecological Age," what would that entail?
2. Climate scientists James Hansen, Makiko Sato, Pushker Kharecha, David Beerling, Robert Berner, Valerie Masson-Delmotte, Mark Pagan, Maureen Raymo, Dana L. Royer and James C. Zachos have argued that the only way to avoid major climate change is to phase out coal until we have the technical capacity to effectively engage in carbon sequestration and storage. They explain: "Coal is the largest reservoir of conventional fossil fuels, exceeding combined reserves of oil and gas. The only realistic way to sharply curtail CO<sub>2</sub> emissions is to phase out coal use except where CO<sub>2</sub> is captured and sequestered." Target Atmospheric

CO<sub>2</sub>: Where Should Humanity Aim? (2008 draft). Is there any realistic way of achieving such a phase out? How would you go about doing so?

## 2. Environmental Justice Dimensions of Major Climate Change

Although we have not yet hit a point where the climate has changed enough for most of the world's population to face serious consequences, a number of vulnerable populations already experience significant impacts. This disproportionate distribution of harm, particularly given that the major emitters are generally not those facing the most severe harms in the near term, poses a serious environmental justice problem. While efforts exist under the UNFCCC to address some of these justice issues, such as through mechanisms to encourage technology transfer or provide adaptation funding, deep inequities remain.

The following excerpt by Professor Ruth Gordon details the unequal harm faced by Africa, small island states, and indigenous peoples of the Arctic. It provides a window into both the current justice problem and into the kinds of impacts that massive climate change potentially would cause more broadly in the future.

|| **Ruth Gordon, *Climate Change and the Poorest Nations: Further Reflections on Global Inequality*, 78 U. COLO. L. REV. 1559 (2007).** ||

### III. The Asymmetrical Consequences of Global Warming: The View from the South

While the planet will undoubtedly survive the assault on its climate, regardless of how much damage humans cause, the impact upon its inhabitants, be they flora or fauna, is less certain. We do not know how many species will be lost as flora and fauna attempt to adapt to a rapidly changing climate, nor can we totally understand the potentially infinite effects upon ecosystems under severe stress. While we can readily observe the misfortunes of the polar bear, we cannot completely assess what is happening to rain forests that must quickly adapt, or the impact of losing coral reefs, which are sensitive to rising temperatures and greatly affect ocean ecosystems. We can only be humbled by what we do not know and by the scores of previously unanticipated effects that have already come to pass.

What we do know, however, is that southern-tier nations will be disproportionately affected by climate change, and many of these nations will be the least equipped to deal with these consequences. This Part will begin with a focus on African nations, which face a variety of harms and, because of their poverty, will have an especially difficult time dealing with them. It will then turn to small island nations, which face annihilation, and then briefly to the native peoples of the Arctic region, who are giving us a glimpse into one possible future. Both small island nations and Arctic peoples face the most catastrophic consequences: the total destruction of their habitat and thus of their culture, community, and way of life. For them, global warming means the unmitigated end of life as they have always known it.

#### A. Africa

Climate change is already a reality for poor African nations, with Kenya, Sudan, Ethiopia, Somalia, and Chad witnessing the consequences; indeed, the conflict in Darfur may be the first climate change conflict and an indication of similar future wars. Climate change is leading to “reduced rainfall and shrinking areas of arable land,” and the number of food emergencies in sub-Saharan Africa each year has tripled since the 1980s. Desert lands are advancing into once-arable rain-fed areas, and wetter parts of Africa are getting wetter, often leading to devastating floods. Yet African nations have contributed very little to global warming, with emissions of less than 8% of the world's GHGs and most of this low sum coming from South Africa. The continent is particularly vulnerable to the effects of global warming, which will have a disproportionate impact on low-income unindustrialized nations, many of which also happen to be the nations that are, and will continue to be, least able to handle it. In other words, the world's poor will be shouldering yet another burden not of their making.

Africa is particularly at risk to climate change, in part because of its poverty and a lack of resources to deal with a problem that is beyond its control. Taken as a whole, it is the poorest continent in the world and probably the least industrialized. Technological and economic resources are minimal. Drought, floods, and food scarcity are already problems in some areas, and these problems are likely to multiply and intensify. In countries already vulnerable to drought, less rainfall is predicted, which will raise particular difficulties regarding water resources. Fourteen countries in Africa already suffer from water insufficiency, and it is estimated that another eleven nations will join this unenviable club within the next twenty-five years. Where water resources are shared, there is a potential for conflict as nations clash over an increasingly insufficient supply. Moreover, there are already discussions regarding the prospect of “climate change refugees,” to portray the large scale and pervasive displacement of African peoples. Desertification is expected to intensify as there is less rainfall and land becomes increasingly scarce.

Global warming is expected to put an additional 80 to 120 million people at risk of hunger, and 70% to 80% of these people will be located in Africa. As weather patterns become more unpredictable, farmers are having a difficult time determining where and what to plant. Food insecurity is expected to increase as agricultural production declines due to lack of water and changing ecosystems. It is predicted that climate change could lead to a 5% drop in the production of food crops.

Rapidly changing ecosystems also raise the specter of risks to biodiversity and natural resource productivity. Many impoverished peoples depend on the diversity of surrounding ecosystems to support their way of life. Global warming, however, will have potentially devastating effects on habitats and the diversity found within already fragile ecosystems; between 25% and 40% of Africa's natural plant habitats could be lost by 2085. The Working Group on Climate Change and Development predicts that as plant species used in traditional medicines become extinct, local peoples' capacity to combat illnesses will become increasingly impaired. Vector- and water-borne diseases are expected to escalate, especially in areas with an inadequate health infrastructure. Heat stress, air pollution, water failures, water- and food-borne diseases, and food insecurity present other potential health hazards that are particularly problematic in the absence of sufficient medical services. Women may bear the brunt of these disasters, having limited access to land, education, and credit, while producing 80% of the crops. Their traditional knowledge may be crucial in addressing these issues, even if this knowledge alone is insufficient.

Finally, global warming is expected to intensify coastal erosion, flooding, and subsidence, problems that already plague Africa's coastal areas. Coastal zones are vulnerable to rising sea levels, with roads, bridges, buildings, and other infrastructure at risk of flooding, and populations that are vulnerable to the kind of disaster flooding brings. Rising sea levels could destroy an estimated 30% of Africa's coastal infrastructure.

## B. Small Island States

Like their counterparts in impoverished nations, small island states did not contribute to climate change to any measurable extent; most are unindustrialized, relying mainly on tourism and light industry to support their economies. Yet, despite their lack of responsibility, these nations are likely to suffer especially abysmal consequences, including paying the ultimate price—their possible annihilation. This may be the definitive manifestation of unsustainability.

Small island states are “especially vulnerable to the effects of climate change, [such as] sea level rise and extreme events,” and the prospect of rising oceans is especially dangerous and threatening. Climate change has been linked to deteriorating weather patterns that will include more severe storms, tornadoes, hurricanes, and cyclones, and islands are more likely to be in areas where many of these events take place. Predictions of how much the oceans will rise over the next one hundred years range from a best case scenario of .18 meters to a worst case of .59 meters, if melting glacial ice sheets are not taken into account. If this melting is included, in one hundred years, ocean levels could rise by four to six meters, and perhaps as high as seven meters. Many small island states are less than three to four meters above the present mean sea level, and thus the potential to be completely inundated is undeniable. Sea levels have already begun rising and pervasive and irreversible changes at the poles have commenced. The Kiribati Islands have shrunk, and some have been cut in half by the sea. Salt water has encroached upon land, making it impossible to grow breadfruit and forcing the inhabitants to relocate. The island nations of Kiribati, Tuvalu, and Niue and the Marshall Islands are already beginning to contemplate relocating their inhabitants, looking toward Australia. Indeed, some inhabitants of islands in Kiribati have already been forced to relocate.

Rising sea levels will present other problems. They will exacerbate coastal and other low-lying area flooding, and intensify storm surges, erosion, and other coastal hazards. This in turn will threaten vital infrastructure, settlements, and facilities that support the livelihood of island peoples. Rising sea levels may also directly affect freshwater resources, agricultural production, and island biodiversity. By mid-century, water resources in many small islands are predicted to reach the point where they become inadequate to meet the needs of their inhabitants during low rain periods.

Increasing ocean temperatures may also stress ocean ecosystems, destroying habitats and altering migratory patterns of some ocean species. Coral reefs, which have been termed the rainforests of the ocean, are acutely sensitive to water temperature and thus are at particular risk. Coral reefs grow slowly and take many years to recover from damage. Their destruction has very serious implications because “fish depend on coral reefs for food and shelter, while coastal inhabitants depend on coral reefs for culture and food.” Increasing ocean temperatures may also cause the migratory patterns of some ocean species to change, which could destroy habitats. In addition, higher temperatures may cause non-native species invasions to increase.

Finally, many island states heavily depend on tourism for income and foreign exchange, and there is little doubt that these negative effects have great potential to disrupt tourism. Beach erosion, soil salinization, increased stresses on coastal ecosystems, and damage to the infrastructure can only have a negative impact on tourism. Thus, at best, these nations face a tremendous assault upon their environment and, since their economies are intimately tied to the environment, their economies are likely to decline, perhaps drastically. At worst, they face the total destruction of their homes, cultures, and communities--that is the end of their existence as a community.

### C. Native Communities of the North

Island nations might look to the societies of the Arctic as a window into their future. Arctic communities are already being displaced as their surroundings become uninhabitable. The Arctic is extremely vulnerable to the effects of current and projected climate change, and it is already experiencing some of “the most rapid and severe climate change on earth.” Given this vulnerability, the region is already experiencing “deterioration in ice conditions, a decrease in the quantity and quality of snow, changes in the weather and weather patterns, and a transfigured landscape as permafrost melts at an alarming rate, causing slumping, landslides, and severe erosion in some coastal areas.” One of the most important changes has been in the sea ice, which has diminished and become thinner, and is freezing later and thawing earlier. This has had a profound impact, as the Inuit depend on ice of a certain thickness to travel, hunt, harvest, and communicate between communities. “The quality, quantity and timing of snowfall have also changed,” with implications for igloo building and travel. “Permafrost, which holds together unstable underground gravel and inhibits water drainage, is melting at an alarming rate, causing . . . landslides, severe erosion and loss of ground moisture, wetlands and lakes.” This erosion has had a devastating effect on Inuit tribes, forcing relocations in some cases. There have been changes in water levels, more unpredictable weather, and changes in the location, characteristics, amount, and health of plant and animal species. “Increased temperatures and sun intensity have heightened the risk of previously rare health problems.”

All of these changes have wrought profound changes upon the Inuit community, gravely affecting their way of life. The projected impact, however, may mean total destruction of their way of life. In the Arctic Climate Impact Assessment, it is predicted, inter alia, that:

- warming will increase four to seven degrees Celsius or twice the global average rate;
- precipitation will increase, winters will become shorter and warmer, and snow and ice cover will substantially decrease;
- reductions in sea ice will drastically shrink marine habitats for a number of species;
- land based creatures will likely be increasingly stressed as climate change alters breeding grounds, food sources, and migration routes;
- species ranges will shift northward;
- more diseases will shift from animals to humans;
- rising sea levels and a reduction in sea ice will result in higher waves and thus contribute to coastal erosion;
- thawing permafrost will weaken coastal lands; and
- flooding in coastal wetlands will increase.

The species upon which many indigenous peoples depend “not only for food and to support the local economy, but also as the basis for cultural and social identity,” are at severe risk. Moreover, it will be increasingly difficult to safely travel to access these species, posing perhaps

insurmountable challenges to human health and food security. Because of this intimate connection between Inuit culture and the health of their environment, the “widespread environmental upheaval resulting from climate change violates the Inuit’s right to practice and enjoy the benefits of their culture.”

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## NOTES AND QUESTIONS

1. What do you think are the most appropriate way of addressing the injustices that Professor Gordon describes? Professor Maxine Burkett recommends setting up a reparations system at a global scale to address climate justice concerns. She argues that “any successful reparations effort must contain three critical elements: an apology, a monetary or other award that gives actual or symbolic weight to that apology, and, most importantly, a commitment by the perpetrator not to repeat the offending act, also known as the ‘guarantee of nonrepetition.’” Maxine Burkett, *Climate Reparations*, 10 MELBOURNE JOURNAL OF INTERNATIONAL LAW 509 (2009). How might such a system complement current efforts to engage in Clean Development Mechanism projects and establish an adaptation fund? What would be a reparations system’s greatest benefits and limitations?
2. At a domestic level, Professor Alice Kaswan has argued for weaning our nation from fossil fuels and greening the energy grid as important mechanisms for addressing climate change justice. Alice Kaswan, *Greening the Grid and Climate Justice*, 9 ENVTL. L. 1143 (2009). To achieve clean energy goals and also address justice concerns, Professor Burkett additionally argues that we need a domestic Clean Development Mechanism (CDM) that creates clean energy projects in low-income communities of color. As she explains:

In the short term, adoption of the domestic CDM, though not the overarching remedy that environmental justice advocates would like to see most, is the remedy that is consistent with the current trajectory of policy-makers and, as such, is the most feasible approach. There are also significant advantages that attach to this solution. Besides meeting the theoretical and practical mandates of the environmental justice movement, it is an important engine for emergent economic development opportunities across the nation's rural and urban communities. This and the struggle for more fundamental systemic changes can, and should, be done concurrently.

The additional, though less obvious, benefit of this analysis is that it sets a framework for how the United States can meet its responsibilities and obligations to poor and of-color communities throughout the globe. Climate justice, in other words, can forcefully encourage the United States to consider the consequences of its political and economic character and incorporate the attendant moral obligations into its choice of solutions. If the environmental justice movement cannot curb the excesses of the United States' political economy, however, it will surely be ill-equipped to do so on a global scale. There is a growing sense that the continued relevance of the movement is hinged on its ability to have consequence

in the fate of the global poor and of-color. The environmental justice movement, therefore, must be a critical and consequential crafter of domestic, and ultimately global, solutions.

Maxine Burkett, *Just Solutions to Climate Change: A Climate Justice Proposal for a Domestic Clean Development Mechanism*, 56 BUFF. L. REV. 169 (2008).

What do you think about the possibility of developing a domestic CDM as part of our domestic effort to address climate change injustice?

### 3. Climate Change Refugees

If major climate change takes place, many people will need to move from their communities and, in some cases, their countries. This relocation will not only pose issues for those forced to leave, but also for those receiving them. These concerns raise questions about the legal structures needed to manage these shifts.

The following excerpt from an article by Professors Bonnie Docherty and Tyler Giannini details the looming problem of migration induced by climate change. It describes the inadequacy of our existing refugee and climate change legal frameworks to address the needs of these migrants.

|| **Bonnie Docherty & Tyler Giannini, *Confronting a Rising Tide: A Proposal for a Convention on Climate Change Refugees*, 33 HARV. ENVTL. L. REV. 349 (2009).** ||

#### I. Introduction

Climate change will force millions of people to flee their homes over the coming century. Rising sea levels threaten to envelop small island states. Desertification will make swaths of currently occupied land uninhabitable. More intense storms will drive people, at least temporarily, to relocate to safer ground. Studies predict that by 2050 the number of climate change refugees may dwarf the number of traditional refugees--that is, those entitled to protection under the 1951 Refugee Convention and its 1967 Protocol. Climate change is an environmental phenomenon, yet most scientists agree that human activities around the world contribute to it. Because the nature of climate change is global and humans play a contributory role, the international community should accept responsibility for mitigating climate-induced displacement. States should develop an innovative, international, and interdisciplinary approach that can be implemented before the situation reaches a crisis stage. To date, no such satisfactory solution exists.

