BACKDRAFT:
The Conflict Potential of Climate Change Adaptation and Mitigation

EDITED BY Geoffrey D. Dabelko, Lauren Herzer, Schuyler Null, Meaghan Parker, and Russell Sticklor

Wilson Center
ecsp
environmental change & security program
VOL 14 | ISSUE 02

ENVIRONMENTAL CHANGE AND SECURITY PROGRAM **REPORT 2013**

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ECSP REPORT

Series Editor: Meaghan Parker

Design and Production: Lianne Hepler

Cover Photograph: ©Robb Kendrick, Getty Images

SUGGESTED CITATION

Dabelko, Geoffrey D., Lauren Herzer, Schuyler Null, Meaghan Parker, & Russell Sticklor (Eds). (2013). *Backdraft: The Conflict Potential of Climate Change Adaptation and Mitigation* (Environmental Change & Security Program Report Vol. 14, Issue 2). Washington DC: Woodrow Wilson International Center for Scholars.

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Eyes Open: Recognizing the Conflict Potential of Climate Change Responses

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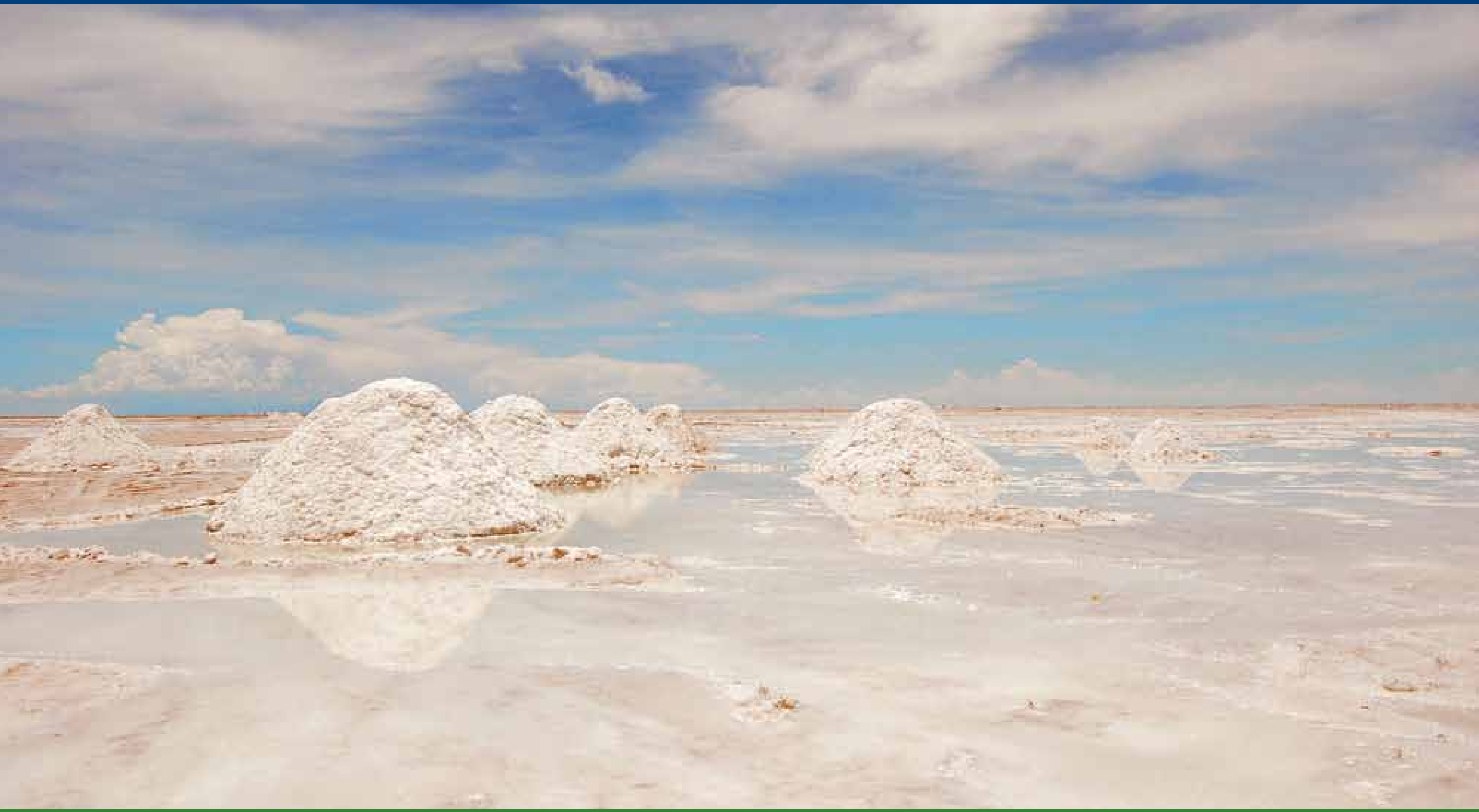

Lithium flats of Bolivia. Courtesty of flickr user Eva L., http://www.flickr.com/photos/13724361@N00/5381939519.

AMID THE GROWING NUMBER of reports warning that climate change could threaten national security, another potentially dangerous—but counterintuitive—dimension has been largely ignored. Could efforts to reduce our carbon footprint and lower our vulnerability to climate change inadvertently exacerbate existing conflicts—or create new ones?

If designed or implemented without consideration for conflict potential, unforeseen negative spillover effects might damage economic development prospects, undermine political stability, or fray the social fabric of communities. How can policymakers anticipate and minimize these potential risks? More ambitiously, can mitigation and adaptation efforts be designed to not only avoid conflict, but also help build peace?

The potential security risks posed by mitigation and adaptation policies and technologies are intriguing and underexplored aspects of climate change responses. *Backdraft: The Conflict Potential of Climate Mitigation and Adaptation* draws on the insights of leading environmental security experts to examine different facets of the conflict potential of climate change mitigation and adaptation—not only physical violence, but also the broader spectrum of social and political confrontation. A parallel line of inquiry—the potential of climate mitigation and adaptation efforts to build peace and encourage cooperation—is not addressed in this series but holds great promise for future analysis.

Defining Backdraft: A New Research Program

Can subnational and transnational climate change adaptation be harnessed as a tool for peace? In their essay "The Need for Conflict-Sensitive Adaptation to Climate Change," Dennis Tänzler, Alexander Carius, and Achim Maas kick off *Backdraft* by placing different adaptation approaches in the context of current international climate talks. The authors urge policymakers to think beyond national borders in order to more effectively address the transboundary impacts of climate change in conflict settings. A series of policy recommendations provides the aid and development communities with a potential blueprint for conflict-sensitive adaptation measures.

With climate change slated to place further strain on the planet's already overburdened natural resources, regions rich in natural wealth may find themselves increasingly drawn into conflict as competition for arable land, water, oil, and mineral wealth increases. In "Resource Curses: Redux, Ex-Post, or Ad Infinitum?" Stacy VanDeveer peers over the horizon, speculating about the fate of oil-exporting states as the world economy slowly transitions away from fossil fuels. Highlighting the complications inherent in petroleum states' eventual transition away from an oil-based economy—a transition that will not be welcomed by OPEC member states—VanDeveer contends it is analytically important to examine how countries with significant depletions of fossil-fuel reserves have handled such transitions in the past. Using the lens of "peak oil," he points out that a greener world energy supply might destabilize regimes traditionally propped up by oil revenue.

Turning to a vulnerable global resource threatened by both climate change and economic development, Dennis Tänzler examines the fate of woodlands in "Forests and Conflict: The Relevance of REDD+." Focusing on the United Nations' Reducing Emissions from Deforestation and Forest Degradation (REDD) program, Tänzler explores not only REDD's positive economic and environmental benefits for forest-rich countries in the developing world, but also highlights how such initiatives could trigger disputes over land rights, carbon ownership, and equitable distribution of REDD-related financial benefits. He concludes with a series of policy recommendations to improve the effectiveness of such initiatives through heightened incorporation of local conflict dynamics in target countries.

In "Climate Gambit: Engineering Climate Security Risks?" Achim Maas and Irina Comardicea analyze one of the most controversial aspects of climate change mitigation and adaptation—geoengineering. The technological revolution of the last 50 years has turned what was once the realm of science fiction—such as seeding clouds with chemical pellets to induce rain or burying harmful atmospheric gases deep beneath the earth—

into real science. This technology is now available to any nation with the financial and physical capability to deploy it. What are the security implications of using these novel, but largely untested, technologies? Could deployment of geoengineering technology in the skies, seas, or soils of one country inadvertently impact weather or soil fertility in a neighboring country? More broadly, how can policymakers ensure that such technology, once deployed, remains under control, and does not trigger unintended impacts? Maas and Comardicea analyze both the drawbacks and positive potential of humans exercising greater control over the natural environment in the coming decades.

Stressing that climate change impacts unfold across various sectors of society and rarely occur in isolation, Chad Briggs argues in "Risk and Scenario Planning for Climate Security" that new models are needed to more accurately analyze current climate security hotspots and forecast future flashpoints. Since older notions of state security do not necessarily apply to climate change—given the long time horizons that typically characterize climate change impacts—models must incorporate system-level vulnerabilities, more tightly focused data gathering and analysis, and an understanding of how different governmental systems and adaptation measures influence climate-security outcomes.

Rounding out *Backdraft* are spotlights on two key emerging issues. Christian Webersik and Mikael Bergius shine a light on how measures to reduce future emissions levels by supporting the development of biofuels could affect international and human security. Christina Daggett explores the potential impacts of wealthy countries' recent "land grabs" in developing countries on the global agricultural system and the host countries' food and water security.

Avoiding Backdraft: Eyes Wide Open

Making a transition to a green economy in a warmer world is a necessary transition. Smart long-term thinking on climate adaptation and mitigation, and the conflict and peacebuilding potential of both, will be critical to fortifying human security in the century ahead.

Taking a systematic look at the conflict potential of mitigation and adaptation tools is an analytical and policy challenge that we must face head-on. To avoid or downplay the possibility of conflict generated or exacerbated by such changes threatens the larger project of aggressively addressing climate change. Three key principles should inform our policy decisions on climate change adaptation and mitigation:

- **Do no harm:** Recognize that all interventions have the potential to exacerbate or alleviate existing tensions.
- **Be open to new ideas:** Improve communication and collaboration across communities and disciplines, from climate science and natural resource management experts to international development entities and the military. Intelligent adaptation and mitigation policies need flexible programs that measure their success against multiple objectives, not just one target.
- **Build pathways to peace:** Identify and implement climate change programs that can support peacebuilding initiatives.

The contributors to *Backdraft* help lay the groundwork for this emerging field. The authors examine and weigh the considerations we must bear in mind as we make the necessary transition to a greener economy. The types of tactics deployed and how they are sequenced will determine the consequences of the transition. Where applicable, we must study and incorporate evidence of past climate and conflict trends, and engage in thoughtful deductive arguments about what could happen in the coming decades.

Our future climate security interventions must be guided not only by lessons learned, but also by new models that incorporate more aspects of contemporary human security, including rapid demographic change, depleted fresh water supplies, and more erratic agricultural output, as well as political instability and fragility. In doing so, we can move forward with our eyes open to conflict dynamics around us, implementing more sustainable, more cost-effective, and ultimately more peaceful ways to adapt to and mitigate the climate challenge.

The Need for Conflict-Sensitive Adaptation to Climate Change

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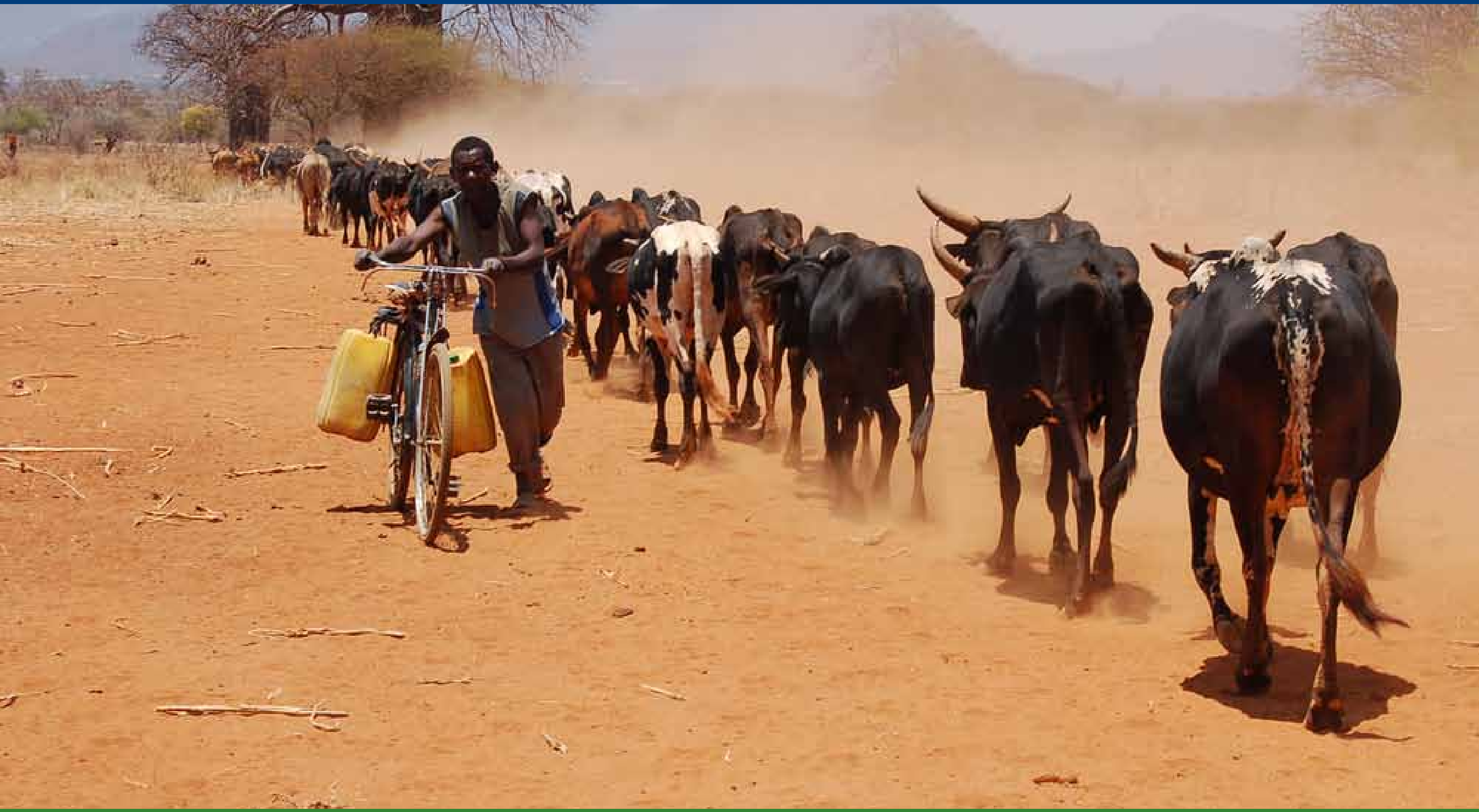


Humans and cattle have to walk several kilometers to their water supply in Kongwa, Dodoma region of Tanzania. Courtesy of flickr user BCClimateChampions, http://www.flickr.com/photos/bcclimatechampions.

CLIMATE CHANGE WILL HIT HARDEST the nations with the lowest capacity to adapt in the decades to come. Impending shifts in our climate will likely heighten social tensions and conflict potential in these countries. Institutions in fragile states may prove to be particularly unprepared or unequipped to cope with climate change impacts, such as food and water shortages, severe weather events, and mass migrations. In turn, these institutions' inability to adapt may accelerate the onset of national or regional destabilization and possibly even trigger violence (WBGU, 2007; Carius et al., 2008). The UN Security Council (2011) highlighted this risk, stating that climate change impacts represent "a challenge to the implementation of Council mandates."

Nevertheless, it is important to avoid one-dimensional causal explanations when assessing whether natural resource competition and population movements may lead to an increase in violent conflict. Climate change alone will not likely generate conflict. Instead, it will more likely serve as a threat multiplier that exacerbates pre-existing issues, such as weak rule of law or social and economic injustice.

At the same time, populations affected by climate change could use environmental cooperation as a tool to build confidence between former antagonists and strengthen peacebuilding efforts (Conca & Dabelko, 2002; Feil et al., 2009). However, climate change's potential for catalyzing cooperation and transcending enmities depends largely on the design of conflict-sensitive adaptation policies. This article aims to shed light on the prospects for such policies by examining the elements shaping the rapidly expanding arena of adaptation policy.[1]

Approaches to Adaptation

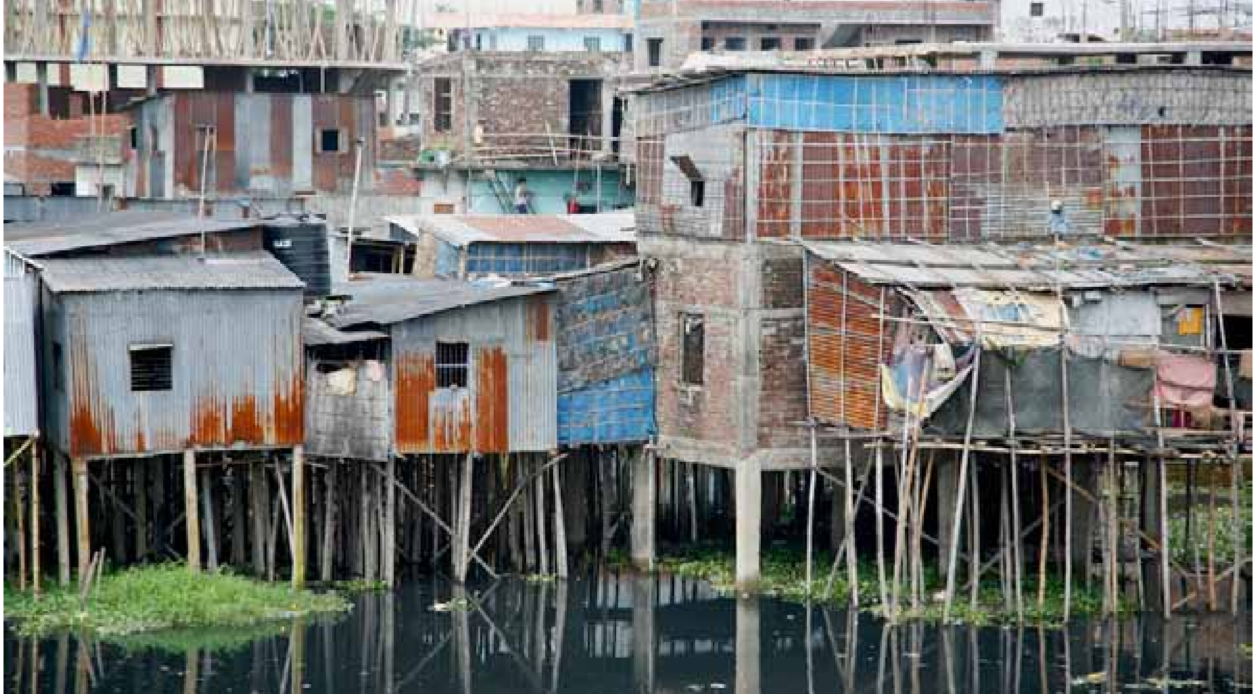
The United Nations Framework Convention on Climate Change (UNFCCC) defines climate adaptation as an "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (UNFCCC, 2007). Adaptation has also become a focal point of debate over the security implications of climate change, given that greenhouse gas emissions have already triggered irreversible global warming.

