SUSTAINABLE DEVELOPMENT

Climate Change and Economic Development

Michael Toman, Barbora Jemelkova, and

Joel Darmstadter

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Resources for the Future
1616 P Street, NW
Washington, D.C. 20036

Telephone: 202–328–5000
Fax: 202–939–3460
Internet: http://www.rff.org

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Climate change continues to be one of the most attention-getting issues in the international environmental arena. Increasingly, it is a topic of debate in development circles as well. There are several reasons why climate change receives such scrutiny.

One is the long-term threat of climate change in developing countries. A concern for sustainable development over the longer term is undercut if flooding, disruption of food and water supplies, and other problems caused by climatic changes destroy the basic conditions needed for development. Alleviating this threat requires both increased capacity for adaptation to climate change in developing countries and mitigation of human-induced climate change through global action to reduce emissions of carbon dioxide (CO_2) and other greenhouse gases (GHGs).

Yet the fact remains that developing countries by and large need to increase their energy use—and therefore their national GHG emissions—as part of the imperative for economic development. Furthermore, developing countries arguably are at greater risk from future climate change; however, most current and historical emissions have come from today's wealthier countries, which arguably are less vulnerable. This complicates the second component of the climate-development nexus, the need for global mitigation.

How are the imperatives for global GHG mitigation and broader economic development to be reconciled? The current debate over responsibility for curbing GHG emissions is at somewhat of an impasse, notwithstanding the negotiation of the 1997 Kyoto Protocol to the 1992 United Nations Framework Convention on Climate Change. And no one yet has a compelling idea for how an international agreement on future GHG emissions would fold in the developing countries while leaving them needed room for economic development.

The third component of the climate-development nexus does emerge from the Kyoto Protocol, which set forth a so-called clean development mechanism (CDM) for promoting both GHG mitigation and sustainable development in poorer countries. The emergence of CDM can be seen as an imperfect but potentially useful initial step for North-South cooperation on climate and sustainable development. But how and how well this mechanism will operate remains to be seen.

The last component, which is often a missing link in the international climate debate, involves focusing on development that is more or less climate friendly. What are the options and challenges for promoting more GHG mitigation through different approaches to development?

In this paper, we consider each of those elements of the climate-development linkage in turn.

The Long-Term Threat of Climate Change in Developing Countries

In its Third Assessment Report, Working Group I of the Intergovernmental Panel on Climate Change (see IPCC in Further Readings) clearly asserted that a human impact on the global climate system could be distinguished from natural climate variability. In particular, rising temperatures and sea levels have been recorded. Many scientists say that impacts on human and natural systems already are noticeable. Any impacts experienced now, though, are minimal compared with what may be coming in the future. Temperatures and sea levels can be expected to rise further, and a host of harmful repercussions may follow, although the exact timing, location, and severity are still difficult to predict.

IPCC Working Group II is concerned with assessing the potential impacts of climate change, which are expected to vary by region. Some regions can anticipate initial benefits, but economies in climate-sensitive parts of the world, such as most of the developing world, are poised for losses.

In tropical regions, for example, severe weather will likely become more of a problem as the patterns of floods, droughts, storms, and precipitation are disrupted. Aquatic, terrestrial, and marine environments, including glaciers and reefs, will suffer, and biodiversity will be threatened. Human health and standards of living will be compromised in many ways by changes in water supplies, forestry, fisheries, flooding, vector-borne disease, and agricultural productivity. The last is particularly worrisome for South Asia, where 24% to 40% of the gross domestic product (GDP) comes from agriculture. Latin America and Africa will experience similar disruptions. Population growth, unregulated resource depletion, and ongoing poverty—features endemic to the developing world—will only exacerbate these impacts.

Although the details of global warming are uncertain, the risk of severe and irreversible impact cannot be ignored. For example, many regions are predicted to experience deteriorating water quality and supply and damage to hydrologic systems in general. Water resource management techniques set up today, such as flood defense mechanisms and improved water collection and distribution infrastructure, can enhance resilience to long-term climate change. Furthermore, regions that face a rise in incidence of infectious diseases can invest in public sanitation and medical facilities now so that the human health repercussions of the future can be coped with more easily.

