Distributional Impacts of Climate Change and Disasters

Concepts and Cases

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9. The security challenges of climate change: who is at risk and why?

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INTRODUCTION

This chapter focuses on identifying the potential security problems posed by climate change. Where the security challenges of the twentieth century were largely defined in terms of large-scale interstate conflicts (for example, World War II and the Cold War), the challenges of the twenty-first century have been typified by civil conflicts (for example, the genocide in Rwanda), and asymmetric conflicts (for example, the 'Global War on Terror'). The drivers and dynamics of such civil conflicts cannot be explained by extensions of theories developed in an interstate context (Steinbruner and Forrester 2004). Because climate change is a fundamentally disruptive force, it is important to think carefully about the implications of these disruptions for different forms of armed conflict and for human security in general.

Like the direct impacts of climate change, many of the associated conflict-related risks are likely to fall most heavily upon the poor. This fact is acknowledged in studies of resource scarcity as a driver of conflict. Still, there are other important, but less direct, connections between climate change and human conflict that add another aspect to the distributional analysis. Civil conflicts in the less developed parts of the world can pose real threats to wealthy nations. Technological responses, if not handled adequately, may threaten the wealthiest citizens of the most powerful countries.

The security challenges of climate change can be broken down into two overarching categories: (1) those which stem from the environmental disruptions of climate change itself (including uncoordinated human reactions to these events); and (2) those which stem from our coordinated attempts to avoid more catastrophic change by shifting the structure of our economies and energy production systems. The first class of problems needs to be assessed in order to understand the costs of inaction. The second class needs to be assessed in order to weigh the relative worth of various courses of action.

What follows is not an attempt to deal exhaustively with the contents of these classes, but instead to populate them along with their subcategories. An important argument contained in this chapter is that, while nuclear fission is likely to play a major role in decarbonizing the world energy supply system, security concerns make a simple scaling-up of current nuclear technologies and institutions unworkable. The production of nuclear power on the scale required to make a real contribution to climate stabilization will require a deeper reworking than has generally been appreciated of both the related technology and global institutions aimed at preventing the proliferation of nuclear weapons.

ENVIRONMENTAL SCARCITY AS A DRIVER OF CONFLICT

Climate change poses direct threats to human security through its disruptive impacts on our ability to meet the basic needs of food, water and shelter. Rising sea levels and more powerful storms threaten to displace large numbers of people, particularly in low-lying areas. At the same time radical shifts in climate pose real threats to agricultural production and to the supply of clean drinking water.

Developing countries are more vulnerable than industrialized countries to the impacts of climate change for several reasons (Moss et al. 2001). First, their economies are generally less diversified, leaving them fewer options for adaptation. Second, they generally depend on primary agricultural products and are located in warm regions which stand to lose the most in agricultural terms from climate change. Third, people in these countries tend to live more traditional lifestyles, which are more closely tied to their particular environment, than people in industrialized countries. When that environment shifts, traditional lifestyles adapt much more slowly than do industrial economies. These and other factors place the populations of developing countries in a position to be highly vulnerable to the impacts of even modest changes in climate (McCarthy et al. 2001). The same can generally be said for the poorest people within all nations.

Many studies have analyzed the role of environmental scarcity as a conflict driver (Gleditsch and Theisen 2006; Khagram and Ali 2006). Notably, Homer-Dixon identified three distinct classes of scarcity and various mechanisms by which their interactions can lead to violence (Homer-Dixon 1991, 2001). He classifies environmental scarcities as demand-induced (that is, stemming from increasing population and/or increasing per capita consumption), supply-induced (that is, stemming

from environmental degradation which leads to a reduced supply of such resources as clean water or arable land) and structural (that is, stemming from the uneven distribution of access to resources which leaves the majority with inadequate supply). These scarcities can interact and reinforce one another through resource capture. Resource capture occurs when a scarce resource becomes valuable and is taken over by powerful minority groups within a society. Resource capture can be caused by ecological marginalization, wherein impoverished people are driven to make use of increasingly marginal resources (for example, arable land) which are then damaged by overuse so as to lead to increased scarcity and poverty. These patterns of scarcity can lead to destabilizing social effects such as lower agricultural production, economic stagnation or decline, massive migrations out of areas of scarcity, and a weakening of governing institutions (Homer-Dixon 2001).

