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Climate Change, Adaptation, and Development

*Daniel H. Cole**

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I.

INTRODUCTION

The earth has entered a new period of significant climate change. While it has experienced many such periods in the past, this episode is different because there is a connection to human activities – specifically, anthropogenic emissions of greenhouse gases. As a result of the human connection, some scientists are now referring to this new geological period as the “Anthropocene Age.”¹

Since the early 1990s, the international community has been working to mitigate climate change and its effects. Negotiations

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1. See, e.g., ANDREW REVKIN, GLOBAL WARMING: UNDERSTANDING THE FORECAST 55 (1992). The most recent report of the Intergovernmental Panel on Climate Change (IPCC) concludes that anthropogenic emissions of greenhouse gases are “very likely” responsible for “most of the observed increase in globally averaged temperatures since the mid-20th century.” Intergovernmental Panel on Climate Change [hereinafter IPCC], *Climate Change 2007: The Physical Science Basis, Summary for Policymakers, Contribution of Working Group I to the Fourth Assessment on Intergovernmental Panel on Climate Change* 10 (Feb. 2007), available at <http://www.ipcc.ch/SPM2feb07.pdf>.

have focused on reducing levels of greenhouse gases (GHGs) in the atmosphere. That is the sole purpose of the Kyoto Protocol to the Framework Convention on Climate Change,² which calls on developed countries (but not developing countries) to reduce GHG emissions at least five percent below 1990 levels by the year 2012.³ As the international community attempts to implement and enforce Kyoto, it bemoans the U.S.' failure to participate in the Treaty.⁴ Additionally, many climate scientists and social scientists wonder whether Kyoto's targets are sufficient.⁵ Moreover, another vitally important component of the Framework Convention has been largely neglected. That component is adaptation.⁶

This paper argues that greater attention to adaptation is needed because mitigation efforts alone are unlikely to solve the problems of climate change. Even in the unlikely circumstance that a substantially strengthened version of the Kyoto Protocol

2. United Nations Framework Convention on Climate Change, May 9, 1992, S. Treaty Doc. No. 102-38, 1771 U.N.T.S. 107 [hereinafter Framework Convention or FCCC]; Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, 37 I.L.M. 32 (1998) [hereinafter Kyoto, Kyoto Protocol, or Protocol]. The Framework Convention on Climate Change was opened for signature in New York in 1992, and entered into force in 1994. It has been signed and ratified by 189 countries, including the U.S. The Kyoto Protocol to the Convention was opened for signature in Kyoto, Japan in 1997, and entered into force in 2005. As of the end of 2006, it had been ratified by 169 countries, not including the U.S.

3. Kyoto Protocol, *supra* note 2, art. 3.1.

4. See, e.g., CNN.com, *Dismay as U.S. Drops Climate Pact*, Mar. 29, 2001, <http://archives.cnn.com/2001/WORLD/europe/italy/03/29/environment.kyoto/index.html>. The economist William Nordhaus estimates that lack of U.S. participation in the Kyoto Protocol reduces the fraction of global emissions covered by Kyoto by approximately one-third. See William D. Nordhaus, *Life After Kyoto: Alternative Approaches to Global Warming Policies* 24 (Nat'l Bureau of Econ. Research, Working Paper 11889, Dec. 2005), available at http://www.econ.yale.edu/~nordhaus/kyoto_long_2005.pdf.

5. See, e.g., William K. Stevens, *Experts Doubt Rise of Greenhouse Gas Will Be Curtailed*, N.Y. TIMES, Nov. 3, 1997, at A1; CBCNews.com, *Kyoto Protocol Not Enough to Stop Warming*, Nov. 10, 2004, <http://www.cbc.ca/health/story/2004/11/09/ACIA041109.html>.

6. The Framework Convention's use of the terms "mitigation" and "adaptation" is somewhat problematic. "Mitigation" is used to refer to efforts to reduce GHG levels in the atmosphere, so as to minimize the extent of climate change. "Adaptation" is used to refer to efforts to deal with whatever consequences occur. There is, of course, substantial overlap between the two concepts. For example, if rising sea levels due to climate change inundate some low-lying Pacific Island nations, moving the populations to other islands may be the only realistic adaptation option. This would, in a literal sense, mitigate the harm of climate change. But it would not be a mitigation measure as contemplated in the FCCC. Despite potential interpretive problems, this paper will participate in the now conventional usage of "mitigation" and "adaptation."

were fully implemented and enforced, global emissions of GHGs almost certainly will rise at least in the short run, as emissions from developing countries such as China and India are expected to outpace any emissions reductions by developed countries.⁷ Meanwhile, climate change is already occurring,⁸ and its effects are expected to grow more pronounced over the course of this century.⁹ As a consequence, the *costs* of climate change are expected to rise, especially in the less-developed countries (LDCs) of the world's tropical regions.¹⁰ For those countries, adaptation efforts are crucial.

Section I of this paper explains that the costs of climate change will not be distributed uniformly, equitably, or randomly, but will be most pronounced in regions of the world that can least afford to bear them. Section II describes the international community's general approach to adaptation in the Framework Convention on Climate Change and subsequent negotiations. Section III follows Thomas Schelling's¹¹ lead in arguing that the best adaptation policy LDCs can follow is to develop and diversify their economies, and further argues that the world's developed countries should assist them (to the extent feasible) in the process of building "adaptively efficient" institutions.¹²

7. See, e.g., Frank N. Laird, *Just Say No to Greenhouse Gas Emissions Targets*, ISSUES IN SCI. & TECH., Winter 2000, available at <http://www.issues.org/17.2/laird.htm>. China is expected to overtake the U.S. as the world leader in GHG emissions within the next decade. See *Anti-hero*, THE ECONOMIST, Sept. 9, 2006, at 18; Keith Bradsher, *China to Pass U.S. in 2009 in Emissions*, N.Y. TIMES, Nov. 7, 2006, at C1.