Such adaptation strategies require adequate wealth, knowledge, technology, skills, and well-functioning infrastructure and institutions—factors that are scarce or lacking altogether in many developing countries. The countries that are more vulnerable to climate change are the least capable of preparing for it on their own with the resources they have today.

The Marrakech Accord from the seventh Conference of Parties (COP7) negotiations in 2001 addressed the need for adaptation assistance in the developing world. Capacity building to improve adaptation has in principle been placed high on the agenda of Annex B (developed) countries, and an adaptation fund has been established. This is a pragmatic approach, since many of the actions prescribed for global warming adaptation simultaneously promote development and alleviate poverty and resource disparity. The extent to which these intentions are successfully implemented is yet to be seen, however.

Energy, Economic Development, and GHG Emissions: Broad Trends

CO_2 releases from fossil fuel combustion are by far the major component of global greenhouse gas emissions; in the United States, the share is around 80%. Tables 1, 2, and 3 provide a broad picture of CO_2 emissions and important associated indicators by major country groupings in 1999. The industrialized countries have a more carbon-intensive GDP than the developing world, but the increase in carbon intensity is less than proportionate with the GDP ratio. Although the developed world has on average a more energy-intensive system than the developing world, it also has a less carbon-intensive energy base (due no doubt in part to the heavy reliance on coal in China and India). As a group, the transitioning economies of the former Soviet Union and Eastern Europe maintain a disproportionately energy-intensive GDP, and this is reflected in a correspondingly high carbon intensity of GDP. In stark contrast to these figures, the data in Table 2 indicate how energy use per capita is strongly related to GDP per capita. This in turn implies much lower CO_2 emissions per capita for the poorer parts of the world.

Table 4 shows historical and projected trends in the various components of total CO_2 emissions for the same country groupings. Growth in CO_2 emissions is the sum of growth in population, GDP per capita, energy per unit of GDP, and CO_2 per unit of energy. During the 1990s, worldwide CO_2 emissions rose only moderately, as the driving forces of population and per capita GDP were almost exactly counterbalanced by the inhibiting factors of both lowered energy intensity and carbon intensity. The latter decline was in part due to the closing of unprofitable coal operations in several European countries. Over the next several decades, the U.S. Energy Information Administration (EIA) sees a fairly sharply rising rate of CO_2 emissions, notwithstanding a continuation of more-than-modest improvements in energy efficiency. Rising CO_2 emissions in EIA's "business-as-usual" forecast are predicated on sharply rising per capita income and a halt, at least for the near term, of the decline in carbon intensity.

EIA, it must be noted, is frequently taken to task for an overly gloomy assessment about the prospects for changes toward a more climate-friendly energy mix; for example, some critics see little justification for the agency's prediction of only a token role for renewable energy sources. The position one takes on this matter revolves less around the question of technical feasibility (solar photovoltaic cells and hydrogen-based fuel cells can generate electricity today) than around the pace at which the cost of such systems can meet the test of a competitive marketplace. Viewed in this light, even a more optimistic scenario would not easily show a constant level of global CO_2 emissions over the next 10 to 20 years, much less a decline. This is a significant message for climate change policy.

The Status of North-South Climate Policy Issues

In the debate over allocating responsibility for longer-term global GHG mitigation, developing countries by and large take the view that they are not the ones historically responsible for emissions accumulation in the atmosphere. Meeting their needs for economic and social progress, moreover, will require growth in total emissions for some time to come (even if the emissions intensity of their economies drops somewhat with changes in the composition of economic activity and progress in reducing energy and carbon intensity). These countries thus interpret the requirement for "common but differentiated responsibility" to mitigate climate change (Article III of the U.N. Framework Convention) as calling for aggressive measures by the richer countries to cut their own emissions and to promote more climate-friendly economic development in poorer countries. At some future date, the argument goes, poorer countries will be able to assume more responsibility for mitigating their own emissions. The Kyoto Protocol in fact explicitly encompasses this perspective by exempting developing countries from legally binding national targets for GHG emissions, though these countries are obliged more generally to track their emissions and pursue more climate-friendly development options (with assistance from richer countries).