The UN has called attention to the need for adaptation in the context of global security, particularly in the 2009 UN Secretary-General's report on climate change and security (UN General Assembly, 2009). However, these summons to action have remained somewhat vague about how adaptation policies might be designed and implemented, thus preventing countries from taking concrete action. One reason for this situation may be that most security policy discussions and deliberations over adaptation take place in separate political arenas, with minimal exchange between the two fields. Another potential explanation is that different conceptual perspectives on adaptation have made it difficult for policymakers to form a consensus, especially when it comes to addressing adaptation needs in conflict-prone countries.

Adaptation is commonly viewed as a primarily technical challenge. Seen through this lens, adaptation reduces climate change's negative impacts by sharing technology and building better capacity for natural resource management. Yet to avoid negative impacts, it is necessary to anticipate the potential social and political implications of such adaptation measures. By applying the "do no harm principle," it becomes clear that adaptation measures raise not only technical and financial questions, but political questions as well, especially when such measures are implemented in fragile states (Anderson, 1999).

Designing conflict-sensitive adaptation measures could be a tool for socio-political transformation. Climate change is projected to induce major changes in individual living situations, as in the case of small island states such as the Maldives, whose very existence is threatened by rising sea levels. In such contexts, adaptation measures represent no less than a fundamental redistribution of the resources of an entire society. In principle, such adaptation policies foster opportunities to build a more sustainable society. However, depending on how they are designed and implemented, they can also contribute to the erosion of established societal structures and induce instability within and between states.

Adaptation measures may generate friction or resistance, predominantly from those who profit from the



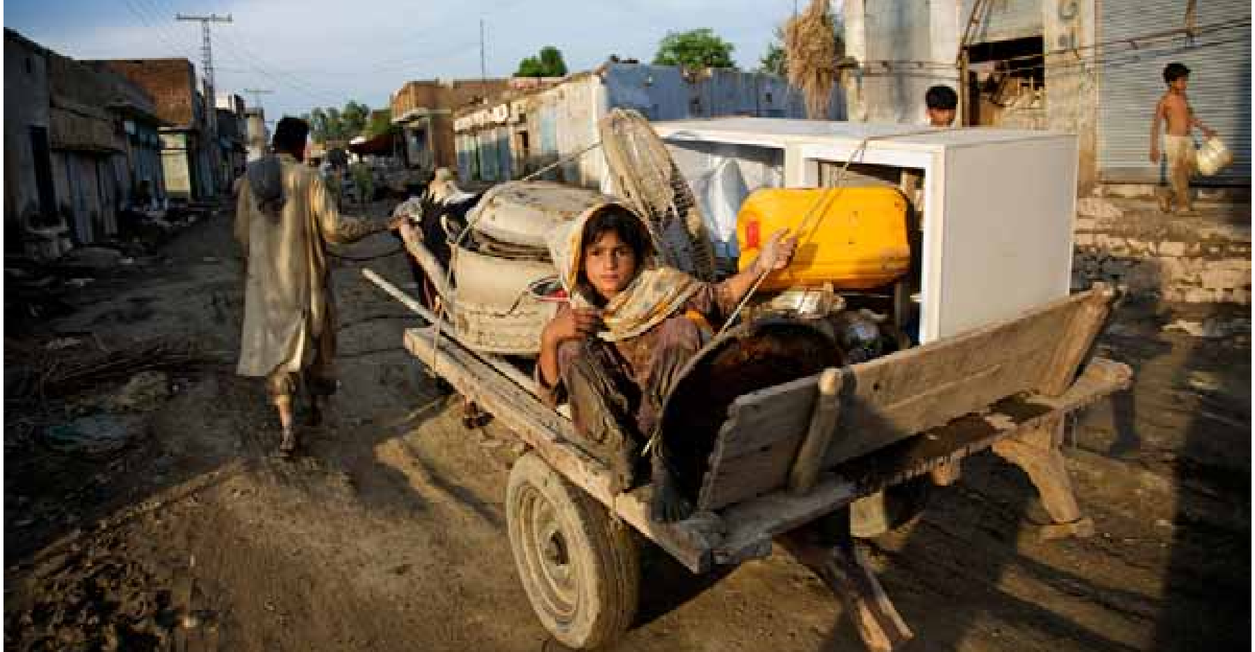
Dhaka, Bangladesh. Courtesy of flickr user Michael Foley Photography, http://www.flickr.com/photos/michaelfoleyphotography.

status quo or who are interested in diverting adaptation-related funding for other purposes. Thus, adaptation measures may also potentially be a direct cause of conflict. When two or more states share the waters of a transboundary river, for example, climate change adaptation measures may increase the likelihood of confrontation between upper and lower riparians, especially if the policies reduce water supply in the downriver states (Wolf, 2007). In some areas, conflicts may occur as a result of efforts to adapt to decreasing water availability. In Kasese, Uganda, tensions arose due to competing demands for available water supplies. Efforts to provide communities with additional water taps also stirred tensions, as an initial effort only placed a tap in the Rukoki area, causing anger among the Mahango people. In the future, the planning, design, and implementation of new water access policies would benefit from greater involvement of district water officials and representatives of communities competing for the same water supplies (Saferworld, 2008b).

Adaptation measures could potentially spur cooperation instead of conflict. For example, nations may be able to use non-violent conflict resolution tactics to help implement necessary but unpopular adaptation measures, such as resettling populations and negotiating suitable compensation packages. It is quite possible that as those nations increase their ability to adapt to climate change, they will also increase their social resilience and thus improve their capacity to achieve peaceful conflict resolution and conflict transformation in other areas of society. Successful climate change adaptation could empower countries to better withstand various social and economic stressors, while avoiding the destabilization of their governing institutions and societal structures. If adaptation processes are participatory, they can also give marginalized groups a voice to integrate their concerns in building resilient communities. To this end, mechanisms for consensus-building, public dialogue, and coordination among different government branches and stakeholder groups are needed (Saferworld, 2008a; Ruckstuhl, 2009).

Adaptation in the International Climate Debate

To date, international debates on climate protection have been characterized mainly by attempts to mitigate climate change by reducing the level of greenhouse gases in the atmosphere. For instance, in its 4th assessment, the Intergovernmental Panel on Climate Change



A girl rides on a cart carrying her family's salvaged belongings in Khwas Koorona Village, Pakistan. Courtesy of flickr user UNICEF Canada, http://www.flickr.com/photos/unicefcanada.

(IPCC) recommended a 25 to 40 percent reduction in greenhouse gas emissions for industrialized countries by 2020 (IPCC, 2007). However, going forward, it is much less clear how building a sustainable adaptation structure can be measured by performance goals.

Progress in establishing a robust, internationally acceptable framework for implementing adaptation measures has been slow. The adoption of the Marrakesh Accords by governments in the course of negotiations in 2001 helped support adaptation policies in developing nations by establishing a number of funding streams—the two most important being the Adaptation Fund and the Least Developed Countries Fund—to design and implement concrete adaptation projects and programs in developing countries. But these funds' financial impact has been modest, at least in comparison to the estimated tens of billions U.S. dollars per year deemed necessary by some to enable a comprehensive adaptation system (IIED, 2009). The Adaptation Fund, which receives two percent of the income generated from the sale of emission certificates linked to Clean Development Mechanism projects, might help close the gap. In addition, key financing decisions made during negotiations in Copenhagen in 2009, Cancun in 2010, Durban in 2011, and Doha in 2012 offer new opportunities for immediate adaptation activities. "Fast-start financing" for both mitigation and adaptation measures should amount to a total of US$30 billion between 2010 and 2012. However, in the first year, only 8 percent of this money was spent for adaptation projects (Caravani et al., 2011).

These financing pledges have been linked to the establishment of a Global Green Fund that aims to coordinate USD$100 billion a year from 2020 onward. As a result of the 2011 Durban climate negotiations on adaptation, there is an increased focus on a long-term supporting structure, leading to the establishment of an Adaptation Committee for further high-level policy guidance, as well as the initiation of a process to formulate National Adaptation Plans with a medium- and long-term perspective (Nassef, 2012). In addition, the adaptation governance framework is complemented by a work program to address loss and damage arising from climate change. To guide the implementation of the work program, the most recent climate negotiations in Doha decided to establish appropriate institutional arrangements until the end of 2013 (Bickersteth et al., 2012).

However, the quality of an international framework for funding climate change adaptation measures should not be measured solely by the amount of money it generates. It is also critical that when financial support is provided, it is accompanied by administrative capacity-building to avoid any misappropriation of funds.

In the absence of such capacity-building, an influx of cash for adaptation programming could strengthen the influence of corrupt elites and exacerbate pre-existing conflict dynamics in target countries (Transparency International, 2011).

Adaptation Efforts in Conflict-Prone Regions

Existing adaptation activities have already made some headway: As of the end of 2010, for example, 45 National Action Plans for Adaptation (NAPAs) for least developed countries had been submitted to the UNFCCC. Twenty-one plans were developed in countries considered to be at high risk of destabilization, and 19 in countries at increased risk of destabilization (Fund for Peace, 2011). Hence, fragile states have been influenced by international support to initiate adaptation plans.

The sectoral approach of NAPAs enables countries to analyze risks in different areas impacted by climate change. In the case of water resources, for example, NAPAs make it possible to identify the most urgent priorities for improving urban and rural water-supply infrastructure, enhancing water storage, and stemming water pollution. Similar analyses identify priorities for improving food security, such as by changing traditional cultivation patterns or diversifying agricultural goods. As a result, the method by which NAPAs are created generates not only a list of national priorities for adaptation but also sensitizes different groups of stakeholders to pending climate change challenges, allowing countries to more effectively develop responses. Still, the slow pace of deployment for adaptation projects reveals that insufficient funding remains an issue, as well as a lack of appropriate governance structures. But with more than 70 adaptation projects under the Least Developed Countries Fund now underway, there are signs of concrete progress (GEF, 2012).

The pressure to integrate adaptation processes into ongoing development initiatives and poverty-alleviation campaigns is increasing. A United Nations Development Program (UNDP) assessment of the importance of fresh water resources in NAPAs, for example, shows that greater integration has already begun, with countries such as Bhutan, Rwanda, and Sudan integrating adaptation measures into their poverty-reduction strategies to ensure overall coherence of policy planning (UNDP WGF, 2009). Nevertheless, integration can often prove superficial. To ensure that adaptation measures are compatible with larger political processes, it is crucial that states establish good governance structures to help manage such programs.

Adaptation programming's rigid demarcation into sectoral tasks can fall short when it comes to conflict, however. A more systematic, integrated approach is needed to meaningfully incorporate existing conflict dynamics—as well as overarching socio-political and economic conditions—into the design of adaptation measures.

Even in industrialized countries with adequate administrative capacity, coordinating various political processes can be a major challenge. In post-conflict societies, the difficulties of coordination are disproportionately greater. Institutionalizing responsibility for the coherent implementation of adaptation policies by assigning those measures to a specific state institution or inter-ministerial body could help. National Implementing Entities, which are currently established in select countries (including Rwanda, Senegal, and Kenya, among others) to facilitate the direct access of a country to the Adaptation Fund, may be appropriate to serve this purpose.

Thinking Beyond National Borders

Adaptation programs often lack a regional focus. NAPAs typically do not emphasize transboundary environmental issues, since anticipating the scale of future climate change impacts across boundaries remains difficult. Further, the conventional, state-oriented focus of the UNFCCC makes it challenging to develop regional adaptation policies.

Nevertheless, this problem must be overcome. Limiting NAPAs to a national perspective ignores the transboundary nature of resource scarcity, especially with regard to water supply. In a worst-case scenario, an isolated national approach to adaptation can trigger new

The international community must make substantial financial and political commitments to ensure that climate change does not exacerbate preexisting social and economic injustices. Policymakers, development practitioners, and environmental ministers in states around the world will also have to maintain an open dialogue to create and successfully implement innovative, conflict-sensitive adaptation programs.

conflicts in neighboring states. Furthermore, adaptation programming that doesn't take neighboring states into account wastes a potentially valuable opportunity for cross-border trust-building and collaboration.

One step in this direction may be to build on processes of regional integration. In Africa, the policy continuum linking the African Union, Regional Economic Communities, and national policies may offer interesting entry points for dialogues that could also involve civil society and research organizations in joint exploration of options for guiding regional adaptation processes (Comardicea et al., 2011; Yanda & Bronkhorst, 2011; Tänzler & Mohns, 2013).

Conclusions: Building Conflict-Sensitive Adaptation Strategies

Fragile states are at a heightened risk of suffering from the debilitating effects of climate change in the future, but states regarded as stable are also likely to face severe challenges to their water and food security. To stave off destabilization in different types of countries, adaptation measures should be implemented to bolster states' social, political, economic, and environmental resilience. How can we maximize the chances for positive outcomes? One approach would be to follow the three main principles of conflict sensitivity:

- Understand the context in which an organization operates;
- Understand the interaction between it, its activities, and the context; and
- Act upon their understanding of this interaction to avoid negative impacts and maximize positive ones (Saferworld, 2008a).

By applying these principles of conflict sensitivity to the field of climate change adaptation, the following measures can be formulated to guide adaptation processes in both stable and unstable states, but with special attention in conflict-prone settings:

1. **Identify the sectors of society critically affected by climate change** and the roles they play in national and regional policy, which will help ensure coherency and coordination at the national level. If necessary, additional peace and conflict assessments can be used to reduce the risk of maladaptation.

2. **Work together with stakeholders both inside and outside the government** to formulate strategies and develop programs that help

raise awareness among the general public about the potential impacts of climate change. Doing so will make it easier for states to win public support for the steps needed to secure future food and water supplies and improve disaster preparedness.

3. **Ensure institutional support.** National steering committees should be responsible for monitoring the progress of adaptation programs, coordinating public authorities and external stakeholders (such as donor organizations), and establishing mediation bodies. The creation of National Implementing Entities is a step in the right direction.

4. **Integrate adaptation measures into countries' development initiatives and poverty-reduction campaigns.** Embracing a systematic, integrated approach to creating National Adaptation Plans will lead to more conflict-sensitive adaptation measures.

5. Through the UNFCCC Conferences of Parties, **adopt a broader framework for adaptation** to enhance the international financial architecture for fighting climate change.

6. **Strengthen regional cooperation** to meet the challenges of adapting to global climate change.

7. Develop methods to **enable civil society and decision-makers in fragile states to design and implement conflict-sensitive adaptation strategies,** starting with formulating guidelines for donors and implementing agencies in the partner countries.

In the years ahead, the international community must make substantial financial and political commitments to ensure that climate change does not exacerbate preexisting social and economic injustices. Policymakers, development practitioners, and environmental ministers in states around the world will also have to maintain an open dialogue to create and successfully implement innovative, conflict-sensitive adaptation programs. While the prospects for success remain largely unknown at this time, adaptation policies could bolster human security in the face of a changing climate—and nowhere more so than in the world's most fragile states.

Note

1. This paper is based in part on "Climate Change Adaptation and Peace," by Dennis Tänzler, Achim Maas, and Alexander Carius (2010), and published in *Wiley Interdisciplinary Reviews*, and updated with the results of the research project "Adaptation, Security and Peace" (FKZ 3710 41 142) commissioned by the German Federal Environmental Agency. Achim Maas co-authored this paper while Senior Project Manager for adelphi.

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SPOTLIGHT:
In the Rush for Land, Who Will Pay?

CHRISTINA DAGGETT, Database Manager, National WWII Museum, and former ECSP Intern[1]

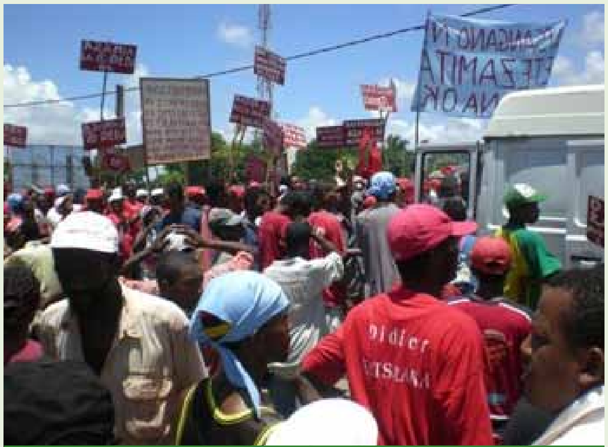
Over the past few years, wealthy countries with shrinking stores of natural resources and relatively large populations (such as China, India, South Korea, and the Persian Gulf states) have quietly purchased huge parcels of fertile farmland—especially in sub-Saharan Africa, South America, and Southeast Asia—to grow food for export to the parent country. With climate change expected to have an increasing impact on food security, and staple food prices shooting up, it is little wonder that countries are looking abroad to secure future resources. Less obvious is the impact that these "land grabs"—and the access to water that they frequently represent—will have on international security.

In 2012, the International Land Coalition estimated that more than 200 million hectares' worth of land deals had been approved, or were under negotiation, between 2000 and 2010 (Kugelman & Levenstein, 2013). Oxfam has estimated that land equivalent to eight times the size of Britain was sold or leased worldwide in the last 10 years (Geary, 2012).

As the chart on the next page illustrates, some of these deals are of immense scale, with several in excess of a million hectares. They are spearheaded not just by food-security-minded national governments, but also by the private sector.