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#### II. Foundational Issues

Studies predict that, over the coming decades, environmental disruptions caused by climate change will lead tens, and perhaps hundreds, of millions of people to leave their homes and in some cases their countries. At the same time, both international legal frameworks and their associated institutions have gaps in their mandates that make it difficult for them to address the problem adequately. The existing refugee and climate change regimes in particular are ill-suited

to handle this foreseeable migration. Any solution to the population flows resulting from climate change will require a new holistic and interdisciplinary approach because the problem does not fit solely within a human rights or an international environmental law framework.

#### A. The Emerging Problem of Climate Change Migration

Acknowledgment of the emerging problem of climate change migration has grown over the past two decades. As early as 1990, the Intergovernmental Panel on Climate Change (“IPCC”), a United Nations scientific body that won the 2007 Nobel Peace Prize for its comprehensive and objective reports on climate change, highlighted the effect of climate change on humans. It stated that “[t]he gravest effects of climate change may be those on human migration as millions are uprooted by shoreline erosion, coastal flooding and agricultural disruption.” More recently, the United Nations Office of the High Commissioner for Human Rights (“OHCHR”) has begun to pay specific attention to climate change, noting that it could affect hundreds of millions of people in numerous ways, including through “permanent displacement.” In February 2008, the Deputy High Commissioner for Human Rights said:

By 2050, hundreds of millions more people may become permanently displaced due to rising sea levels, floods, droughts, famine and hurricanes. The melting or collapse of ice sheets alone threatens the homes of 1 in every 20 people. Increased desertification and the alteration of ecosystems, by endangering communities' livelihoods, are also likely to trigger large population displacements.

Thus, experts in both the environmental and human rights communities have expressed concern about the seriousness of climate change migration.

Estimates of the number of people who will flee their homes because of climate change vary depending on the definition of the class of displacees and the source of the data. While some research urges caution in attempting to predict a number, other studies present figures ranging from 50 million to 200 million displaced persons before 2100. Norman Myers, for example, observed in 1995 that “global warming could put large numbers of people at risk of displacement by the middle of next century if not before.” Myers continued:

Preliminary estimates indicate the total [number] of people at risk of sea-level rise in Bangladesh could be 26 million, in Egypt 12 million, in China 73 million, in India 20 million, and elsewhere 31 million, making an aggregate total of 162 million. At the same time, at least 50 million people could be at risk through increased droughts and other climate dislocations.

The oft-cited 2006 Stern Review, a major British government study on climate change, notes that while Myers' estimate of 150 to 200 million persons has not been “rigorously tested,” such numbers “remain in line with the evidence presented . . . that climate change will lead to hundreds of millions more people without sufficient water or food to survive.” Estimates for displacement in Egypt and the Mekong Delta alone run as high as ten million for each area. By comparison, the Office of the United Nations High Commissioner for Refugees (“UNHCR”), the central United Nations organ that deals with traditional refugees, reported that globally in 2006 there were fewer than ten million refugees as defined by the 1951 Refugee Convention. Regardless of the exact figure of those displaced by climate change, experts have recognized this burgeoning problem.

The displaced will include both those who relocate within a country and those who leave their home state. In reviewing climate change's impact on security in 2008, the German Advisory Council on Global Change observed that “[i]t is likely that growing numbers of people will be affected by environmentally-induced migration and migration movements will more and more

frequently take place across national borders.” This transboundary displacement could have negative effects around the globe. According to the German Advisory Council, climate change has “implications not only for the affected societies but for the international system as a whole. . . . Migration, for example, could become unmanageable.” While exact numbers of those who will cross borders in such situations is difficult to predict at present, the numbers will be substantial--likely in the millions given the consistent projections of much higher levels of overall displacement.

Observers predict that climate change migration will particularly affect certain hotspots, especially small island states, coastal zones, and regions of Africa and Asia. Floods and the frequency and intensity of storms will likely increase internal and international displacement, particularly in Asia. Sea-level rise will probably be most acute for small island states and areas of Asia. Glacial melts have been linked to environmental migration in South Asia. Drought and water scarcity will probably have the greatest impact on people who live in Africa and Asia.

Three categories of climate change effects--rising sea levels; an increasing quantity and intensity of storms; and drought, desertification, and water shortages--are expected to contribute most to migration flows. The number of people forced to migrate may dramatically increase as these effects become more pronounced. These impacts are among the most agreed-upon consequences of climate change and appear to be those most likely to result in forced transnational flight. Such migration may occur temporarily, as when people flee a severe storm, or on a more permanent basis, as either an entire state or a substantial part of a state becomes uninhabitable.

The prospect of entire nations disappearing is real for small island states. Their low elevation (sometimes only a few meters above sea level) and large coastal areas will exacerbate the effects of climate-induced disruptions. The Maldives, for example, could see portions of its capital flooded by 2025. Other states, including Kiribati, Tuvalu, the Marshall Islands, and several Caribbean islands, are also considered threatened. Although there has been much publicity about rising sea levels and potentially “sinking states,” storms or water shortages also pose significant risks to small island states. Any of these effects of climate change could cause inhabitants to flee their country.

While some states may cease to exist, others may lose portions of territorial lands, which would in turn spur migration. Climate change will greatly affect coastal zones in certain regions, particularly in Asia. Major disruptions loom for certain low-lying, shoreline areas, such as those in Bangladesh, regions of which will be submerged. Eighty percent of Bangladesh is a delta, and the country is “specially susceptible to the impacts of global warming, including enhanced typhoons, storm surges and sea-level rise.” In 1995, half of Bhola Island in Bangladesh became permanently flooded, leaving homeless 500,000 people, who have been described as some of the world's first climate change refugees. In all, scientists predict rising sea levels may ultimately swallow more than twenty percent of Bangladesh's land.

While the exact numbers of people who will be forced to cross borders because of climate change is not known, there are growing indications that the numbers are significant. This displacement may overwhelm not only receiving states but also the international legal system, which has yet to develop an adequate legal regime or institutionalized response to the problem.

## B. The Legal Gap

Neither of the most relevant legal frameworks--namely refugee law and climate change law--precisely and definitively addresses the issue of climate change refugees, a term that in this

Article refers to those who flee climate-induced disruptions across national boundaries and that will be defined in detail below. While broad principles of international law may have some normative value and provide arguments for assisting these refugees, there is a clear lacuna in the existing international legal system. No legal instrument specifically speaks to the issue of climate change refugees, and no international institution has the clear mandate to serve this population, which needs human rights protection and humanitarian aid. Discussing the relationship between climate change, migration, and human rights in February 2008, OHCHR's Deputy Commissioner of Human Rights emphasized the importance of “reflect[ing] upon gaps in protection.” In short, displacement due to climate change is a de facto problem currently lacking a de jure solution.

#### 1. Lack of Legal Frameworks

In principle, refugee and climate change law offer possibilities for addressing the problem of climate change migration. Despite proposals for them to do so, however, neither regime has embraced the notion of providing rights and aid to those who flee environmental disruption.

The refugee regime's narrow definition of refugee restricts its power to help with the climate change situation. The 1951 Refugee Convention defines a refugee as someone with a “well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion.” Most commentators do not believe that environmental refugees, a concept that gained traction decades after the Refugee Convention's adoption, fall within its scope. They argue that climate change refugees have not been persecuted in the same way that traditional refugees have. Climate change refugees can, and still do, look to their home states for protection in ways that those fleeing traditional persecution, often at the hands of the state, do not. There has also been little political mobilization to amend the Refugee Convention's core definition, leaving the Convention too narrow an instrument to look to for protection for climate change refugees. The UNFCCC applies directly to climate change, but it too has legal limitations for dealing with climate change refugees. As an international environmental law treaty, the UNFCCC primarily concerns state-to-state relations; it does not discuss duties that states have to individuals or communities, such as those laid out in human rights or refugee law. It is also preventive in nature and less focused on the remedial actions that are needed in a refugee context. Finally, although the UNFCCC has an initiative to help states with adaptation to climate change, that program does not specifically deal with the situation of climate change refugees. Like the refugee regime, the UNFCCC was not designed for, and to date has not adequately dealt with, the problem of climate change refugees.

#### 2. Lack of Institutions

Even if a legal framework for providing protection and aid to climate change refugees could be found in international law, the practical reality is that the international community and existing institutions are not addressing the problem. No comprehensive response, either internationally or nationally, has emerged, and small ad hoc initiatives are unlikely to provide the consistency and breadth needed for a long-term solution.

UNHCR has not instituted protections for environmental refugees and has not viewed its mandate as including such protections. Given the potential number of climate change refugees, UNHCR is likely concerned about expanding its mandate to include a population that would overwhelm its institutional capacity.

The UNFCCC's existing institutions are also ill-suited to take on the climate change refugee problem at present. Its adaptation efforts focus primarily on prevention and mitigation of climate change itself, rather than assistance for those who cross borders to flee climate change's effects.

In sum, because neither the refugee nor the climate change regime was specifically created to solve such climate-induced dislocation, a major legal and policy void needs to be filled.

### C. A Broad, Interdisciplinary Legal and Policy Framework

Climate change is expected to spark migration, and the lack of existing law and institutions will exacerbate the situation. A number of other factors, however, play a role in the emerging climate change refugee problem and should inform the solution. Conditions beyond environmental disruption, such as poverty, can contribute to displacement that is primarily caused by climate change. Climate-induced problems may lead to circumstances, such as armed conflict, that increase population flows. Various stresses, including population growth and poor governance, affect countries' abilities to prevent the need for relocation and to cope with any displacement that occurs. Climate change migration also involves a wide range of actors, including individuals, communities, home and host states, and the international community more broadly, which complicates efforts to deal with climate change migration fairly and effectively. A holistic approach to the climate change refugee problem should consider the needs and positions of parties and encompass a variety of relevant disciplines, including law, science, economics, technological innovation, development, and poverty alleviation.

The climate change refugee instrument that this Article proposes is only part of a larger framework for tackling foreseeable climate change migration. Because there are limits to what the law can achieve, other policy efforts are likely to be just as critical. Policies that help decrease the factors that compel people to leave are important. For example, the UNFCCC's 2007 Bali Action Plan promotes national initiatives to support sustainable development, economic diversification, conservation of forests, and technology transfers. In the context of considering climate change's impact on security, the German Advisory Council recommends the use of multiple disciplines, such as water management, poverty reduction, and agricultural programs, to help prevent security concerns from arising in their most severe form. The climate change refugee instrument should thus complement, rather than replace, other efforts that can reduce the need for individuals to flee their nations and generally mitigate the situation.

In addition, more inclusive approaches that apply to all those who flee climate change disruptions should supplement the binding climate change refugee instrument. Internally displaced persons (“IDPs”), who involuntarily leave their homes but not their countries because of climate change, should be part of the framework to deal with climate change displacement more broadly. Such displacement fits under the rubric of improving human security and well-being. In some situations, such as when a state fails in its responsibility to protect a community, IDPs may have as much need as refugees for international assistance. The issue of climate change IDPs is beyond the scope of this Article, but it deserves attention as the international community develops ways to deal with climate change migration.

### D. Conclusion

The international community is now faced with the emergence of climate change-induced migration that will likely lead to millions of refugees crossing state borders during the next century. As evidenced by the inadequacies of the existing refugee and climate change frameworks, there is a clear need for a more specific and specialized legal instrument to fill the gap that presently exists within international law. While that instrument should be viewed as one

piece of a larger solution to the problem of displacement, it would be a critical step toward mitigating the burgeoning crisis of climate change refugees.

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## NOTES AND QUESTIONS

1. Lester Brown first used the term “environmental refugee” in 1976, and since then it and other variations have been used to describe people who are relocating in significant part due to environmental factors. The situations in which people migrate are often complex, with poverty and political instability interacting with the environmental factors involved. Professor Gaim Kibreab argues that this complexity makes a clear understanding of the precise role of climate change in migration difficult. He notes:

Although the warming of the earth's climate system is not any longer controversial, its social impacts, for example, on precipitation, food insecurity, land use changes and overall agricultural production are still ambiguous. More equivocal are also the impact of climate change on human migration. This should not be construed to imply that climate change is an irrelevant factor in causing migration--be it forced or voluntary. What is emphasized is the fact that climate change operates in interaction with other multiple factors from which it is impossible to isolate. The claim that climate change causes population displacement is based on the wrong assumption that displacement is partly mono-causal and climate change can be isolated from other inextricably interwoven drivers of migration or displacement.

The reason the available estimates of people displaced by climate change are unreliable is due to the fact that migration is the result of multiple causes and, therefore, it is difficult to isolate the role of the environment from the other drivers of migration....

Therefore there is need for concerted international action not only in terms of addressing the root causes of climate change and in mitigating its detrimental consequences, but also in meeting the protection and assistance needs of those who are affected. In the presence of political will, negotiated scheme of burden-sharing, international and regional solidarity, investment in poor and vulnerable countries' disaster preparedness and effective early warning systems, the protection and assistance needs of many of the persons whose displacement is induced by environmental change can be met within the framework of the existing international protection regime manifested in the 1951 U.N. Convention, the 1967 Protocol, the 1969 OAU Convention, the 1984 Cartagena Declaration and the 1998 Guidelines on the Principles of Internal Displacement.

Gaim Kibreab, *Climate Change and Human Migration: A Tenuous Relationship?*, 20 FORDHAM ENVTL. L. REV. 357 (2009).

How should strategies for dealing with relocation related to climate change deal with its multi-factor character?

2. How should we address the gaps in the law regarding climate change refugees? In the above article, Professors Docherty and Giannini argue for a new instrument on the issue. Professor Elizabeth Burleson suggests that these issues be dealt with in the adaptation mechanisms under the UNFCCC. Elizabeth Burleson, *Climate Change Displacement to Refugee*, 5 J. ENVTL. L. & LITIG. 19 (2010). What do you think would be the best approach?

#### 4. National Security Concerns

The impacts of major climate change would be massively destabilizing at subnational, national, regional, and international levels. In some circumstances, resulting resource scarcity or shifting of particular ethnic groups might lead to armed conflict. Even when they do not, climate change will still cause significant shifts in the geopolitical map that also raise national security concerns.

The United Nations Security Council debated these issues for the first time in April 2007. The following excerpt from that debate illuminates some of the complexities at the intersection of climate change with peace and security.

**Dept. Public Info., News & Media Division, New York, Security Council, 5663<sup>rd</sup> Meeting (AM & PM), SC/9000, Security Council Holds First-Ever Debate on the Impact of Climate Change on Peace and Security, Hearing over 50 Speakers, Apr. 17, 2007, available at <http://www.un.org/News/Press/docs/2007/sc9000.doc.htm>.**

With scientists predicting that land and water resources will gradually become more scarce in the coming years, and that global warming may irreversibly alter the face of the planet, the United Nations Security Council today held its first-ever debate on the impact of climate change on security, as some delegates raised doubts over whether the Council was the proper forum to discuss the issue.

The day-long meeting, called by the United Kingdom, aimed to examine the relationship between energy, security and climate, and featured interventions from more than 50 delegations, representing imperilled island nations and industrialized greenhouse gas emitters alike. While some speakers praised the initiative, there were reservations from developing countries, which saw climate change as a socio-economic development issue to be dealt with by the more widely representative General Assembly. Many delegations also called for the United Nations to urgently consider convening a global summit on the issue.

The session was chaired by British Foreign Secretary, Margaret Beckett, whose country holds the presidency of the 15-nation Council for April. She said that recent scientific evidence reinforced, or even exceeded, the worst fears about climate change, as she warned of migration on an unprecedented scale because of flooding, disease and famine. She also said that drought and crop failure could cause intensified competition for food, water and energy.

She said that climate change was a security issue, but it was not a matter of narrow national security -- it was about "our collective security in a fragile and increasingly interdependent world". By holding today's debate, the Council was not seeking to pre-empt the authority of other bodies, including the General Assembly and the Economic and Social Council. The decisions that they came to, and action taken, in all those bodies required the

fullest possible understanding of the issues involved. “[So] climate change can bring us together, if we have the wisdom to prevent it from driving us apart,” she declared.