INDIRECT EFFECTS OF CLIMATE CHANGE ON DRIVERS OF CONFLICT

There is an intuitive relationship between climate change, resource scarcity and conflict. Thus, it is noteworthy that none of the major cross-national quantitative studies of factors that make some countries more conflict-prone than others have identified resource scarcity or other environmental factors directly affected by climate change as an important driver of conflict. The fact that environmental scarcity has not played a major role in the mainstream of quantitative conflict literature does not indicate that its role is unimportant. Its absence is likely due to the fact that its effects are indirect and often too complex to be picked up in a regression model.

Using a case-control-based logistic regression model to predict the onset of political instability (defined in such a way that political instability correlates closely with civil violence), the Political Instability Task Force (Goldstone et al. 2005) identified several consistent drivers of conflict between the middle of the twentieth century and the early years of the twenty-first century. The most notable is the combination of a factional political system with one that is only partially democratic. A factional political system is here defined as one where the major political parties represent ethnic, religious or regional groups, rather than differing policy approaches. Other consistently significant variables include having several neighboring countries also in conflict, having a government that actively condones ethnic discrimination, and having a high rate of infant mortality.

Infant mortality is not a likely driver in its own right. Instead, it is a

proxy for the combination of economic development and inequality of distribution of that development. Other research has independently demonstrated that conflict is often associated with poor economic performance (Collier and Sambanis 2002). The fact that Goldstone et al. found infant mortality to be a better indicator than other measures of economic performance offers evidence that inequality, as broadly defined, is also an important contributor to political instability and violence.

There is good reason to assume a connection between poverty and scarcity on the one hand, and civil conflict and violence on the other. These two phenomena are linked regardless of whether the conditions in question consist of absolute poverty (that is, incomes below levels required for subsistence) or relative poverty (that is, the perception of inequality irrespective of income). The existence of widespread hunger and desperation, or resentment and frustration, among populations appears likely to increase competition for scarce resources. In addition, it tends to exacerbate existing social, ethnic, racial and religious tensions and encourages political and social movements to use such tensions to mobilize supporters to violence. Demonstrating these relationships, and establishing a causal link, is a challenging task for scholars.

Other quantitative work conducted by researchers at the World Bank shows a strong link between conflict and dependence on primary commodity exports (Collier 2000; Collier and Hoeffler 2001). This line of thought is known as the 'greed' theory of conflict and is distinguished from more traditional 'grievance' theories. Civil conflict, in this conception, is not driven so much by political disagreement or resistance to oppression, but rather by the desire for profits that can be used to fund further rebellion. Diversified economies are generally resistant to this kind of activity because of the mutual interdependence of their various sectors. Primary commodity exports (for example, diamonds, oil and timber), are more suited for control by an elite group, which can then operate more or less independently of the rest of the nation's economy and use the revenues from these exports to fund efforts to gain control over additional resource streams.

Though the field has not reached consensus on the relative importance of these drivers, it appears likely that greed and grievance both play major roles in the development of conflict. Sambanis (2001, 2003), using a case study approach, found that understanding the relative importance of these drivers requires appropriate categorization of conflicts according to their origin in ethnicity or economics.

Work on the relationship between economic performance and subjective well-being also has implications here (Graham and Pettinato 2002). Graham and Pettinato found that people's satisfaction with their economic

lot and with their government depends more on their performance relative to their perceived comparison group than it does on their absolute level of income. While rapid economic growth can go some way toward offsetting the dissatisfaction engendered by radical inequality, people in high-growth economies are particularly frustrated when this growth slows. In a highly connected world where the comparison group for the average person in the developing world includes members of the industrialized world, and where economic growth needs to be tempered by the need to maintain a livable atmosphere, these feelings of frustration must be anticipated and taken seriously.