8. According to the latest IPCC report, *supra* note 1, at 5, "warming of the climate system is unequivocal, and is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level."

9. The IPCC projects that during the course of the twenty-first century, rising mean global temperatures will bring about the following effects (among others): snow cover will contract, sea ice will shrink, sea levels will rise, and extreme weather events, including droughts and floods, will become more frequent. *Id.* at 16.

10. See, e.g., Richard S.J. Tol, *Why Worry About Climate Change? A Research Agenda*, NOTA DI LAVORO 136.2006 (Nov. 2006); see also Mendelsohn et al., *infra* note 17 and accompanying text.

11. See, e.g., THOMAS C. SCHELLING, STRATEGIES OF COMMITMENT AND OTHER ESSAYS ch. 2 (2006).

12. DOUGLASS C. NORTH, INSTITUTIONS, INSTITUTIONAL CHANGE, AND ECONOMIC PERFORMANCE 80-82 (1990).

II.

THE COSTS OF CLIMATE CHANGE

The costs of climate change are expected to rise during the course of this century, but these costs will not be distributed uniformly or equitably. They will be most severe for the countries that can least afford them – the less-developed countries (LDCs) of the world's tropical regions, where higher mean temperatures and coastal flooding will have costly and potentially catastrophic effects on human life and social welfare.¹³

In relatively rich and well-developed countries like the U.S., which emit the most GHGs, climate change may significantly impact coastal regions and impose other costs amounting perhaps to two or three percent of gross domestic product (GDP).¹⁴ However, climate change will not likely constitute a major threat to the overall economy, our government institutions, or our lives. Our existing government and market institutions are diversified, robust and adaptable; our technological capabilities are superior; and our economic ability to absorb exogenous shocks to the system is well tested. Although we do not always respond well to environmental crises like Hurricane Katrina, our failures are more a matter of political will (in both planning and response) than a lack of resources or incapability of national institutions. As Professor Schelling notes, even if the climate changes significantly, the U.S. will still be able to manufacture automobiles, refine oil, perform open-heart surgery, produce pharmaceuticals,

13. See, e.g., *id.* at 34-35; Tol, *supra* note 10. For introductions to the concepts of adaptation and adaptive capacity, including how the concepts are used in the climate change literature, see generally B. Smit & J. Wandel, *Adaptation, Adaptive Capacity and Vulnerability*, 16 GLOBAL ENVTL. CHANGE 282 (2006); G.W. Yohe & R.S.J. Tol, *Indicators for Social and Economic Coping Capacity – Moving Towards a Working Definition of Adaptive Capacity*, 12 GLOBAL ENVTL. CHANGE 25 (2002).

14. See WILLIAM D. NORDHAUS & JOSEPH BOYER, WARMING THE WORLD: ECONOMIC MODELS OF GLOBAL WARMING 91, Table 4.10 (2000) (estimating that a 2.5°C increase in global mean temperatures would cost European members of the OECD, on average, 2.83% of GDP). For the United States, the economist William Nordhaus, in the early 1990s, estimated that climate change would cost between 0.25% and 1% of annual national income. William D. Nordhaus, *To Slow or Not To Slow: The Economics of the Greenhouse Effect*, 101 ECON. J. 920, 933 (1991). Ten years later, Nordhaus and co-author Joseph Boyer, *supra* this note at 97, conclude that climate change will cost the US economy approximately 0.5% of annual national income. Most recently, Nordhaus, using a different model, has received his cost estimate upward to between 0.9% and 1.7% of annual national income. To put these numbers in some context, the First Persian Gulf War (1990-91) cost the US economy an estimated 1% of annual GDP. See William D. Nordhaus, *The Economic Consequences of a War with Iraq*, in C. KEYSEN ET AL., eds., *War with Iraq: Costs, Consequences, and Alternatives* 51, 55 tbl. 2 (2002).

and do millions of other jobs that are, at least relatively speaking, climate insensitive.¹⁵

The point here is not to downplay the effects of climate change on the American economy. Even if the costs are not destabilizing, they will likely be significant enough to require or justify some amount of adaptation or mitigation. Moreover, the distribution of climate change costs will not be uniform across the country. The expected costs of climate change in Indiana are almost certainly much lower than the expected costs in a state like Florida, where rising sea levels are likely to inundate vast coastal areas.

The effects of climate change in the U.S. are not likely to be nearly as destabilizing as in the world's poorer countries. These countries emit very few GHGs, but they are far more vulnerable to climactic impacts on health, resources, and economic production because they lack diversified economies and "adaptively efficient" institutions. They rely predominantly on agricultural or other resource-based industries like tourism or fishing, all of which are highly climate-sensitive. This is especially true for poor countries in warmer climates, where the marginal effects of additional heating are likely to be greater.¹⁶ Simply put, these countries could not, at present, afford the costs of climate change.¹⁷

III.