Calling for a “long-term global response” to deal with climate change, along with unified efforts involving the Security Council, Member States and other international bodies, Secretary-General Ban Ki-moon said that projected climate changes could not only have serious environmental, social and economic implications, but implications for peace and security, as well.

“This is especially true in vulnerable regions that face multiple stresses at the same time - pre-existing conflict, poverty and unequal access to resources, weak institutions, food insecurity and incidence of diseases such as HIV/AIDS,” he said. The Secretary-General outlined several “alarming, though not alarmist” scenarios, including limited or threatened access to energy increasing the risk of conflict, a scarcity of food and water transforming peaceful competition into violence and floods and droughts sparking massive human migrations, polarizing societies and weakening the ability of countries to resolve conflicts peacefully.

China’s representative was among those who argued that the Council was not the proper forum for a debate on climate change. “The developing countries believe that the Security Council has neither the professional competence in handling climate change -- nor is it the right decision-making place for extensive participation leading up to widely acceptable proposals,” he said.

The issue could have certain security implications, but, generally speaking, it was, in essence, an issue of sustainable development. The United Nations Framework Convention on Climate Change had laid down the fundamental principles for the international community’s response to climate change. The Kyoto Protocol had set up targets for developed countries -- limited, but measurable -- for reducing greenhouse gas emissions. To effectively respond to climate change, he said it was necessary to follow the principle of “common, but differentiated, responsibilities” set forth in the Convention, respect existing arrangements, strengthen cooperation and encourage more action.

The representative of Pakistan, speaking on behalf of the “Group of 77” developing countries and China, agreed, saying that the Council’s primary duty was to maintain international peace and security. Other issues, including those related to economic and social development, were assigned to the Economic and Social Council and the General Assembly. The ever-increasing encroachment of the Security Council on the roles and responsibilities of the other main organs of the United Nations represented a “distortion” of the principles and purposes of the Charter, infringed on the authority of the other bodies and compromised the rights of the Organization’s wider membership.

But Papua New Guinea’s representative, who spoke on behalf of the Pacific Islands Forum, said that the impact of climate change on small islands was no less threatening than the dangers guns and bombs posed to large nations. Pacific island countries were likely to face massive dislocations of people, similar to population flows sparked by conflict. The impact on identity and social cohesion were likely to cause as much resentment, hatred and alienation as any refugee crisis.

“The Security Council, charged with protecting human rights and the integrity and security of States, is the paramount international forum available to us,” he said. The Forum did not expect the Council to get involved in Climate Change Convention negotiations, but it did expect the 15-member body to keep the issue of climate change under continuous review, to ensure that all countries contributed to solving the problem and that those efforts were

commensurate with their resources and capacities. It also expected the Council to review sensitive issues, such as implications for sovereignty and international legal rights from the loss of land, resources and people.

Singapore's speaker said that, while it was obvious that there was some discomfort about the venue and nature of today's debate, it was equally obvious that climate change was "the" global environmental challenge. Given their paucity of resources, developing countries would be the hardest hit, and some had their survival at stake. But it was not only the poor that would suffer. There was broad consensus that it was necessary to act to arrest what "we ourselves are responsible for". Many of the problems caused by climate change could only be tackled if nations worked together.

"Let us view our procedural disagreements against this backdrop," he said. While it might be difficult to quantify the relationship between climate change and international peace and security, there should be no doubt that climate change was an immediate global challenge, whose effects were transboundary and multifaceted. He was not advocating that the Security Council play a key role on climate change, but neither could he deny that body "some sort of a role, because it seems obvious to all but the wilfully blind that climate change must, if not now, then eventually have some impact on international peace and security.

Also participating in today's debate were the Minister for Foreign Affairs of Slovakia, the Under-Secretary of State for Foreign Affairs of Italy, the Federal Minister for Economic Cooperation and Development of Germany (on behalf of the European Union), the Minister for Development and Cooperation of the Netherlands and the Minister for State and Foreign Affairs of the Maldives.

Others taking part in the meeting were the representatives of Belgium, Ghana, Congo, Qatar, United States, France, Indonesia, Panama, South Africa, Russian Federation, Peru, Switzerland, Japan, Namibia, Barbados, Ukraine, Egypt, Australia, New Zealand, Tuvalu, Bangladesh, Venezuela, Sudan (on behalf of the African Group), Solomon Islands, Palau, Denmark, Iceland, Marshall Islands, Philippines, Mexico, Brazil, India, Republic of Korea, Norway, Federated States of Micronesia, Argentina, Cuba (on behalf of the Non-Aligned Movement), Liechtenstein, Bolivia, Cape Verde, Costa Rica, Israel, Canada, Mauritius and Comoros.

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## NOTES AND QUESTIONS

1. The countries participating in this interchange disagreed about whether the U.N. Security Council was an appropriate venue for engaging these issues. What do you think about the venue and about the substantive issues being discussed?
2. Professor David Caron is exploring the economic, geopolitical, and security consequences of Arctic melting. He argues that we are in a transitional state between a frozen Arctic Ocean and a fully melted one, with the sea now accessible for part of the year. Once the Arctic Ocean is fully melted, there will be difficult questions of national and international control and access. How do you think an open Arctic Ocean should be managed?
3. A dozen retired U.S. generals and admirals served as a Military Advisory Board to assess how climate change could affect this country's national security over a thirty to forty year timeframe. Their primary findings were:

Projected climate change poses a serious threat to America's national security....Climate change acts as a threat multiplier for instability in some of the most volatile regions of the world....Projected climate change will add to tensions even in stable regions of the world. Climate change, national security, and energy dependence are a related set of global challenges.

Their recommendations were:

1. The national security consequences of climate change should be fully integrated into national security and national defense strategies....
2. The U.S. should commit to a stronger national and international role to help stabilize climate change at levels that will avoid significant disruption to global security and stability....
3. The U.S. should commit to global partnerships that help less developed nations build the capacity and resiliency to better manage climate impacts....
4. The Department of Defense should enhance its operational capability by accelerating the adoption of improved business processes and innovative technologies that result in improved U.S. combat power through energy efficiency....
5. The Department of Defense should conduct an assessment of the impact on U.S. military installations worldwide of rising sea levels, extreme weather events, and other projected climate change impacts over the next 30 to 40 years.

CNA Corporation, *National Security and the Threat of Climate Change (2007)*, available at [http:// www.cna.org/nationalsecurity/climate/report/SecurityandClimate\\_Final.pdf](http://www.cna.org/nationalsecurity/climate/report/SecurityandClimate_Final.pdf).

## **B. Scenario Two: Efforts to Reverse Climate Change through Geoengineering**

As the prospects seem increasingly poor of bringing emissions down to the levels that scientists say are needed to avoid the most serious impacts of climate change, some scientists and policymakers have begun to consider whether a technological solution to climate change is possible. Specifically, they hope to reverse climate change by altering the key components of the climate system in ways that reduce greenhouse gases already in the environment or limit their warming effects. These strategies are referred to as geoengineering.

This section explores the scenario in which we attempt to reverse climate change through these geoengineering approaches. It begins by considering the capacity of current science and technology to reverse climate change and the direction that this research is going. It then turns to the limited legal regime currently applicable to geoengineering. It concludes with an assessment of the risks and benefits of attempting to solve climate change in this fashion.

### **1. The State of the Science and Technology**

The science and technology of geoengineering are developing rapidly and numerous leading groups of scientists are considering different options. Geoengineering approaches, as a physical matter, largely fall into two categories. The first, known as solar radiation management (SRM), involves increasing the reflectivity of the earth to decrease the warming. These

techniques do not address the root causes of climate change, but might work rapidly to stop the planetary heating and its associated harms (though not some of the other problems like ocean acidification). The second, known as carbon dioxide removal (CDR), involves physically removing carbon from the environment in a variety of ways. These approaches address the root causes of climate change, but tend to be slower in their impacts.

The following excerpt from Professor Albert Lin describes the growing interest in finding technological fixes for climate change and some of the leading proposed methods for using geoengineering to address climate change. It focuses on two widely discussed approaches: putting aerosols into the atmosphere and fertilizing the ocean.

|| **Albert C. Lin, *Geoengineering Governance*, 8 ISSUES IN LEGAL SCHOLARSHIP (2009),** ||  
**available at <http://www.bepress.com/ils/vol8/iss3/art2>.**

Mounting evidence of the seriousness of the climate change problem has prompted increased domestic and international efforts to slow or counter expected changes. The main focus of such efforts has been to curb greenhouse gas (GHG) emissions, whether through cap-and-trade schemes, vehicle emission standards, land use regulation, or other tools. Recent proposals in Congress have called for an 80% reduction in U.S. GHG emissions from 2005 levels by the year 2050, and according to widely accepted estimates, GHG emissions must decrease by at least 50% worldwide within the same period if the most serious climate change impacts are to be avoided.

Global and national-level efforts to reduce emissions, however, have been relatively unsuccessful thus far. Internationally, the Kyoto Protocol called for reductions of up to eight percent in GHG emissions from 1990 levels by industrialized countries during the period from 2008 to 2012, yet even this modest goal appears out of reach. Meanwhile, atmospheric GHG concentrations have continued rising steadily, as have mean global temperatures. Indeed, observations of actual changes in climate, such as the rate of glacial retreat and the extent of polar ice melt, have tended to exceed predictions regarding such changes.

The difficulties associated with achieving the drastic emissions reductions needed to avoid the more serious risks of climate change have led scientists, scholars, and policymakers to begin to consider potential technological approaches to the problem. One such approach, carbon capture and sequestration (CCS), would capture CO<sub>2</sub> from power plants and compress it for sequestration in stable geological formations underground or in the oceans. CCS is not a perfect solution: some of the sequestered CO<sub>2</sub> would likely return to the atmosphere over time; additional energy would be required to separate, compress, and inject CO<sub>2</sub>; and surface releases of CO<sub>2</sub> at high concentrations could result in deaths or cause harm to flora and fauna. Nevertheless, policymakers consider CCS to be a low-risk abatement strategy, the design of potential regulatory regimes for CCS is underway, and implementation of CCS projects has begun.

Another, more controversial, technological approach to climate change is geoengineering. Geoengineering refers to various techniques, such as the release of aerosols into the stratosphere or the fertilization of the oceans, that focus on mitigating the consequences of higher GHG concentrations, rather than on reducing GHG emissions or capturing emissions before they are released into the environment. To date, the debate over geoengineering technologies among

policymakers and scientists has tended to concern whether or not they should be deployed in response to the climate change problem. What has received less attention are the preliminary yet fundamental questions of geoengineering governance. These questions include: who should decide whether geoengineering research or deployment should go forward, how such decisions should be made, and what mechanisms should be in place to address the risk of deployment by rogue actors.

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## **I. THE BASICS OF GEOENGINEERING**

In contrast to relatively uncontroversial technologies that reduce GHG emissions through increased energy efficiency or the use of renewable energy, geoengineering technologies involve projects that are intended specifically to mitigate the effects of GHG emissions once they are released. This intent, combined with the grand scale of these projects, are defining features of geoengineering proposals, scientist David Keith has suggested. This Part provides a brief overview of leading geoengineering proposals, including potential risks associated with each.

### **A. Albedo Modification**

Some geoengineering proposals seek to reduce the amount of energy the Earth absorbs by modifying the Earth's albedo (i.e., reflectivity). Examples of such proposals include (1) the release of particles into the stratosphere, and (2) the use of space-based deflectors. Each of these technologies presents its own engineering challenges and environmental risks. Scientists have observed that the addition of sulfur to the stratosphere, either through natural activity such as volcanic eruptions or through human activity that generates SO<sub>2</sub> and other pollutants, produces a cooling effect by causing more sunlight to be reflected into space. Chemical and micro-physical processes convert the SO<sub>2</sub> into light-reflecting particles (or aerosols) that remain in the stratosphere for one to two years, counteracting the warming effect associated with higher GHG concentrations. While the deliberate release of SO<sub>2</sub> might stabilize global average temperatures to some degree, it would not necessarily prevent significant local climate changes from taking place. Nevertheless, the use of stratospheric aerosols is probably the most seriously discussed geoengineering proposal because of its relative technical and economic feasibility.

There could be substantial environmental and safety impacts associated with implementing such a scheme, however. One serious concern involves ozone depletion: scientists have found that the release of particles by large volcanic eruptions damages the stratospheric ozone layer that provides protection from the sun's ultraviolet rays. The addition of SO<sub>2</sub> particles to the stratosphere is likely to have a similar effect. Another shortcoming of the release of aerosols is that there would be little or no effect on atmospheric GHG concentrations. This means that such a scheme would only provide temporary relief from any warming effect; the release of aerosols would have to continue for several hundred years to allow the oceans to absorb gradually the CO<sub>2</sub> currently being released by humans. This form of geoengineering, in other words, would only buy time to reduce GHG emissions or to find other means of countering climate change.

Meanwhile, cessation of aerosol release after such a program had been in place for some time could cause far more rapid climate change than would have occurred in the absence of any initial geoengineering efforts. Furthermore, the release of aerosols would do nothing to counter the problem of ocean acidification. The acidity of the ocean is directly correlated to GHG levels, and increased acidity could lead to the loss of many of the Earth's coral reefs, which serve as important marine habitat. Elevated GHG levels would affect terrestrial ecosystems as well, as

plant species that flourish under high concentrations of atmospheric CO<sub>2</sub> gain a competitive advantage over other species, leading to changes in habitat and biodiversity. In addition to these concerns, there may be other adverse effects that we cannot currently anticipate.

An alternative albedo modification approach that could sidestep some of these problems would deploy deflectors in outer space. Under one such proposal, a fleet of almost-transparent discs the size of dustbin lids would be launched into orbits that would keep them between the Earth and the sun, reducing sunlight by nearly two percent, an amount sufficient to counter the warming effect of a doubling of atmospheric GHG concentrations. The use of space-based deflectors would avoid the aforementioned risks (such as ozone depletion) associated with tinkering with the Earth's atmosphere via aerosol releases. The deflectors, however, would have to be replaced at the end of their useful lives, lest rapid climate change occur, and would generate debris that could interfere with Earth-orbiting spacecraft. And compared to the use of stratospheric aerosols, this approach would be far more costly and would face immensely more complicated barriers to implementation.

Finally, albedo modification proposals in general would reduce the amount of sunlight reaching the Earth, and thus likely would have other effects that are not yet fully understood. Sunlight plays a key role in global hydrology, for instance, and reduced solar forcing could disrupt the Asian and African monsoons that are vital to food supplies in those regions of the world.

## **B. Enhancing Oceanic Sinks**

Another set of geoengineering proposals involves the addition of micronutrients to the oceans in order to increase the uptake of carbon by phytoplankton. The theory underlying ocean fertilization proposals is that unavailability of various micronutrients limits biological productivity in certain oceanic regions, such that adding a relatively small amount of the limiting micronutrients will drastically increase phytoplankton populations. While some of the carbon absorbed by phytoplankton will return to the surface ocean through natural decay processes, the sinking of dead phytoplankton will remove the rest of the carbon to the deep ocean and prevent it from reentering the atmosphere. The most common ocean fertilization proposal involves iron. Ice-core data reveals that relatively abundant iron supplies from atmospheric dust during glacial periods coincided with lower atmospheric CO<sub>2</sub> concentrations, leading some scientists to conclude that iron is the most important limiting micronutrient. Although an iron fertilization scheme would require significant quantities of iron, global supplies of this micronutrient are sufficient to support the execution of the proposal at a relatively moderate cost.