The threads of democratization, ethnic factionalization, economic inequality, elite dominance of resources and shocks to subjective well-being are not fully integrated within the formal conflict literature. Chua provides a relevant way of combining these issues (Chua 2003). She documents a series of cases in which economic liberalization collided with democratization to create an environment conducive to violence. She observes that unrestrained capitalism has, in many cases, concentrated economic power in the hands of an ethnic minority. Examples include ethnic Chinese in Southeast Asia, people of European decent in Latin America, and Indians in East Africa. These groups tend to become targets of resentment on the part of the broader population. In this environment, Chua observes that the introduction of democratic rule empowers this broader population, leading to potentially deadly conflict between economic and political power centers. She notes that examples of this dynamic include the emergence of Milosovic in Serbia, Mugabe in Zimbabwe and the Hutu leadership in Rwanda. Further, she analyzes the terrorist threat against the US in these terms, casting it in the role of the economically dominant ethnic minority, and modern communications technology as the democratizing force that is empowering the resentful masses.

In short, while the relationship between climate change and the drivers of civil violence is indirect and hard to quantify, it appears to be both powerful and important. Changes in climate may create an abundance of specific resources in some areas (for example, rainfall in northern India). However, climate disruptions will generally lead to increased supply-induced scarcity. This can reinforce scarcity and inequality in a way that may eventually lead to violence.

MITIGATION AND CIVIL CONFLICT

The security challenges posed by climate change itself are among a list of hazards to be avoided by undertaking efforts to reduce greenhouse

emissions. These are either impacts of climate change itself (for example, flooding of low-lying areas, crop failures, and so on), or they are impacts of adaptation to climate change (for example, shifting social structures as a nation grapples with decreased fresh water supply). It must be remembered, however, that many strategies for greenhouse gas reduction have their own security implications. Although the security impacts of climate change mitigation are generally harder to forecast than the effects of climate change, they are just as important.

Another important difference between threats related to adaptation and those created by mitigation policies is that the effects of climate change are essentially given (if not entirely understood), while the effects of mitigation strategies depend on the strategies chosen. The policy-maker who chooses a mitigation strategy chooses its corresponding security implications. This makes an understanding of the implications of mitigation strategies even more important because we are in a position to choose not only the degree of impact we are willing to tolerate, but also the types of problems that we are likely to face.

If not implemented with care, the measures employed to address the global climate change problem could have significant negative, and often regressive, impacts on incomes, thereby contributing to social tensions within nations that may lead to violence. For example, efforts to decrease the use of fossil fuels, or increase the use of higher-cost renewable sources, could raise electricity prices and slow the expansion of the electricity supply. Actions to address climate change could produce broader societal changes as well. Graham (Graham and Pettinato 2002) points out the dangers of stunting development in societies that have been growing, while Chua (2003) identifies the potential for violence that might emerge if a change in fuel consumption patterns or prices were to alter economic relations between an ethnic minority and the rest of society.

In countries where low-carbon energy resources are found in areas that are poor or populated by distinct ethnic or social groups, national efforts to develop these resources could galvanize opposition to such development or lead to charges of inequitable distribution of benefits. This could in turn worsen conflicts between central governments and local ones or indigenous peoples. The Indonesian province of Aceh on the island of Sumatra is an example of this kind of conflict (Ross 2002). The exploitation of this region's rich oil and natural gas deposits has figured prominently in the conflict between the government and the local separatist movement.

Research by Collier and Hoeffler (2001) has disturbing implications for a future where much of the industrialized world's energy needs are met with fuels derived from biomass. Early experience with growing corn in the US, and sugar cane in Brazil, for the manufacture of ethanol

have raised concerns about energy crops driving up food prices. A major expansion of energy crops would require the use of large swaths of land. This land is likely to be located in tropical nations where growing seasons are long, water is plentiful and land prices low. In such a scenario, grower countries would be made even more dependent on primary agricultural exports, along with the concentrated streams of income and conflicts that they tend to produce.

The production of export commodities leads to the concentration of wealth among those who command the resources and have the ability to bring them into the international market. For example, if the world shifted from petroleum to ethanol for transport fuel, we might expect to see further destabilization of the current generation of petro-states with economies that are dependent on high demand for petroleum. In addition, we could find the emergence of a new class of 'biomass-states' in tropical regions. The production of commercial biomass (for example, sugar cane or – assuming advances in the manufacture of cellulosic ethanol – crops like switchgrass) involve high-volume, low-value crops which lend themselves better to mechanized production, as opposed to labor-intensive crops like coffee, cocoa or bananas. The fact that the conversion of biomass to ethanol might be most efficiently done in the originating nation does not help here since the process is highly capital-intensive. Accordingly, it is hard to see how either smallholders, or other small businesses, might fit into an economy based on ethanol production.