In 2008 South Korean industrial giant Daewoo Logistics negotiated one of the biggest African farmland deals with a 99-year lease on 1.3 million ha of farmland in Madagascar for palm oil and corn production (Walt, 2008). The deal amounted to nearly half of Madagascar's arable land—an especially staggering figure given that nearly a third of Madagascar's GDP comes from agriculture and more than 70 percent of its population lives below the poverty line (World Food Programme, 2012). When details of the deal came to light, massive protests ensued and it was eventually scrapped after president Marc Ravalomanana was ousted from power in a 2009 coup ("Madagascar leader axes land deal," 2009).

While perhaps an extreme example, the Daewoo/Madagascar deal nonetheless demonstrates the conflict potential of these massive land deals, which are taking place in some of the poorest and hungriest countries in the world. In 2009, rice grown on farmland in Ethiopia was delivered to Saudi Arabia, while the World Food Program sent food to five million Ethiopians (Bunting, 2011). A Saudi corporation also acquired nearly 5,000 square miles of land in Papua Province, Indonesia—but the project has



In the northeastern coastal city of Tamatave, Madagascar, negotiations between the Malagasy government and South Korea's Daewoo Logistics Corporation to lease nearly half the country's arable farmland to grow food for export to South Korea led to unrest in 2009. Courtesy of flickr user foko_madagascar, http://www.flickr.com/photos/foko_madagascar.

Large-Scale Foreign Land Acquisitions

Investor	Host Country	Scale (in hectares)	Crop	Status
Brazil	Mozambique	6 million	Soy and corn	Concession offered by Mozambique, 2011
Daewoo (South Korean)	Madagascar	1.3 million	Corn and others	Collapsed due to public opposition, 2009
Binladen Group (Saudi Arabian)	Indonesia	1.2 million	Various	Project launched but investments on hold, 2011
China	Philippines	1.2 million	Rice, corn, others	Suspended, 2007
Hong Kong and Philippine firms	Philippines	1 million	Rice, corn, others	MOU signed, 2008
South Korea	Sudan	690,000	Wheat	Deal signed, 2009
Nile Trading and Development (American) and local Sudanese investors	South Sudan	600,000	Jatropha and others	Lease signed, 2008
Karuturi (Indian)	Ethiopia	300,000	Various	Lease agreement in place, 2011
Heilongjiang Beidahuang Nongken Group (Chinese)	Argentina	300,000	Soybeans, wheat, others	Agreement in place, 2010
Libya	Mali	100,000	Rice	Agreement in place, 2009

Source: Kugelman & Levenstein (2013, p. 3).

been suspended because of concern about conflict in this insurgency-riven area (Kugelman & Levenstein, 2013).

Some observers, however, have pointed out that these dealmakers might be more interested in the water than the land.

In a 2009 *Foreign Policy* article, Peter Brabeck-Letmathe, the chairman of Nestlé, claimed that "the purchases weren't about land, but water. For with the land comes the right to withdraw the water linked to it, in most countries essentially a freebie that increasingly could be the most valuable part of the deal."

Consider some of the largest investors in foreign land: China has a history of severe droughts (and recently, increasingly poor water quality); the Gulf nations of Saudi Arabia, Kuwait, Qatar, and Bahrain are among the world's most water-stressed countries; and India's groundwater stocks are rapidly depleting (Townsend, 2011; Maplecroft, 2011; Sticklor, 2011).

A 2010 report from the World Bank on global land deals highlighted the effect water scarcity is having on food production in China, South Asia, the Middle East, and North Africa, stating that "in contrast, Sub-Saharan Africa and Latin America have large untapped water resources for agriculture."

"The water impacts of any investment in any land deal should be made explicit," said Phil Woodhouse of the

University of Manchester during the 2011 International Conference on Global Land Grabbing, as reported by the *New Agriculturist* (2011). "Some kind of mechanism is needed to bring existing water users into an engagement on any deals done on water use."

At the same conference, Shalmali Guttal of Focus on the Global South cautioned, "Those who are taking the land will also take the water resources, the forests, wetlands, all the wild indigenous plants and biodiversity. Many communities want investments but none of them sign up for losing their ecosystems."

Whatever the benefits or pitfalls, large-scale land deals around the world look set to continue. The world is now has more than 7 billion mouths to feed and will face possibly 10 billion plus by the end of the century (United Nations, 2010).

Currently, agriculture, including livestock and grazing land, uses just under 38 percent of the world's land surface and 70 percent of the world's freshwater resources (World Bank, 2009). Demand for water is expected to outstrip supply by 40 percent within the next 20 years. If and when the going gets tough, how will the global agricultural system respond? Whose needs come first—those of the host countries or the investing nations?

Note

1. This article is adapted from Daggett, Christina. (2011, July 26). "In Rush for Land, Is it All About Water?" *New Security Beat.* Available online at http://www.newsecuritybeat.org/2011/07/in-rush-for-land-is-it-all-about-water. Wilson Center Senior Program Associate Michael Kugelman also contributed to this article.

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Resource Curses: Redux, Ex-Post, or Ad Infinitum?

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Offshore oil rig near Catalina Island in southern California. Courtesy of flickr user arbyree (R.B. Reed), http://www.flickr.com/photos/19779889@N00.

PRICES FOR MANY COMMODITIES traded in global markets have moved through booms and busts during the first decade of the 21st century. Goods traditionally prone to wild price cycles—such as oil, gold, copper, silver, and coffee—have been joined by valuable commodities like coltan, lithium, and the rare earth minerals. Demand for these substances has grown in tandem with the explosion of high-tech electronic equipment and personal devices, including cell phones and computers, batteries, electric and hybrid vehicles, laser technologies, medical equipment, high-tech weaponry, and fluorescent lighting. In short, commodities such as the rare earth minerals, lithium, and coltan are demanded in large quantities by the so-called "green economy," as well as many other technology industries and contemporary communication tools and networks. Since renewable energy technologies are quite high-tech, in terms of software and hardware, it remains unwise to draw conceptual lines between the "green" economy and other technology sectors. Paradoxically, while these commodities enable technological innovations needed to make human economies and societies more sustainable, they also require ecologically and energy-intensive extraction and processing operations.

Many countries dependent on the export of high-value resources have to contend with boom-and-bust cycles, as well as the economic instability and underperformance that typically accompany these fluctuations. Such instability is one of the reasons that high-value commodity markets have long been associated with violent conflict, from local skirmishes and civil violence to international warfare and imperial competition. Increasingly, concerns are emerging that the environmental impacts of climate change may similarly endanger human security at the regional and international levels (Moran, 2011; Paskal, 2010). While climate change may well pose serious threats to human welfare and ecological health, it by no means exhausts the potential environmental security challenges linked to economic and technological change.

In this article, I examine the impact of resources needed to drive the new "cleaner" energy and communication industries in a renewable energy-based economy.[1] If green energy sources eventually meet a large percentage of future energy demand, should we expect these resources to produce different economic, social, and political outcomes than oil, gas, and forestry have in the past century? Are we likely to see lithium-funded oppressive authoritarian governments or the return of coltan-funded militias and international criminal organizations? Will large commodity-dependent consumer states plan military and defense strategies around secure access to critical materials? Viewed another way, could the much-debated "resource curse" be repeated, recreated, and redefined with a new set of commodities?

Curses, Curses!

The "resource curse" concept refers to the correlation between a country's high level of dependence on high-value resource exports and the likelihood that the country will exhibit subpar economic performance over time and have undemocratic, corrupt, and/or ineffective governing institutions (Stevens & Dietsche, 2008; Weinthal & Luong, 2006; Karl, 1997). Over the past generation, "petro states" have served as prime illustrations of the curse. Highly reliant on oil exports, these nations have included Nigeria, Bolivia, Angola, Chad, and several states in the Caspian, Persian Gulf, and Central Asian regions. Not only do they tend to be deeply indebted, many also have closed political systems; in 2000, for example, 18 of the world's top 20 oil-exporting nations were run by non-democratic regimes. But the curse is not limited to petro states alone. Many states with large, export-oriented agricultural and mining sectors face a similar set of economic and political challenges, with citizens of mineral-exporting countries often experiencing high levels of poverty and child mortality, despite significant resource-related revenues (Ali, 2009a; Weinthal & Luong, 2006).

While analysts differ on the specific causes of the resource curse, key factors typically include: 1) a lack of economic diversification; 2) boom-and-bust price cycles that trigger instability in commodity-dependent economies; and 3) governing bodies that are weak, corrupt, or heavily entangled in patronage networks. State institutions in resource curse-afflicted nations also tend to exercise little independent authority over resource sectors, and often demonstrate comparatively low levels of capacity to deliver basic services to citizens.

However, the notion that oil or other resource commodities are really "curses" has been the subject of growing debate in recent years (Haber & Menaldo, 2011). Perhaps resource curse dynamics are merely an artifact of a particular era and/or a particular set of institutional configurations. Weinthal and Luong (2010) argue that the resource curse is largely a myth, as it does not account for the wide variation in ownership structure in resource extraction sectors across countries. If one distinguished state ownership from state control and examined more cases of resource wealth over a longer time frame, they contend, the curse would not be the rule, but rather the exception. According to this view, the circumstances most likely to produce outcomes associated with the resource curse are complete state ownership and control of the resource extraction sector, coupled with an extreme dependence on those resources for state revenue. Accordingly, these analysts blame policy failure and ownership structure for resource-related instability, rather than resource wealth itself or its associated funds.

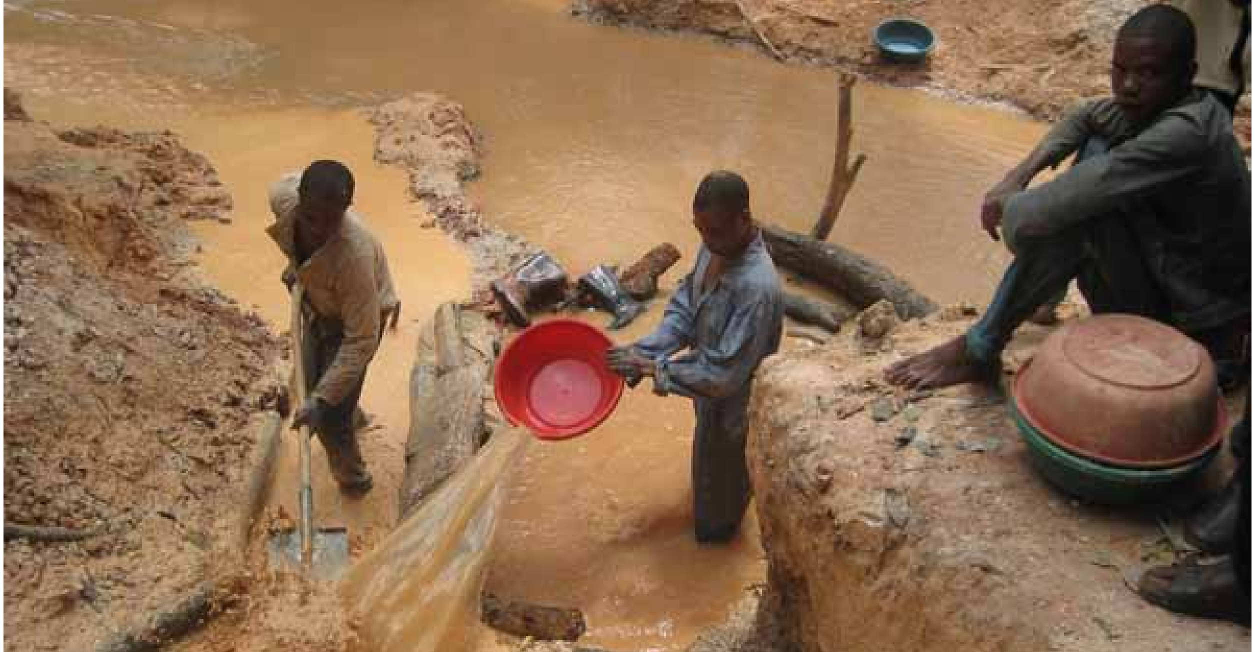
The recent critiques of the resource curse concept are intellectually valuable and have important political implications. They focus attention not on the presence of a valuable resource alone but on the particular economic and political institutions in "cursed" countries and the relationship of these to international markets and institutions. Michael Ross's (2011) work suggests, for example, that the most oil-dependent states are the most likely to experience curse dynamics and that this pattern has been particularly acute since the 1970s. Resource wealth, when prices are high, allows state leaders to fund patronage networks and comparatively large and well-paid militaries. In Ross's words, "geology need not be destiny," but if autocrats can keep their finances hidden and consumers are indifferent to the autocracy (and violence) they may be funding, resource wealth can remain an obstacle to more efficient, effective, and democratic governance.

Mining Under the Microscope

To many, mining and minerals sound old fashioned—part of the dirty old 20th century industrial economy that relied on heavy manufacturing. In fact, resource extraction has long been essential to the functioning of economies and societies around the world, with stone, iron, and bronze having proved so important that entire eras of human history were named after them (Young, 1992). In these eras, as today, metals represented a particularly important class of mineral resources. The financial interests at stake are substantial. In 2011, for example, the globe's top 40 mining companies reached record high profits of $133 billion and revenues of more than $700 billion (PricewaterhouseCoopers, 2012). The mining industry is larger than the GDP of more than 170 countries, and these sums do not include the much larger economic value of the thousands of products requiring mined materials.

Contemporary products and industrial processes have kept metals in high demand, including iron, bauxite, copper, lead, nickel, zinc, silver, gold, mercury, cadmium, cobalt, titanium, tin, manganese, chromium, tungsten, coltan, lithium, the rare earth minerals, and a host of others. Extraction of these metals has been accompanied by high ecological and human costs, however (Ali, 2009a, 2009b; Bridge, 2004; Richards, 2010; Spitz & Trudinger, 2008). From an environmental perspective, the sheer scale of today's mining operations is enormous, with massive volumes of earth moved in the extraction process. In addition to producing large amounts of airborne pollutants, mining industries are also waste-intensive, degrading the quality of surface- and groundwater supplies around the world. Such environmental impacts threaten human security by heightening health risks for populations participating in or living near mining operations, destroying indigenous cultures and local environments, and fostering arms trading and militia violence.[2]

Despite the well-established connection between large-scale mining, environmental degradation, and weakened human security, extractive industries continue to expand, driven by mounting global demand for



Coltan mining in the Democratic Republic of the Congo. Courtesy of flickr user Responsible Sourcing Network, http://www.flickr.com/photos/sourcingnetwork.

many minerals. Today's extractive operations increasingly trade with or come under the control of large multinational mining conglomerates, owned primarily by North American, European, Chinese, Australian, and South African investors. In order to safeguard their assets (and maintain control), mines are often protected or managed by military officials, or companies construct what amount to armed camps around facilities to protect their employees from militia activity and other forms of violence engendered by resentment among local communities (Global Witness, 2005a, 2005b, 2011).

Three worrying examples illustrate how mineral extraction can recreate or perpetuate resource curse dynamics: coltan, lithium, and rare earth minerals.

COLTAN CONNECTIONS: The technology boom of the 1990s and 2000s drove boom-and-bust price cycles in columbite-tantalite, or coltan—a mineral commonly used in cell phones, laptops, iPods, and dozens of other products and industrial processes. While it was often reported that the Democratic Republic of Congo (DRC) dominated global coltan reserves and production in the 2000s, these claims were not correct (Nest, 2011). Coltan is mined around the world, with primary production often greatest in Australia, Brazil, and a few areas of sub-Saharan Africa. When the price of coltan increased rapidly, due to rising demand, speculation, and poor information about supply, a rush to extract the mineral swept across parts of the DRC. Rampant coltan mining, often performed under highly dangerous conditions and with ecologically destructive processes, left thousands of giant pits in or near agricultural land, national parks and reserves, and river basins, while money from the coltan trade fueled state and non-state militia violence and arms transfers among local warlords. In 2000, prices spiked from US$30 to 40 per pound to about $300, before falling back to $30-something again (Nest, 2011). Once the coltan boom subsided and the mineral's price on global markets fell steeply, extraction activity declined, but environmental damage, weapons, and a painful legacy of civil violence remained (Global Witness, 2005b; Albertyn, 2004).

Connections between coltan mining/trading and child labor, child soldiers, widespread sexual violence, and other serious social disruptions are well documented. However, coltan was not (nor is it now) the most important cause of violent conflict in and around the DRC. War in the region has had many causes. But coltan mining has aggravated ethnic tensions and, particularly when the coltan price was high, was both an important object of civil and international conflict in the region as warring parties fought to control it, and a centrally important mechanism through which such violence was funded (Nest, 2011). International activists' campaigns about "blood on mobile phones" and "Playstations made with child labor" explicitly connected Western consumers, products, and firms to Congolese violence via coltan.

Such challenges to environmental and human security are certainly not unique to coltan. Indeed, once this type of cause-and-effect cycle has been established in a given region, it can prove hard to avoid in the future. Demand for one mineral can simply be replaced by demand for another. For example, although the coltan price collapse deprived some Congolese militias of a major source of revenue in early 2002, by 2008 UN reports indicated that the mining of gold, tin ore, and other commodities was helping to fund both the government military and localized militia activity (Nest, 2011). As during the coltan boom, workers were exploited while the environment suffered new rounds of degradation. Militias reasserted their control, not only by profiting from tin ore sales (often to the multinational corporations that ostensibly owned the concession for the tin), but also by levying taxes on bars, brothels, and other commercial establishments used by miners and other members of nearby communities (Polgeen, 2008).

Coltan is only one of the resources exploited and exported in the DRC—and it is far from the highest value resource—but it illustrates the dangers of boom-and-bust commodity price cycles, as well as accompanying unregulated, ungoverned mining interests and the scramble by well-armed state and non-state actors over resources. The DRC relies heavily on oil exports and the mining of diamonds, gold, columbium, copper, cobalt, manganese, lead, and zinc. The coltan boom and the dramatic changes and events it engendered did not last long, but the legacy continues as extractive industries—large corporations and thousands of small mines—remain implicated and involved in the reproduction of violence, poor governance, and poor economic performance in the DRC.