ADAPTATION PROVISIONS OF THE FRAMEWORK CONVENTION ON CLIMATE CHANGE

The 1992 Framework Convention on Climate Change (FCCC) acknowledges that adaptation is both necessary and problematic. Several of the Convention's provisions address adaptation. For example, Article IV requires all parties to "cooperate in preparing for adaptation to the impacts of climate change," and obligates developed countries to provide financial and technological assistance to LDCs for purposes of adaptation.¹⁸ The FCCC notes that climate change poses special risks for low-lying coastal

15. SCHELLING, *supra* note 11, at 34.

16. *See* Tol, *supra* note 10.

17. For a quantitative assessment of the distribution of climate change costs between "rich" and "poor" countries, *see* Robert Mendelsohn, Ariel Dinar, & Larry Williams, *The Distributional Impact of Climate Change on Rich and Poor Countries*, 11 ENV'T. & DEV. ECON. 159 (2006).

18. FCCC, *supra* note 2, at Art. IV.

areas, fragile ecosystems, arid and semi-arid regions, and areas that are subject to drought and desertification or prone to natural disasters.¹⁹

Another adaptation provision (Art. III, § 5) calls for broader development assistance as an adaptation strategy: “the parties . . . should promote . . . sustainable economic growth and development in . . . developing country Parties, thus enabling them better to address the problems of climate change.”²⁰

Since the early 1990s, the international community’s attention has focused mainly on mitigation efforts under the Kyoto Protocol. But, there has been some limited progress under the adaptation provisions of the FCCC. In 2001, the FCCC parties agreed to establish three funds: the Special Climate Change Fund, the Least Developed Countries Fund, and the Adaptation Fund. The combined purpose of these funds is to assist developing countries with technology transfers, capacity building, adaptation planning, and other needs. Although some contributions to the funds have been pledged, as of 2004 none of these funds were operational.²¹ Aside from establishing assistance funds, the parties met at Buenos Aires in 2004 to prepare “a program of work on adaptation and response measures,” and announced a decision to promote “capacity-building” in LDC parties.²² Additionally, two other meetings have been held at Tehran and Bonn pursuant to the broader development assistance mandate from Art. III, § 5. These meetings focused on economic diversification in LDCs in recognition of the over-dependence of many LDC economies on sectors that could be negatively affected by climate change, including agriculture, tourism, and fishing.²³ Efforts to diversify LDC economies are consistent both with Doug North’s

19. *Id.*

20. *Id.* at Art. III, §5.

21. THOMAS A. HELLER & P.R. SHUKLA, PEW CENTER ON GLOBAL CLIMATE CHANGE, *BEYOND KYOTO: ADVANCING THE INTERNATIONAL EFFORT AGAINST CLIMATE CHANGE* 111 (DEC. 2003).

22. *See* Buenos Aires Programme of Work on Adaptation and Response Measures, United Nations Framework Convention on Climate Change [hereinafter UNFCC], Decision 1/CP.10, at 2, U.N. Doc. FCCC/CP/2004/10/Add.1 (Dec. 18, 2004), *available at* <http://unfccc.int/resource/docs/cop10/10a01.pdf>; Capacity Building for Developing Countries, UNFCC, Decision 2/CP.10, at 7, U.N. Doc. FCCC/CP/2004/10/Add.1 (Dec. 18, 2004), *available at* <http://unfccc.int/resource/docs/cop10/10a01.pdf>.

23. *See* Implementation of Article 4, Paragraphs 8 and 9, of the Convention, UNFCC Decision 5/CP.7, at 5, *available at* http://unfccc.int/files/cooperation_and_support/ldc/application/pdf/13a01p32.pdf

focus on “adaptive efficiency” for long-run economic growth and Tom Schelling’s call to promote economic development in LDCs for purposes of climate change adaptation. The next section highlights the significance of North’s and Schelling’s work for climate change adaptation.

IV.

DEVELOPING “ADAPTIVE EFFICIENCY” IN LDCS

A. *What the LDCs Should Do*

Professor Schelling has been studying both the science and the social-science of climate change since the mid-1970s. He theorized that LDCs can best assist global efforts to deal with climate change by developing their economies and increasing per capita income.²⁴ In contrast to many of his fellow economists,²⁵ Schelling believes that the Kyoto Protocol rightly imposed GHG mitigation burdens on developed countries instead of the developing countries that will bear the bulk of the effects of climate change. According to Professor Schelling, the LDCs’ best “adaptation” strategy is to develop their economies because the wealthier they become, the greater their capacity to adapt to climate change. The implicit, seemingly inarguable presumption is that per capita income is among the most important indicators of a county’s relative susceptibility or adaptability to climate change.

The problem, of course, is that economic development can be an elusive goal. Certainly, it has eluded many of the world’s LDCs up until now. In large part, this is because they lack the kind of “adaptively efficient” institutions that the economic historian Douglass North claims are necessary for long-run economic growth. In his 1973 book, *The Rise of the Western World: A New Economic History*, North and co-author Robert Paul Thomas noted that long-run economic growth has been the exception, not the rule, in world history. For a wide variety of reasons, ranging from inefficient social norms to interest-group politics and path dependency, most polities have found it exceed-

24. SCHELLING, *supra* note 11, at 35.

25. See, e.g., Joseph E. Aldy, Scott Barrett & Robert Stavins, *Thirteen Plus One: A Comparison of Global Climate Policy Architectures*, Nota di Lavoro 64.2003 (July 2003) (arguing for global participation in GHG mitigation efforts); Sheila M. Olmstead & Robert Stavins, *An International Policy Architecture for the Post-Kyoto Era*, AEI-Brookings Joint Center for Regulatory Studies Related Publication 06-03 (Jan. 2006).