While such a shift might be an aggregate economic boon for tropical nations, it is likely to lead to an increased concentration of wealth in these nations. At the same time, such a shift could create the kind of hijackable resource stream shown by Collier and Hoeffler (2001) to be destabilizing. This increase of concentrated wealth, without a corresponding increase in internal economic activity, can lead to rapid urbanization and a host of related maladies. This type of phenomenon, as demonstrated in the Middle East, was dubbed by Bonine (1997) as 'petroleum urbanization'. In 1979, reflecting on the effect of the oil boom on his nation, Sheik Yamani, Oil Minster of Saudi Arabia said: 'All in all, I wish we had discovered water.' If not handled with care, large-scale exploitation of biomass has the potential to move the often unstable nations of tropical regions along a similar path.

Studies show that mitigation policies, such as carbon taxes and other measures that increase the cost of energy are also likely to impose greater burdens on poorer households (Brendemoen and Vennemo 1994; Cornwell and Creedy 1996; Aasness et al. 1996; Harrison and Kriström 1999; Barker and Kohler 1998). This is largely the case because energy expenditure consumes a larger share of the income of poorer families.

Appropriate revisions to national tax structures could go a long way toward mitigating the regressive nature of carbon taxes. The difficulty in making such revisions, however, should not be underestimated. Fully offsetting the increased basic commodity prices that poor people would face might require strong redistributive measures, such as negative income taxes. Such measures are bound to face strong opposition from more powerful groups. It seems likely that the theoretical possibility of distributionally neutral carbon taxes would be difficult to realize in poor nations.

Even more difficult would be the task of offsetting the distributional impacts of policies that raise energy prices on the global market. Strong arguments can be made that wealthy nations should compensate less wealthy ones for sacrifices made in the name of climate stabilization. However, compensation on the scale required might prove more politically difficult than national redistributive measures.

It is generally recognized that to be both widely accepted and effective, mitigation measures must also be fair. Most of the excess CO_2 emissions in the atmosphere came from industrialized countries that used the energy from its production to build wealthy, flexible economies. Less developed countries are understandably hesitant to commit to restrictions on their CO_2 emissions until they have reached a similar level of development.

Raising global living standards to a more equitable level would likely require a threefold increase in global energy production over the next 50 years. Under business-as-usual conditions, such an increase would necessarily entail a huge increase in global CO_2 emission levels – even under an optimistic assumption of relatively rapid future declines in carbon intensity. It is generally agreed that the climate will not support the kind of emissions associated with the full industrialization of the 80 percent of the world's population currently living in non-OECD (Organisation for Economic Co-operation and Development) countries. Without a corresponding commitment to reduce the use of fossil fuels dramatically, a global poverty amelioration effort would greatly exacerbate the climate change problem. The resulting climate-related impacts would then likely feed back on the entire effort, providing incentives for renewed conflict and eventually diminishing or eliminating the impact of the original anti-poverty program. However, global policies that deny the right to equal development are bound to breed resentment and discord.

To address this concern, policies must be designed to provide opportunities for sustainable development on the part of poorer nations without breaking the global carbon budget. The 1998 United Nations Development Programme (UNDP) *Human Development Report* stated: 'Poor countries need to accelerate their consumption growth – but they need not follow the path taken by the rich and high-growth economies

over the past half century' (UNDP 1998). However, the responsibility for making such alternative growth paths feasible and attractive may lie as much with industrialized as it does with developing nations. Such equity concerns are being integrated into analyses of the climate change problem (for example, Munasinghe 2000; Jamieson 2000; Schelling 1997; Byrne et al. 1998; Parikh and Parikh 1998; Tolba 1998; Agarwal et al. 2000). The likely impact of these concerns on the formation of effective control regimes has also received considerable study. There exists extensive economic and political science literature that has been reviewed by the Intergovernmental Panel on Climate Change (Metz et al. 2001: 620–30).