That perspective is met with varying mixtures of acceptance and hostility in different parts of the developed world. Even among the staunchest advocates of strong initial action within the richer countries, there is a clear recognition that without long-term constraints on developing countries' emissions, there is no point even trying to mitigate climate change.

Global emissions targets can be loosened, making it easier for developed and developing countries alike to meet them, but at the cost of some hard-to-measure increase in long-term risks from climate change (again, likely to fall disproportionately on developing countries). But for any given long-term global targets for GHG emissions over time, the shares of emissions control between developed and developing countries can vary considerably. The more room is given to develop-

TABLE 1

POPULATION, GDP, ENERGY CONSUMPTION, AND CO2 EMISSIONS, 1999

Country grouping	Population (million)	GDP ($billion)	Energy use (quads)	CO_2 emissions (million metric tons)	CO_2 intensity of GDP (metric tons per $million GDP)
Industrialized nations	942	22,033	210	3,122	142
Eastern Europe, former Soviet Union	413	2,498	50	810	324
Developing countries	4,628	16,202	122	2,158	133
World	5,983	40,733	382	6091	150

Sources and notes: See Table 4.

TABLE 2

PER CAPITA GDP, ENERGY USE, AND CO2 EMISSIONS, 1999

Country grouping	Per capita GDP ($)	Energy use (million Btu)	CO2 emissions (metric tons)
Industrialized nations	23,390	222	3.3
Eastern Europe, former Soviet Union	6,048	122	2.0
Developing countries	3,501	26	0.5
World	6,808	64	1.0

Sources and notes: See Table 4.

TABLE 3

ENERGY AND CARBON INTENSITY, 1999

Country grouping	Energy intensity of GDP (thousand Btu/$GDP)	CO2 intensity of energy use (million metric tons per quad)
Industrialized nations	9.5	14.9
Eastern Europe, former Soviet Union	20.2	16.0
Developing countries	7.5	17.7
World	9.3	16.0

Sources and notes: See Table 4.

ing countries for their emissions to grow, the more developed countries' emissions must be reined in to meet any particular global target. The more developed countries' emissions are reined in, especially over the shorter term, the higher the cost to those countries. These observations thus convert the debate over the environmental integrity of different global approaches to climate change into a debate with a substantial economic component.

The United States, and to some extent other countries in the developed world, have serious concerns about the Kyoto approach. Indeed, the second Bush administration in spring 2001 explicitly repudiated the protocol in part because of concerns about the lack of developing countries' responsibilities for emissions mitigation, as well as because of the cost of the protocol to the United States. But these concerns predate the second Bush administration. The Clinton administration also made clear its reluctance to proceed with Senate ratification of Kyoto, pointing in particular to a Senate resolution (the Byrd-Hagel resolution) that passed 95-0 in summer 1997 and called for more substantial participation by developing countries (see Further Readings). That the principle

TABLE 4

“DE-COMPOSING” THE POPULATION-GDP-ENERGY-CARBON LINK

(AVERAGE ANNUAL PERCENTAGE RATES OF CHANGE)

		1990–1999	1999–2020
POPULATION			
	Industrial	0.6	0.4
	EE/FSU	0.0	0.0
	DC	1.7	1.3
	World	1.4	1.1
GDP PER CAPITA			
	Industrial	1.6	2.2
	EE/FSU	-3.4	4.3
	DC	3.2	3.9
	World	1.3	2.8
ENERGY PER UNIT OF GDP			
	Industrial	-0.6	-1.4
	EE/FSU	-1.1	-2.5
	DC	-1.1	-1.4
	World	-1.7	-1.6
CO_2 PER UNIT OF ENERGY			
	Industrial	-0.6	0.0
	EE/FSU	-1.0	-0.3
	DC	-0.7	-0.1
	World	-0.6	0.1
CO_2			
	Industrial	1.0	1.2
	EE/FSU	-5.4	1.4
	DC	3.1	3.7
	World	0.5	2.3
ADDENDUM:			
ENERGY CONSUMPTION	Industrial	1.6	1.2
	EE/FSU	-4.5	1.7
	DC	3.8	3.8
	World	1.1	2.2