Wealthier consumer states and societies continue to grapple with the challenge of addressing their role in the creation and maintenance of resource curse dynamics in the developing world. In 2010, concern about "conflict minerals" and their connections to widespread human rights abuses and international security concerns led to provisions in the U.S. Dodd-Frank Act on financial service reform that require companies to report to the SEC information about the minerals they use and how they certify these are not from conflict areas. The provision has engendered substantial debate about the ethics and efficacy of using U.S. law to push for such transparency (Null, 2010, 2011). Such debates also extend to the European Union, where officials are grappling with parallel transparency and reporting regulations. Confirming the challenges inherent in attempting to regulate such trade, Bleischwitz, Dittrich, and Pierdicca (2012) recently used trade statistics to estimate that as much as 20 percent of the global coltan trade was from illicit sources in the DRC and its neighbors.

LITHIUM DREAMS: Already used in the production of many types of batteries, lithium could experience a potentially huge increase in demand if renewable energy industries grow substantially in coming years. While it facilitates development of "green" technologies, lithium also may help perpetuate the resource curse, as the case of Bolivia illustrates.

Home to perhaps half of the world's lithium deposits (Carroll & Schipani, 2009), Bolivia already experiences many of the political and economic difficulties common to states dependent on extractive industries. The Bolivian government nationalized parts of the oil sector and maintains high levels of control over other extractive industries. As revenues from these industries are channeled largely to the state government, President Evo Morales' policies, coupled with the demands his government often makes of foreign firms, have likely depressed foreign investment in lithium extraction. However, if global demand for lithium increases significantly in the future, the situation could change quickly, with potentially worrisome consequences for a country that has serious preexisting social and political cleavages. With Bolivia's extractive industries long associated with corruption and violence, there are few indications that a spike in lithium prices would leave the country better governed or more secure. Another worry of some analysts revolves around Bolivia's lack of a coastline and routes for easy export. David Rothkopf's (2009) concern is that Bolivia and Chile's sometimes contentious

Lithium could experience a potentially huge increase in demand if renewable energy industries grow substantially in coming years. While it facilitates development of "green" technologies, lithium also may help perpetuate the resource curse.

relationship might worsen if Chile seeks to use its geographic advantage to block Bolivian exports and to make its own lithium more valuable on the market.

In 2010, the Bolivian government declared lithium the permanent reserve of the state and launched a state company with the goal of coordinating all lithium exploration, mining, processing, and export processes (Achtenberg, 2010). Bolivia's lithium boom has not—indeed may not ever—come to pass. Yet, this much-debated example illustrates that a country that already struggles with resource curse dynamics around its oil industry might, in a "greener" global economy where more cars are fueled by electricity stored in batteries, simply end up substituting state and economic dependence on one export for another. In fact, revenues from oil exports may well fund the state's ongoing investments in lithium mining and processing facilities. Private multinational mining firms would need to account for, and recoup, such large investments when they take products to market, but the Bolivian state may not need to do so if such investments are funded by state oil revenues.

Lithium demand has grown, often rapidly, in recent years and prices have jumped accordingly (Abel, 2010). Bolivia will have competitors, likely including current exporters Chile and Argentina, but if lithium demand grows as rapidly over the next decade as some predict, the global market for high-tech products, greener cars, and energy production may well drive a Bolivian lithium boom to fill state coffers and fund patronage networks similar to those already constructed via oil revenues.

RARE EARTH GEOPOLITICS: The demand for rare earth minerals has increased due to the ongoing expansion of the renewable energy, defense, and communications industries. However, concerns about the scarcity and concentrated control of some key rare earth minerals have sparked an expanding search for additional deposits on several continents and substantial debate in Washington, Brussels, and Tokyo about the dependence of OECD states and economies on rare earths and other so-called "strategic" or "critical" metals and minerals (Bradsher, 2009; Bleischwitz et al., 2011; Collins et al., 2011).

Since 2010, international attention has focused on China's dominance of the extraction and trade of these minerals, as Chinese policies over the past two years have resulted in export declines and price increases. While most of the rare earth minerals are not "rare," by 2009 the U.S. Geological Survey estimated about 97 percent of global rare earth supplies came from China (Hao & Liu, 2011). Many observers interpreted Chinese restrictions on trading rare earth minerals in 2010 as a strategic move to harm or demonstrate power over Japan during a dispute over arrests at sea (Nakano, 2011). In fact, the United States, the European Union, and Japan jointly filed a complaint against China about its restrictions on rare earth mineral trade in 2012, launching an ongoing WTO dispute resolution and adjudication process. However, China's heightened control of the global supply of rare earth minerals may partially be the product of Beijing's desire to curtail illegal, unregulated, and an often environmentally and socially unsustainable operations in the country's domestic mining sector (Hao & Liu, 2011). The supply interruption raised alarms in economic and security policymaking agencies across the West, as well as in many corporate board rooms around the world. Until recently, China has dominated rare earth mining because the country has tolerated low-cost mining operations, many of which have existed outside of direct state control. Such mining has inflicted significant environmental and human costs.

While rare earth mineral reserves are substantial on several continents, many countries that sit on untapped reserves might not exploit them, as China has, because either they may not tolerate the enormous ecological and human costs involved with their extraction, or they cannot compete with the Chinese rare earth prices. In the United States, however, mining firm Molycorp is investing heavily to restart rare earth mining in California and expand mineral processing facilities. Similar investments are occurring in Australia as well.

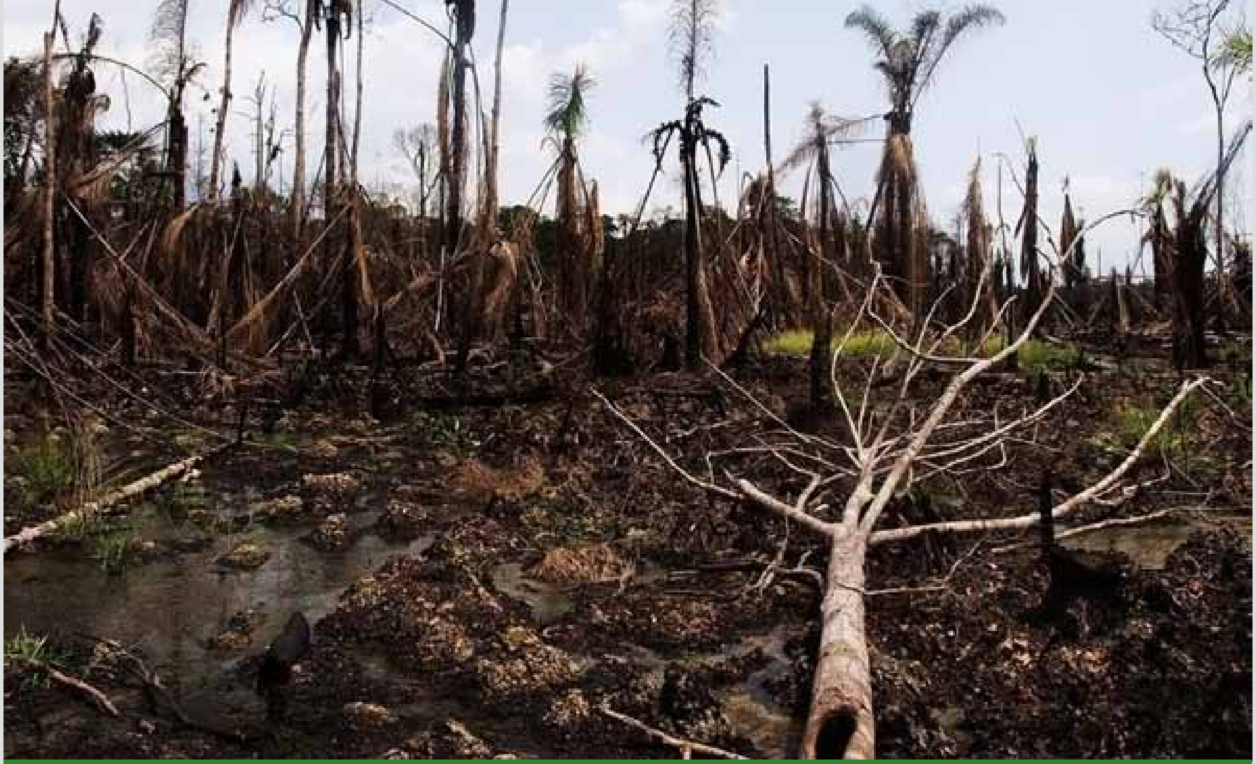
Rare earth politics and market dynamics illustrate a number of challenges facing global markets for the materials used by high-tech and greener technologies. First, some extractive states practice mining with low safety standards in order to undercut competitors and dominate markets. Such market dominance could be used for anti-competitive and political purposes (Humphries, 2010). Another problem is that large-scale mining and mineral processing takes several years to plan and implement in most cases and requires substantial upfront investment. The technological and product development cycles that drive minerals demand may happen on much shorter timeframes. This mismatch increases risks of substantial price spikes and boom and bust cycles in these commodities markets, increasing the vulnerability of consumer states and firms to supply interruptions of critically needed materials and simultaneously offering opportunities for leading producers to use their market position for economic or political advantage (though the many negative ramifications of boom-and-bust price cycles remain).

Greening the Curse?

For centuries, boom-and-bust cycles for resource commodities have been linked to political and social instability. Unfortunately, it appears unlikely that the raw materials demanded by 21st century economies and technologies will break such cycles—at least not without concentrated attempts by policymakers to curb such patterns. Concern about the potential conflicts and injustices that may accompany the much heralded high-tech, greener economy continue to grow (Rothkopf, 2009; Bleischwitz et al., 2011; Andrews-Speed et al., 2012; NIC, 2008; Netherlands Environmental Assessment Agency, 2011).

We are not likely to stop extracting mineral resources anytime soon. However, it is possible to substantially reduce the environmental externalities and humanitarian side effects of extractive industries. We know this because in parts of the world, like Australia and North America, mines already generally operate under comparatively high standards for environmental and worker-safety protection, showing that all states reliant on mineral or oil extraction are not necessarily "cursed." While such operations' environmental, social, and worker safety standards and records can be improved, they are generally not the sources of massive local and regional ecological damage and human health threats. Nor are they armed camps where money flows directly into weapons procurement, dangerously corrupt state actors, and well-armed oppressors. Still, without additional research and greater attention from policymakers at the domestic and international levels, it seems likely that the resources needed to transition to a greener, more sustainable global economy may simply recreate the resource curse, both in states already afflicted and in a new list of countries.

In the end, the resources needed to develop renewable energy technologies will not automatically be mined, processed, or harvested via ecologically sustainable industrial practices or under more sustainable social conditions. Further, even if these resources are widely used to develop and produce more sustainable energy systems, they may not help produce more ecologically and socially sustainable societies around the globe without sustained attention to the effectiveness of governance institutions from the local to global levels. Instead, making progress toward a new global economy that prioritizes environmental sustainability and places a premium on human security will require the ongoing commitment of capable states and the careful regulation of markets and firms. We can draw lessons about how to achieve these ends from a host of on-going attempts to increase information, financial, and price transparency, such as requirements in national law and regulation like those added to the U.S. Dodd-Frank



Niger Delta. Courtesy of flickr user Sosialistisk Ungdom – SU, http://www.flickr.com/photos/sosialistiskungdom.

WHITHER THE PETRO STATES?

To date, global climate change mitigation efforts have failed to curb accelerating fossil fuel use and its carbon emissions. But what might happen to oil-dependent states if global fossil fuel usage was gradually reduced?

The Intergovernmental Panel on Climate Change's Fourth Assessment Report (2007) estimates that carbon dioxide emissions need to decline by 50–85 percent by 2050 (and continue to fall after that) if atmospheric CO_2 concentrations are to stabilize and begin to fall during the 21st century, limiting warming to between 2 and 2.4 degrees Celsius and thereby limiting the most catastrophic impacts of global climate change.

If such an outcome were achieved, how will current oil-producing heavyweights such as Saudi Arabia, Iran, Venezuela, Russia, and Nigeria react? Even smaller producers such as Yemen face risks from declining oil revenues, if such changes are accompanied by political and social instability and violence. Such states, large and small, typically fund the great majority of their entire domestic and military spending via oil revenues. For example, it has recently been reported that the Russian state budget requires a global oil price of about US$110 if it is to remain balanced (Judah, 2013). What would be the domestic impact of a substantial decline in oil prices? What might be the international ramifications of such a decline in many oil-export dependent countries at one time?

Generally, the future of the petro states is under-theorized and under assessed. What is known is that periodic oil price collapses since the first oil crisis of the 1970s have resulted in temporary hardship for the populations of many oil-exporting states. Yet few analyses have been performed that explore the political and economic implications of eventually slowing and curbing global oil consumption.

Act; international efforts via initiatives like the Extractive Industries Transparency Initiative, the Kimberley Process, and other certification schemes; and the development of a Natural Resources Charter (Andrews-Speed et al., 2012). By themselves, these experiments in better governance around resources cannot solve all of the problems associated with the resource curse. They can, however, provide valuable lessons about how more effective and sustainable governance can be built. They can help us all build better governance over time, in both consumer and producer/exporter countries. This will most certainly not happen if we ignore the way the "new" and "greener" economy might recreate many of the most ecologically and socially unsustainable aspects of the national and global economies we now have.

Notes

1. The essay draws on "Consumption, Commodity Chains and the Global Environment," published in Regina Axelrod, Stacy D. VanDeveer, & David Downie (Eds.). (2011). *The Global Environment: Institutions, Law and Policy*. Washington, DC: CQ Press. I am grateful to the Transatlantic Academy and the German Marshall Fund of the United States for their support of this research.
2. See, for example, the many well documented reports and photographs of mining operations and their environmental and social impacts available on the website for the non-governmental organization Global Witness: http://www.globalwitness.org/

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Forests and Conflict: The Relevance of REDD+

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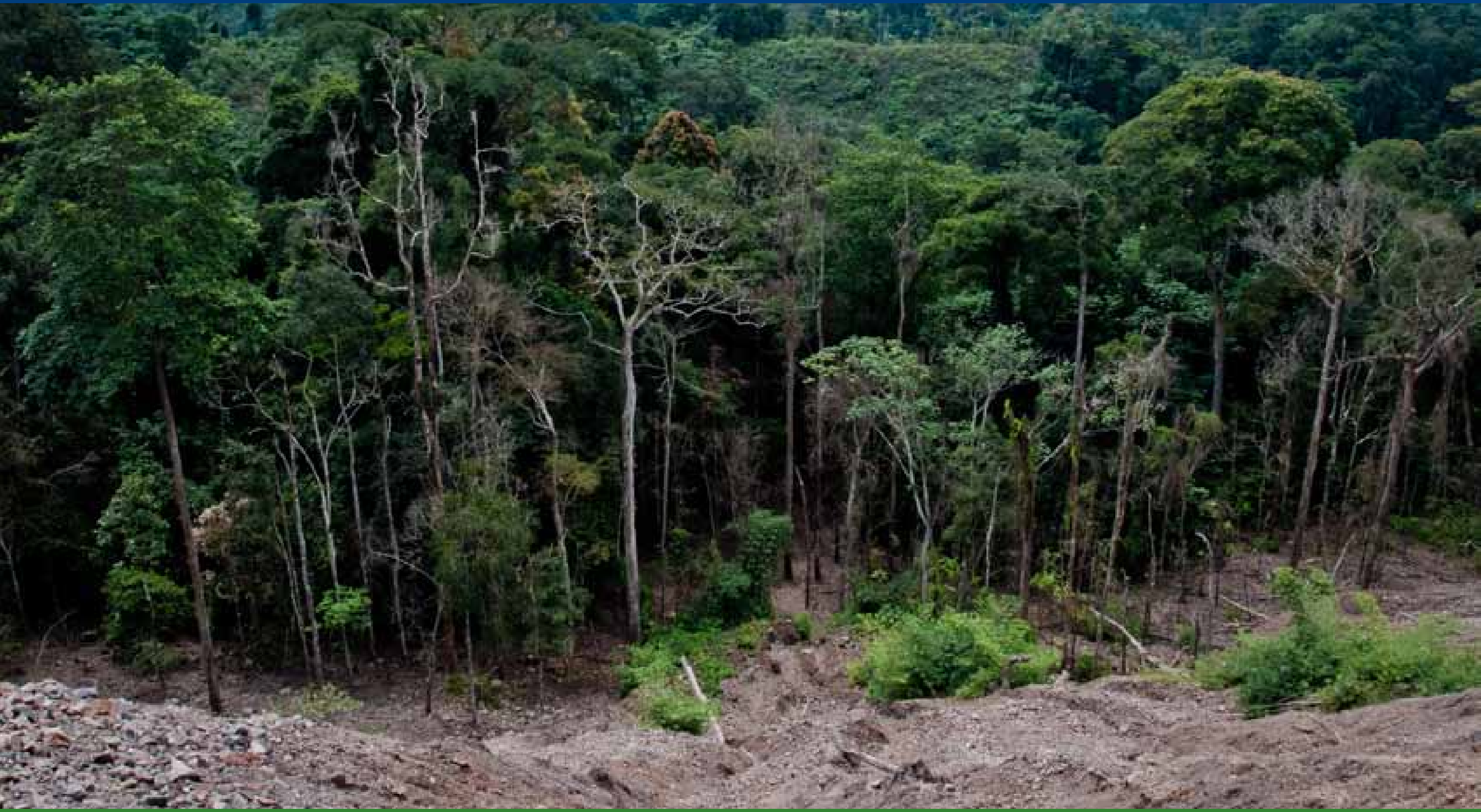

Deforestation for the construction of a new highway between Dolosie and Pointe-Noire, Congo-Brazzaville.
Courtesy of flickr user Bobulix, http://www.flickr.com/photos/bobulix.

FOREST LOSS IS A MAJOR DRIVER of climate change, with deforestation alone contributing to about 20 percent of global greenhouse gases (Gullison et al., 2007). Accordingly, policies aimed at slowing deforestation have attracted growing interest in recent years in the international climate change arena and beyond. Given that competition over forest resources and deforestation-related environmental degradation serves as a potential driver of conflict at the local, regional, and international levels, this article explores the security implications of efforts to mitigate climate change through woodland preservation.

In some ways, climate change mitigation tactics aimed at preserving woodlands provide a sound opportunity for regional and international collaboration, thanks to the cross-border environmental benefits of decelerated deforestation. Forest preservation also can help stabilize conflict-prone areas by strengthening institutional capacities and integrating sustainable woodland management into broader international climate change mitigation efforts. Yet at the same time, mitigation efforts prioritizing forest preservation entail a degree of risk, and must be carried out with great sensitivity to avoid triggering fresh unrest in conflict-prone countries. This article examines the conditions under which such mitigation efforts may contribute to or undermine the likelihood of conflict.