THE CHALLENGES OF INCREASED RELIANCE ON NUCLEAR FISSION

Pacala and Socolow (2004) analyzed the mitigation problem in terms of 'stabilization wedges'. These are changes from business as usual that are intended to deflect the global greenhouse gas production curve from its current growth pattern and stabilize it at current levels for the next 50 years. They found that a combination of proven technologies is capable of achieving stabilization in emissions. Among these technologies, they propose a doubling of current world nuclear power generation (from 700 GW to 1400 GW) over 50 years. This constitutes one stabilization wedge – accounting for one-seventh of the required deflection from the business-as-usual scenario.

In a study with similar aims, Fetter (2000) identifies nine major sources of carbon-free energy. Of these, he determines that four (hydroelectric, geothermal, ocean and nuclear fusion) are unlikely to provide significant sources for additional power by the year 2050. He then identifies five technologies (nuclear fission, biomass, solar, wind and decarbonized fossil fuel) which might make significant contributions. He finds that no single technology can serve all of the carbon-free energy needs of the planet. However, it is entirely plausible that a combination of strategies will enable the world to stabilize climate while producing the 300 to 900 EJ/y of carbon-free energy needed by 2050. This amount is necessary to maintain a high level of material well-being in the OECD countries while substantially improving the material well-being of those in less developed parts of the world. He makes the case that it is difficult to envision a successful combination of policies that does not involve a major increase in the use of nuclear power.

Nuclear power is the most mature of the carbon-free technologies, and is the only one currently deployed on a significant scale. While each

of the other technologies shows promise, they are unlikely to produce enough power to stabilize greenhouse gas emissions by 2050 without an increase in nuclear power. Even if an optimistic assumption of sustainable source biomass energy production is made (for example, on the order of 100 EJ/y), another 200 to 800 EJ/y would be needed from the remaining carbon-free sources.

Nuclear power also has operational advantages over other carbon-free energy sources. Nuclear power plants can be situated almost anywhere – unlike solar, wind and fossil fuel plants with CO_2 disposal. These plants can only be sited in countries and in areas with the appropriate resources. There is also an important qualitative difference between the operation of nuclear plants and renewables. Notably, the former can provide reliable 'baseload' power during most hours throughout the year on a scale sufficient to replace fossil-fired electricity. The latter can provide only intermittent power and could not supply more than 10 to 20 percent of electricity without large-scale energy storage or intercontinental electricity transmission. Neither option is affordable using current technologies (Fetter 2000).

While the exact amount of additional capacity depends on the outcomes of a host of other policy decisions, most stabilization scenarios involve a substantial increase in the use of nuclear fission. Pacala and Socolow's suggestion of a doubling of current capacity is at the low end of current estimates. Feivesion uses an eightfold increase in global nuclear capacity (to 3000 GW) by 2075 as an analytical benchmark (Feiveson 2004). Fetter and Gulden suggest that as many as 2500 GW of new nuclear capacity may be needed by 2050 (Fetter and Gulden 2005).

The number of countries reliant on nuclear power will increase as well, especially fast-growing countries that currently depend upon fossil fuels to meet much of their energy needs. Whereas countries with current nuclear power programs either already have nuclear weapons, or are industrialized democracies with a strong commitment to non-proliferation, the countries whose future energy needs are growing most rapidly are a more diverse group. Nuclear fission is only effective at reducing carbon emissions if it is brought on line as a substitute for carbon-intensive methods. One reason that Pacala's and Socolow's estimate is lower than others is that they are assuming that all of the new nuclear capacity is offsetting potential generation from coal (which has nearly double the carbon intensity of natural gas).

Population growth, growth in per capita consumption and current patterns of energy generation technology all combine to create a situation where a two- to eightfold expansion of the nuclear industry is likely to slant heavily toward the developing world. Currently, China and India

are dependent on coal and have massive coal resources (IEA 2002). They are expected to increase greatly their use of nuclear fission, and their current coal reliance makes this expansion efficient in terms of reducing global carbon emissions. Nuclear fission may also become attractive for other countries with rapidly growing populations that use little or no nuclear power, including Indonesia and Pakistan. Such a large, rapid and diverse global expansion will heighten concerns about accidents, materials management and secure waste disposal. There will need to be more open international discussions concerning the best practices for handling these problems. In addition, there should be a concerted effort to develop and exchange safer nuclear technologies that can keep the risk of accidents as low as they are today; even with the expected eightfold increase in nuclear power production.