ingly difficult to establish and maintain the kinds of “adaptively efficient” institutions needed to produce long-run growth.²⁶

In his 1990 book, *Institutions, Institutional Change, and Economic Performance*, Professor North defined “adaptive efficiency” according to the following characteristics: (1) an institutional and organizational structure that encourages economic experimentation and innovation; (2) decentralized decision-making processes; (3) rules that encourage the use of tacit knowledge and entrepreneurial habits; and (4) well-specified and consistent “rules of the game,” including legal rules to ensure the reliability of contracts and property rights, efficient bankruptcy laws, transparent rule-making procedures, a fair tax system, and non-corrupt governmental organizations, including courts.²⁷ These are essential ingredients for long-run economic growth in a world subject to random exogenous shocks, including changing environmental conditions. Importantly, they are ingredients that are in short supply among the world’s LDCs and inculcating them is more easily said than done.²⁸

Some exogenous shocks can be of such great magnitude that the quality of institutions would matter little. For instance, should a large asteroid suddenly and unexpectedly strike the earth, no country’s institutional structure would be resilient and robust enough to maintain the well-being of its citizens.²⁹ Social welfare would surely decline, perhaps to zero (denoting the termination of human life on earth). But, most scientists do not expect climate change to be like a large, sudden, and unexpected asteroid strike; they believe that mitigation and adaptation are both possible.³⁰ If they are wrong, and the effects of climate are both inevitable and overwhelming, then there is little point in ar-

26. DOUGLASS C. NORTH & ROBERT PAUL THOMAS, *THE RISE OF THE WESTERN WORLD: A NEW ECONOMIC HISTORY* (1973).

27. NORTH, *supra* note 12, at 81-2.

28. Indeed, in his 1993 Nobel Prize address, North asserted that the development of adaptively efficient institutions has been a long-term, gradual process. “We do not know how to create adaptively efficiency in the short run.” Douglass C. North, *Economic Performance Through Time* (Dec. 9, 1993), http://nobelprize.org/nobel_prizes/economics/laureates/1993/north-lecture.html.

29. Institutions would matter, however, if the asteroid were identified early enough to, say, affect its trajectory to avoid the collision. They would also matter should a smaller asteroid (e.g., one large enough to cause great harm, but not eradicate human existence) strike the earth. See Scott Barrett, *The Problem of Averting Global Catastrophe*, 6 CHI. J. INT’L L. 527, 534-9 (2006).

30. See SCHELLING, *supra* note 11, at 41 (noting that “[c]omprehensive estimates of climate change are invariably gradual”).

guing about what should be done. In this respect, all scientists, scholars, policy analysts and government officials who are participating in climate-change policy debates are, at least relatively speaking, climate optimists.³¹

V.

HOW THE DEVELOPED WORLD CAN HELP

A. *Problems and Prospects of Foreign Aid*

The LDCs are unlikely to be able to develop the kind of adaptively efficient institutions needed to cope with significant climate change on their own. They are going to require assistance from the developed world.

One obvious way the developed world can help reduce adaptation costs for LDCs is by mitigating their GHG emissions. If, by reducing GHG emissions, the parties to the Kyoto Protocol could reduce the extent of expected climate change by one to two degrees Celsius, expected adaptation costs borne predominantly by LDCs could be significantly reduced.³² However, substantial scientific uncertainty persists about relations between GHG levels in the atmosphere, global mean temperatures, and the expected costs of temperature increases in different locations. In other words, it is difficult to estimate how much LDCs might save in adaptation costs over the next fifty to one hundred years from various levels of GHG mitigation by developed countries.

Beyond mitigation, developed countries can more directly assist LDC adaptation efforts by providing funding, technology transfers, and foreign direct investment aimed at either discrete adaptation projects or more general development assistance. As we have seen, the Framework Convention on Climate Change obligates developed country parties to provide this kind of adaptation assistance to developing country parties. But, the FCCC is short on specifics and fails to recognize significant obstacles to adaptation assistance. These are the same obstacles that have af-

31. As R.B. Alley and co-authors have noted, "abrupt climate changes have occurred repeatedly throughout the geological record." R.B. Alley et al., *Abrupt Climate Change*, 299 *SCI.* 2005 (Mar. 28, 2003). And as Scott Barrett (among others) notes, "[a]brupt climate change could precipitate a catastrophe." Aldy, Barrett & Stavins, *supra* note 25, at 546.

32. As Thomas Schelling has written, climate change mitigation by developed countries is in the nature of foreign aid to LDCs, which would be the primary beneficiaries of those mitigation efforts. Thomas C. Schelling, *The Costs of Combating Global Warming: Facing the Tradeoffs*, 76 *FOREIGN AFF.* 8 (1997).

flicted developed country efforts to provide foreign aid (and other forms of development assistance) since the middle of the twentieth century.