Sources for Tables 1–4: Historical population, energy, and CO2 data and all projections from U.S. Department of Energy, Energy Information Administration, International Energy Outlook 2001 (March 2001), Tables A2, A3, and A16. Historical GDP data from United Nations Development Programme, Human Development Report 2001 (New York and Oxford: Oxford University Press for UNDP, 2001), 181.

Note: “Energy” refers to the sum of the different energy sources, aggregated according to their respective calorific properties. See accompanying text for discussion.

of common but differentiated responsibility was already enshrined in the U.N. Framework Convention, which was ratified by the Senate under the first Bush administration, does not obviate the practical debate about what degree of differentiated responsibility is politically acceptable in the developed or developing worlds.

To some extent it may be possible to finesse this debate by using time itself as a cost-mitigating mechanism. The Kyoto Protocol raised concerns not just because of the degree of asymmetry between developed and developing countries' obligations, but also because the size and rate of emissions control obligations of the developed countries were seen as very costly for at least some countries. Again the United States has voiced the loudest concerns over this issue, but it seems likely that several other developed countries will find it economically unpleasant to reach their Kyoto emissions targets in less than a decade. To mitigate these costs, developed countries that do seek to meet their Kyoto targets may rely significantly on importing surplus emissions from Russia and other areas with economies in transition (including eastern Germany)—a surplus derided by environmentalists as "hot air."

Climate policy analysts have pointed out that long-term targets for the quantity of GHGs in the atmosphere, and thus for the degree of potential climate change, can be met by following different pathways for the rate of emissions per year; and that there may be substantial cost savings from setting modest initial targets for reducing GHGs and then accelerating the reductions over time. The potential cost savings come from several causes, including the ability to turn over longer-lived fixed capital more gradually and the ability to take advantage of progress in reducing the energy and carbon intensity of economic activity. This graduated approach also would mean less energy cost disparity between developed and developing countries, implying less of a threat to industrial competitiveness in the developed countries and less likelihood of emissions "leakage" as energy use shifts from developed to developing countries.

But there are disadvantages to the graduated approach, too. It generates a weaker market signal for the development and diffusion of climate-friendly technology in developed countries and therefore probably slows the evolution of technology of interest to the developing world as well. Moreover, it may exacerbate a problem already built into the asymmetric obligations under the Kyoto Protocol—namely, that a rapid increase in more carbon-intensive development in the poorer countries may make it more difficult for these countries subsequently to go down less carbon-intensive paths. Addressing this problem requires that international climate agreements be slower but also broader and induce, as early as possible, more climate-friendly energy use and economic development in the developing countries without compromising the scale of needed development. With more flexibility over time, the total burden shouldered could be lighter—though the question would remain, Who shoulders what share of the costs?

The debate over burden sharing has lasted more than a decade and shows no sign of abating (see the summary in Cazorla and Toman, in Further Readings). Some environmental advocates and analysts have argued that international responsibility should be distributed as if every individual had a certain right to use of the global biosphere for carbon deposition. Under this approach, the developed world, having experienced such high emissions historically, would have used up its carbon allotment and would have to pay to acquire additional carbon deposition capacity from the developing world, which could use the proceeds of such transactions to pursue climate-friendly development. In short, this scheme would create a global market in GHG emissions permits but with a certain initial allocation of those permits internationally. Additional nuances to proposals along these lines include ideas for phasing in the requirements to mitigate the short-term economic burden on the developed world.