Experimental studies, however, have yielded unimpressive results regarding the amount of CO<sub>2</sub> that an iron fertilization scheme would ultimately remove from the atmosphere. Uncertainties surround the rate of vertical mixing in the oceans (which would be necessary to remove carbon from the atmosphere), the form of iron that would optimize phytoplankton growth, and the presence of other nutrients necessary for iron fertilization to be effective. Moreover, ocean fertilization schemes risk significant alteration of marine ecosystems. Phytoplankton form the foundation of marine food webs, and changes in their populations could lead to unpredictable changes in ecosystems, as well as heightened production of methane and other GHGs. Perhaps ameliorating these concerns somewhat, the iron fertilization process can be halted fairly readily if serious negative consequences arise.

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As noted above, the growing number of high level scientific meetings on geoengineering serves as an indicator that this approach is being taken more seriously. These meetings often involve a great deal of contentiousness among scientists as they struggle with the physical uncertainties and ethical implications of deliberate manipulation of the climate system.

The following article describes one such meeting in 2007. It provides the historical context for the meeting and the ethical complexities that arose.

|| **Eli Kintisch, *Scientists Say Continued Warming Warrants Closer Look at Drastic Fixes*, 318 SCIENCE 1054 (2007).** ||

Should scientists study novel ways to alter Earth's climate to counteract global warming? Last week, a group of prominent researchers who gathered here gave a qualified “yes”—after agreeing that the road to understanding the science is fraught with booby traps and that deliberately tinkering with the climate could make the problem worse. Some even admitted to being surprised by their affirmative answer.

“My objective going [into the meeting] was to stop people from doing something stupid,” says climate modeler David Battisti of the University of Washington, Seattle. But rising temperatures and carbon emissions, combined with little meaningful action by politicians, convinced him and his colleagues that it was time for mainstream climate science to look more closely at geoengineering. Even so, Battisti suspects that the participants share the hope of many of those who took part in the Manhattan Project to build the atom bomb: that society would never have to use the knowledge they provided. “It would be incomprehensible that we deploy this,” Battisti says, emphasizing the greater need to cut carbon emissions.

Organized by the University of Calgary and Harvard University, the event allowed 50 elite climate, energy, and economics researchers to explore and debate geoengineering. For decades, the subject has been mostly confined to the pages of science fiction and unfunded by research agencies. But a 2006 paper in *Climatic Change* by Nobelist Paul Crutzen (*Science*, 20 October 2006, p. 401) served as an “enabler” to drive discussion among scientists of the once-taboo topic, says Harvard environmental chemist Scot Martin. Harvard geochemist Daniel Schrag and physicist David Keith of the University of Calgary in Canada then decided to organize the Cambridge event.

One reason most scientists have been leery of probing the topic was the fear that if such technical fixes were taken seriously, public support for cutting carbon emissions would be even more difficult to achieve. “The very best would be if emissions of the greenhouse gasses could be reduced so much that the [geoengineering] experiment would not have to take place,” Crutzen wrote last year. “Currently, this looks like a pious wish.”

Some scientists, however, have been thinking about geoengineering for quite some time. The field's roots lie in dueling Soviet and U.S. weather-modification programs of the 1960s. Since then, advocates have dreamed up schemes to fight warming by blocking sunlight with giant space shades or by creating sea clouds to increase the albedo of the ocean. In 1997, physicist and Star Wars stalwart Lowell Wood and colleagues affiliated with Livermore Berkeley National

Laboratory suggested using aerosols to mimic the cooling effect of volcanoes, and a handful of modeling papers since have simulated that effect.

One of Wood's central points is that the aerosol method is cheap. In 1992, recalls Harvard physicist Robert Frosch, a National Academies' panel on climate resisted his suggestion to include the cost of geoengineering options in a figure on possible solutions to global warming. One relatively simple option: Inject sulfur dioxide into the stratosphere to reduce the amount of solar energy reaching Earth's surface. "Nobody wanted to put the geoengineering line on the figure because it looked too [economically] easy," Frosch told participants.

That cost was a major factor behind the discussions here, with a number of preliminary technical studies hinting that the SO<sub>2</sub> option could be deployed for a few billion dollars a year. That amount could make geoengineering attractive to politicians looking for radical fixes in a warming world. "The decision on whether to do this will not be made by this group," Schrag told his colleagues sitting in the wood-paneled premises of the American Academy of Arts and Sciences. But what scientists can do, he said, is offset the input of groups driven by profit or ideology with solid research on the possible side effects of various geoengineering techniques.

And to get started, the group certainly suggested plenty of side effects. Atmospheric dynamicists attacked the few modeling studies that have simulated geoengineering efforts for down-playing details such as ocean currents or complex feedbacks. (Modelers defended their studies, which use simplified models, as preliminary.) Ecologists pointed out that artificial cooling could lead to serious drying in the tropics and that any fix that lowers Earth's temperature wouldn't address the problem of the steadily acidifying ocean.

Modeler Raymond Pierrehumbert of the University of Chicago in Illinois warned that geoengineering could become a global addiction. "I don't actually work on geoengineering," he told the group. "But now that the genie's out of the bottle, I feel I have to." In one unpublished experiment, Pierrehumbert simulated a future scenario, presumably in the next century, in which the amount of atmospheric CO<sub>2</sub> had quadrupled but Earth was kept cool by a yearly dose of geoengineering. His model showed that a halt in the geoengineering effort—"by, say, a war or revolution"—would result in an 7°C temperature jump in the tropics in 30 years. That rise, he says, would trigger unimaginable ecological effects.

Sallie Chisholm, an MIT biological oceanographer, urged caution. She told *Science* that her colleagues are down-playing the difficulty of determining how "inherently unpredictable" biospheric feedbacks will react to "turning the temperature knob. ... We cannot predict the biosphere's response to an intentional reduction in global temperature through geoengineering."

Other scientists were more willing to entertain the idea of studying climate manipulation but warned about a likely public backlash. Political scientist Thomas Homer-Dixon of the University of Toronto in Canada talked about street protests. "Some people may consider geoengineering to be an act of ultimate hubris," he says. "It's going to provoke fear, anger, guilt, and despair."

Others, however, viewed public alarm about geoengineering as a potentially positive effect. "If they see us talking about this as a last-ditch effort, it might increase their alarm" and drive them

to cut emissions, explained Harvard climate dynamicist Peter Huybers during one of the sessions. By the end of the 2-day event, participants were stunned that they had come so far. “In this room, we’ve reached a remarkable consensus that there should be research on this,” announced climate modeler Chris Bretherton of the University of Washington, Seattle. Nobody dissented.

Mixed in with his new sense of “responsibility,” Battisti says, is dismay that the climate problem has grown so serious as to drive scientists to contemplate steps that, in theory, might lead to more serious problems than continued warming. After speaking on the phone with his wife from his hotel room, Battisti confessed, “I told her this meeting is terrifying me.”

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In a further sign of the shift toward serious consideration of geoengineering, the Intergovernmental Panel on Climate Change (IPCC) will be including geoengineering for the first time in its upcoming Fifth Assessment Report. It is currently convening discussions among experts about how geoengineering fits into the science, impacts and adaptation, and mitigation aspects of its report.

The following excerpt describes the IPCC’s efforts on these issues. It provides an overview of the motivations behind and core goals of a summer 2011 meeting to frame the IPCC’s reporting on geoengineering.

**IPCC Secretariat, Thirty-Second Session of the IPCC, Busan, 11-14 October 2010, IPCC-XXXII/Doc. 5 (3.IX.2010), Agenda Item: 4.2, The IPCC Fifth Assessment Report (AR5), Proposal for an IPCC Expert Meeting on Geoengineering (Submitted by the Co-Chairs of Working Group I, II and III) IPCC-XXXII/Doc.5, p.1.**

### 1. Background

Geoengineering, or the deliberate large-scale manipulation of the planetary environment, is increasingly being discussed as a potential strategy to counteract anthropogenic climate change. Prevailing uncertainty in the sensitivity of the climate system to anthropogenic forcing, inertia in both the coupled climate-carbon cycle and social systems, and the potential for irreversibilities and abrupt, nonlinear changes in the Earth system with possible significant impacts on human and natural systems call for research into possible geoengineering options to complement climate change mitigation efforts.

Geoengineering methods can be largely classified into two main groups: Solar Radiation Management (SRM) and Carbon Dioxide Removal (CDR). While both approaches aim to reduce global temperatures, they clearly differ in their modes of action, the timescales over which they are effective, their effects on temperature and other climate variables (e.g., precipitation), and other possible consequences.

SRM techniques attempt to offset the effects of increased greenhouse gas concentrations by reducing the amount of solar radiation absorbed by the Earth. This may be achieved by increasing the surface reflectivity of the planet, for example by brightening human structures, planting crops with a higher albedo, or covering deserts with reflective material. Other techniques aim to enhance marine cloud reflectivity by introducing sea salt aerosols in low clouds, mimic the effects of volcanic eruptions by injecting sulphate aerosols into the lower

stratosphere, or place shields or deflectors in space to reduce the amount of incoming solar radiation.

CDR techniques aim to address the cause of climate change by removing greenhouse gases from the atmosphere. This would include advanced land use management strategies to protect or enhance land carbon sinks, and the use of biomass for both carbon sequestration (including biochar) and as a carbon neutral energy source. The removal of carbon dioxide from the atmosphere, either through the enhancement of natural weathering processes or direct capture from ambient air are further examples, as well as the enhancement of oceanic CO<sub>2</sub> uptake through ocean fertilisation with scarce nutrients or the enhancement of upwelling processes.

Major uncertainties exist regarding the effects of these techniques on the physical climate system and on biogeochemical cycles, their possible impacts on human and natural systems, and their effectiveness and costs. SRM, for example, could impact regional precipitation patterns while offering no solution for CO<sub>2</sub>-induced ocean acidification. Unilateral action may have environmental side effects on other countries and regions, and may not appropriately address the global scale of the issue. Thus, geoengineering itself may constitute "dangerous anthropogenic interference with the climate system" (Article 2, UNFCCC), and consideration needs to be given to international governance frameworks.

## **2. Expert Meeting**

Current discussions that suggest geoengineering as an option to support climate mitigation efforts remain rather abstract and lack comprehensive risk assessments that take into account possible adverse impacts over short and longer time frames. The understanding of the physical science basis of geoengineering is still limited and IPCC will, for the first time, assess this in several chapters of the WGI [Working Group I] contribution to AR5. Improved scientific understanding of the impacts of geoengineering proposals on human and natural systems will be assessed by WGII [Working Group II]. WGIII [Working Group III] needs to take into account the possible impacts and side effects and their implications for mitigation cost in order to define the role of geoengineering within the portfolio of response options to anthropogenic climate change. Furthermore, this includes an evaluation by WGIII of options for appropriate governance mechanisms.

### **2.1 Objectives:**

The aim of the proposed expert meeting is to discuss the latest scientific basis of geoengineering, its impacts and response options, and to identify key knowledge gaps. The expert meeting would be organised by Working Group III with a cross-Working-Group focus. The following issues will be discussed in more detail:

- different geoengineering options, their scientific basis and associated uncertainties;
- associated potential risks and related knowledge gaps;
- effect of impacts and side effects on mitigation cost and the role within the portfolio of mitigation options
- suitability of existing governance mechanisms for managing geoengineering, including social, legal and political factors
- key knowledge gaps that could be filled in the shorter and longer terms.

### **2.2 Expected Outcome:**

The expert meeting will provide a platform for exchange and discussion among experts from the

different disciplines in order to better address the important cross-cutting issue of geoengineering. This should also encourage the consistent treatment of geoengineering options across the WGs' assessments that will build the basis for the AR5 Synthesis Report. The Expert Meeting will produce a report that could include summaries of keynote presentations, abstracts of expert contributions, reports from breakout group discussions, and a noncomprehensive bibliography of recent literature related to geoengineering.

### 3. Organization

A Scientific Steering Committee will be formed with relevant experts in geoengineering from the IPCC Working Groups.

*Timing:* first half of 2011

*Duration:* 2 to 3 days

*Participants:* About 40 invited experts, with broad international representation. It is proposed that 25 journeys for experts from developing countries and economies in transition including Co- and Vice-Chairs from all Working Groups are allocated as part of the line item "expert meetings related to the AR5" in the IPCC Trust Fund budget for 2011. Participants will be needed with expertise in:

- WGI: clouds/aerosols & climate, carbon cycle & climate, coupled climate - carbon cycle projections
- WGII: impacts on human and natural systems
- WGIII: bottom-up modelling experts, risk analysis, integrated assessment modelling groups, governance and international cooperation. <http://www.ipcc-wg3.de/meetings/expert-meetings-and-workshops/em-geoengineering>

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## NOTES AND QUESTIONS

1. Geoengineering is a broad term that could be applied in its least invasive variation to carbon sequestration and storage efforts (though carbon storage and sequestration is often differentiated from geoengineering, as in the Lin article) and in its most intrusive variation to active changes in the ocean or atmosphere. Carbon storage and sequestration raises its own set of legal issues and risks. For example, Professors Alexandra Klass and Elizabeth Wilson have explored the complex property law questions raised by injecting carbon into the pore space of deep subsurface rock and potential solutions to them. Alexandra B. Klass & Elizabeth J. Wilson, *Climate Change, Carbon Sequestration, and Property Rights*, 2010 U. ILL. L. REV. 363 (2010). Do you feel differently about efforts to capture greenhouse gases and efforts to change the climate system? Why or why not?
2. Those advocating for more aggressive mitigation often have avoided engaging either adaptation or geoengineering for fear of causing disincentives for greenhouse gas emissions reduction. Is there a way to engage those topics while minimizing such risks? As explored in the excerpt from the Intergovernmental Panel on Climate Change's latest report in Chapter One, adaptation will happen in any mitigation scenario because of the extent of our past greenhouse gas emissions and a focus on adaptation may help people engage the consequences of mitigation failures more concretely. Is there an equivalent argument that could be made in the geoengineering context?

## 2. Legal Dilemmas

The legal regime dealing directly with geoengineering is extremely limited. However, international and domestic law on several other topics may apply to geoengineering efforts to reverse climate change. This multiplicity of applicable law poses a significant governance challenge because these treaties and statutes function largely separately from one another. As scientists and policymakers consider the option of geoengineering more seriously, addressing this simultaneous overlap and fragmentation of applicable law is critical.

Moreover, geoengineering raises two phases of governance challenges. The first phase involves research about geoengineering techniques. Since research projects that move beyond modeling often involve some level of implementation, there have been numerous international efforts to create a governance model for the research. The second phase involves full-scale implementation. Although few are arguing for immediate, full-scale implementation, the international mechanisms for it need to be established before such calls become more mainstream.

Many efforts have been made to address the phase one concerns. In a recent example, as the Durban climate change negotiations commenced in December 2011, the Royal Society, Environmental Defense Fund, and TWAS [the academy of sciences for the developing world] published a short report under the auspices of a collaborative project called the Solar Radiation Management Governance Initiative (SRMGI). Based on a March 2011 expert conference, the report presented nine emerging conclusions regarding the governance of SRM research:

**Environmental Defense Fund, The Royal Society & TWAS, Solar Radiation Management: The Governance of Research (2011), available at <http://www.srmgi.org/report/> (last visited Dec. 16, 2011).**

### Message 1

Nothing now known about SRM provides justification for reducing efforts to mitigate climate change through reduced GHG emissions, or efforts to adapt to its effects. The evidence to date indicates that it could be very risky to deploy SRM in the absence of strong mitigation or sustainable CDR methods.

### Message 2

Research into SRM methods for responding to climate change presents some special potential risks. Governance arrangements for managing these risks are mostly lacking and will need to be developed if research continues.

### Message 3

There are many uncertainties concerning the feasibility, advantages and disadvantages of SRM methods, and without research it will be very hard to assess these.

### Message 4

Research may generate its own momentum and create a constituency in favour of large-scale research and even deployment. On the other hand, ignorance about SRM technology may not diminish the likelihood of its use, and in fact might increase it.