While the history of development assistance since the end of World War II is a mixed bag of notable successes and more frequent failures, Tom Schelling has argued in favor of something like a Marshall Plan to assist LDCs with climate change adaptation.³³ Under the Plan, the U.S. provided \$13.2 billion to rebuild the ravaged economies and polities of Europe following World War II.³⁴ The Marshall Plan was not just a matter of funding reconstruction projects, nor was the goal of the Plan simply to stimulate economic growth, as some have argued.³⁵ Rather, the Plan was intended to create modern, representative democracies and “mixed economies” in Western Europe. More specifically, the Marshall Plan promoted institutional structures that would ensure free (but not unregulated) markets, free trade, popular sovereignty, and financial stability. It did so by successfully conditioning funding on structural adjustments and by promoting European economic integration.³⁶

However, the Marshall Plan may not be the best analogy for climate change adaptation efforts. The Plan was limited to a group of countries in a single region of the world that had many shared historical experiences and several formal and informal institutions in common. All had been through the Renaissance, the Reformation, the Industrial Revolution, and two world wars fought on their continent. Despite important differences in language, culture, and traditions, the citizens of England, France, and Germany had what Denzau and North have referred to as “shared mental models” about the world.³⁷ Under the historical

33. See Thomas C. Schelling, *What Makes Greenhouse Sense?*, 81 *FOREIGN AFF.* 2-9 (2002). Schelling cut his teeth as a young economist working on the Marshall Plan, first in Washington and later in the Copenhagen field office and Paris headquarters.

34. See J. BRADFORD DELONG & BARRY EICHENGREEN, *The Marshall Plan: History's Most Successful Structural Adjustment Program*, in *POSTWAR ECONOMIC RECONSTRUCTION AND LESSONS FOR THE EAST TODAY* 189, 196 (R. Dornbusch, W. Nölling, & R. Layard eds., 1991).

35. See ALAN S. MILWARD, *THE RECONSTRUCTION OF WESTERN EUROPE 1945-51* (1984) (noting that the Marshall Plan did not provide enough aid to make much of a difference for European country growth rates).

36. See DELONG & EICHENGREEN, *supra* note 34.

37. Arthur T. Denzau & Douglass C. North, *Shared Mental Models: Ideologies and Institutions*, 47 *KYKLOS* 3 (1994).

and institutional circumstances, the structural adjustments required by the Marshall Plan were incremental, not radical.

Promoting institutional change and economic development has not proven nearly as easy in other parts of the world where cultures, social norms, and mental models are very different from our own. Prompted in part by the success of the Marshall Plan, the U.S. and multinational institutions including the World Bank and International Monetary Fund (IMF) have attempted to promote institutional change through structural adjustment and economic development in many underdeveloped countries of the world. However the success has been limited and the reputation of foreign aid has suffered mightily, as billions of dollars have been wasted on ineffective projects and corrupt regimes in Africa, Latin America, and elsewhere.³⁸ Critics such as Milton Friedman and Peter Bauer have complained that foreign aid has “enlarged government bureaucracies, perpetuated bad governments, enriched the elite in poor countries, or just been wasted.”³⁹ Their claims are supported by a good deal of empirical evidence, including evidence that “conditionality” – requiring reforms as a precondition for receiving aid – often does not work because of donee resistance to reforms and donor reluctance to cut off aid.⁴⁰ Despite receiving millions of dollars in foreign aid, per capita income in African countries has actually declined.⁴¹

Not all foreign aid has been wasted, however. As Nicholas Kristof points out, “many of the people you meet in any African village are alive because of foreign aid.”⁴² Steven Radelet notes

38. See generally WILLIAM EASTERLY, *THE WHITE MAN’S BURDEN: WHY THE WEST’S EFFORTS TO AID THE REST HAVE DONE SO MUCH ILL AND SO LITTLE GOOD* (2006).

39. Steven Radelet, *A Primer on Foreign Aid* (Center for Global Development, Working Paper No. 92, 2006). See PETER BAUER, *DISSENT ON DEVELOPMENT: STUDIES AND DEBATES IN DEVELOPMENT ECONOMICS* (1971); MILTON FRIEDMAN, *Foreign Economic Aid: Means and Objectives*, in *ESSAYS IN PUBLIC POLICY*, vol. 60 (Hoover Institution, 1995).

40. See, e.g., EASTERLY, *supra* note 38; Radelet, *supra* note 39, at 13.

41. See EASTERLY, *supra* note 38, at 46 fig. 2. This is not to say that foreign aid actually caused the decline in per capita income, although some observers argue that aid programs are more likely to obstruct than promote development. See, e.g., Peter Bauer & Basil Yamey, *Again Foreign Aid*, *Econ. Notes* No. 23 (1989), available at <http://www.libertarian.co.uk/lapubs/econn/econn023.pdf>. David Osterfeld, *The Failures and Fallacies of Foreign Aid*, 40 *THE FREEMAN* (Feb. 1990), available at <http://www.fee.org/publications/the-freeman/article.asp?aid=560> (claiming that foreign aid has led to the “pauperization” in developing countries).

42. Nicholas Kristof, *Aid: Can it Work?*, 53 *N.Y. REV. BOOKS* (Oct. 5, 2006) (reviewing WILLIAM EASTERLY, *THE WHITE MAN’S BURDEN: WHY THE WEST’S EFFORTS TO AID THE REST HAVE DONE SO MUCH ILL AND SO LITTLE GOOD* (2006)).

that most empirical studies of the effects of foreign aid since 1990 have found positive correlations with public health and economic growth.⁴³ William Easterly agrees that “foreign aid likely contributed to . . . dramatic improvements in health and education indicators in poor countries.” Indeed, Easterly confirms, during the last four decades, life expectancy in the “typical poor country” has risen by twenty years, infant mortality has declined from 131 per 1,000 babies to only 36 per 1,000 babies, and the percentage of children enrolled in primary school rose from 65 to 100.⁴⁴ Despite being a staunch critic of traditional forms of foreign aid, Easterly would not end all such aid, but would instead “put the focus back where it belongs: get the poorest people of the world such obvious goods as the vaccines, the antibiotics, the food supplements, the improved seeds, the fertilizer, the roads, the boreholes, the water pipes, the textbooks, and the nurses.”⁴⁵