Acceptance of such an approach in practice by the developed world seems problematic, to put it mildly. The size of the income transfers from richer to poorer countries would be huge both in absolute terms and relative to the scale of current international transfers through development assistance. It also raises difficult questions about the ability of developing countries to use the funding to promote sustainable and climate-friendly development: the track record of previous assistance is mixed, and many developing countries face real institutional obstacles to effective use of aid transfers. Moreover, the very nature of international agreements is such that it is difficult to construct meaningful sanctions for nonperformance, leaving developed countries with little recourse if the desired emissions mitigation outcomes in developing countries were not realized over the longer term.

As Wiener points out (see Further Readings), an international market in GHG emissions permits can lower the global cost of achieving global emissions targets with a various allocations of responsibility. Several "graduation" approaches have been suggested for phasing in explicit obligations in the developing world, but at this time, none appear politically compelling: any allocation would have to give developing countries some insurance that they could adhere to the agreement without compromising economic progress. In other words, the allocation would have to build in the very "hot air" reviled by environmentalists while also overcoming substantial political hostility to the costs of international income transfers—even if the net cost of compliance for the United States and other countries was lower with international emissions trading than if only domestic measures had been taken.

One other option that has received some attention among climate policy analysts is a more indirect and implicit assignment of long-term responsibility through the international negotiation of production performance standards. Suppose, for example, that the world agreed on an international limit on the carbon intensity of electricity production that acted in practice to phase out coal in favor of natural gas and renewables. The agreement could be phased in over time, with developed countries acting first. International agreement on automotive fuel economy would be another example.

From a political perspective, the virtue of the production performance approach is that it is less transparent in terms of the size and distribution of costs incurred than a direct international negotiation of national GHG budgets. But it nonetheless seems likely that if the costs were significant, the parties most adversely affected would quickly pierce the veil and come forward with estimates of those costs. Moreover, a patchwork of product and performance standards would be costlier in the aggregate than the potential costs under a well-functioning international emissions market, elusive though the latter may be in practice. The jury is still out on the possibilities for this approach.

The Clean Development Mechanism

In the meantime, the clean development mechanism (CDM) within the Kyoto Protocol is a homely and imperfect approach that nevertheless offers some real possibilities for North-South cooperation on climate change and sustainable development (see Toman in Further Readings for more details). Basically, the CDM is designed to offer those with emissions control obligations—emitters or energy suppliers in developed countries—a chance to offset their emissions with less expensive emissions mitigation activities in developing countries. Since developing countries do not have national GHG targets under Kyoto, the offsets would arise from specific project activities. If it could be shown that emissions were lower than some baseline as a result of some specific investment activity—for example, the development of new renewable power capacity in lieu of a default fossil fuel capacity—then those undertaking the investment could use or trade the resulting certified emissions reductions (CERs).

Among the other operational elements of the CDM established in the international climate negotiations subsequent to Kyoto (in particular, the COP7 negotiations in 2001 in Marrakech), it was agreed that CERs could be unilaterally produced by a host developing country or could result from a joint investment with a developed country partner. This allows developing countries the potential to fully participate in an international market for permits, rather than being limited in what they can do in partnerships with individual foreign investors. CERs also are fully exchangeable with emissions permits resulting from trading systems in the developed world. Moreover, a host country always has the option not to approve a project that it believes is not in its best interest in terms of sustainable development. Finally, CDM projects will in effect be taxed, with a share of CERs going toward additional adaptation assistance for the most vulnerable countries.

Establishing the environmental integrity of project-based activities like the CDM is one of the weakest links in the chain: the baseline is a counterfactual outcome, changes in emissions even under baseline conditions must be factored in, reductions at the project level must be measured and certified, and changes in emissions beyond the project boundaries must be considered. This last problem is most starkly illustrated by an example involving carbon sequestration through reforestation: how does one know that more intensive tree cutting elsewhere did not offset the avoided timber harvesting on one plot? However, various forms of “leakage” can arise in energy projects, too: a project that reduces the carbon intensity of electricity supply but also increases the reliability of supply stimulates electricity demand, or people simply demand more electricity as they grow richer.