Message 5

A moratorium on all SRM-related research would be difficult if not impossible to enforce.

Message 6

Some medium and large-scale research may be risky, and is likely to need appropriate regulation.

Message 7

Considering deployment of SRM techniques would be inappropriate without, among other things, adequate resolution of uncertainties concerning the feasibility, advantages and disadvantages. Opinion varied on whether a moratorium on deployment of SRM methods would be appropriate at this stage.

Message 8

The development of effective governance arrangements for potentially risky research (including that on SRM) which are perceived as legitimate and equitable requires wide debate and deliberation. SRMGI has begun, and will continue to foster, such discussion.

Message 9

International conversations about the governance of SRM should be continued and progressively broadened to include representatives of more countries and more sectors of society. Appropriate international organisations should also be encouraged to consider the scientific, practical and governance issues raised by the research of SRM methods.

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An examination of the details of particular geoengineering schemes highlights the overwhelming legal complexity. The following excerpt by Professor Randall Abate and Mr. Andrew Greenlee provides an example of the difficulties of regulating the leading CDR technique of ocean iron fertilization under existing international law. The article describes ambiguity and, at times, conflict among the treaties that likely apply to this type of geoengineering and their applicability to recent controversial efforts by private companies to attempt projects.

**Randall S. Abate & Andrew B. Greenlee, *Sowing Seeds Uncertain: Ocean Iron Fertilization, Climate Change, and the International Environmental Law Framework*, 27 PACE ENVTL. L. REV. 555 (2010).**

## INTRODUCTION

In a world plagued by the effects of climate change, ocean iron fertilization and other geoengineering techniques could help to respond and adapt to this global environmental crisis. Nevertheless, the international community, consistent with its reactions to other science-inspired

responses to modern problems, has approached the promise of ocean iron fertilization with a half-hearted embrace and a surplus of healthy skepticism.

The controversy surrounding ocean iron fertilization reached a critical juncture in the past year. On January 7, 2009, a team of researchers from Germany's Alfred Wegener Institute for Polar and Marine Research and India's National Institute of Oceanography embarked on an expedition to the Antarctic Peninsula to assess the potential of ocean iron fertilization as a new approach to address climate change. The LOHAFEX team proposed to dump six tons of dissolved iron sulfate over 116 square miles of ocean surface between 200 and 500 nautical miles north or northwest of South Georgia Island to induce rapid growth of a phytoplankton bloom. In theory, such blooms can absorb massive amounts of carbon dioxide from the atmosphere and subsequently fall to the ocean floor, creating a "carbon sink" that effectively sequesters carbon, offsets global emissions of carbon dioxide, and mitigates some of the impacts of global warming.

Despite its laudable intentions, the LOHAFEX ocean iron fertilization proposal drew significant opposition. On January 13, 2009, the German Environment Ministry requested that the German Research Ministry immediately halt the expedition. The Environment Ministry raised concerns about the compatibility of the project with the decisions of the 9th Meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD); the lack of an independent assessment into the potential environmental impacts of the experiment; and the adverse international response to the project by members of the media, who might view the project as a government-subsidized entrance into what could become a multi-billion dollar market. The German Research Ministry responded to these concerns by temporarily halting the project.

Several days later, however, the German Environment Ministry reversed its course and decided to allow the project to proceed. Research Minister Annette Schavan declared that "[a]fter a study of expert reports, I am convinced there are no scientific or legal objections against the . . . ocean research experiment LOHAFEX." Shortly thereafter, the German Environment Ministry issued a press release reiterating its objections and voicing its regret over the decision to allow the experiment to proceed.

Private enterprises proposing ocean iron fertilization experiments have also stirred controversy. Planktos, a company based in the United States, announced plans to use similar technology to generate carbon credits that might be sold or traded. When warned by the United States Environmental Protection Agency (EPA) that such research activities might violate the Ocean Dumping Ban Act of 1988, Planktos responded that its activities would no longer be conducted with a U.S.-flagged vessel. Though Planktos later abandoned the project after failing to secure adequate funding, other commercial outfits such as Climos, which recently announced its plans to engage in iron fertilization of up to 40,000 square kilometers of ocean, are attempting to profit using a similar business model.

The dire threats posed by climate change have inspired innovative methods of carbon sequestration, including ocean iron fertilization as one of a variety of tools to mitigate the threat. However, there is little concrete data available about the environmental consequences of ocean iron fertilization or the efficacy of ocean iron fertilization as a method of carbon sequestration. Moreover, because ocean iron fertilization activities generally take place on the high seas, beyond the jurisdiction of domestic legal regimes, it is unclear which sources of international law should regulate the two categories of ocean iron fertilization projects: (1) the small-scale

research activities that have taken place to date, and (2) the large-scale, and potentially more dangerous, ventures contemplated by private companies.

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## I. THE SCIENCE OF OCEAN IRON FERTILIZATION

Ocean iron fertilization involves adding iron to the sea to artificially stimulate the rapid growth of phytoplankton, whose photosynthetic activity could potentially absorb enough heat-trapping carbon dioxide to help cool the atmosphere of the Earth. In practice, this strategy requires spreading iron particles in ocean areas where iron exists in such low concentrations that its absence limits phytoplankton growth. These waters include the Southern Ocean and the equatorial and northern regions of the Pacific Ocean.

Proponents emphasize the vast potential of ocean iron fertilization as a way to rapidly deploy “carbon sinks” that could draw large amounts of carbon dioxide from the atmosphere. The addition of relatively small amounts of iron offers the possibility of large increases in carbon sequestration and rapid mitigation of climate change at a relatively low financial cost. A pioneer of this method, the late John Martin, famously quipped, “[g]ive me half a tanker of iron, and I’ll give you an ice age.” Yet critics point to three major flaws with this strategy: (1) it may be less efficient than it seems; (2) it could raise a host of foreseeable and unforeseeable adverse environmental consequences; and (3) its effectiveness is difficult to measure.

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## II. THE EXISTING LEGAL FRAMEWORK

A regulatory framework for ocean iron fertilization requires the use of international law because the vast majority of waters best suited for ocean iron fertilization are located in the high seas, beyond the 200-mile jurisdictional boundaries of any coastal nation’s exclusive economic zone. Three international environmental law treaties govern ocean iron fertilization: (1) UNCLOS; (2) the CBD; and (3) the London Convention and Protocol. This part of the article addresses the legality of ocean iron fertilization under each of these treaties and considers the initial responses under these treaties to the legal challenges that ocean iron fertilization has presented.

### A. The United Nations Convention on the Law of the Sea

UNCLOS provides the basic legal framework for both the protection of the world’s oceans and the use of the resources contained therein. UNCLOS is widely regarded as “the constitution for ocean governance.” Its provisions codify the customary international law obligation binding on all states, including non-party nations such as the United States, to prevent practices that damage the marine environment of other nations or areas beyond national jurisdiction.

UNCLOS Article 192 expresses the broad general obligation of all states “to protect and preserve the marine environment.” Likewise, Article 145 provides in principle that “necessary measures shall be taken . . . with respect to activities in the Area to ensure effective protection for the marine environment from harmful effects which may arise from such activities.” While these broad obligations are qualified somewhat by provisions that allow parties the sovereign right to exploit the natural resources in areas within their territorial control, states are nevertheless required to take all necessary measures to: (1) prevent, reduce and control pollution

of the marine environment, (2) prohibit the transfer of damage or hazards from one area to another, and (3) protect rare and fragile ecosystems, as well as the habitat of depleted, threatened, or endangered species from pollution.

Under Article 1(1)(4), UNCLOS defines pollution as:

[T]he introduction by man, directly or indirectly, of substances or energy into the marine environment . . . which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities.

Under this definition, it is not the nature of the substance introduced into the environment that brings an activity within its prohibitions, but the potential deleterious effects that its introduction may have. Proponents of ocean iron fertilization might argue that this definition of pollution would not cover their activities because such activity has not “resulted” nor is it “likely to result” in the deleterious effects proscribed because this same result occurs naturally and the dire results predicted by some are largely based on modeling that operates under the assumption of worst case scenarios. Alternatively, proponents may argue that ocean iron enrichment could have a net positive effect because the phytoplankton blooms stimulate the base of the food chain.

One way for critics to respond to this line of argument, which emphasizes the uncertainty surrounding ocean iron fertilization, is to invoke the precautionary principle. The precautionary principle provides that “where there are threats of serious or irreversible damage, lack of scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.” A corollary to this principle is that the burden of proof falls on those who propose to engage in activity that may harm the environment.

Unlike the majority of modern environmental legal and regional seas agreements, however, UNCLOS does not contain an express endorsement of the precautionary principle. However, some scholars have read the pollution provisions of UNCLOS to contain an implicit endorsement of the precautionary principle because the definition of pollution refers to actions that “result or are likely to result” in the proscribed deleterious effects. Under this reading, the obligations to prevent pollution are triggered even when no direct causal link has been established, so long as environmental harm is likely. Even assuming that the probability of harm does not rise to the level of likelihood, the party advocating the action should nevertheless bear the burden of proof that the action is benign.

The problem with the precautionary principle in this context, however, is that the action proposed seeks to address the catastrophic environmental consequences of inaction in the face of climate change. In other words, when the threat of environmental degradation posed by mitigation measures such as ocean iron fertilization is considered in the context of the more significant threat of large-scale environmental degradation from global warming, concerns regarding the risks of ocean iron fertilization become less compelling. Advocates for ocean iron fertilization could argue that this climate change mitigation strategy is a cost-effective measure that could prevent the serious and irreversible environmental damage caused by climate change, and that lack of scientific certainty should not prevent its evaluation as a potentially critical mitigation tool. This inversion of the logic of the precautionary principle, along with the absence of the principle in the language of UNCLOS, diminishes the applicability of the precautionary principle in the ocean iron fertilization context.

There is, however, another way to bring ocean iron fertilization activities within the regulatory ambit of UNCLOS. Article 194 provides that states must act to prevent, reduce, and

control pollution from all sources, which includes “dumping.” Dumping is defined as “any deliberate disposal of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea.” Article 210 of UNCLOS requires states to adopt laws and regulations to prevent and regulate dumping that must be no less effective than internationally agreed global rules and standards. UNCLOS delegates the promulgation of global rules and standards regarding “dumping” to other international treaties, and endorses the recently enacted rules and standards under the CBD and the London Protocol, which specifically address iron fertilization on the high seas. It is to these two treaty regimes that the analysis now turns.

## B. The Convention on Biological Diversity

The 1992 Convention on Biological Diversity (CBD) seeks to conserve biodiversity and encourage the sustainable use of its components, including genetic resources. The protection of marine and coastal areas within the framework of the CBD emerged as an important agenda item in the mid-1990s following the conclusion of the Jakarta Mandate in 1995 and the adoption of a program of related works in 1998.

Parties to the CBD directly addressed ocean iron fertilization at the May 2008 Ninth Meeting of the Conference of the Parties in Bonn. Section C of Decision IX/16 urged States to use the utmost caution when considering proposals for large-scale ocean iron fertilization and declared that such large-scale operations were not justified. Decision IX/16 further recommended that parties and governments act in accordance with the precautionary principle to ensure that ocean iron fertilization activities do not take place until there is: (1) an adequate scientific basis on which to justify such activities, including assessing associated risks; and a (2) global, transparent, and effective regulatory mechanism for these activities.

Decision IX/16 established an exception for “small-scale” scientific research studies undertaken within “coastal waters.” It qualified the exception by authorizing only those experiments justified by the need to gather specific scientific data, provided that the studies were subject to a thorough prior assessment of the potential impacts of the research studies on the marine environment. Finally, Decision IX/16 distinguished between research conducted for scientific purposes and research conducted for generating and selling carbon offsets or any other commercial purposes, and forbade ocean iron fertilization activities designed to promote research in the latter category.

Interpreting the effect of Decision IX/16 has raised some important questions. First, Decision IX/16 fails to define “small-scale” activities that would fit within the scientific research exception of the framework. When compared to the vast expanse of the oceans, one thousand square miles might be considered to be “small scale.” Yet such an experiment would far exceed the scope of any experiments yet undertaken. Second, Decision IX/16 calls for the restriction of research activities to “coastal waters.” Yet this limitation deprives scientists of the most useful regions for experimentation - the iron-deficient high seas of the Southern Ocean. This language was likely included in an attempt to internalize the externalities perceived to be present on the high seas. However, Decision IX/16 essentially imposes a moratorium on ocean iron fertilization experiments, particularly since the international system has not yet framed a global, transparent, and effective regulatory mechanism as required under this CBD decision.

## C. The London Convention and Protocol

Both the 1972 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and its more recent incarnation, the 1996 London Protocol, provide rules and standards that pertain generally to marine pollution and, more specifically, to ocean iron fertilization. Parties to the London Convention cannot dump any prohibited substances without first undergoing an environmental impact assessment, obtaining a permit, and complying with the monitoring requirements of Annex 2 of the London Protocol.

By contrast, under the stricter London Protocol, dumping of any waste or other matter is prohibited, except for five categories of substances listed in Annex 1. Parties to the London Protocol must additionally abide by the precautionary principle under Article 3 of the Protocol. Article 3 requires the adoption of “appropriate preventative measures” whenever an activity is “likely to cause harm” even when there is “no conclusive evidence to prove a causal relation between inputs and their effects.” However, both the London Convention and the London Protocol provide an exception to these restrictions whereby the “placement of matter for a purpose other than the mere disposal thereof does not qualify as dumping,” provided that such placement is not contrary to the aims of the Convention or Protocol.

On May 8, 2007, the Scientific Group of the London Convention and the Scientific Group of the London Protocol released a joint Statement of Concern about Ocean Fertilization. This document stated that the current knowledge about the practice was insufficient to justify large-scale projects and characterized iron fertilization as largely a speculative endeavor. It also noted the risk of negative impacts that large-scale projects posed to the marine environment. Ultimately, the joint statement recommended that any operations be carefully evaluated to ensure that activities were not contrary to the aims of the London Convention and the London Protocol.

The parties to the London Convention and Protocol revisited this topic in London in October 2008 and agreed to adopt Annex Six Resolution LC-LP.1 on the Regulation of Ocean Fertilization (Annex Six Resolution). This resolution stated that the scope of the London Convention and Protocol includes ocean iron fertilization activities, which it defined as any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans. The resolution further stated that “legitimate scientific research” should be regarded as “placement of matter for a purpose other than mere disposal” under both the London Convention and the London Protocol. As such, this resolution exempted from the prohibitions of both treaties ocean iron fertilization projects that qualify as “legitimate scientific research.”

The Annex Six Resolution does not specify what activities constitute “legitimate scientific research.” The resolution merely provides that proposals should be assessed on a case-by-case basis using an assessment framework to be developed by the Scientific Groups under the London Convention and Protocol, which should include tools for determining whether the proposed activity is contrary to the aims of the Convention and Protocol. Until such guidance is available, the resolution urges contracting parties to use utmost caution and the “best available guidance” to evaluate whether the proposal will ensure protection of the marine environment consistent with the Convention and Protocol. Finally, the resolution expressly forbids any ocean iron fertilization activities other than legitimate scientific research and states that such projects cannot qualify for any exemption from the definition of dumping.

The Intersessional Technical Working Group on Ocean Fertilization had its first meeting from February 9-13, 2009 under the Chairmanship of Dr. Chris Vivian. Delegations from eighteen Contracting Parties to the London Convention attended, as did delegations from fifteen members of the Contracting Parties to the London Protocol. Several non-governmental organizations, including Greenpeace International, as well as an intergovernmental organization,

the North Pacific Marine Science Organization, also attended the meeting. The group convened to develop an assessment framework on ocean fertilization and compile information for the contracting parties on ocean iron fertilization and its impacts on the marine environment.