Foreign aid programs can achieve remarkable success in very short periods of time if they are well-conceived and targeted, as suggested by Easterly. Most recently, a vaccination campaign spearheaded by the American Red Cross, the U.S. Centers for Disease Control and Prevention, the United Nations Foundation, and the United Nations Children’s Fund (UNICEF), cut the measles rate in Africa by 75 percent in just six years.⁴⁶ Such aid efforts may or may not directly relate to climate change adaptation. Warmer mean temperatures are expected to increase the global incidence of malaria, among other vector-borne diseases. Therefore, foreign aid targeted at reducing the rate of malaria infection and successfully treating the disease bears a direct connection to climate change. Other forms of foreign assistance, such as micro-credit - small, uncollateralized loans for small business enterprises - would have no direct bearing on climate change adaptation, but might help to *offset* some of the expected costs of climate change by raising living standards.⁴⁷

43. Radelet, *supra* note 39, at 15-16.

44. EASTERLY, *supra* note 38, at 176.

45. *Id.* at 368-69. For more on foreign aid successes, *see, e.g.*, RUTH LEVINE ET AL., *Millions Saved: Proven Successes in Global Health* (2004); JEFFREY D. SACHS, *THE END OF POVERTY: ECONOMIC POSSIBILITIES OF OUR TIME* (2006).

46. *See* <http://www.measlesinitiative.org/index3.asp>; Margaret Chan, *Defeating Measles*, INT’L HERALD TRIB., Jan. 18, 2007, at 7.

47. *See* SCHELLING, *supra* note 11, at 36 (noting how assistance aimed at improving public health in developing countries “can significantly offset the adverse effects of climate change”).

Another issue is whether foreign aid can happen quickly enough to generate the kinds of institutional developments that increase adaptive efficiency. According to Schelling's estimates,⁴⁸ the effects of climate change will become significant over the next fifty to seventy-five years. This seems precious little time in which to cultivate diversified, robust, and resilient market and government institutions in countries that have never had them before. Consider, for example, the plight of millions of Bangladeshis currently employed in subsistence agriculture on low-lying lands along the Bay of Bengal, which will likely be inundated before the end of this century.⁴⁹ According to a report by the Organization for Economic Cooperation and Development (OECD), a one meter rise in sea level would inundate 18 percent of Bangladesh's total land area, and displace 11 percent of its population (about thirteen million people). Creating alternative employment opportunities within a few short decades for those millions in Dhaka and other cities, which sit on higher ground, will be no easy feat. As noted earlier,⁵⁰ Professor North believes that we do not yet know how to introduce adaptively efficient institutions in the short run. That may be true, but we have had at least some success in promoting adaptive efficiency changes in the past.

The Marshall Plan achieved important structural adjustments in Western European economies within a single generation. Since then, several countries, including Singapore and Korea, achieved first-world economic status within a few decades (and without much in the way of direct foreign aid). Today, given the expected costs of climate change, LDCs should at least have some incentive to make whatever structural adjustments are necessary for successful adaptation.⁵¹ Development assistance that

48. *Id.* at 33 ("Climate change may become serious, if little or nothing is done about it, in the second half of this century and, even if substantial mitigating efforts are undertaken, toward the end of the century.").

49. Shardul Agrawala et al., Organization for Economic Co-operation and Development, *Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sundarbans*, Environment Directorate and Development Co-operation Directorate (2003), available at <http://www.oecd.org/dataoecd/46/55/21055658.pdf>.

50. See North, *supra* note 28.

51. HELLER & SHUKLA, *supra* note 21, at 119, caution that "[e]ven though the threat of climate-induced damage is most severe in developing nations, political actors concentrate on immediate issues like local air and water pollution that may help them claim public resources and satisfy popular expectations, rather than on long-term, invisible concerns like climate change." That might be true, but it could also be true that reducing local air and water pollution would enhance social welfare more than specific climate change-related projects. After all, we would not expect

is appropriately targeted, tailored, and conditional might work – subject, of course, to persistent obstacles such as inefficient social norms and institutional path dependencies. This is not to say that all of the world’s economies are likely to attain first-world status by the end of the present century, but something clearly needs to be done to help LDCs adapt to climate change and there have been *some* development success stories to give us hope that adaptation assistance has the potential to be truly helpful.

The final and perhaps easiest issue for climate change adaptation assistance is how to pay for it. The obvious solution is to impose a tax on either the carbon content of inputs or on emissions. The revenues generated by such a tax could be devoted to international aid efforts to assist developing country efforts to create adaptively efficient market and government institutions. However, taxes are politically unpopular in many countries, including the U.S. Moreover, introducing a scheme of emissions taxes would require a major shift away from tradeable permitting, which has been the mitigation instrument of choice under the Kyoto Protocol.

During the negotiations that resulted in the Kyoto Protocol, the U.S. pushed for tradeable permitting based on its successful experiment with that tool in the acid rain program of the 1990 Clean Air Act Amendments.⁵² The chief virtue of tradeable permitting (as opposed to traditional, non-tradeable quotas) is that it minimizes compliance costs for industry. And, in contrast to tax-based approaches to pollution control, tradeable permitting is not politically unpopular. On the contrary, it is currently the *en vogue* solution for many environmental problems.⁵³

Nevertheless, several prominent economists, including William Nordhaus, have long advocated carbon taxes as the best overall

future damage from climate change damage to figure prominently in the welfare functions of thousands (or millions) of individuals threatened by dysentery from unsanitary water supplies. On one point, however, Heller and Shukla are undeniably correct: “Climate-related policies . . . are most likely to draw political support within developing countries when they piggyback on and enhance more salient development priorities.” *Id.* at 126.