A major increase in nuclear power use will also exacerbate concerns about the proliferation of nuclear weapons. If nuclear power grows substantially, demand for low-enriched uranium will increase and the reprocessing of spent fuel may become necessary or economically attractive. Since bomb-grade plutonium is a major by-product of current reprocessing technology, additional technical and institutional barriers will be needed to prevent, deter or detect theft and diversion. This could include novel reactor concepts such as lifetime cores; new reprocessing techniques that do not involve the separation of pure plutonium; and fuel cycles that minimize the production of high-quality plutonium (for example, the thorium fuel cycle) (Galperin et al. 1997; Kasten 1998; Feiveson 2004).

INTERNATIONAL CONTROL OF NUCLEAR ENERGY

Currently, nuclear safety concerns are handled at the national level, while nuclear proliferation concerns are addressed by the Nuclear Non-Proliferation Treaty (NPT). The NPT was designed in 1970 to prevent the spread of nuclear weapons beyond the five states that already had them when the treaty was negotiated (the USA, Russia, the UK, France and China). This is achieved through a bargain in which the non-nuclear weapon states pledge not to acquire nuclear weapons and to accept International Atomic Energy Agency (IAEA) safeguards on their civilian nuclear programs. The nuclear weapon states promise not to help non-nuclear weapon states proliferate, to share nuclear technology with appropriate safeguards, and to reverse the nuclear arms race. The treaty has been largely successful. Three key states with known nuclear weapons programs (India, Pakistan and Israel) are not signatories to the treaty and

so are not required to have full-scope IAEA safeguards on their civilian nuclear programs. North Korea was accused of violations and withdrew from the treaty in 2003. In 2006 it conducted a nuclear test. Iran has been embroiled in a controversy with the international community over its desire to have uranium enrichment capabilities and its nuclear weapons ambitions.

Currently, the NPT gives non-nuclear weapons states in good standing the right to enrich uranium for civilian reactors and to reprocess spent fuel for reuse under IAEA supervision. Both activities could be misused since the same processes can be used to make weapons-grade uranium or plutonium. NPT member states have devised an IAEA Additional Protocol to improve oversight at declared facilities and to help the IAEA detect clandestine nuclear activity. Compliance with the Additional Protocol is currently voluntary, and there is serious doubt as to whether full adoption of the Additional Protocol could prevent all diversion of weapons material from all nuclear facilities under national control. This is particularly likely to occur if there is a great deal of growth in civilian nuclear power and related fuel processing in non-nuclear weapons states.

Various proposals to strengthen the non-proliferation regime have been put forward (Bush 2004; Wolfsthal 2004), but these proposals suffer from political and/or technical problems. For example, the Bush administration proposed that all NPT members agree to follow the IAEA's Additional Protocol in addition to their current safeguards, and that no new countries be allowed to have their own advanced fuel-cycle capabilities. Because participation in any new obligations related to the NPT is voluntary, the burdens and benefits of additional measures must be equitably shared. Non-nuclear weapons states tend to view any extensions that further restrict their access to nuclear technology, without corresponding new commitments on nuclear disarmament, as unfair and against their national interests – thus making their broad adoption impossible.

The Director General of the IAEA has proposed an alternative approach that would reduce proliferation risks while expanding access to peaceful nuclear technology and creating a more equitable system. The proposal builds on the NPT and IAEA safeguards system while adding several new elements. Notably, it would restrict all processing of weapon-usable materials to facilities under multinational control. In addition, it proposes that all nuclear energy systems should be proliferation-resistant by design, including the accelerated conversion of all highly enriched uranium (HEU) reactors to low-enriched uranium (LEU) reactors. Further, the proposal advocates consideration of multilateral arrangements for the management and disposal of spent fuel and radioactive waste. It stresses the need for all countries to end the production of fissile material for nuclear weapons

and to make further progress on nuclear arms reductions. Incentives for proliferation would be reduced through an inclusive effort to address all countries' security concerns by developing a new collective security system that does not depend on nuclear weapons or deterrence. Once in force, this new framework would be a 'peremptory norm' of international law without a right of withdrawal (El Baradei 2003; IAEA 2005).