Exploring the Nexus Between Forest Resources and Conflict

The majority of forest-dwelling and forest-dependent households suffer from poverty and lack public services (Dubois, 2002). For these impoverished populations, woodlands are a vital resource. However, in part because of their economic importance, forests can also become hotbeds of conflict, since they tend to be remote and inaccessible, far from government presences, and home to multiple ethnic groups and minority populations with competing claims (Blundell, 2010). Sustainable forestry management, if carried out in a way that helps improve livelihood security, can therefore be a key to preventing violent conflict in some places (ETFRN, 2008).

A background study for the *World Development Report 2010* identified different ways woodlands can contribute to armed conflict (Harwell, 2010). One of the study's central focuses was the timber industry's contributions to the outbreak, escalation, or continuation of armed conflict, which assumed the following forms:

- Financial flows from timber revenue or corrupt payments that fund violence;
- Direct engagement in violence or weapons trafficking by loggers or those employed by loggers; and,
- Linkages between logging and other forms of crime and violence.

Many of the world's prime tracts of woodland are located in countries already considered fragile or conflict-prone. With climate change mitigation policies now becoming a regular part of environmental peacebuilding discussions, intriguing new questions have arisen regarding how woodland-preservation plans might impact conflict dynamics within these states.

A Closer Look at the REDD Approach

During the last few decades, competing land-use demands and emissions from deforestation have become an increasingly important climate change issue, with forest preservation often emerging as a focal point of such debates. As used by the Intergovernmental Panel on Climate Change (IPCC), "emissions from land use, land-use change, and forestry" include aggregated emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) from deforestation, biomass, and burning; decay of biomass from logging and deforestation; and the decay of peat.

Worldwide, forests support the livelihoods of an estimated 1.6 billion people and are home to 300 million (UN Forum on Forests, 2011). In Indonesia alone, 36 million people out of a total population of 235 million rely on the forestry sector as their primary source of income (Indonesia Ministry of Forestry, 2002). While forests' role as an economic lifeline for local communities is undeniable, woodland preservation also provides concrete benefits in other realms of society. For instance, forests play a vital role in boosting communal adaptive capacities by reducing the impact of events connected to climate change, such as landslides, flooding, and erosion.

Over the course of the last several years, international climate change negotiations have brought fresh attention to the question of how to most effectively address deforestation in developing countries. The debate has focused on designing policy instruments that can reduce emissions from deforestation and integrating these instruments into the post-2012 architecture of global climate change mitigation measures, when the first commitment period under the Kyoto Protocol will end and the reform process of the international climate policy landscape will take shape.

In 2007, delegates at the 13th Conference of the Parties in Bali adopted a decision on forest protection as a climate policy instrument called "Reducing emissions from deforestation in developing countries: approaches to stimulate action (REDD)." The REDD document specifically encourages parties to "explore a range of actions, identify options, and undertake efforts, including demonstration activities, to address the drivers of deforestation relevant to their national circumstances, with a view to reducing emissions from deforestation and forest degradation and thus enhancing forest carbon stocks due to sustainable management of forests" (UNFCCC, 2007).

In the ensuing years, a number of governments and multilateral institutions have launched initiatives indicating that REDD will be relevant not only for stable countries, but also for conflict-prone and post-conflict countries as well:

- The UN Food and Agriculture Organization, UN Development Programme, and UN Environment Programme launched UN-REDD, which has invested US$42.6 million in nine pilot countries: Bolivia, the Democratic Republic of Congo, Indonesia, Panama, Papua New Guinea, Paraguay, Tanzania, Vietnam, and Zambia.

- The World Bank established a number of initiatives addressing forest issues in developing countries. The Forest Carbon Partnership Facility, launched in Bali in 2007, looks to build capacity for REDD in developing countries, testing a program involving performance-based incentive payments in select pilot countries (the Central African Republic, Liberia, and Nepal) to gauge the feasibility of a much broader system of financing mechanisms and incentive payments in the future.

- Various governments have set up REDD initiatives on a bilateral basis. For instance, Norway has committed US$600 million a year to REDD activities, including the country's high-profile work in Indonesia. Australia, meanwhile, is actively engaged with deforestation issues in the South Pacific, while German International Cooperation is a participant in REDD projects in Indonesia and Laos. The United States is working on a number of REDD-ready programs with a focus on building capacity for inventories, monitoring, and verification in Latin America (Brazil, Colombia, Mexico), Asia (India, Indonesia, Cambodia) and Africa (Zambia, Uganda).

A Means for Promoting Peace and Stability?

Given that REDD programming to date has been designed to generate new income streams for local populations and build strong institutions that improve governance, it serves as an example of how climate change mitigation policies could have potentially stabilizing effects in fragile or conflict-prone environments.

First, in principle, REDD can contribute to economic development by generating new sources of revenue for oft-marginalized social groups. Depending on the design of benefit-sharing agreements, central governments as well as local communities could earn income and put it to productive use by rebuilding infrastructure and expanding public services. Further, employment opportunities under a REDD agreement could be created for forest monitoring and law enforcement positions, while

Local communities may be marginalized if REDD programs are badly designed or poorly implemented. Proactively addressing questions of land tenure and land-use rights is therefore of the utmost importance.

afforestation campaigns could provide at least temporary employment, given the need for workers to run nurseries and plant tree seedlings (Agrawal & Angelsen, 2009).

Second, at present, many developing nations and active-conflict countries lack the governance capacity required to implement REDD programming. An established REDD mechanism could provide incentives to improve governance capacities as a prerequisite for receiving funds for anti-deforestation projects. In fact, some ongoing initiatives and pilot projects explicitly aim to improve target countries' governing capacities to make them "REDD ready" (Williams et al., 2011). In this way, the financial resources and technical assistance provided for "REDD readiness" support the building of governance capacity and the strengthening of institutions—trends that may yield positive spillover effects for peacebuilding beyond the forest sector.

Third, REDD can foster cooperation, dialogue, and confidence-building at all levels. Whereas large-scale logging, mining, oil extraction, and other activities incompatible with REDD often lead to conflict with local communities, REDD approaches should protect the environment and are much less likely to provoke conflict. Using REDD programs as a vehicle for land tenure reforms that provide legal titles to local communities could also help reduce the type of conflicts that often arise when land tenure is unclear (Cotula & Mayers, 2009).

Potential Risks of REDD Policies

The potential stabilizing effects of REDD programs aside, there are a number of possible risks that must be taken into account when considering the introduction of REDD into fragile or conflict-prone countries and regions.

First, the procedures required to measure and monitor carbon emissions can prove expensive to implement, as can the establishment of REDD governance systems. Accordingly, indigenous communities and micro-project enterprises could be excluded from participating in REDD projects because they would not be able to recover transaction costs. One way to address this problem might be to foster better communication and cooperation among communities in a given REDD target country as a means of cutting transaction costs. The confidence-building that would accompany such collaboration could prove especially helpful for divided or rival communities. However, unless measures to ensure the transparent and fair distribution of related benefits are outlined ahead of time, REDD projects could potentially create new rifts.

Second, local communities may be marginalized if REDD programs are badly designed or poorly implemented. Proactively addressing questions of land tenure and land-use rights is therefore of the utmost importance. For instance, if REDD campaigns that successfully stave off deforestation are rewarded financially and linked to global compliance markets, enormous amounts of money may flow to the country. The main beneficiaries would most likely be government entities that would need to redistribute resources, e.g., by establishing a transfer system. The likely increase of the value of forested land would serve as an incentive for governments and powerful private sector actors to seize control of woodlands and reap the profits of REDD. Consequently, the rights of forest-dwelling communities, especially those without formalized land titles, could either be denied or ignored.

The danger inherent in selling carbon rights to investors without first consulting forest dwellers is especially high in the 75 percent of the world's woodlands that are officially owned by governments. Even communities with recognized land rights in woodlands could be pressured into signing deals that limit their access to forest resources while providing them with scant compensation (Cotula & Mayers, 2009). Income generated by successful REDD campaigns could instead be "used by the state to equip forest protection agencies with jeeps, walkie-talkies, arms, helicopters, and GPS in an outdated and anti-people 'guns and guards' approach to forest protection," leading to a potentially violent escalation of local resource conflicts (Griffiths & Martone, 2009, p. 24).

Third, unclear land-tenure rights within woodlands could be complemented by the still largely undefined ownership of carbon. To date, only a few countries have legislated who owns the carbon stored in trees. New Zealand's move to declare forest carbon the property of the government, for instance, sparked resistance from private forest owners. After several years of lawsuits, continuing protests, and stalled efforts to inventory carbon stocks, carbon ownership was eventually transferred back to the forest owners (Rights and Resources Initiative, 2010). To successfully implement REDD programming, a target country or region must first have legal institutions capable of fairly resolving disputes, as well as clearly defined land-tenure rights and carbon-ownership rights.

Fourth, unequal benefit sharing under REDD programming could trigger another set of conflicts. The local elites who likely would emerge as primary negotiation partners could capture a disproportional share of REDD income, while poorer and landless households might receive far less revenue. Such increased income inequality could spark social or political unrest or conflict at the local level. Since the forestry sector in many countries already has a reputation for irregular and corrupt business practices, REDD programs will have to be designed in a manner that minimizes the potential for corruption—otherwise, REDD projects could be viewed by locals as illegitimate, and the projects' effectiveness would likely be compromised as a result (Tacconi et al., 2009). Transparency International devoted a special section of its most recent report on climate change and corruption in the forest sector. The analysis made clear that corruption will be an ongoing risk even once well-designed REDD programs are fully operational. "To avoid inappropriate validation of projects, the verification of fictitious projects, and the overestimation, double-counting, or fraudulent trade of carbon credits," strong monitoring and enforcement mechanisms are needed, as well as a role for independent civil society groups to participate in monitoring efforts (Transparency International, 2011).

Logging in New Guinea. Courtesy of flickr user Greenpeace/ Jeremy Sutton-Hibbert, http://www.flickr.com/photos/ greenpeace_esperanza.

Fifth, setting the right baseline—making an accurate estimation of how much deforestation would occur without intervention—is crucial for the integrity of any REDD program. Further, deforestation rates are influenced heavily by conflict. Sierra Leone, for example, lost more than 19,000 hectares of forest per year from 2000 to 2005, as the country worked to recover from civil war (Forest Industries, 2011). Deforestation can be accelerated due to the lack of law enforcement, extraction of timber to finance the purchase of firearms, or the survival strategies of war-affected and displaced communities.

Even once an active conflict has ended, woodlands remain under threat. For instance, when formerly dangerous battlegrounds become accessible again, large-scale logging operations may move into those areas, pushing the agricultural frontier forward. Consequently, setting the right baseline in the context of a post-conflict scenario poses a serious challenge: What amount of avoided deforestation can be attributed to a specific intervention financed by REDD, and what amount can be attributed to pre-existing peace and conflict dynamics?

Initial Experiences With REDD

Since most REDD-related activities have started only recently, it is too early to assess positive and negative impacts in conflict-prone countries. To a certain extent, however, current REDD projects backed by the United Nations or the World Bank can be linked to relevant preexisting programs and agencies within the target countries.

In Nepal, for example, the Swiss Agency for Development and Cooperation commissioned the Nepal Swiss Community Forestry Project to participate in a project intended to contribute to economic growth and social development by focusing on gender, social equity, peacebuilding, and poor peoples' livelihood issues under the umbrella of Forest User Groups (Hobley, 2007). Meanwhile, the International Union for the Conservation of Nature (IUCN) has been helping Liberia restore its woodlands, focusing on refugee camp reforestation and forest sector reform as a means of restoring stability as the country recovers from civil war. IUCN has expanded its approach into a broader portfolio that currently emphasizes community forest management, climate change, and forest governance, with the latter category focused primarily on REDD and forest sector policy support. The initiative is built on local community-based natural resource management strategies that seek to achieve poverty reduction; empower impoverished forest-dependent populations through enhanced land rights; improve forest law enforcement and governance; and revitalize woodland ecosystems through forest landscape restoration.

A Conflict-Sensitive Approach to REDD

While REDD programming can potentially create or exacerbate conflicts and increase the marginalization of certain populations, it can also provide opportunities to develop sustainable livelihoods, generate new income streams, and strengthen the political and economic position of forest dwellers in post-conflict settings. How REDD projects fare depends largely on the existence of detailed and well-balanced REDD-related frameworks and institutions in target countries. To design REDD programming that not only reduces conflict potential but also plays a constructive role in peacebuilding, I recommend the following:

- **Clarify legal issues surrounding land tenure**: In order to prevent conflicts, REDD projects should be used to strengthen the political and economic clout of communities living in woodland areas, rather than marginalizing or displacing them. It is critical that REDD program designers also take into account traditional, and often complicated, land tenure arrangements, as well as the rights of resource users without legal titles.

- **Ensure fair sharing of REDD-related benefits**: The equitable sharing of benefits generated by REDD projects is a necessary condition for conflict-sensitive strategies to succeed. Since corruption is rife in the forest sector of many developing countries, greater openness in forest-resource management must be fostered to increase the legitimacy of REDD programming, secure benefits for local populations, and reduce conflict potential.

- **Establish reliable, transparent, and efficient governance structures**: REDD projects require transparent and dependable local institutions to ensure that measurement, reporting, and verification duties are carried out accurately. Local institutions should also be capable of identifying and dealing with the drivers of deforestation effectively, as well as building confidence among investors. Building these capabilities will be particularly difficult in post-conflict settings, but the development of such institutions could potentially yield positive spillover benefits that bolster the target country's overall stability.

- **Design pro-poor REDD programs so that revenues are used to advance socioeconomic development**: Apart from reducing the risk of conflict, allocating REDD-related income in this fashion could make REDD programs more attractive to investors and reduce the risk of project failure. Additionally, reinvesting revenue to bolster socioeconomic development in a target country could help advance the well-being of the entire population, especially traditionally marginalized groups.

- **Secure international support for capacity-building and "REDD-readiness" and prioritize local participation**: Generating new REDD-related jobs within a target country will happen only if tasks like project monitoring and accounting are at least partly performed by the local population and not just by international consultants. Developing alternative income opportunities must be a part of any comprehensive REDD scheme.

REDD Fulfills a Need for Conflict-Sensitive Climate Change Mitigation Policies

In addressing the lack of reflection on the linkages between climate change, peacebuilding, and sustainable forest stewardship, this article has outlined how reducing deforestation may help contribute to political stability and the socioeconomic advancement of post-conflict countries. While climate change policies aimed at mitigating deforestation pose certain risks and opportunities, the prospects for the success of such initiatives are bolstered by the establishment of REDD mechanisms that are the product of both multilateral negotiations and bilateral initiatives. Anti-deforestation programs can also contribute to peacebuilding by helping to strengthen institutional capacities, creating new streams of income generation, and engaging various local stakeholders in participatory processes.

Creating conflict-sensitive climate policies that have positive, transformative effects is undoubtedly an ambitious task. This is true not only for REDD programming, but also for the design and implementation of climate-change adaptation measures in general. To reduce the likelihood that climate policies have unintended adverse impacts in the countries they are meant to benefit, it is critical that policymakers and program designers conduct careful conflict assessments to ensure an understanding of the local contours of conflict within their target countries *before* implementing programming. Further, in order for climate policies to be conflict-sensitive, they must be developed using a multi-faceted system that incorporates various levels of decision-makers, from the administrative to the societal.

Ultimately, designing and implementing REDD programming in a manner that is sensitive to local conflict dynamics will increase the likelihood that anti-deforestation climate change policies can serve as a threat minimizer in post-conflict settings. Indeed, since anti-deforestation strategies are still being fine-tuned, there is a good chance that efforts to preserve and sustainably manage woodlands can be conducted in a way that mitigates the potential for unrest in conflict-prone, resource-rich nations. For that reason, REDD programming, if carefully and thoughtfully designed and implemented, can go a long way toward promoting and supporting peace and stability across the developing world.

Note

1. This paper is based on a more comprehensive analysis in Dennis Tänzler and Felix Ries (2012).

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SPOTLIGHT:
The Biofuels Transition

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During the past century, oil has proven crucial for enabling transportation and maintaining mobility, but to decrease fossil-fuel emissions that contribute to climate change, we must reduce our dependency on oil. According to the International Energy Agency (IEA), biofuels could supply about a quarter of the world demand for transportation fuels by 2050 (IEA, 2011). But concerns have been raised about biofuels' impact on land-use change, as well as their actual impact on greenhouse gas emissions.

First-generation biofuels are generated from a variety of crops, such as palm oil, maize, sugar cane, and rapeseed, and are largely used in the transportation sector (Webersik, 2010). When biofuel feed stocks are grown on land that was previously forested, the impact of this land-use change must be considered when calculating actual emission cuts (IEA, 2011). Indeed, deforestation and forest degradation are estimated to account for roughly one-fifth of total global greenhouse-gas emissions (IPCC, 2007). Thus, land-use changes to produce biofuels may reduce the emissions saved by using biofuels instead of oil (Fargione et al., 2008).