52. 42 U.S.C. § 7651 (1990). See, e.g., A. DENNY ELLERMAN ET AL., *MARKETS FOR CLEAN AIR: THE U.S. ACID RAIN PROGRAM* (2001); DANIEL H. COLE, *POLLUTION & PROPERTY: COMPARING OWNERSHIP INSTITUTIONS FOR ENVIRONMENTAL PROTECTION* 51-57 (2002).

53. On the proliferation of tradable permitting programs since 1990, see *id.* at 57-59.

approach to mitigating GHG emissions.⁵⁴ Emissions taxes have various advantages over tradeable permits including the prospect of a “double dividend.”⁵⁵ The taxes would create incentives for pollution sources to reduce emissions *and* provide revenues that governments could then invest in climate change mitigation and adaptation projects.⁵⁶ In addition, by increasing the cost of using conventional carbon-based technologies, such as gasoline, a carbon tax would increase incentives for innovating cleaner substitute fuels.⁵⁷

B. *Technological Innovation and Transfer*

Another way the developed world might help reduce or offset climate change adaptation costs in LDCs is by innovating and transferring new mitigation and adaptation technologies. There is every reason to expect that technological innovations will emerge over the next several decades that will reduce the costs of mitigation and adaptation. Professor Schelling notes that seventy-five years ago, “we didn’t have nuclear energy, antibiotics, genetics, satellites or even plastics.”⁵⁸ What technological marvels do the next seventy-five years hold in store? It is worth noting that we have only considered climate change as a *potential* problem for the last thirty years and we have just begun the search for solutions.⁵⁹

One potentially useful technological innovation to ameliorate climate change is coal gasification, which can make the energy produced from coal virtually carbon-free. This is not a fanciful

54. Nordhaus, *supra* note 4. See also William A. Pizer, *Choosing Price or Quantity Controls for Greenhouse Gases*, in THE RFF GUIDE TO CLIMATE CHANGE ECONOMICS AND POLICY 46 (2003).

55. Michael Porter, *America’s Green Strategy*, 264 SCI. AMER. 96 (1991)

56. Because a carbon tax would be regressive – the tax would fall most heavily on poorer individuals – at least some of the revenues from a carbon tax should replace or provide credits for existing taxes (e.g., on income).

57. See, e.g., RUUD A. DE MOOIJ, ENVIRONMENTAL TAXATION AND THE DOUBLE DIVIDEND (2000); Ian W.H. Parry & Antonio M. Bento, *Tax Deductions, Environmental Policy, and the “Double Dividend” Hypothesis* (World Bank Policy Research, Working Paper No. 2119, 1999); CRAIG HANSON & DAVID SANDALOW, GREENING THE TAX CODE (2006); David Pearce, *The Role of Carbon Taxes in Adjusting to Global Warming*, 101 ECON. J. 938 (1991).

58. SCHELLING, *supra* note 11, at 46.

59. Those solutions will certainly include “geo-engineering,” a term with ominous connotations, but which denotes uncontroversial measures, such as afforestation to absorb more carbon dioxide, as well as more controversial (potential) measures such as introducing more aerosols in the upper atmosphere to reflect more sunlight. See, e.g., SCHELLING, *supra* note 11, ch. 3.

new process; the technology has been around since the first half of the twentieth century. The coal is converted to gas by heating it with oxygen to over 2,000 degrees Fahrenheit in a pressurized chamber. After the coal has been gasified, carbon dioxide, as well as hazardous pollutants like mercury, is relatively easy to separate and remove. Unfortunately, the technology is not yet cost-effective. At current prices, building an “integrated gasification combined cycle” power plant is estimated to cost ten to twenty percent more than a conventional coal-fired power plant, not including costs of sequestering carbon removed from the coal.⁶⁰ Moreover, carbon sequestration technologies are still unproven.⁶¹ With further technological refinements or changes in the relative prices of other energy sources,⁶² gasified coal could become a cost-effective alternative fuel source.

Although nothing guarantees that favorable technological refinements will occur, innovation is not purely serendipitous. Given a proper structure of incentives for innovators (e.g., intellectual property rights that allow them to internalize a sufficient amount of the benefits from innovation), there is no particular reason to believe that favorable, cost-reducing technological innovations will not occur. If not coal gasification, then perhaps fuel cells, fusion reaction, or some other breakthrough.⁶³

If and when technological changes arrive, diffusion can be rapid. Jeremy Rifkin notes that the first gasoline station opened in Detroit in 1911 and, only nineteen years later, the U.S. had more than twenty-one million cars.⁶⁴ Importantly, the U.S. has institutional structures and a commercial culture to facilitate the rapid development and diffusion of new technologies. Other cul-

60. See, e.g., Christopher Swope, *Coal Converts*, GOVERNING (Apr. 2006), available at <http://www.governing.com/articles/4coal.htm>.

61. China, which happens to be among the world leaders in coal gasification technology, has been experimenting with “in situ” gasification, where the coal is gasified while still underground, presumably solving the sequestration problem. Then the biggest problem is to capture and store the gas fuel produced. Peter Fairley, *Part I: China's Coal Future*, TECH. REV., Jan. 4, 2007, available at <http://www.technologyreview.com/Energy/17963/>.