The COP7 agreements at Marrakech contain general guidelines that are likely to crowd out some attractive project opportunities in the name of environmental integrity, such as requirements for conservative baselines (e.g., assuming best performance of the default energy technology), limited periods over which projects can earn credits, and sharp limits on the eligibility of carbon sequestration projects. Efforts to increase environmental integrity in the design of specific projects also will increase the costs of designing and implementing such projects, at least initially. These factors will limit not only the scope for CDM projects generally but also the geographical distribution of projects and benefits. In particular, Africa's low energy use per capita implies that CDM energy projects will be small and thus potentially crowded out by significant project development costs; some valuable opportunities for carbon sequestration also may be lost there. Special rules are envisaged for expedited approval of small-scale projects, and there is to be international support for increased capacity to design and implement projects, especially in poorer countries, but the efficacy of these measures remains to be seen.

Despite those drawbacks, the CDM seems like a valuable first step toward enhancing cooperation in GHG mitigation, technology transfer, sustainable development, and maybe even the evolution of international norms for burden sharing over the longer term. One of its biggest practical constraints may have less to do with the nature of the institutional arrangements for operating the

GHG Co-Benefits from Conventional Pollutant Control

Conventional wisdom holds that pollution abatement—for example, the control of sulfur dioxide (SO2) emissions—requires additional energy to operate scrubbers or other equipment, thereby leading to an *increase* in carbon emissions. However, some developing countries have recently begun including in their mix of local pollution control measures bans on uncontrolled coal combustion, particularly in densely populated areas. Although such policies are not yet widespread, they have the potential to significantly reduce both carbon and SO_2 emissions simultaneously.

Taiyuan, a large, industrial Chinese city heavily dependent on coal as a source of primary energy, recently banned uncontrolled coal combustion in certain small boilers as part of its overall SO_2 control strategy. Because the policy was implemented in 2000, it is possible to go beyond the typical *ex ante* calculations and examine its actual, *ex post* operation. In-use SO_2 and carbon reductions were estimated via analysis of individual boilers in a survey designed and conducted by Resources for the Future and the Taiyuan Environmental Protection Bureau.

Overall, large reductions in both SO_2 and carbon followed the decision to ban uncontrolled coal combustion in small boilers in certain classes of establishments in the downtown area of Taiyuan (see Table 5). The size of the estimated reductions depends on assumptions made about the future operation of recently shut-down facilities, and about the incremental emissions from large, centralized facilities used as replacement sources of energy. The researchers concluded that emissions of carbon fell by 50% to 95% as a result of the ban. Although the incremental cost of SO2 abatement through banning uncontrolled coal combustion in small boilers is relatively high, it is less than the value of the policy's additional benefits to human health, even without taking into account health damages from indoor exposure to coal smoke or the possible future economic value of credits from reductions in carbon emissions. These results could have profound implications for carbon reductions in China if conditions in Taiyuan obtain in other cities.

CDM than with the global demand for CERs. The withdrawal of the United States from the Kyoto Protocol reduced demand for carbon offsets, implying a significantly lower price than might otherwise have obtained, and less economic return for the CER-producing countries. The price could be so low that projects are not even worthwhile, though this will not be the case if the low prices prompt Russia to withhold some of its own emissions surplus from the market.

Given the operational and financial uncertainties that attend the CDM, we can next consider another approach from the opposite direction: what might be achieved in mitigating GHG emissions through changes in development policy?

Climate Protection through Development Assistance: Possibilities and Challenges

GHG mitigation policy, at least as traditionally defined, addresses emissions control or sequestration. GHG policies can have positive spillover effects on sustainable development by, for example, improving local environmental and health conditions, or by reducing energy costs and improving productivity. *International* GHG policies like emissions trading and the CDM may have additional spillover benefits by lowering barriers to new information and technology and providing an additional avenue for an inflow of scarce financial capital.

Turning the argument around, one can ask whether there are opportunities within the scope of development policy, more broadly defined, to reduce GHG emissions. The answer is unambiguously yes. Improved energy sector efficiency, either as a direct policy goal or as a by-product of policies to reduce local air pollution, also can reduce GHGs. So can renewable energy development that displaces growth in fossil fuel use, and land protection programs that increase carbon sequestration. Internationally supported development assistance programs can increase leverage by reducing technology and capital barriers. (Before continuing this line of argument, we should note that support for *adaptation* to climate change also can be thought of as a particular kind of development policy with favorable impacts on the risk of climate change, though our focus here is on development policies whose ancillary effects operate through GHG mitigation.)