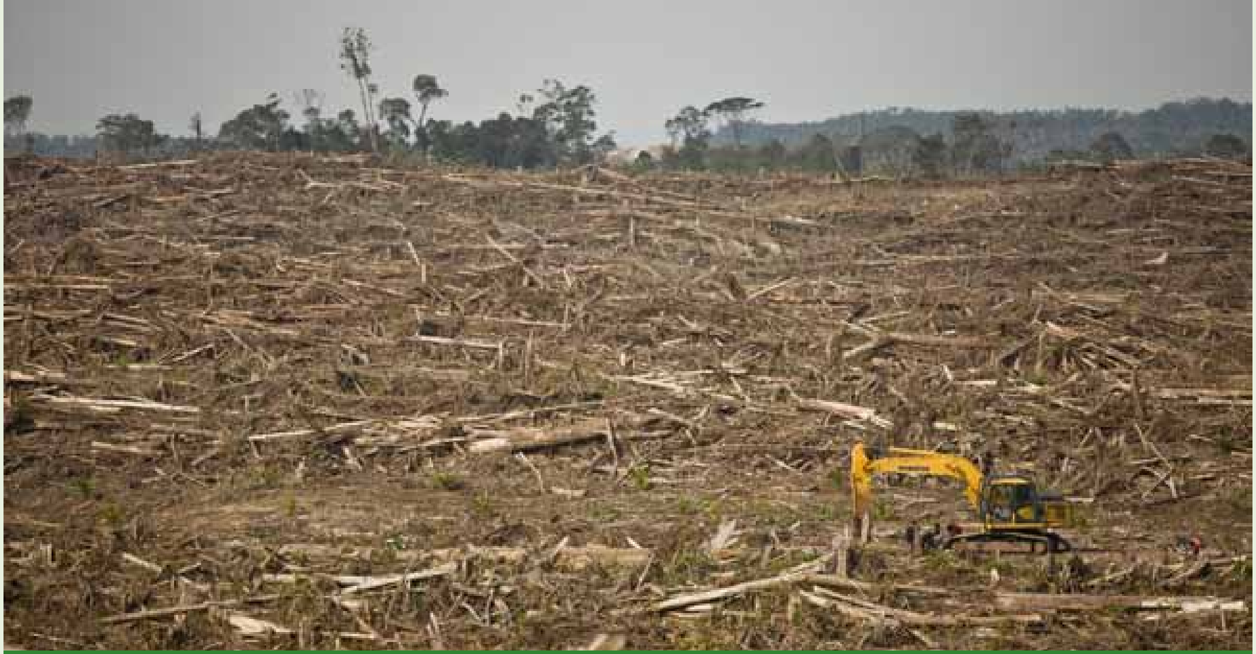
Increased production of first-generation biofuels also heightens the potential risk of conflict over land use. Recent large-scale land investments for biofuel feedstock production—particularly in Africa—have led to conflicts between investors and local land users, who depend on the land for food and other livelihood activities (Matondi et al., 2011; Anseeuw et al., 2012).

Even where biofuels are not being grown directly on agricultural land, they may conflict with food production as farmers re-prioritize their labor towards the biofuel plantations established in their local area (Bergius, 2012). As increasingly large areas of land are allocated to the production of biofuel crops, food production may decline while prices increase.

As global demand for animal feed, biofuels, and food has increased in recent years, world food prices have soared, reaching an all-time high in August 2012 (PREG, 2012). While many other factors contribute to the skyrocketing cost of food, biofuels have undeniably been one of the determinants.

For poor households, the impact of rising food prices can be particularly dramatic. Food expenses account for more than 60 percent of household income in sub-Saharan Africa (Thirlwell, 2008; Maxwell, 1999). Where food insecurity increases, due to price hikes or other causes, the chances of civil unrest are heightened, as seen in the 2007–2008 food price crisis, when more than 30 countries were hit by food riots (UNCTAD, 2009). Some have argued that food price spikes spurred the Arab Spring revolutions in the Middle East (Baragona, 2011).

A World Bank paper argues that a large expansion in biofuel production in the United States and European Union accounted for about 75 percent of the total food price increase between 2002 and 2008, as land was increasingly being used for biofuel feedstocks, supported by state subsidies and mandates (Mitchell, 2008). And following the record high prices in the summer 2012, the FAO (2012) called biofuels the largest source of new demand for agricultural production, reporting that 80 percent of vegetable oil produced in the EU was made



Deforestation for palm oil expansion in West Kalimantan, Indonesia. Courtesy of flickr user David Gilbert/Rainforest Action Network, http://www.flickr.com/photos/rainforestactionnetwork.

into biodiesel and 37 percent of the United States' grain crop was used to produce ethanol.

Increasingly, the political incentives that support agriculture-based biofuel productions are being called into question. Following the Summer 2012 drought, the heads of FAO and Nestle called for the United States and European Union to change their biofuel and ethanol targets (Vidal, 2012).

While food is an absolute human necessity for which no alternatives exist, there are alternatives to first-generation biofuels. For example, second-generation biofuels—such as algae—are derived from biomass sources that do not compete for land with food or feed production. These second-generation sources have not yet entered full commercialization, and are not predicted to be integrated into the market until 2030, but these new fuel sources have a huge amount of upside potential.

Utilizing algae as a fuel source is appealing because compared to other biofuel sources, it needs very little input in order to yield high output. One of the key arguments for the increased exploitation of algae is that it presents the possibility of recycling carbon dioxide and other nutrient waste streams. Further, since it is possible to grow algae in salt water, wastewater, or fresh water, it does not conflict with land-use requirements for food production (IEA, 2011).

Still, hurdles remain. The cultivation of algae and extraction of the oil is currently very expensive and energy intensive. Algae cultivation also faces challenges "related to availability of locations with sufficient sunshine and water, required nutrient inputs, and oil extraction" (IEA, 2011).

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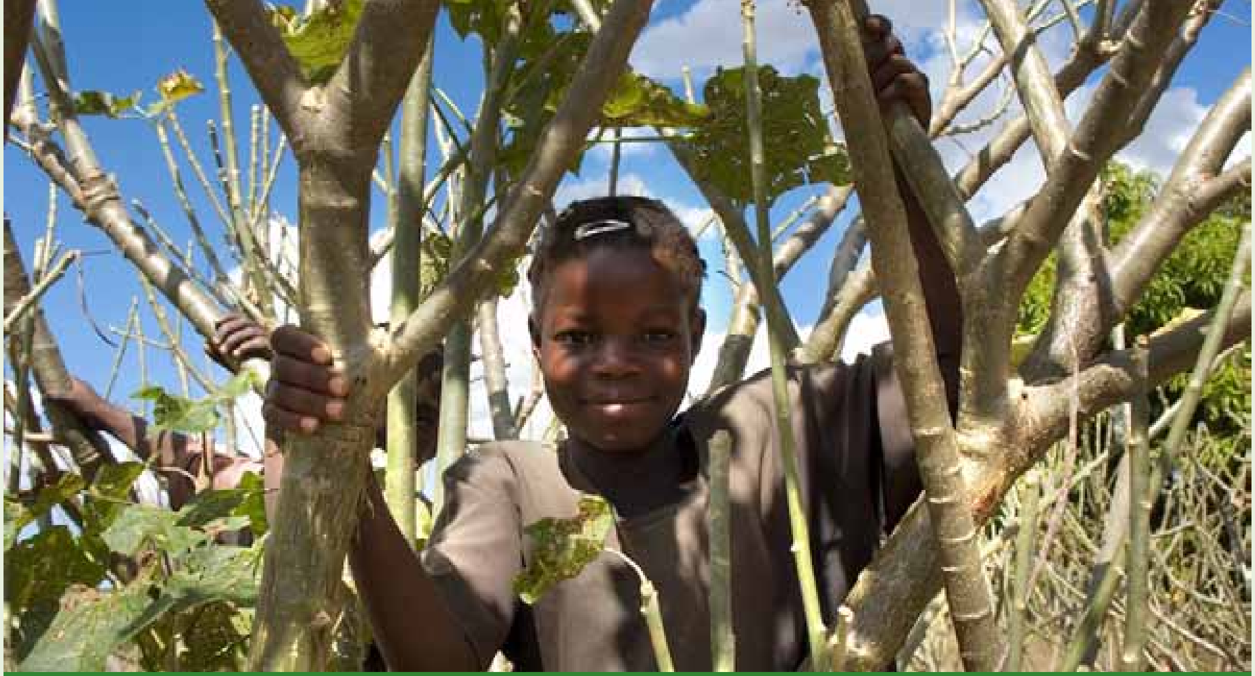

Jatropha requires high inputs of labor and agrochemicals, good rainfall, and high quality agricultural land. Courtesy of flickr user Jeff Walker/Center for Forestry Research, http://www.flickr.com/photos/cifor.

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Climate Gambit: Engineering Climate Security Risks?

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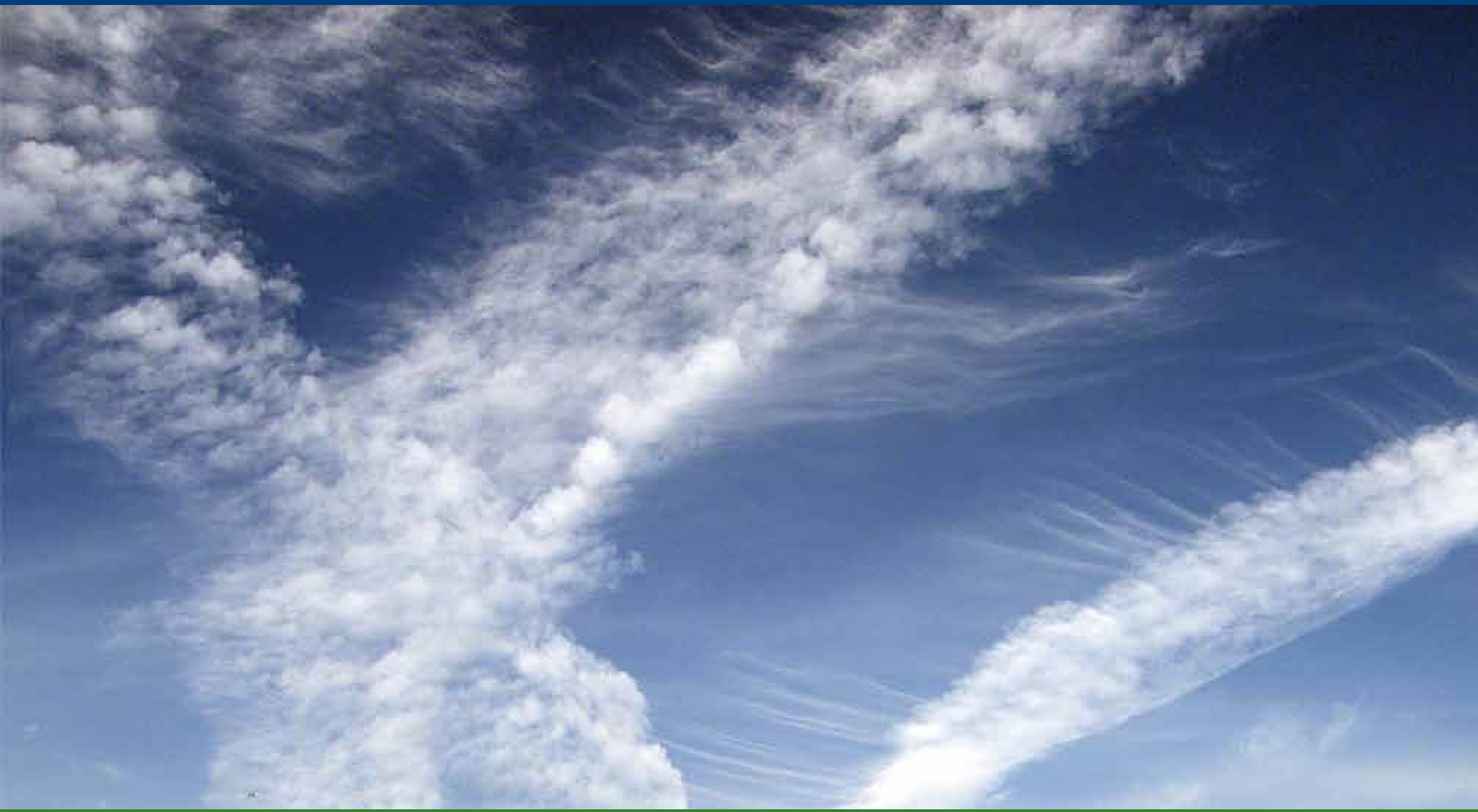


Seeded cirrocumulus virga. Courtesy of flickr user DocJ96, http://www.flickr.com/photos/jacobs_ian.

CURRENT CLIMATE CHANGE TRENDS are generally considered undesirable, with many leading experts viewing them as potential threats to international security (CNA, 2007; UN General Assembly, 2009; UN Security Council, 2011). In developing potential solutions to this global challenge, the international political community has agreed to limit the increase of average global air temperatures to two degrees Celsius above pre-industrial levels by 2100. However, the political will to reach this goal appears lacking—a warming of three to four degrees Celsius is considered a more realistic scenario, while a warming of six degrees is considered the worst-case scenario (IEA, 2011; Rogelj et al., 2010; Mabey et al., 2011; Lenton & Watson, 2011).

Consequently, policymakers and scholars are paying greater attention to technologies that could intentionally manipulate Earth's climate on a large scale.[1] A number of influential papers have recently fueled the debate surrounding climate engineering, or geoengineering (Crutzen, 2006; Victor et al., 2009).[2] At a 2010 meeting in Asilomar, California, 175 scientists, policymakers, and civil society representatives gathered to discuss emerging questions on the governance, ethics, and technological implications of climate engineering (ETC Group, 2011). This newfound interest was underscored further by a joint working group meeting conducted on climate engineering in Peru in June 2011 by the Intergovernmental Panel on Climate Change (Edenhofer et al., 2011). Consequently, it will be more prominently featured in all three working groups of the Fifth Assessment Report to be published in 2013–2014.

However, while powerful economic, political, and social forces are combining to promote climate engineering (see, e.g., Hamilton, 2013), resorting to such technologies is problematic partly because they address only the symptoms of climate change, rather than the causes. In this way, climate engineering may do little to wean the global community away from its current fossil fuel-intensive economic model. Further, widespread deployment of climate engineering technologies could replace the risks of unmitigated climate change with other security risks triggered by intentional changes to our climatic system—a gambit of significant unknowns.

Unilateral or uncoordinated deployment of climate engineering technologies could further destabilize the climate, for example, while sparking interstate tensions. In particular, two types of security risks emerge:

First, deployment of climate engineering—which by definition would have global consequences—by a single state or group of states may result in negative impacts on other states, thus creating international conflict potential. This would be particularly detrimental if it creates rifts between the world's global powers—countries such as the United States, China, India, and Russia—that are simultaneously those most capable of implementing climate engineering technology (Maas & Scheffran, 2012).

Second, unintended and unknown side effects may result from research and deployment, creating security risks akin to the "classic" security implications of climate change, such as altering precipitation patterns or aggravating land-use conflicts.

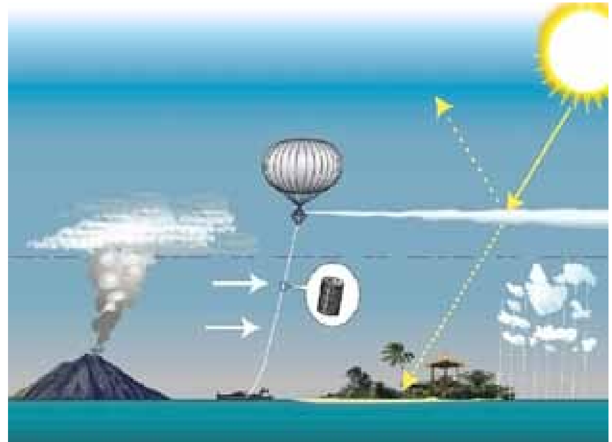
To avoid such outcomes, a transparent international dialogue on climate engineering is needed to identify suitable governance mechanisms prior to any real world experimentation or deployment. In this article, we explore some of these potential security implications, viewing them within the broader context of the "Anthropocene" era (age of man). We argue that several types of incentives exist to encourage international consideration of climate engineering but conclude that transparent, thorough deliberations involving a wide range of stakeholders are needed to evaluate its potential for effectively addressing climate change.

Climate Engineering in the Anthropocene

The degradation of many of the world's ecosystems reveals that the impact of human presence and processes is equal to—and in some cases, even greater than—natural forces (Berardelli, 2008). Indeed, during the last two centuries, humans have induced massive changes in the planet's carbon cycle, releasing levels of fossil carbon that will take the planet hundreds of millions of years to store away (Crutzen & Stoermer, 2000; Zalasiewicz et al., 2010). Given not only the degree, but also the type of human influence on the planet's ecosystem, "Anthropocene" may be an appropriate label for the era in which we now live. Yet the term also implies a human-centric approach toward managing the planet—e.g., having realized how much we have influenced the planet, we become emboldened to continue doing so—even as our knowledge of how the Earth regulates itself remains relatively limited.

Climate engineering is thus among the most recent manifestations of humans seeking to assert control over the natural environment, serving as a perfect symbol for the Anthropocene; however, it is not necessarily a new concept. Its origins can be traced to the late 19th century, when Swedish scientist Svante Arrenhius calculated the amount of emissions necessary to warm the planet to mitigate cold Swedish winters (Fleming, 2010). Decades later, during the 1950s, Henry Houghton, then-head of the meteorology department at the Massachusetts Institute for Technology, predicted that "international control of weather modification will be as essential to the safety of the world as control of nuclear energy is now" (Houghton, 1958). Weather and climate control subsequently emerged as the focus of serious research during the Cold War, but those efforts did not produce any breakthroughs of significance (Fleming, 2010). Though proposed and discussed in the 1970s and 1980s as a possible solution for global warming in the United States, it was not proactively pursued (Schneider, 2008). It has been only in recent years that climate engineering has gained significant momentum and moved into the realm of mainstream science (Kinitsch, 2010).

There are two main approaches to climate engineering (U.S. GAO, 2011; Royal Society, 2009; Bracmort et al., 2011). The first, radiation management, focuses on decreasing the amount of sunlight that reaches the Earth, while the second, carbon dioxide removal, focuses on removing carbon dioxide already present in the atmosphere. Within these two overarching categories, there is a broad range of measures for influencing the climate. Solar radiation management, for example, could either involve the deployment of large amounts of mirrors into space to reflect sunlight or the injection of aerosols into the atmosphere to block sunlight. Carbon dioxide removal techniques, meanwhile, could range from massive afforestation campaigns to fertilizing oceans so that algae blooms increase their carbon uptake capacity.[3]



The controversial Stratospheric Particle Injection for Climate Engineering (SPICE) project is a UK government-funded geoengineering research project that aims to assess the feasibility of injecting particles into the stratosphere from a tethered balloon for the purposes of solar radiation management. Field tests scheduled for 2012 were canceled, partly out of concern over lack of government regulation of geoengineering. Image courtesy Wikimedia user Hughhunt, http://commons.wikimedia.org/wiki/File:SPICE_SRM_overview.jpg.

These methods all share the common aim of easing the symptoms of climate change, as opposed to addressing the root causes (Ginzky et al., 2011). Aside from a range of predictable side effects—e.g., massive afforestation may change local ecosystems, and aerosol injection may reduce the effectiveness of solar power—these methods may engender a host of unpredictable or unanticipated risks that are far more problematic. In the case of ocean fertilization, for example, it is unclear to what extent the proliferation of algae blooms might alter ocean ecosystems, while injecting aerosols into the atmosphere has unclear impacts upon the African and Asian monsoons (Wolff, 2011; Robock et al., 2008; Burns, 2011; Sagarin et al., 2007).