62. One obvious way to encourage efforts to innovate new, cleaner energy technologies is to make existing, dirtier energy sources more expensive to use, e.g., by imposing Pigouvian taxes. The single greatest impediment to technological change in the energy section may be the relatively low prices of oil and coal.

63. See Scott Barrett, *Climate Treaties and “Breakthrough” Technologies*, 96 AM. ECON. REV. 22 (2006) (discussing the role of technological innovation in climate change).

64. JEREMY RIFKIN, *THE HYDROGEN ECONOMY: THE CREATION OF THE WORLD-WIDE ENERGY WEB AND THE REDISTRIBUTION OF POWER ON EARTH* 72 (2002).

tures and institution sets may not be so innovation-friendly. For example, before the fall of the communism in Europe, the socialist economies of Eastern Europe produced far fewer technological innovations, and were far slower to adopt efficiency-enhancing innovations than the market-based economies of Western Europe.⁶⁵ It can be a struggle to get even generally available technologies to all the places where they may be needed. That struggle is often exacerbated by adaptively *inefficient* institutions.

VI. CONCLUSION

Finally, there is reason for both optimism and pessimism about climate change in the twenty-first century. The bad news begins, of course, with the brute fact of climate change and the social costs it will likely entail. Those costs are already being felt, and they will multiply during the course of this century. Meanwhile, the near-term prospect for meaningful action on climate change appears bleak. The parties to the Framework Convention on Climate Change and the Kyoto Protocol seem far more interested in minimizing regulatory compliance costs for regulated industries than in actually reducing carbon emissions or assisting LDCs with the consequences of climate change. If the LDCs do not soon begin paying more attention to the issue of adaptation, those consequences could be severe.

The best climate change policy for the LDCs is to raise their per capita income by diversifying their economies and building more adaptively efficient institutions. As they grow wealthier, their capacity to adapt to the effects of climate change will increase. However, there is no certain formula for increasing per capita income and inculcating adaptively efficient institutions in LDCs. For many, if not most, of the countries, the process will require substantial international assistance, which so far has not been forthcoming.

To end on a more optimistic note, developed countries certainly have the *capability* to both mitigate a significant percentage of their GHG emissions at reasonably low cost and assist LDCs with adapting to changing environmental circumstances by

65. See JÁNOS KORNAI, THE SOCIALIST SYSTEM: THE POLITICAL ECONOMY OF COMMUNISM 292-301 (1992) (regarding the relative technological backwardness of countries with socialist economies).

funding discrete adaptation projects and broader economic development projects.

Mitigation cost estimates vary widely. Some analysts conclude that full compliance with the Kyoto Protocol would generate net social losses.⁶⁶ Others estimate that costs vary by more than an order of magnitude because of large uncertainties concerning the effects of climate change. For example, Christopher MacCracken and co-authors find that the cost of mitigating one ton of carbon may be as low as \$26 or as high as \$250.⁶⁷ However, the costs of reducing GHG emissions may well be exaggerated. *Ex post* analyses of regulatory costs reveal that *ex ante* cost estimates often are inflated.⁶⁸ Regulated industries have political incentives to exaggerate *ex ante* cost estimates as a strategy for fighting proposed regulations. Even where good faith efforts are made to provide accurate cost estimates, those estimates often prove too high because, once regulations are in place, regulated industries have incentives to minimize compliance costs through technological innovations, materials substitution, or process changes.

For evidence of how carbon mitigation can be accomplished at reasonable cost, or even at a net benefit, consider the experience of British Petroleum (BP), which managed to reduce its emissions ten percent below 1990 levels in a very short period of time merely by eliminating leaks and other sources of waste. Those emissions reductions were obtained at a net cost of zero. In fact, according to BP's former Chief Executive, Lord Browne, the waste reductions increased shareholder value by about \$650 million.⁶⁹

Arguably, mitigation is a simpler, more manageable proposition for developed countries than aiding adaptation efforts in LDCs. As we have seen, foreign aid is no panacea. There will be resources wasted and some countries will simply refuse to be

66. See, e.g., William D. Nordhaus & Joseph G. Boyer, *Requiem for Kyoto: An Economic Analysis of the Kyoto Protocol*, ENERGY J. (SPECIAL ISSUE) 131 (1999).

67. Christopher N. MacCracken et al., *The Economics of the Kyoto Protocol*, ENERGY J. (SPECIAL ISSUE) 73 (1999). See also Carolyn Fischer & Richard D. Morgenstern, *Carbon Abatement Costs: Why the Wide Range of Estimates?* (Resources for the Future, Discussion Paper No. 03-42, 2003).

68. See Winston Harrington, Richard D. Morgenstern, & Peter Nelson, *On the Accuracy of Regulatory Cost Estimates* (Resources for the Future, Discussion Paper No. 99-18, 1999).

69. See John Browne, *Beyond Kyoto*, 83 FOREIGN AFF. 20 (July/Aug. 2004), available at <http://www.foreignaffairs.org/20040701faessay83404/john-browne/beyond-kyoto.html>.

helped. But, carefully targeted, tailored, and conditioned foreign aid will enable at least some LDCs to improve living standards, thereby offsetting some of the costs of climate change. We may also hope for limited improvements to overall adaptive efficiency in *some* LDC economies. At this point, that may be the most for which we can reasonably hope.