The Group agreed to draft a Risk Assessment and Management Framework for Scientific Research involving Ocean Fertilization. The parties agreed this would be a “work in progress,” and would serve as a preliminary model for a final framework that the governing bodies would adopt in October 2009. The South African delegation suggested that the project not monetize any carbon offsets generated nor use such offsets for meeting targets of the Kyoto Protocol. However, the Group decided that such a policy matter should be considered at a meeting of the governing bodies. Finally, the delegations of Brazil and Argentina expressed concern about the LOHAFEX experiment and requested a report from the German and Indian sponsors on how the experiment might impact their coastal areas and EEZs [Exclusive Economic Zones].

The draft framework proposed at the meeting was designed to serve as a tool to assess scientific research proposals on a case-by-case basis to determine if a proposed activity would comport with the London Convention or Protocol. This guidance would also help “determine whether a project is legitimate scientific research,” characterize the risks to the marine environment on a “project-specific basis,” and “collect the necessary information to develop a management strategy.” The elements of the assessment, which the sponsor of the proposed project would present to a national regulator, would include: (1) problem formulation and initial assessment that would define the parameters of the experiment; (2) site selection and description; (3) exposure assessment that would describe the movement and fate of the added substances; (4) an effects assessment; (5) a risk characterization that would estimate the likelihood for adverse impacts and the magnitude of those impacts; and (6) a list of risk management procedures.

The framework further requires that the sponsor of a project provide evidentiary support for key assumptions and explain the potential impacts to countries that might be affected. The approval for projects would only be issued for defined periods of time and within defined areas, and sponsors would also have to report on the conduct of the experiment, as well as compliance with the conditions set forth by the Secretariat. Finally, the assessment and approval documentation would be made publicly available.

Interestingly, neither the language of the Annex Six Resolution nor the subsequent draft framework includes any reference to the language of the CBD Decision IX/16, which limits research to “small-scale” experiments in “coastal waters” in its criteria for permitted ocean fertilization research. Since the resolution and framework came after the CBD Decision and refer to the CBD Decision in their text, it is reasonable to conclude that the parties to the London Convention and Protocol considered and rejected these limitations.

The omission of this language perhaps reflects the findings of the UNESCO Intergovernmental Oceanographic Commission ad hoc Consultative Group on Ocean Fertilization (IOC ad hoc group), a group of five leading scientists on ocean iron fertilization that was formed at the request of the Scientific Groups of the IMO in advance of the Resolution of the London Convention and Protocol. In a statement released by the IOC ad hoc group in June 2008, the group sharply criticized the limitations imposed by the CBD decision. It railed against the “arbitrary” and “new” limitation of scientific research to “coastal waters” as “counterproductive” given that the most useful scientific experiments to date have taken place on the open ocean.

The IOC ad hoc group statement also stressed that the size of the activity should not be determinative, noting that ocean iron fertilization projects conducted only over one square

kilometer might be damaging if undertaken over a coral reef, while ocean fertilization undertaken over thousands of square kilometers might be benign. The statement further maintained that “small-scale” was a relative term and it expressly approved of larger experiments as a means to diminish the dilution of iron near the center of smaller experiments and obtaining better data relating to vertical transport of carbon dioxide. It endorsed experiments as large as 200 kilometers by 200 kilometers as clearly justified.

The IOC ad hoc group conceded that it lacked expertise in international law or policy, but it nevertheless offered two alternatives to policy makers of the London Convention and Protocol. The first called for an independent committee composed of scientists and representatives from the policy, legal, and industry sectors that would assess each proposed fertilization activity on the basis of the risks posed to the environment. This committee would have veto power over those projects it considered to fall below a clearly defined threshold of damage to the environment. The second suggestion would allow “legitimate scientific experiments”--those with defensible scientific goals and public disclosure of methods and results--to proceed, while delaying those activities designed to generate carbon credits or other monetary gain until environmental safeguards can be developed and enacted.

The IMO London Convention and Protocol Working Group on Ocean Fertilization (Working Group), which met in Guayaquil, Ecuador in May 2008, reviewed the IOC ad hoc group input and information from other international organizations with special expertise in ocean iron fertilization issues. The Working Group issued three recommendations for the scientific and legal groups: (1) it requested advice from the Legal Intersessional Correspondence Group regarding the appropriateness of the phrase “contrary to the aims of the Convention/Protocol;” (2) it requested that the London Convention and Protocol consolidate new information on scientific research on ocean iron fertilization as it becomes available and make it available for use in assessing proposals; and (3) it recommended that Annex 3 be used as the list of considerations for evaluating ocean iron fertilization activities.

There are some indications that the CBD is retreating from its de facto moratorium on ocean iron fertilization. A draft CBD document entitled “Scientific Synthesis on the Impacts of Ocean Fertilization on Marine Biodiversity” noted the need for international oversight for all ocean iron fertilization activities. In addition, it called for the adoption of an assessment framework to validate side effects and, surprisingly, for legitimate scientific research to advance the collective understanding of biogeochemical processes within the global oceans.

The London Convention and Protocol Correspondence Group reviewed this document and stated that the CBD draft could serve as a background paper for the London Convention and Protocol. However, it noted that the document does not offer an assessment framework for scientific research proposals involving ocean iron fertilization, nor does it provide the level of technical guidance necessary to ensure precautionary protection of the marine environment. The Group further noted that the CBD document “contained gaps” and served a different purpose--to compile and synthesize available scientific information on potential impacts on marine biodiversity-- than that of the Correspondence Group.

Based on the text of the Annex Six Resolution released by the London Convention and Protocol, the extent to which the statements of the IOC ad hoc group or the Scientific Working Group were considered is unclear. Nor does the resolution offer any indication as to the applicability of the limitations imposed by the CBD Decision IX/16. However, it is clear that the London Convention and Protocol do not authorize sanctions for violations. While voluntary compliance with the London Convention and Protocol is reported to be high, it is unclear

whether the prohibition provides sufficient deterrence for commercial enterprises that might engage in large-scale ocean iron fertilization research to test their methods in advance of expected future carbon trading.

### III. THE LOHAFEX PROJECT AND THE NEED FOR A NEW LEGAL FRAMEWORK

If one of the goals of international environmental law is to provide clear guidelines so that states may regulate entities subject to their jurisdiction, then the LOHAFEX project provides an ideal illustration of the shortcomings of the current legal framework governing ocean iron fertilization. This part of the article examines the legality of the LOHAFEX expedition under existing international environmental law and illustrates why a new legal framework is necessary.

The LOHAFEX project fails to comply with the mandate of CBD Decision IX/16, which restricts ocean iron fertilization projects to “small-scale” studies within “coastal waters.” Neither the decision, nor Article 2, of CBD defines “small-scale” or “coastal waters,” but the proposed site in the Southern Ocean does not appear to qualify as coastal waters.

The risk assessment prepared by the Alfred Wegener Institute, the German group that co-sponsored the experiment, does not claim that the site falls within coastal waters. Instead, the assessment states that its proposed approach complies with the requirements of the CBD. It first references the recent CBD decision, placing emphasis on the stated need for further research to assess the impact on the ecosystem and the efficacy of iron fertilization. It then asserts that the proposal is based on “intercomparisons . . . of previous iron fertilisation experiments all carried out in the Southern Ocean including coastal waters that provide the basis for the assessment of the impact of such experiments on the environment.” It later describes the location as “downstream from an extensive land mass” (the Antarctic Peninsula), which “contains waters with coastal plankton species.” With regard to the “small-scale” requirement, the assessment describes the spatial scale as “small in respect to the surrounding environment” and small “in comparison to natural iron enrichments by coastal waters or icebergs.”

According to the assessment, the LOHAFEX experiment: (1) fulfills the need to assess its impact on the ecosystem; (2) fits within the scope of the term “coastal waters” because the subject matter has previously been studied in coastal water and coastal plankton live in the water; and (3) satisfies the “small-scale” requirement if compared to the size of the Southern Ocean and natural iron enrichments. This argument is hardly an ironclad legal defense. Therefore, it is reasonable to conclude, as did the German Environment Ministry, that the experiment would not comply with a strict interpretation of CBD Decision IX/16.

In response to a letter from a non-governmental organization (NGO) that alleged that a violation of the CBD had occurred, the Bureau of the Conference of the Parties to the CBD addressed the issue of the LOHAFEX expedition in Nairobi, Kenya on February 19, 2009. After the German representative left the room to let the Bureau discuss the course of action, the Executive Secretary noted that the issue of implementation of COP decisions was not addressed in the rules of procedure and that the responsibility to implement COP decisions lay with the parties at the national level. Nevertheless, the Bureau members felt compelled to issue a formal response to the NGO. The Bureau concluded that it was up to Germany to respond to the letter from the NGO. The Bureau also indicated that it would send a letter to Germany and India to convey the Bureau's concerns about the LOHAFEX expedition.

This interaction highlights the decentralized nature of international law. Instead of providing a centralized enforcement mechanism, the CBD (and the other treaties discussed above) relies on

states to police the activities of nationals within their jurisdiction. While the results might have disappointed the expectations of observers in favor of more concrete action against Germany in response to the LOHAFEX expedition, the CBD Bureau's response demonstrates that its members shared the concerns that the NGO expressed regarding possible violations of the CBD's restrictions on ocean iron fertilization.

By contrast, the legal justification for the LOHAFEX expedition appears somewhat stronger under the London Convention and Protocol Resolution, whose terms do not include the restrictions of the CBD resolution. The project would very likely meet the threshold requirement that it be a scientific research project. However, the Scientific Groups under the London Convention and Protocol have not yet issued an assessment framework. Therefore, as a party to the Convention and Protocol, Germany must “use utmost caution and the best available guidance to evaluate the . . . proposal to ensure “protection of the marine environment consistent with the Convention and Protocol.” The risk assessment plausibly maintains that the naturally occurring iron enrichment in the region is much larger in scale than the level of iron to be deposited in the proposed experiment; therefore, it would cause no greater ecological damage than that presently occurring naturally. Accordingly, Germany could reasonably conclude that this experiment fits within the scientific research exception to the resolution.

As demonstrated by the foregoing analysis, these two overlapping treaties impose different levels of obligations for scientific research projects that seek to conduct ocean iron fertilization, with the CBD imposing several highly restrictive terms that are conspicuously absent in the London Convention and Protocol. Yet the German Ministry of Research still allowed the project to move forward, despite the uncertainty regarding its compliance with the CBD and over the objections of the Ministry of the Environment. The rationale for this decision is unclear, but press releases from both the Alfred Wegener Institute and the Indian National Institute of Oceanography used the ambiguity and incongruity in international legal instruments to justify the LOHAFEX expedition.

#### IV. FOUNDATIONS FOR A NEW LEGAL FRAMEWORK

The unclear and conflicting mandates in the existing legal framework governing the LOHAFEX project illustrate the need for a new legal framework to regulate scientific research on ocean iron fertilization. First, and most importantly, the new legal framework would harmonize the incongruous treaty obligations in the existing framework to ensure that states understand whether actors subject to their jurisdiction are in compliance with international law. Second, the framework would address ground rules for those parties seeking to capitalize on ocean iron fertilization through the trade of carbon credits, as well as for those parties that wish to engage in scientific research. In lieu of an artificial distinction based on the motivation of those looking to explore ocean iron fertilization, the new framework would treat all parties equally and distinguish proposed activities on the basis of the scope of the project. Third, the proposed legal framework would include differentiated standards for small-scale and large-scale ocean iron fertilization projects.

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#### NOTES AND QUESTIONS

1. One dominant concern for those considering geoengineering is whether it can be tested effectively in smaller scale ways. For example, Alan Robock, Martin Bunz, Ben Kravitz, and Georgiz Stenchikov argue that “geoengineering [referring to SRM] cannot be tested without full-scale implementation.” *A Test for Geoengineering?*, 327 SCIENCE 530 (Jan. 2010). If the only real test for some approaches to geoengineering is actual implementation, how should that affect our assessment of the phase one and phase two governance options?
2. The Abate and Greenlee excerpt reinforces that a good deal of law already applies to particular geoengineering approaches to climate change. Can these complex issues be addressed adequately through applying existing conventions to these new issues? How should conflicts among them be resolved? What are the benefits and limitations of existing law?
3. Albert Lin has argued for addressing geoengineering under the UNFCCC agreements, perhaps through a protocol focused on the issue. He argues that failing to engage these issues through that framework increases the risk of undesirable deployment of this technology. See Albert C. Lin, *Geoengineering Governance*, 8 ISSUES IN LEGAL SCHOLARSHIP (2009), available at <http://www.bepress.com/ils/vol8/iss3/art2>. Based on what you have learned of the UNFCCC process, what would be the advantages and disadvantages of addressing geoengineering in that forum?
4. If a new agreement specifically on geoengineering were crafted, what would be the ideal process for doing so? What should it include? Who should be involved in crafting it? Should it be a treaty among nation-states, or a soft law instrument that includes more stakeholders?

### 3. The Possibilities and Risks of a Technological Fix

Geoengineering to reverse climate change not only poses technical, scientific, and legal complexities, but also raises difficult ethical and strategic policy issues. These concerns range from workability and cost-effectiveness to the appropriateness of intentional human interference in the climate system. For geoengineering to be taken seriously as a solution to climate change, policymakers must grapple with these issues.

The following excerpt from Jay Michaelson, which predates the latest wave of interest in geoengineering, aims to provide such a foundation. It lays out some of the objections to geoengineering and responds to them.

|| **Jay Michaelson, *Geoengineering: A Climate Change Manhattan Project*, 17 STAN. ENVTL. L.J. 73 (1998).** ||

#### IV. In Defense of Geoengineering

##### A. “It Just Won't Work”/ “It Will Do More Harm than Good”

Immodest proposals should elicit skepticism. When one faces a costly proposal involving unproven and potentially dangerous technology, particularly when it involves interfering with a

system as complex as the Earth's climate, it is natural to expect Babel-like failure to follow Babel-like arrogance. Geoengineering has a checkered history, at best, from the Army Corps of Engineers' choking of the Everglades to the Soviet Union's attempts to reverse the flow of Siberian rivers to grow cotton and melt part of the Arctic ice cap. What if the Big Fix leaves us worse off than we were before?

The danger of altering the Earth's climatic systems, when we cannot even successfully maintain a tiny "Biosphere II," was well expressed by the National Academy of Sciences:

Geoengineering options have the potential to affect greenhouse warming on a substantial scale. However, precisely because they might do so, and because the climate system and its chemistry are poorly understood, these options must be considered extremely carefully. . . . Some of these options are relatively inexpensive to implement, but all have large unknowns concerning possible environmental side-effects. They should not be implemented without careful assessment of their direct and indirect consequences.

The response to such concerns, however, should be caution, not dismissal. Regarding primary efficacy, there is good evidence that some geoengineering proposals--iron seeding or particulate scattering, for example--show considerable promise. Though . . . it is far too early to be certain of success, it is also far too early to be dismissive. While the case for technological optimism is "uneasy," the case for technological pessimism--in the face of a century of technological progress that shows little sign of abating--is just plain weak.

Regarding secondary effects, caution should inspire more research, not less. A global "sunscreen" may also cause acid rain or affect the ozone layer, but it may not: what is needed by policymakers are answers from scientists. Of course, as any scientist knows, "answers" are more often estimates and prognostications than definite results. If this turns out to be the case at the end of Phase One of a Climate Change Manhattan Project, than Phase Two should proceed carefully. In the case of the "sunscreen" dust proposal, we could proceed gradually, releasing less dust than Mount Pinatubo did in 1991. In any event, we should not let panic at the scale of the problem or the danger for unintended effects replace calm investigation of the possibilities before us. What is important to remember, again, is (1) that we can progress slowly and cautiously, and (2) that we have not yet even begun to do so.