Having asserted that opportunities exist, we must then turn to the challenges of realizing such an alignment of development and climate priorities. There are several. In many developing countries, climate-friendly development opportunities must compete for scarce funds and institutional capacity with other, non-climate-related priorities. This is the same problem these countries face in taking full advantage of the CDM. But there are more fundamental obstacles as well.

In impacts or costs, the best development policies and programs—best from a particular country's perspective—may not be climate-friendly. Economic development, including energy efficiency investment, can stimulate energy use (so-called rebound effects), especially where energy access has been scarce and development reduces barriers to its availability. In some cases, capital-intensive end-of-pipe pollution control may be the most cost-effective means to improve the local environment, but it increases total energy intensity and GHG emissions. In other cases, fuel and technology switching may generate reductions in both conventional pollutants and CO2 (see box).

Promoting costly renewables may handicap economic development if cheaper options are available. From the standpoint of human health, one of the most powerful development opportunities may be improved access to fossil fuels that are cleaner than improved biomass but emit more GHGs. (Another option is improved stove efficiency and cleaner operation with continued reliance on traditional fuels; see Ezzati and Kammen in Further Readings for more discussion.) Finally, land use practices that maximize commercial yields and ostensibly carbon sequestration, like plantation forestry, may have adverse effects on biodiversity.

TABLE 5

SO_2 AND CARBON EMISSIONS BEFORE AND AFTER BANNING OF UNCONTROLLED COAL COMBUSTION IN SMALL BOILERS IN TAIYUAN (2000–01)

		Emissions before shutdown (tons)		Emissions after shutdown (tons)			
				CASE A		CASE B	
	Boilers	SO_2	Carbon	SO_2	Carbon	SO_2	Carbon
All boilers	268	1916.80	112,336.32	651.13	55,766.42	25.78	5,197.65
Boilers continuing to operate	99	532.20	21,434.70	25.68	5,197.65	25.68	5,197.65
Boilers shut down	98	515.36	20,636.82				
Centralized heating boilers	71	869.25	70,264.80	625.35	50,568.77		

Note: Case A counts SO_2 and carbon emissions of centralized heating as 72% of emissions before the shutdown. Case B counts SO_2 and carbon emissions of centralized heating as zero.

Source: Ex Post Analysis of the Co-Control of SO_2 and CO_2 in the People's Republic of China, by Richard Morgenstern and Alan Krupnick, Resources for the Future, forthcoming.

If climate-friendly development initiatives are not the best development policies from the standpoint of developing countries, then one is back to the question of how much of the burden richer countries are willing to bear—though in this case the burden would be increased development assistance for the costlier but more climate-friendly options. That official development assistance from most developed countries has been stagnant or declining does not bode well. The reasons are many but include donor fatigue with the frequent failure of development initiatives due to weak institutions and corruption in some developing countries..And private sector investment incentives cannot be relied upon, since the private sector has no independent motivation for limiting GHGs in the absence of stronger carbon policies in the developed world and eventually worldwide.

Concluding Remarks

We have almost come full circle in the discussion. There may be opportunities to make development aid more climate-friendly, just as climate change mitigation measures can be made more development-friendly as through the CDM. But neither pathway will generate substantial development or climate protection benefits unless, first, climate policies in the richer countries create a self-interest in development-friendly GHG mitigation activity and climate-friendly development activity; and unless, second, obstacles to implementing more effective climate and development measures are lowered in developing countries through internal policy and institutional reforms that go well beyond energy sector changes. Against this backdrop, international climate negotiations need to advance in a way that promotes greater convergence of interests in participation by the developing countries *and* by the United States.

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Michael Toman and Joel Darmstadter are senior fellows at RFF; Barbora Jemelkova is a RFF research assistant.