In short, the unintended consequences of both radiation management and carbon dioxide removal measures could be severe, as they might endanger the marine life or agricultural output that hundreds of millions of people depend on for their food security and income generation. However, due to many unresolved research questions, the extent of such environmental impacts is difficult to estimate. Ironically, answering some of these questions definitively may necessitate large-scale experiments that could cause their own significant environmental side effects (U.S. GAO, 2011; Royal Society, 2009).

The Upside of Climate Engineering

Despite the manifold predictable—as well as unknowable—risks, climate engineering technologies may seem appealing in several respects. First, there is concern that limiting the increase of average global air temperature to two degrees Celsius above pre-industrial levels by 2100 may be unattainable. Around 1750, the atmospheric CO_2 concentration was approximately 280 parts per million (ppm), but that concentration rose from 317 ppm to 390 ppm in the decades between 1960 and 2010 and is set to hit 400 ppm in early 2013 (U.S. GAO, 2011; Walsh, 2013). According to the International Energy Agency (IEA), being on the "safe side" would require limiting CO_2 concentrations to 450 ppm and quadrupling mitigation efforts between 2020 and 2035, compared to the period between 1990 and 2008 (IEA, 2010). Continuing business as usual would likely lead to a six degrees Celsius warming, an outcome almost certainly beyond humanity's managing capacity (IEA, 2010; Mabey et al., 2011). This mounting sense of urgency has served to make climate engineering an apparently increasingly acceptable strategy for combating climate change (U.S. GAO, 2011).

Second, states may embrace climate engineering because many methods seem to permit a continuation of carbon-intensive lifestyles and fossil fuel-based economic development. Indeed, since it does not address the causes of climate change, climate engineering would impact the status quo of global economic development much less significantly than mitigation and adaptation measures, thus giving the former much more traction in international negotiations (Hamilton, 2013).

Third, while no internationally accepted assessment exists, the IEA estimates that limiting greenhouse gas concentration to 450 ppm (e.g., the two degree goal) would cost roughly US$220 billion per year for the period spanning 2010 to 2020 alone, with annual estimated costs rising further to more than US$900 billion from 2020 onwards (IEA, 2010). Meanwhile, adaptation costs may amount to several billion dollars more (Parry et al., 2009). The climate engineering techniques discussed above may be comparatively cheaper to implement, though still quite expensive in terms of operating costs. For instance, the operating costs for aerosol injection to block sunlight are estimated at between US$35 billion to US$65 billion in the first year, and between US$13 billion and US$25 billion in subsequent years (U.S. GAO, 2011). Many other measures are in similar or higher price ranges (U.S. GAO, 2011).[4] This estimate includes only the actual operating costs; since climate engineering would change global warming and precipitation patterns, additional costs for adapting to the effects of climate engineering may emerge (Schmidt et al., 2012).

A systematic assessment of the potential security risks posed by climate engineering does not exist, and the widespread implementation of the various technologies under research or discussion may be a risky gambit.

Fourth, despite the sizeable price tags, some of the costs of climate engineering measures may be offset to some degree because such technologies could offer significant financial incentives and drive new commercial activity. For example, widespread deployment of carbon dioxide removal technology would not only allow for continued carbon-intensive economic activity, it could also create new jobs and create more robust, profitable market sectors, such as the carbon market (Reyes, 2011). Experiments with ocean fertilization have already been supported by government research funds and venture capital (Hamilton, 2013). Independent experiments have already engendered controversy, most recently when an American businessman conducted a large-scale iron sulfate dump west of Canada, ostensibly to promote salmon restoration (Pappas, 2012).

Finally, climate engineering may prove attractive because it can be implemented unilaterally or by small coalitions of states, thus side-lining tedious and potentially frustrating climate negotiations (Wiertz, 2011). While some aspects of some climate engineering methods may be covered by existing international conventions (e.g. carbon sequestration), there is no treaty or international body with a sufficiently broad mandate to regulate all aspects of proposed climate engineering measures (House of Commons Science and Technology Committee, 2010). For instance, the moratorium placed on certain climate engineering methods by the Convention on Biological Diversity in late 2010 has had limited impact because key countries, such as the United States, have not ratified it and are therefore not bound by its restrictions. For this reason, it is a plausible that individual states may attempt to modify climate at the global and regional level for their own benefit, and not only as a last resort (Ricke et al., 2008).

Multiple government agencies and initiatives around the world have already started to investigate the potential benefits of climate engineering and its implications, risks, and challenges. Activities are particularly advanced in the United States, Canada, and Europe, where the United Kingdom and Germany are most active; additional research projects are currently being prepared or implemented in France, Finland, and the Netherlands. The committed funds remain relatively modest: The Fund for Innovative and Energy Research, backed by Bill Gates and focusing mostly on carbon dioxide removal, has distributed US$4.6 million; the Priority Programme of the German Research Foundation, focusing exclusively on risks and challenges of climate engineering with specific focus on aerosol injection, enhanced weathering, and afforestation, will distribute just over €5 million (approx. US$6.2 million) from 2013 to 2015. Additionally, more research projects are planned in various countries.

Accidental vs. Deliberate Climate Change: Crossing Which Rubicon?

While current climate change trends can be considered accidental side effects of economic development, climate engineering provides a means of making future climate changes intentional or at least controllable to a certain extent. As such, climate engineering could theoretically help address the possible security implications of climate change by easing some its symptoms, such as altered precipitation patterns and the resulting food and water security impacts (CNA, 2007; Lee, 2009a). At the same time, however, a systematic assessment of the potential security risks posed by climate engineering does not exist, and the widespread implementation of the various technologies under research or discussion may be a risky gambit. This issue becomes especially important in the Anthropocene, which to a certain extent encourages tackling global problems such as climate change with human technologies and prowess.

While still speculative, three general categories of security risks may be discerned:

First, the consequences of climate engineering could be very similar to those of climate change. As mentioned earlier, climate engineering measures could affect the monsoon cycles in South Asia and Africa, which would have significant negative impacts on regional food security and imperil the livelihoods of literally hundreds of millions of people. Similarly, the use of ocean fertilization on a large scale in the southern oceans may also have significant negative impacts on ocean ecosystems and fisheries, potentially endangering the food security of populations relying on marine resources (IPSO, 2008). In such cases climate engineering, unlike mitigation, would not deflect the risks of climate change but rather reproduce them—and waste a great deal of money at the same time.

The risks of climate engineering, however, are not limited to actual deployment of the technology, but also to its discontinuation. For example, once implemented, radiation management and carbon dioxide removal techniques may need to be continued for long periods of time to ensure their effectiveness. If radiation management measures failed or were discontinued at some point, the planet could warm rapidly, potentially threatening human and environmental security. Meanwhile, ocean fertilization might cause other greenhouse gases to be released into the atmosphere, potentially accelerating the very global warming process they are designed to mitigate (Brovkin et al., 2009; Dutt, 2011; Sagarin et al., 2007). There is even some speculation that discontinued climate engineering efforts could dramatically accelerate the onset of serious climate change impacts—e.g., widespread food insecurity, increases in extreme weather events, and acute water scarcity—and exceed humanitarian, development, and security organizations' capacity to respond accordingly (cf. Royal Society, 2009).

On a technical level, carbon sequestration poses additional challenges. The tremendous amount of new infrastructure needed to transport captured CO_2 to storage sites could threaten human security in populated areas, since pipeline breaches could cause violent eruptions or heighten acidity levels in local water supplies (Lucas, 2010). Indeed, some studies indicate that CO_2 pipelines would entail higher security risks than pipelines transporting either hydrocarbons or other hazardous substances (Barrie et al., 2005). Meanwhile, sequestration installations could inadvertently trigger earthquakes, since storage sites in saline aquifers are vulnerable to seismic stress, and the injection of CO_2 below ground could possibly result in sudden pressure releases, inducing well blowout (Woollacott, 2010). Further, leaks or blowouts at offshore sequestration sites could even cause underwater landslides, generating tsunami waves (Klose, 2010).

In the same way that states raced to develop arsenals of nuclear weapons during the Cold War, states may compete to develop and control climate engineering technology.

Second, while climate change itself may intensify resource-use conflicts, climate engineering technologies may also pose risks, albeit a different set. For instance, in the case of mass afforestation, huge tracts of land would be required in order to have a significant environmental impact. This demand may fuel land-use conflicts, especially in regions of the world currently witnessing scrambles for agricultural land to boost food security. Additionally, using crops and plants whose albedo is increased via genetic engineering could exacerbate the risk of drought, due to the regional cooling effect of enhanced albedo and the unpredictable response of rainfall patterns to regional modifications (Ridgwell et al., 2009).

Afforestation could also lead to changes in regional climates. The Sahara and parts of Australia have been suggested for large-scale afforestation, but the necessary areas are large enough that modifying them could potentially negatively impact continental climates (Ornstein et al., 2009). Though no studies exist on the likely effects, it can be assumed that such inter-regional changes may also aggravate environment-related migration. Furthermore, as the civil wars in Sudan and Somalia have shown, this region is among the most volatile and politically fragile in the world. Consequently, initiating a massive afforestation program may prove not only challenging, but may upset a very fragile social, political, and ecological balance. If implemented, measures would require a conflict-sensitive approach and would need to draw on solid regional cooperation.

Adding to potential conflicts over existing resources is the need for new resources. Aerosol injection or cloud whitening would require machinery to implement these measures world-wide, and this would in turn require large amount of resources, including fuel for their operation. Similarly, afforestation projects would require large amounts of water for irrigation, while artificial trees and carbon sequestration require new infrastructure and large amounts of energy. These efforts may constrain global resource markets, leading to higher prices, which could be detrimental to global development.

Third, there is a risk of cold and hot wars over climate control (Robock, 2008). Those suffering from severe climate change impacts—e.g., China, which may be threatened with sea-level rise and extreme weather events—could devise and implement climate engineering schemes to counter regional impacts (Heberer & Senz, 2011). However, the application of climate engineering may have repercussions for other areas, and even if there may be no direct connection between a state's regional climate engineering scheme and the crop failure of another state, it may provide a convenient scapegoat and lead to increased tensions (Robock, 2008; Fleming, 2010). Indeed, once the global climate is actively controlled, the question of liability emerges with each extreme weather event; e.g., would hurricanes be still considered "natural" or would those controlling the climate be liable?

The possibility of unilaterally implemented climate engineering, either via world powers or smaller coalitions of states, may thus lead to a "climate control race." In the same way that states raced to develop arsenals of nuclear weapons during the Cold War, states may compete to develop and control climate engineering technology (Fleming, 2010; Blackstock & Long, 2010). As weather modification for drought relief is very similar to climate engineering methods such as cloud seeding, countries may develop a "break-out capacity" (Lee, 2009b). Nuclear energy in Iran provides a good example: Is it simply a civilian nuclear power program—which, after all, is allowed under the Non-Proliferation Treaty (NPT), much as localized weather control schemes for peaceful purposes are allowed under the Environmental Modification Convention (ENMOD) and are practiced by various states—or does it have any militarily offensive quality (Fleming, 2010)? Given this uncertainty, states may start developing climate engineering technologies simply out of fear that other states may do so first, implying that "counter-measures" should be available (Lane, 2010). However, as even field experiments can have detrimental effects, such activities may become a self-fulfilling prophecy (Royal Society, 2009).

On the other hand, joint research on climate engineering and a discussion of regulation and governance may hold the potential to counteract some of these security concerns. Participants at the Asilomar International Conference on Climate Intervention Technologies not only recommended that climate engineering research should be open, cooperative, and based on a framework of international support, but also asked governments to create new mechanisms for climate engineering oversight where needed (MacCracken et al., 2010). Clearly, however, self-regulation alone is not an appropriate governance response, given the scope of possible global consequences of climate engineering (Scott, 2013). It is important to note, however, that a multilateral agreement or treaty may face the same pitfalls as international climate change negotiations. Additionally, treaties are based on a conservative process; states that think that the required commitments are not in their favor will refuse to join, putting the global community at the same starting point described above (Bracmort et al., 2011).

This does not mean that all treaties must fail; in fact, the United Nations Convention of the Law of the Sea (UNCLOS) may provide a legal and scientific framework for coordinating international ocean fertilization activities beyond the current negotiations at the London Convention and the London Protocol. Still, some states are not members of the Convention (including the United States), leading to potentially significant gaps in effectiveness (Bracmort et al., 2011). Since climate engineering measures are still in the emerging phases of design and implementation, governments may still have the time needed to amend existing or write new international agreements. The question remains whether the push for climate engineering technologies becomes great enough to engender a discussion on that scale.

Climate Engineering: A Public Good?

During the coming decades and beyond, climate engineering may under certain conditions help ease some of the symptoms of climate change at the regional and global levels once its uncertainties are better understood. But while radiation management or carbon dioxide removal may alleviate some of the environmental and human security risks associated with global warming, they may also create substantial new risks, some like those produced by climate change itself, such as food insecurity; some created by conflicting uses of resources, such as using land for afforestation or acquiring raw materials for new infrastructure; and some created by the potential for climate engineering measures to be developed and deployed unilaterally, which could lead to cascading negative regional impacts. Thus, climate engineering may merely redistribute climate security risks and add new kinds of risks (Maas & Scheffran, 2012).

It is becoming clear that under certain conditions—such as climate change impacts that exceed our coping capacity—it may become necessary to engage in climate engineering. Indeed, achieving the two-degree goal with mitigation alone becomes increasingly unfeasible. But given the unknown impacts of the technologies under discussion, the development and deployment of climate engineering must be carried out with great caution and not be viewed as a cure-all substitute for emission reduction or adaptation. Instead, it should only be seen as a possible amendment to other climate change prevention and mitigation measures, as it does not address the root causes of climate change (Ginzky et al., 2011). Thus, climate engineering can, if at all, only serve as a complement—but never as a substitute—for mitigation and adaptation.

To reduce the conflict potential of climate engineering, a transparent international dialogue on the research and applications of climate engineering technologies is crucial prior to any field research. Ongoing talks and deliberations should involve a wide variety of stakeholders, and critically evaluate the potential technological benefits and pitfalls, as well as the regulatory development of the range of climate engineering techniques (Scott, 2013). Along those lines, the June 2011 IPCC meeting on climate engineering provides a good template for bringing the issue to a wider audience of researchers and soliciting a broader range of perspectives.

Finally, there may also be merit in understanding climate engineering as a public good, similar to the global climate system itself. Regulating it, therefore, would mean taking into account the public interest and may help steer states away from covert pilot tests with unknown consequences by engaging a wide range of stakeholders (House of Commons Science and Technology Committee, 2010). Climate engineering could provide a platform for international cooperation in the face of potential catastrophic climate change. Further, sharing information on the research and development of climate engineering technologies—as well as information on its associated risks and uncertainties—could help mitigate the risk of unilateral deployment and thus reduce the likelihood of associated interstate tensions.

Indeed, conducting joint transnational research activities may actually even reduce risks of inter-state tensions due to the transparency involved (U.S. GAO, 2011). Though even more speculative, joint climate engineering research and capacities for deployment on a global scale could even lead to global détente, as it would require a cooperative effort of states as different as the United States, European Union, Russia, India, China, and Brazil. As such, climate engineering research may in fact provide a peace dividend on its own, even if the technologies are never actually deployed. While this could be one development, the immediate focus must be on starting an international dialogue on the governance research before countries venture into large-scale testing on their own.

Notes

1. This paper is based on several projects and activities by adelphi on geo-engineering beginning in 2010.
2. The term "geoengineering" was used for a broad range of activities relating to larger scale man-made

changes to the environment—such as redirecting rivers—before it was used to refer specifically to climate modifications. In this sense "climate engineering" is a more specific term, as its clear focus is the engineering of the climate. While climate engineering is increasingly used in the international arena—especially in Europe—the term geoengineering is more often used in North American discussions.

3. While there is no universally accepted definition of climate engineering, see the U.S. Government Accountability Office (2011) for a set of "selected" techniques. Also note that while geological sequestration is part of the climate engineering repertoire, since it captures already released CO_2 from the atmosphere, carbon capture and storage at power plants only prevents point source emissions, which is not a direct climate intervention.
4. It is important to note that new research on climate engineering techniques often presents new and sometimes very divergent cost information, which makes a concrete cost comparison difficult. For instance, iron fertilization costs have been calculated to vary between US$8 billion and US$80 billion per year (U.S. GAO, 2011).