Clearly, it would be easy--and tragic--for confidence to turn to hubris, and for would-be climate engineers to repeat old mistakes. This consequentialist objection does not undermine the principle of a geoengineering project, however, or the efficacy of geoengineering as a policy tool. Nor does the objection recognize that some geoengineering techniques have already produced favorable and reliable experimental data. Finally, this complaint does not adequately consider the uncertain and grave context in which climate change policies are made. We are already in a mess; the question is how best to clean it up.

## B. "It Costs Too Much"

Although the relative economy of geoengineering is treated above..., two objections remain based not on geoengineering's cost relative to that of preventive regulation, but on its cost alone. It may be that the up-front investment in geoengineering makes it either (1) impractical or (2) counterproductive.

1. The high cost of geoengineering makes it impractical.

The first major cost-based objection to geoengineering is that it is simply impractical to expect the nations of the world to spend billions of dollars on ocean seeding in an era of shrinking budgets and (in the United States, at least) suspicion of cooperative international activity. The obvious rebuttal is that some geoengineering proposals may turn out to be quite affordable-- particulate matter spreading, for example. Nevertheless, even if geoengineering techniques demand large up-front investments, the objection is answerable.

Assuming arguendo that geoengineering will be expensive up front, it still seems less different to throw money at a problem than to enforce a restrictive and costly regulatory regime. Even if the price tag is high, the geoengineering project remains affordable in terms of political economy because it minimizes costs that factor into the political calculus, such as social costs and efficiency costs borne by distributionally advantaged (politically powerful) parties.... So long as the cost of a geoengineering project is not so astronomical as to prevent consideration of the political economies, it is likely to be more "affordable" in political-economic terms than any other option currently on the table.

Two more general responses to the contention that geoengineering's potentially high cost makes it impractical are warranted. First, any serious debate on climate change must recognize that a geoengineering project is not a decorative boondoggle; it is a necessary measure taken to prevent serious degradation to the earth's environment that would have huge attendant costs for many human interests. If serious debate were to emerge, geoengineering's "sticker shock" might wane in the context of rational reflection of the costs of climate change itself. Second, and in a similar vein, the fairness of a "polluter pays" approach as embodied in geoengineering may itself help ameliorate the reluctance of the polluters to pay. Thus, the charge that the cost of a geoengineering project renders it impractical is rebuttable by reconsidering the political economy of geoengineering as compared with regulatory solutions and recalling that notions of propriety and fairness also have political value, however attenuated.

## 2. The high cost of geoengineering makes it inefficient at best, counterproductive at worst.

Even if we can afford geoengineering, the cost-objector may retort, perhaps there is a better investment. Instead of throwing billions of dollars at a dubious plan to cool the Earth, perhaps we would be better off allowing developing countries to progress technologically (and thus adapt better to a changed climate) and coaxing private enterprise to develop zero-emission vehicles, nanotechnological carbon-eaters, or some other decentralized "Small" Fix. One might even argue, as Gregg Easterbrook has, that geoengineering is a misappropriation of funds, because, while climate change is a problem, it is not as severe as more prosaic challenges such as providing safe drinking water or curbing urban pollution in the developing world.

In response, the first objection is really just a variation on "wait and see," and as such is a high-risk proposal. Perhaps nanotechnology will save the world. But perhaps it will not. In the meantime, climate change policymakers must develop strategies to cope with today's (and tomorrow's) problems in the best possible way. A successful strategy may include grants to private enterprise to develop climate-friendly technologies. Just as we ought not put all our hopes in a Big Fix, however, we should not put all our hopes in the white knight of as-yet-unknown technology.

The second objection--that geoengineering is inefficient or perhaps even inhumane in the face of widespread malnutrition and disease--is basically an argument against any climate change strategy, and it is simply not borne out by the facts. The Easterbrook policy of "give me a fish today, and let the ocean burn tomorrow" is particularly inept in light of the probability that the

most serious effects of climate change will be felt by the developing world. Moreover, many local problems (e.g., the lack of safe drinking water) are difficult for the “international community” to address, for reasons of high transaction costs, national sovereignty, and the myriad of difficulties associated with any long term, overseas commitment. The concept of a Climate Change Manhattan Project, on the other hand, allows and encourages the developing world to be a free rider on a project financed mostly (one would presume) by the industrialized nations of the world. Finally, since it restricts growth less in the developing world than would regulation, a Climate Change Manhattan Project allows developing nations to more quickly progress away from the serious environmental threats of unsafe water, unhealthy air, and topsoil loss, through proven means such as sewage treatment, newer (cleaner) automobiles and factories, and modern agriculture.

### C. “It Is Unnatural”

One intuitive objection to intentionally manipulating the climate is that it is unnatural. Surely, “Nature knows best.” And if it does, geoengineering is misguided, not only because of the practical risks just addressed, but because human interference with the Earth's climate is both unethical and profoundly unwise. Seen in this light, geoengineering is a question not of Nordhaus's risk proposals, but of Bill McKibben's “The End of Nature.” Almost all aspects of the natural world, the argument runs, are somewhat less “Other” than they were, something closer to a manufactured event than they once had been. These may seem like “soft” concerns, of minimal consequence to a policymaker. However, supposedly soft concerns often translate into very “hard” political preferences. More importantly, soft concerns define who we are and why we live. Ultimately, the hardest and driest economic calculations reduce to the “soft” inner preferences of putatively rational actors, who reveal themselves in myriad expressions of utility. If geoengineering is seen as cutting the Earth's nose off to spite its face by a majority of people, then it is not a good policy since it fails to achieve the environmental objectives in which we are interested.

Several responses to the unnaturalness objection are possible. First, the need to mitigate climate change may simply outweigh the aesthetic valuation of the natural world. The costs of coping with dead forests and shifting agricultural zones are not scare tactics, but serious concerns that may outweigh eco-aesthetic (or even religious) reservations about a man-made sky. If the consequences of global warming track the more acute predictions of greenhouse “doomsayers,” this is certainly the case: few may insist on the integrity of Gaia if millions of people (and animals) will starve.

Second, one may respond fatalistically by noting that geoengineering is no more a direct alteration of the environment than the everyday effects of millions of cars and factories. Any refusal to tinker with Nature is an illusion: we have already done so, and the only remaining question is whether to continue to do so negligently, or to begin to tinker benevolently. It would be better to “let the meadow be,” and not move mounds of Earth around with bulldozers, but not once the meadow has already been plowed over.

Finally, one may counter wilderness-aesthetes on their own terms by replying that while geoengineering is an ugly interference with nature, it removes even uglier ones. Global warming is no mere abstract, aesthetic injury. While problematic, geoengineering is actually right in the context of global warming insofar as “a thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community.” We are not cutting off our nose to spite our face; we are performing corrective plastic surgery.

It is true that the ethical and aesthetic objections favor preventive regulation that would avoid the initial ecological insult. Yet climate change policies must be viewed in terms of their effects. What will work best? If geoengineering fulfills Leopold's above-quoted dictum best, it seems the most ethical choice. To be sure, the objections are strong: it was Henry David Thoreau who said that "[i]n wildness is the preservation of the world." And it is also true that, at first, geoengineering seems like the ultimate betrayal of this ideal. But if models of climate change are correct, New England will experience a warming of 1.5 to 4.5 degrees Celsius, which will render Walden woods unable to sustain its native flora. What then?

#### D. "It Subverts Other Efforts"

While there is a chance that geoengineering will work, there is also a chance that it will not. In the meantime, one might object, a focus on geoengineering subverts other efforts to attain sensible reductions in GHG emissions. Stephen Schneider voices this concern in his account of the 1992 National Research Council panel on climate change policy, where some worried that "even the very thought that we could offset some aspects of inadvertent climate modification by deliberate climate modification schemes could be used as an excuse by those who would be negatively affected by controls on the human appetite to continue polluting and using the atmosphere as a free sewer." This political concern is warranted. Insofar as the Big Fix lulls us into thinking that we have done all we need to do about global warming, it is, as one environmentalist put it, a classic "high risk-high gain" policy. Either it works, or we are in a lot of trouble.

By way of response, it must be conceded that geoengineering can be a high risk option. But it does not have to be. First, geoengineering should be developed in parallel with emissions reductions. Recall that economists believe a sizable amount of GHG emissions can be reduced quite cheaply. Surely, those inexpensive reductions should be pursued vigorously to produce a "safety cushion" while the potential of geoengineering is evaluated. Second, wise geoengineering is timely geoengineering. As stated above, we ought not wait until remediation is necessary before exploring the option: we must build the drill before the cavity develops. If Phase One of the Climate Change Manhattan Project begins now, a reasoned set of answers to many geoengineering questions may emerge well in advance of the "point of no return" for climate change regulation.

Geoengineering undoubtedly strengthens the hand of the procrastinator, but prompt and wise policy planning cuts against the complacent position. We must begin now. Advocates correctly fear putting their eggs into an untested basket, but we need not drop the emissions-reductions basket to grab hold of the geoengineering one. Proponents of geoengineering must take responsibility for ensuring that the policy does not degenerate into simple procrastination.

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#### NOTES AND QUESTIONS

1. To what extent does Michaelson's list of potential objections seem like a complete one? Are you persuaded by his responses to those objections?
2. Geoengineering could be approached as an alternative to difficult mitigation choices or as a complement to them. For example, Albert Lin has argued that pursuing geoengineering in lieu of mitigation would be a mistake. He proposes an adaptive approach that explores how geoengineering might complement mitigation over time.

However, in doing so, he takes a different approach than Michaelson to the baseline question of when geoengineering strategies are appropriate. Lin explains:

A critical initial question would involve the baseline from which geoengineering governance decisions would be made. Given the widespread unease and uncertainty associated with geoengineering proposals, the international community should begin with a default presumption against the implementation of any geoengineering project. Such a presumption is also warranted by the difficulty of reversing course after a geoengineering project has already been operating for many years: suddenly stopping a long-running aerosol release program, for instance, would almost surely cause a rapid warming that both human and nonhuman populations would struggle to adjust to. Notwithstanding any presumption against geoengineering deployment, an adaptive governance approach counsels in favor of revisiting that presumption at regular intervals.

Regularly revisiting the issue offers several advantages. First, this would allow the parties to take account of updated information regarding climate change and its impacts, the success (or lack thereof) of efforts to reduce emissions, and geoengineering risks and refinements. Review of the issue must be sufficiently frequent to allow the parties to respond to “climate surprises” – unexpectedly rapid or large climate changes that are not accounted for in most climate models, which tend to assume relatively smooth increases in GHG concentrations and temperature. Second, a schedule to periodically reconsider the issue reduces the stakes involved in each vote, thereby ameliorating the tendency for parties to assume entrenched positions that make agreement more difficult and increasing the likelihood that parties will be willing to agree to a nonconsensus decisionmaking process. Third, repeated consideration of geoengineering can foster a continuing international dialogue on the matter. Such a dialogue essentially would serve as ongoing negotiations that can lead to the building of coalitions or the formation of consensus on an issue. In addition, consistent views or decisions with regard to the conditions under which geoengineering may be deployed can also promote the formation of norms and even customary international law to govern the conduct of nations and institutions with respect to geoengineering.

Albert C. Lin, *Geoengineering Governance*, 8 ISSUES IN LEGAL SCHOLARSHIP (2009), available at <http://www.bepress.com/ils/vol8/iss3/art2>.

What do you think our baseline presumptions should be?

3. Simone Tilmes, Rolf Müller, and Ross Salawitch have argued that proposed sulfur aerosol geoengineering schemes would accelerate ozone depletion. *The Sensitivity of Polar Ozone Depletion to Proposed Geoengineering Schemes*, 320 SCIENCE 1201 (2008) (published online Apr. 4, 2008). Arguments such as these raise difficult issues about what precaution means in this context. Is it more dangerous to take measures to reverse climate change that may have

other ecosystem consequences or to opt out of a potential solution to climate change? Or, in a more nuanced variation, how can we ensure that we minimize collateral ecosystem impacts in geoengineering schemes?

### C. Choosing Our Future

This final section revisits the question of what would be required to mitigate adequately. It analyzes both the economics of mitigation and potential political and legal pathways forward. It concludes by providing an opportunity for reflection on where to go from here.

#### 1. The Economics, Politics, and Governance Challenges of Mitigating Adequately

In 2007, Sir Nicholas Stern published a lengthy assessment of the economics of climate change which argued that the costs of impacts and adaptation far exceed those of aggressive mitigation. See NICHOLAS STERN, *THE ECONOMICS OF CLIMATE CHANGE: THE STERN REVIEW* (Cambridge University Press 2007). While this assessment resulted in a firestorm of commentary, with some agreeing with and some disputing his claims, it remains the most significant analysis to date of our economic choices.

The following excerpt provides a Summary of Conclusions from the *Stern Review*. It provides an overview of the core components of Stern's assessment.

NICHOLAS STERN, *THE ECONOMICS OF CLIMATE CHANGE: THE STERN REVIEW, Summary of Conclusions (2006 pre-publication version)*, available at [http://webarchive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/d/Summary\\_of\\_Conclusions.pdf](http://webarchive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/d/Summary_of_Conclusions.pdf).

*There is still time to avoid the worst impacts of climate change, if we take strong action now.*

The scientific evidence is now overwhelming: climate change is a serious global threat, the impacts of climate change and on the economic costs, and has used a number of different techniques to assess costs and risks. From all of these perspectives, the evidence gathered by the Review leads to a simple conclusion: the benefits of strong and early action far outweigh the economic costs of not acting. Climate change will affect the basic elements of life for people around the world – access to water, food production, health, and the environment. Hundreds of millions of people could suffer hunger, water shortages and coastal flooding as the world warms. Using the results from formal economic models, the Review estimates that if we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more. In contrast, the costs of action – reducing greenhouse gas emissions to avoid the worst impacts of climate change – can be limited to around 1% of global GDP each year.

The investment that takes place in the next 10-20 years will have a profound effect on the climate in the second half of this century and in the next. Our actions now and over the coming decades could create risks of major disruption to economic and social activity, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th

century. And it will be difficult or impossible to reverse these changes. So prompt and strong action is clearly warranted. Because climate change is a global problem, the response to it must be international. It must be based on a shared vision of long-term goals and agreement on frameworks that will accelerate action over the next decade, and it must build on mutually reinforcing approaches at national, regional and international level.

*Climate change could have very serious impacts on growth and development.*

If no action is taken to reduce emissions, the concentration of greenhouse gases in the atmosphere could reach double its pre-industrial level as early as 2035, virtually committing us to a global average temperature rise of over 2°C. In the longer term, there would be more than a 50% chance that the temperature rise would exceed 5°C. This rise would be very dangerous indeed; it is equivalent to the change in average temperatures from the last ice age to today. Such a radical change in the physical geography of the world must lead to major changes in the human geography – where people live and how they live their lives.

Even at more moderate levels of warming, all the evidence – from detailed studies of regional and sectoral impacts of changing weather patterns through to economic models of the global effects – shows that climate change will have serious impacts on world output, on human life and on the environment. All countries will be affected. The most vulnerable – the poorest countries and populations – will suffer earliest and most, even though they have contributed least to the causes of climate change. The costs of extreme weather, including floods, droughts and storms, are already rising, including for rich countries. Adaptation to climate change – that is, taking steps to build resilience and minimize costs – is essential. It is no longer possible to prevent the climate change that will take place over the next two to three decades, but it is still possible to protect our societies and economies from its impacts to some extent – for example, by providing better information, improved planning and more climate-resilient crops and infrastructure. Adaptation will cost tens of billions of dollars a year in developing countries alone, and will put still further pressure on already scarce resources. Adaptation efforts, particularly in developing countries, should be accelerated.