The fundamentally international approach to fuel supply proposed by the IAEA Director General would be a real step forward in preventing the diversion or misuse of fissionable material. It would provide strong international assurance to non-nuclear weapons states that they could have reliable access to nuclear fuel and, therefore, would not need to develop a domestic fuel processing or reprocessing capability. This would place the most dangerous part (from a weapons standpoint) of the nuclear cycle under direct international control. The approach would do little to protect against accidents and the diversion of non-bomb grade nuclear material which could be used in a 'dirty bomb'.

A novel approach to integrated international control of the entire fuel cycle involves the centralization of all sensitive nuclear facilities in a few heavily guarded 'energy parks' which would be under international control. Long-life reactor cores could be sealed and exported to faraway users who would plug them into their electrical generation system, operate them for 15–20 years, and then return the sealed core with the spent fuel to a central international repository (Feiveson 2004). There would be a number of difficult technical, institutional and political problems involved in any approach that is so different from current practice. Given the magnitude of the global warming problem, a serious effort should be made not only to assess incremental expansion of existing arrangements but also to think creatively about new reactor designs and novel institutional arrangements that would be proliferation-resistant.

Any major change in the international regulation of atomic energy will require a protocol to the NPT or the adoption of an additional treaty. Since such agreements must be voluntarily adopted, the distributional implications must be considered carefully. Less powerful states will not be inclined to sign on to a treaty that leaves them worse off after signing than they were before. Further, they may not comply fully if they sign under duress (as is evidenced by the withdrawal from the treaty of North Korea). The current nuclear states should recognize that it is in their interest to promote the adoption of such a framework by making it progressive. Unlike most of the impacts of climate change, the increased threat of nuclear weapons proliferation falls at least as heavily on the urban residents of wealthy nations as it does on the rural poor of less developed ones.

CONCLUSIONS

This discussion indicates the fine balance that must be maintained if the world is to address successfully the twin problems of armed conflict and global climate change. Both represent important challenges to future global security that must be confronted. Simultaneously, however, an intensive effort to address either problem in isolation can make the other worse. There is a strong case to be made for global recognition of the interdependence of these issues, and for tackling them together, with complementary measures and approaches.

Environmental scarcities resulting from climate change can drive conflicts as societies strive to adapt. These scarcities are often hardest on the poor and those living traditional lifestyles because they tend to concentrate wealth further and lead to destabilizing resource capture by conflicting elites. Existing studies provide some leverage for thinking about these relationships, but more needs to be done to synthesize the various strands of research on civil conflict and its relationship to environmental scarcity and climate change.

Climate change mitigation strategies also raise security concerns. An abrupt shift away from oil would be extremely destabilizing for petroleum-producing nations, many of which are already marginally stable. A major shift toward biomass as a source of energy could give tropical nations some of the same problems that petroleum-producing states currently suffer. These stem from reliance on a single export commodity, concentrated wealth and hijackable income streams.

While most of the security-related impacts of climate change adaptation and mitigation will fall hardest on the poor in developing nations, the likely need for increased reliance on nuclear fission is a major exception. The most direct threat stemming from a greatly expanded and more widely distributed nuclear industry would be the potential for the illicit development or diversion of bomb-grade fissionable materials by additional states or non-state actors. Nuclear weapons threaten cities – even in wealthy nations. It is therefore in the interest of wealthy nations to take strong steps to place the nuclear fuel cycle under credible international control. It may even be in the interest of developed nations to place the whole of the nuclear power generation system under such control by underwriting international efforts to supply sealed nuclear cores on terms that are sufficiently attractive that non-nuclear nations would be willing to give up the right to independent nuclear programs. This would likely require real concessions on the part of wealthy nations, and security threats associated with free-market development of sufficient nuclear power capacity may justify such an investment.

Understanding the distributional impacts of the security implications of both climate change, and efforts to control climate change, is far from simple. Thus there remains a great deal of work to be done in this area. This chapter has outlined some of the major issues and makes the case that this area is an important one. Our analysis indicates that failure by wealthy nations to consider these security implications is not only unjust but also unwise.

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