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Risk and Scenario Planning for Climate Security

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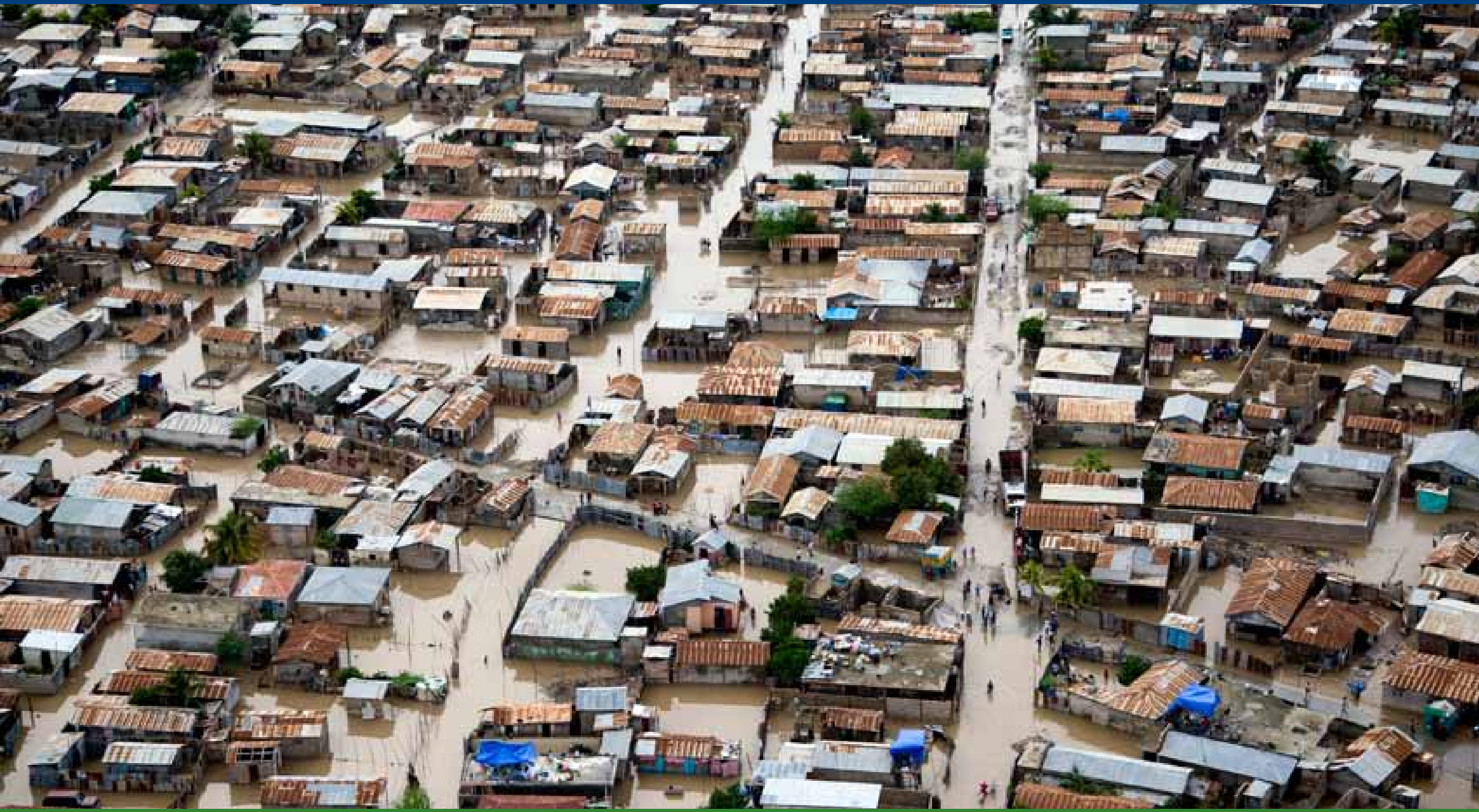


Hurricane Tomas floods streets of Gonaives, Haiti, in 2010. Courtesy of flickr user United Nations Photo, http://www.flickr.com/photos/un_photo.

THE RISKS AND IMPACTS of climate change are difficult to envision at times. The complexity of the issue and the novel nature of its associated changes make it difficult to ground discussions in prior experience, and previous security concepts may no longer apply. The surprises and cascading impacts witnessed from environmental events—from the wildfires in Russia and floods in Pakistan in 2010, for example—suggest that previous assumptions about the slow nature of climate change may be incorrect. Indeed, many in the science community have warned that climate changes may be far more abrupt than earlier IPCC reports suggested (Alley et al., 2003). The question is, if the future will not look like the present, how can we plan for future risks and understand their potential security impacts? And further, how can we ensure our policy-making does not unintentionally make things worse?

To date, attempts to define climate and security links have often been muddled, relying on classical notions of state security to explain how gradual changes in air temperature and resulting impacts could influence conflict dynamics within and between states. Such discussions often end with either overly simplistic predictions of failed states or dismissal of the entire cause-and-effect construct because it does not fit neatly into Cold War models of military security (Walt, 2009).

New models are needed for understanding climate security challenges because the strategic and operational interests for environmental security do not lend themselves to overly alarmist predictions of violence or imminent state collapse. The actual risks are more complex and harder to visualize, but since these risks are unknown, they may pose even more significant challenges. Indeed, just because we do not anticipate risks does not mean that they do not exist; history is replete with failures of intelligence and early-warning systems that have left societies and communities unprepared.

The U.S. government has recognized that energy and environmental issues are likely to create new security risks in the future and that failure to anticipate these challenges could result in haphazard and ineffective responses after the fact. The Multinational Planning Augmentation Team (MPAT) at the U.S. Pacific Command (PACOM) has been working on complex disaster response via its Tempest Express scenarios since 1996, and its multinational approach can be used as a template for future climate risks. Even when climate change impacts are not traditional security risks (e.g., violent conflict between states), the sudden nature of floods or other disasters can often demand response capabilities that only exist within the military. Anticipating such scenarios can help determine when military assistance is necessary and how to coordinate with local governments and non-governmental organizations.

The need for greater foresight and warning requires:

1. The development of analytic systems to provide relevant data;

2. More robust recognition of critical system-level vulnerabilities;

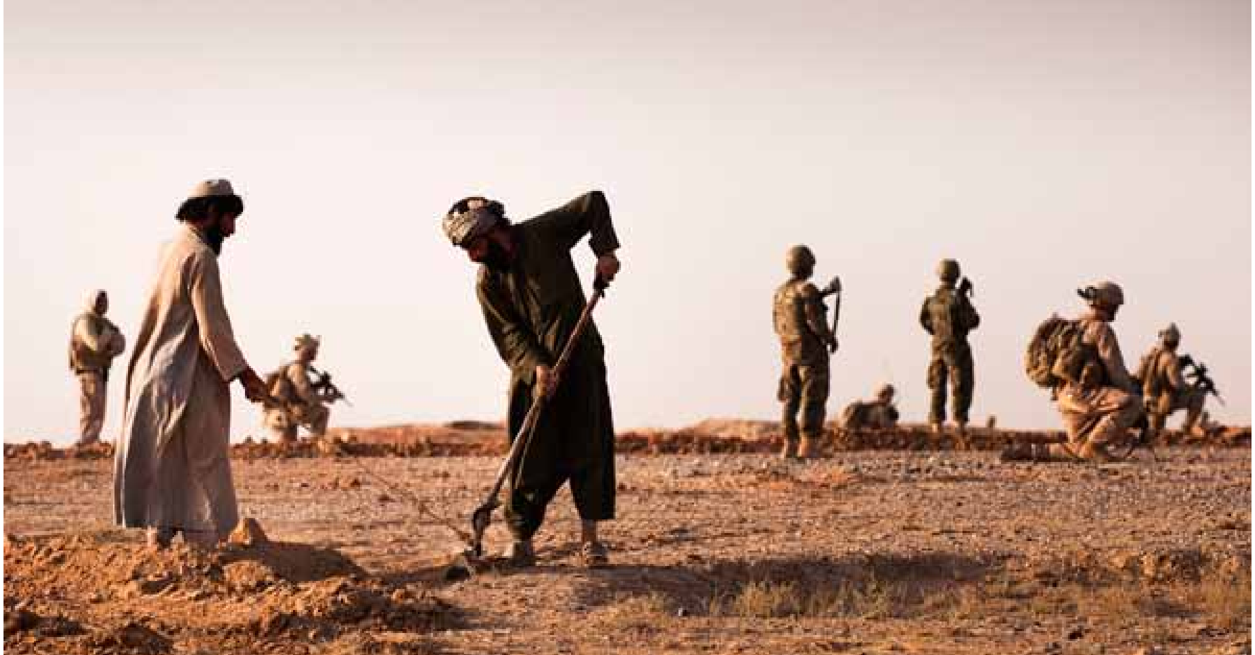
3. A better understanding of how these vulnerabilities can be viewed as security concerns (Bray, 2007); and

4. More thorough understanding of how our actions to address one problem may create unintended consequences elsewhere.

What are the key factors that bring together apparently disconnected systems such as climate change, ecosystems, and national security? Are there "latent" systems that underlie security and appear stable, but whose existence becomes manifest only if current systems break or are disrupted beyond safe operating limits? Could our actions to mitigate climate change raise new security concerns elsewhere?

None of these questions can be answered easily. Still, investment in forecasting and early-warning intelligence on these issues is potentially valuable for many levels of strategic planning. Additionally, since scientific data alone is insufficient to guide planning and policy, we need "risk translators" who can apply environmental knowledge to help determine the nature and scope of energy- and environment-related security impacts.

Complex risk assessment often relies on scenarios for describing potential impacts. Military planners for



Afghan farmers plow a field guarded by U.S. Marines. Courtesy of flickr user isafmedia, http://www.flickr.com/photos/isafmedia.

operational and strategic risks have employed scenarios and war games dating back to at least early 19th century Prussia. Such scenarios were institutionalized in the United States following World War II. Herman Kahn and the RAND Corporation developed a systemic framework for complex futures scenarios with an emphasis on combining future trends (Kahn & Wiener, 1969). Pierre Wack and Royal Dutch Shell used these methods in the 1970s to navigate the oil crises and OPEC embargo (Wack, 1985). The purpose of scenarios has been to challenge decision-makers about conditions under which they could have to act in the future, thus enabling them to react more effectively under changing circumstances. Scenario planners assume that certain poor decisions are irreversibly costly and that decision-makers cannot rely upon past experience in all situations; even metaphorically speaking, one should not always use the last war as model for the next.

Critical Environmental Risks

Environmental scenarios should differ from scenarios devised in the Kahn-Weiner and Wack traditions in two crucial aspects.

First, environmental scenarios should be devised in a more systematic fashion and should be created by the participants themselves, rather than having a group of experts prepare them in advance. Environmental changes rely on complex interactions legible only to broad geographic and interdisciplinary communities of scholars, meaning the process cannot be "black boxed" and handled by small groups of specialists. Drawing climate data primarily from summaries released by the Intergovernmental Panel on Climate Change (IPCC) provides an incomplete view of potential risks and interactions, as those summaries rely on primary data that is often significantly out of date (IPCC, 2007). Indeed, IPCC efforts tend to be conservative by nature and aimed at establishing what is known beyond doubt in the peer-reviewed literature. This approach results in a scenario process that is somewhat fragmented between issue areas and that can lag behind emerging research by as much as eight years. Further, ignoring cutting-edge research on complex environmental systems creates potential blind spots in risk assessments (Briggs, 2010). Scenarios addressing environmental changes require constant updating and discussion, necessitating iterative work from interested scientists and field experts. The more traditional narrative style of scenarios provides insufficient detail to incorporate complex scientific data.

Second, environmental scenarios do not require overlays of complex projections from other areas of future change, highlighting another key departure from the Kahn-Weiner and Wack models. Military scenarios refer to background assumptions as "environmental factors," meant to remain constant while variations are introduced into other military, political, or economic situations.[1] Climate security scenarios, in contrast, can shift geophysical factors while keeping other factors steady, which can highlight cascading impacts, much as the 2011 Japanese tsunami set off a chain of events that quickly led to massive shifts in the worldwide nuclear power industry (King, 2011).

In instances where the natural environmental factors shift abruptly, it may be difficult to maintain even business-as-usual operations, particularly in cases where critical vulnerabilities are exposed by the changes. For instance, the 2010 eruption of the Eyjafjallajökull volcano in Iceland challenged basic assumptions concerning air transport operations in Europe and the North Atlantic region. The environmental change itself was unanticipated (at least in the European commercial air sector), and cascading impacts stemmed from the environmental event, unmasking critical systemic vulnerabilities, such as the fragility of aircraft engines to volcanic ash and densely populated regions' reliance on air travel (Lawless, 2011).

Using certain environmental changes as a starting point, it is possible to trace impacts and reactions as well as determine whether appropriate actions can be taken in advance. Often, policies are considered in a linear fashion, meaning that only direct consequences are considered in a risk-cost-benefit assessment, while the reality is that significant dislocations can occur as indirect, second, or third-order consequences of actions. Climate-related scenarios can be plotted using a multi-step process, which enables transparent, systematic application of scientific data, and allows for exploration of cascading risks across complex systems. The transparency is necessary not only for critical examination, but also for updating potential geophysical conditions and feedbacks. Particularly when scientific issues need to be debated among communities of scientists, scenarios may have lasting legitimacy only if they are interactive *processes*, rather than closed *products*.

Climate security scenarios are created by first plotting potentially abrupt environmental changes in a given region (Briggs, 2010). Abrupt changes can result from either

TRACING CASCADING IMPACTS

Multi-dimensional environmental analysis was first used by the U.S. Department of Energy in 2009 for a scenario focused on the risks of accelerated glacial melt affecting water supplies in Peru. Starting with five-year assumptions about glacial melt, the team identified the key sectors that would be impacted first (agriculture, municipalities, energy, and ecosystems). Regional experts then identified multiple decision paths from each sector (e.g., how would people in Lima cope with loss of drinking water; what choices would farmers have?). From those decisions, further paths and impacts could be traced (e.g., if Peru turns away from hydropower, what are its alternative sources of energy and what are the consequences of those choices?). Despite starting from relatively simple points, expert group analysis can trace how impacts ripple across complex systems and at times overlap with one another (Briggs, 2010; Gonzalez, 2010).

By including experts from disparate fields and identifying (rather than assuming) system dynamics, environmental scenarios could help predict unforeseen security impacts and allow for advance planning.

major geophysical changes occurring quickly or sets of marginal changes that create a "perfect storm" of impacts. Focusing on just one driver of change can lead to underestimating other impacts from environmental changes. A multi-dimensional analysis can help determine potential interactions between key environmental factors, thus systematically mapping the boundaries of what is possible. Climate and environmental scientists can then identify 1) areas where monitoring and/or research is weak; 2) areas in which changes are already known to be occurring; or 3) outcomes deemed either too unlikely or too insignificant to warrant further study (Briggs & Carlsen, 2010). Later, key environmental events are chosen to examine potential security impacts. Selection criteria should focus on events that are poorly monitored but have a high potential impact or where significant related changes have already been observed, making the probability of such an event moderate to high. Although the science behind abrupt changes has seemingly lagged in climate security debates, the recent IPCC report on extreme events adds important global dimensions to the understanding of such complex interactions (IPCC, 2012).

Once key potential events are chosen for scenarios, groups of experts can begin mapping cascading impacts. The subsequent impact tracing can and often should be undertaken by multiple teams, either to incorporate different perspectives or account for the regional specificity of impacts. Starting with the central assumptions of environmental changes, potential first-order (immediate) impacts could then be identified. Next, working off of each potential first-order impact, a group of related second-order impacts could be identified, and so on in scale-free network topology. Impacts generating feedback (i.e., worsening or alleviating the original problem) would be highlighted, allowing for critically vulnerable parts of the system to be isolated.

By including experts from disparate fields and identifying (rather than assuming) system dynamics, environmental scenarios could help predict unforeseen security impacts and allow for advance planning. The process outlined above is also designed to incorporate scientific data as it becomes available, rather than waiting years for such data to work its way into an IPCC assessment summary.

An Urgent Issue

The steps outlined above are designed to identify areas of security risk that are currently not recognized, either because of a too-narrow focus or because interactions between events are not sufficiently explored in advance. It is crucial to remember that climate changes do not occur in isolation. While precipitation variations can affect tropical rainforests, for instance, deforestation can worsen those impacts, leading to altered flow levels in rivers and hindering rainforests' ability to absorb carbon from the atmosphere. While some types of environmental and social systems are resilient enough to withstand changes, certain vulnerable systems may become unstable with much slighter pressure, particularly if there is a "perfect storm" set of conditions that accelerates environmental changes.

Research and observations suggest that when changes occur in environmental systems, these systems can shift very quickly (Ananthaswamy, 2009). Indeed, complex, adaptive systems (such as the global financial system) often exhibit "phase shifts": long periods of relatively minor changes followed by abrupt changes that lead to a new equilibrium once a tipping point has been reached.

A tipping point materializes when movement beyond this point becomes self-reinforcing, allowing feedback mechanisms to accelerate changes. For example, in the case of global warming, rising air temperatures can trigger die-off in large areas of forested land, either directly through fires, or indirectly through the proliferation of pests such as the pine beetle. In turn, these events and trends increase the release of greenhouse gases (Alley et al., 2003). Likewise, the warming and melting of permafrost releases large amounts of trapped carbon in the form of carbon dioxide and methane, increasing the concentration of atmospheric methane over the Arctic (Isaksen et al., 2011).

While the timing and location of tipping points cannot be known in advance, research suggests we may have already passed some points and are fairly close to others (Schneider, 2003; Bonan, 2008). Additionally, it is important to remember that climate change occurs at different rates in different areas of the world. While the greatest warming trends to date have been observed closer to the poles, significant second-order impacts have been observed in areas where air temperature changes have been modest, such as melting of equatorial glaciers (Jones et al., 2009).

Changes in water supply and water temperature can also adversely affect systems not normally thought to be threatened by climate change. Energy resources collectively serve as an example of a complex system whose components may be unable to withstand significant changes to water conditions, as nearly one-third of water consumption globally is used in energy processing or production (U.S. DOE, 2006). Power plants are highly sensitive to changes in water temperature or supply, leaving them vulnerable to environmental changes that had not been accounted for during construction. Indeed, during the 2003 heat wave in Europe, coolant water exceeded planned variance, resulting in 16 French nuclear reactors—one-third of the country's total—being powered down as a precautionary measure (Paskal, 2009).

In the future, ongoing energy development and continuing strains on water supplies will likely combine to create further bottlenecks that may seriously impact security operations (National Intelligence Council, 2012). Since critical infrastructure and facilities are difficult to replace or move, implementing adaptation measures in the face of climate changes could prove costly. Decisions will have to be made either to abandon facilities at high risk or undertake long-term planning investments that take account of potential changes (Naval Studies Board, 2011).

Proper scenario planning for climate security can help determine whether reactions to future events are positive or whether they unintentionally exacerbate the situation by placing undue pressure on related systems.

Considering the rapid nature of environmental changes and their impacts, it is crucial that the potential changes and unintended consequences of mitigation and adaptation actions be taken into account during the policy-making process. Further, with cascading impacts from environmental changes affecting different regions in unique ways, it is also necessary to recognize that policy solutions and responses should be flexible and tailored to specific contexts. One-size-fits-all solutions are unlikely to be applicable, and neither will policies that merely respond to changing conditions with little thought as to the scope of future changes (Lobell et al., 2008). It is particularly difficult to foresee unintended consequences and interactions within and between complex systems, which requires moving beyond linear models of policy action and impact.

Ultimately, proper scenario planning for climate security can help determine whether reactions to future events are positive or whether they unintentionally exacerbate the situation by placing undue pressure on related systems. Choices between mitigation and adaptation policies cannot be determined simply according to direct impacts, as that approach may create new risks or difficulties. Do we turn to biofuels as a means of climate change mitigation, or do the associated environmental costs outweigh the benefits? What are the security risks of inaction, and what are relative risks of mitigation efforts versus adaptation in a given area? If these categories remain abstract, political discussions on such matters cannot be easily resolved. However, if scenarios are applied in a systematic way, we will at least be able to weigh and debate alternative futures.

Note

1. This terminology can create confusion, as in scenario parlance, the phrase "environmental changes" often refers to everything except geophysical factors.

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