*The costs of stabilising the climate are significant but manageable; delay would be dangerous and much more costly.*

The risks of the worst impacts of climate change can be substantially reduced if greenhouse gas levels in the atmosphere can be stabilised between 450 and 550ppm CO<sub>2</sub> equivalent (CO<sub>2</sub>e). The current level is 430ppm CO<sub>2</sub>e today, and it is rising at more than 2ppm each year. Stabilisation in this range would require emissions to be at least 25% below current levels by 2050, and perhaps much more. Ultimately, stabilisation – at whatever level – requires that annual emissions be brought down to more than 80% below current levels.

This is a major challenge, but sustained long-term action can achieve it at costs that are low in comparison to the risks of inaction. Central estimates of the annual costs of achieving stabilisation between 500 and 550ppm CO<sub>2</sub>e are around 1% of global GDP, if we start to take strong action now.

Costs could be even lower than that if there are major gains in efficiency, or if the strong co-benefits, for example from reduced air pollution, are measured. Costs will be higher if innovation in low-carbon technologies is slower than expected, or if policy-makers fail to make

the most of economic instruments that allow emissions to be reduced whenever, wherever and however it is cheapest to do so.

It would already be very difficult and costly to aim to stabilise at 450ppm CO<sub>2</sub>e. If we delay, the opportunity to stabilise at 500-550ppm CO<sub>2</sub>e may slip away.

*Action on climate change is required across all countries, and it need not cap the aspirations for growth of rich or poor countries.*

The costs of taking action are not evenly distributed across sectors or around the world. Even if the rich world takes on responsibility for absolute cuts in emissions of 60-80% by 2050, developing countries must take significant action too. But developing countries should not be required to bear the full costs of this action alone, and they will not have to. Carbon markets in rich countries are already beginning to deliver flows of finance to support low-carbon development, including through the Clean Development Mechanism. A transformation of these flows is now required to support action on the scale required.

Action on climate change will also create significant business opportunities, as new markets are created in low-carbon energy technologies and other low-carbon goods and services. These markets could grow to be worth hundreds of billions of dollars each year, and employment in these sectors will expand accordingly. The world does not need to choose between averting climate change and promoting growth and development. Changes in energy technologies and in the structure of economies have created opportunities to decouple growth from greenhouse gas emissions. Indeed, ignoring climate change will eventually damage economic growth.

Tackling climate change is the pro-growth strategy for the longer term, and it can be done in a way that does not cap the aspirations for growth of rich or poor countries.

*A range of options exists to cut emissions; strong, deliberate policy action is required to motivate their take-up.*

Emissions can be cut through increased energy efficiency, changes in demand, and through adoption of clean power, heat and transport technologies. The power sector around the world would need to be at least 60% decarbonised by 2050 for atmospheric concentrations to stabilise at or below 550ppm CO<sub>2</sub>e, and deep emissions cuts will also be required in the transport sector.

Even with very strong expansion of the use of renewable energy and other low carbon energy sources, fossil fuels could still make up over half of global energy supply in 2050. Coal will continue to be important in the energy mix around the world, including in fast-growing economies. Extensive carbon capture and storage will be necessary to allow the continued use of fossil fuels without damage to the atmosphere. Cuts in non-energy emissions, such as those resulting from deforestation and from agricultural and industrial processes, are also essential.

With strong, deliberate policy choices, it is possible to reduce emissions in both developed and developing economies on the scale necessary for stabilisation in the required range while continuing to grow.

Climate change is the greatest market failure the world has ever seen, and it interacts with other market imperfections. Three elements of policy are required for an effective global response. The first is the pricing of carbon, implemented through tax, trading or regulation. The second is policy to support innovation and the deployment of low-carbon technologies. And the

third is action to remove barriers to energy efficiency, and to inform, educate and persuade individuals about what they can do to respond to climate change.

*Climate change demands an international response, based on a shared understanding of long-term goals and agreement on frameworks for action.*

Many countries and regions are taking action already: the EU, California and China are among those with the most ambitious policies that will reduce greenhouse gas emissions. The UN Framework Convention on Climate Change and the Kyoto Protocol provide a basis for international co-operation, along with a range of partnerships and other approaches. But more ambitious action is now required around the world.

Countries facing diverse circumstances will use different approaches to make their contribution to tackling climate change. But action by individual countries is not enough. Each country, however large, is just a part of the problem. It is essential to create a shared international vision of long-term goals, and to build the international frameworks that will help each country to play its part in meeting these common goals.

Key elements of future international frameworks should include:

- *Emissions trading*: Expanding and linking the growing number of emissions trading schemes around the world is a powerful way to promote cost-effective reductions in emissions and to bring forward action in developing countries: strong targets in rich countries could drive flows amounting to tens of billions of dollars each year to support the transition to low-carbon development paths.
- *Technology cooperation*: Informal co-ordination as well as formal agreements can boost the effectiveness of investments in innovation around the world. Globally, support for energy R&D [Research & Development] should at least double, and support for the deployment of new low-carbon technologies should increase up to five-fold. International cooperation on product standards is a powerful way to boost energy efficiency.
- *Action to reduce deforestation*: The loss of natural forests around the world contributes more to global emissions each year than the transport sector. Curbing deforestation is a highly cost-effective way to reduce emissions; largescale international pilot programmes to explore the best ways to do this could get underway very quickly.
- *Adaptation*: The poorest countries are most vulnerable to climate change. It is essential that climate change be fully integrated into development policy, and that rich countries honour their pledges to increase support through overseas development assistance. International funding should also support improved regional information on climate change impacts, and research into new crop varieties that will be more resilient to drought and flood.

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Addressing the economics of climate change raises important governance questions. Economic transformation will not automatically take place. The “business as usual” scenario in the various climate models reflects this difficulty. Without intervention, rapid increases in atmospheric concentrations of greenhouse gases will continue. But widespread disagreement exists over what would constitute a more appropriate and effective climate change governance structure.

The following excerpt by Professor David Held and Mr. Angus Fayne Hervey propose one version of such a structure. It outlines the core elements of a governance approach that incorporates democratic principles.

**David Held & Angus Fane Hervey, Democracy, Climate Change and Global Governance: Democratic Agency and the Policy Menu Ahead, Policy Network Paper (Nov. 2009), available at [www.policy-network.net/publications\\_download.aspx?ID=3426](http://www.policy-network.net/publications_download.aspx?ID=3426).**

#### 4. The political elements of a democratic global deal

Climate change is a problem with global causes and consequences. A coordinated international effort is therefore required to achieve cost effective and successful mitigation policies. However, the nature of the problem also means that international agreements will be difficult to reach. Countries and regions have very different interests in achieving a solution, implying a highly contested distribution of costs and benefits. In addition, developing countries, given their relatively small contribution to historical emissions, object to having their development impeded by restrictions. Finally, the challenges associated with enforcing a global solution may make some nations reluctant to participate, adding a source of uncertainty about how cost-effective the policies will be. However, despite the vigorous debate surrounding the type of policies required to combat climate change and how they should or should not be implemented, there is considerable overlap on what the political elements of a global deal might look like. At the most general level, most commentators agree that it should be broadly inclusive, multi-faceted, state-centric and sustainable.

#### **Participation**

The key requirement is participation from all countries, and most importantly, participation by the most powerful democracy in the world. The world has been waiting for the United States to join the collective effort against climate change; there is now reason to believe that it is ready to act. The integration of less developed states is also crucial, as already noted. Even if the developed states of the world were to cut their emissions to zero by 2050, without significant cuts in the rest of the world the overall goal of keeping a global rise in temperatures to under 2<sup>0</sup>C would be missed. Developing countries need to be convinced that they can simultaneously reduce their emissions and increase their growth rate by increasing their energy efficiency. They need, for instance, to eliminate distortions in their energy markets, such as large oil subsidies. But for most developing countries, the cheapest form of energy is coal (or other high-emission energy sources), and in those cases, there is a real trade-off. Money spent to reduce GHG emissions is money that could be spent to provide education, better health and clean water, or to grow faster. In such cases, developed countries, it can be argued, should pay for the incremental costs. However, as Victor et. al. have pointed out, this is unlikely to happen – it is simply unrealistic to expect industrialised nations to contribute the tens or hundreds of billions of dollars needed for such a compensation scheme when official development assistance (including for wars in Iraq and Afghanistan) currently stands at around \$100 billion for all purposes. Moreover, the countries that would get the most compensation, such as China, are now [the] west's most potent economic competitors.

#### **Offset schemes and financial incentives**

The alternative is some form of offset scheme that allows industrialised nations to fund emissions reductions in developing nations, and counting those reductions towards their own legal commitments. The idea is that this would require industrialised nations to pay a majority of the costs while also laying a foundation for the creation of a global emissions trading market. This was the aim behind the creation of the Clean Development Mechanism (CDM). However, although the CDM has, after a difficult start, been successful in creating a global market for GHGs, its design is fundamentally flawed, and it has done very little to actually cut emissions or to assist host countries in achieving sustainable development.

Another important requirement will be the prevention of deforestation, which contributes 17% of current carbon emissions, almost twice as much as transport. Developing countries' tropical forests are an important source of carbon sequestration, yet they are not provided with any compensation for these environmental services. Providing them with financial incentives will help to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. In this regard, encouraging steps have been made in the implementation of the United Nations Fund for Reducing Emissions from Deforestation and Forest Degradation (UN-REDD). However, the establishment of a final framework for the transfer of funds is still some years away, with a final agreement only likely to come into effect after 2012. Moreover, there are serious concerns about the appropriate geographical scale of accounting and incentive mechanisms, monitoring, land tenure, elite capture of funds and the potential for fraud.

Participation and deliberation on a global scale are necessary, yet in their current forms, existing instruments of global environmental governance are ill-equipped to achieve results. What is needed are representative institutions armed with the capacity and legitimacy required to translate policy commitments into real world outcomes. If a global deal is going to work it must have an answer to the problem of governance, and embody an institutional structure that shapes and determines decisions which reflect the whole world in an even-handed way. Recourse to inclusive and broadly representative global decision-making channels is the most appropriate and effective way of doing this, and strengthening mechanisms of global governance will be key to constructing a global democratic response to the issue.

##### 5. Democracy and the policy menu ahead

The challenge of tackling climate change will require the development of considerable additional institutional capacity and policy innovation. The goal of achieving this capacity, and the means to get there, will be undermined if countries of all stages of development are not directly involved in the shaping of solutions. Current policy development demonstrates this concern. The short term path to effective environmental governance is to integrate a broader set of interests into existing multilateral governance capacity. The existing mandate of the GEF [Global Environmental Fund] could be broadened in order to help coordinate and fund international environmental agreements and reflect developing country priorities. Complementary to this, the UNEP [United Nations Environmental Program] could increase its status and responsibilities by becoming a specialised UN agency, with all the compulsory UN funding that this entails. The central challenge in the years ahead of compliance monitoring and enforcement could be facilitated through a formal international mechanism for settling environmental disputes through mediation and arbitration, potentially similar to the World Bank's investment dispute body. Enhancing the capacities and responsibilities of the GEF and the UNEP in this way would be a step toward the more consolidated and formal institutional

capacity of a World Environmental Organisation as a longer term goal, driven perhaps by the G2 + 1 (the USA, China and the EU), but accountable to the G195.

### **The key role of the state**

In all of these challenges, states remain the key actors, as they hold the key to both domestic and international policymaking. The implementation of international agreements will be up to individual states, emissions trading and carbon pricing will require domestic legislation, and technological advance will need state support to get off the ground. However, state strategies at the domestic level should involve the creation of incentives, not overly tight regulation. Governments have an important role in “editing” choice, but not in a way that precludes it altogether. This approach is represented in the form of what Giddens calls “the ensuring state,” whose primary role is help energise a diversity of groups to reach solutions to collective action problems. The state, so conceived, acts as a facilitator and an enabler, rather than as a top-down agency. An ensuring state is one that has the capacity to produce definite outcomes. The principle goes even further; it also means a state that is responsible for monitoring public goals and for trying to make sure they are realised in a visible and legitimate fashion.

This will require a return to planning – not in the old sense of top down hierarchies of control, but in a new sense of flexible regulation. This will require finding ways to introduce regulation without undermining the entrepreneurialism and innovation upon which successful responses will depend. It will not be a straightforward process, because planning must be reconciled with democratic freedoms. There will be push and pull between the political centre, regions and localities, which can only be resolved through deliberation and consultation. Most importantly, states will require a long term vision that transcends the normal push and pull of partisan politics. This will not be easy to achieve.

All this takes place in the context of a changing world order. The power structure on which the 1945 multilateral settlement was based is no longer intact, and the relative decline of the west and the rise of Asia raises fundamental questions about the premises of the 1945 multilateral order. Democracy and the international community now face a critical test. However, addressing the issue of climate change successfully holds out the prospect of reforging a rule-based politics, from the nation-state to the global level.... By contrast, failure to meet the challenge could have deep and profound consequences, both for what people make of modern democratic politics and for the idea of rule-governed international politics. Under these conditions, the structural flaws of democracy could be said to have tragically trumped democratic agency and deliberative capacity.

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### **NOTES AND QUESTIONS**

1. Professor Ilya Somin has disputed the need for such governance approaches regarding climate change:

In my view, such global governance is neither necessary nor sufficient to prevent global warming. As co-blogger Eric Posner points out, an effective climate change deal requires the agreement of only about 20 or so major emitting nations, such as the US, China, India, Russia, and several major European States. Obviously, most of these states would suffer serious harm if catastrophic global

warming scenarios turn out to be true. They therefore have strong incentives to reach a deal. Collective action problems are not a serious danger when a solution only requires the cooperation of a few major actors, each of whom knows their participation is essential to the success of the overall project. There is little incentive to free-ride if the potential “free-rider” knows that the problem can’t be solved without his participation.

Ilya Somin, *Do We Need Global Governance to Combat Global Warming*, Volokh Conspiracy Blog, Dec. 21, 2009, available at <http://volokh.com/2009/12/21/do-we-need-global-governance-to-combat-global-warming/>.

Do you agree with Professor Somin? What are the strongest arguments for and against this position?

2. The book began with a quote from United Nations Secretary General Ban Ki-moon arguing for the importance of the world facing its 50-50-50 challenge of reducing greenhouse gas emissions by at least 50 percent as population increases by at least 50 percent by 2050. United Nations, Press Release, Better Global Governance Needed to Help Most Vulnerable, Stave Off Climate Change, Meet ‘New Generation’ Challenges, Says Secretary-General in Marrakesh, Oct. 18, 2010, available at <http://www.un.org/News/Press/docs/2010/sgsm13188.doc.htm>. Do you think that the options proposed in the above readings are promising ways of meeting this challenge or do you prefer other approaches, such as the one Professor Somin proposes? Which ones do you think are most promising?

## 2. A Vision for Effective Climate Change Law

Regardless of one’s opinion on climate science, economics, or politics, a fundamental reality remains. If we do not take aggressive steps to mitigate climate change, there is a risk that we will face the devastation of the first scenario laid out in this chapter. Those who disagree with consensus climate science or with Stern’s analysis might view that risk as very low or long-term, but even they are hard pressed to deny that any risk exists. Those who agree with IPCC assessments and the science emerging since the 4th Report suggesting that climate change may be happening even faster than we expected likely will view this risk as very high.

This risk frames the core question of the book: What is the most appropriate role of law in addressing this problem moving forward? Answering it requires deciding how you view the risks and what you think the appropriate international or transnational governance strategies are. The latter task necessitates a further decision about how subnational and nongovernmental actors should fit into those governance strategies and how dominant the UNFCCC structure should be in them.

This question is not simply a hypothetical one. As students interested in thoughtfully engaging the hard questions posed by the problem of climate change, a problem that seems very unlikely to go away in the near term, you represent the best hope for the creative solutions that our future so desperately needs. We encourage you to use your understanding of current approaches to climate change law and policy to envision an alternative future and the steps that will get us there.