Climate Change and Developing Countries

Dr. Ambuj Sagar
John F. Kennedy School of Government
Harvard University

In recent years, climate change has received significant and increasing attention, in terms of, both, its possible impacts on humans, ecosystems, and economies, and the scale of efforts that will be needed to tackle and mitigate this problem. Climate change is driven by the accumulation in the Earth's atmosphere of heat trapping ("greenhouse") gases (GHG) resulting from anthropogenic activities. Carbon dioxide (CO_2), mostly the product of the combustion of fossil fuels for energy use, is the single largest contributor to the problem, accounting for about 60% of the direct radiative forcing of all greenhouse gases. [i] Thus, the climate issue is intimately linked to the energy sector.

The most recent data indicates that CO2 levels in the atmosphere now exceed 380 parts per million by volume (ppmv), a significant rise from the pre-industrial concentration of about 280 ppmv (and other greenhouse gases have also shown significant rise in atmospheric concentrations). Over the last century, global mean surface temperatures have risen by about 0.8 °C, with the two hottest years on record, 1998 and 2005, having come in the last decade. [ii] At the same time, manifestations of a warming planet and changing climate have become more apparent -- for example, the reduction of snow cover and ice in the northern latitudes and changes in precipitation patterns.

Scenarios developed by the International Panel on Climate Change (IPCC) indicate that global mean surface temperatures will increase anywhere between 1.4 to 5.8^{o}C over the 21st century. [iii] This will be accompanied by an estimated sea-level rise of about 0.1 to 0.9 meters, increased variances in temperature and precipitation patterns, further reductions in snow cover as well as polar and sea-ice in the Northern hemisphere. [iv] At the same time, there are likely to be significant changes in extreme climate and weather events (see Table 1). There is also the potential for large-scale and possibly irreversible changes such as a slowdown of the North Atlantic thermohaline current, reductions in (or collapse of) the Greenland and West Antarctic Ice sheets, and release of carbon from permafrost regions. [v]

Table 1 Some possible changes in extreme weather and climate events over 21st century and confidence in projections

Changes in extreme weather and climate events	*Confidence in projected changes (during the 21st century)*
Higher maximum temperatures and more hot days over nearly all land areas	Very likely
Higher minimum temperatures, fewer cold days and frost days over nearly all land areas	Very likely
Reduced diurnal temperature range over	Very likely

most land areas	
Increase of heat index over land areas	Very likely, over most areas
More intense precipitation events	Very likely, over many areas
Increased summer continental drying and associated risk of drought	Likely, over most mid-latitude continental interiors. (Lack of consistent projections in other areas)
Increase in tropical cyclone peak wind intensities	Likely, over some areas
Increase in tropical cyclone mean and peak precipitation intensities	Likely, over some areas

Source: IPCC, *Summary for Policymakers: A Report of Working Group I of the Intergovernmental Panel on Climate Change* (2001).

Such changes in the climate could have enormous human, ecological, and economic impacts. For example, more intense rainfall could lead to floods and landslides and also contribute to greater erosion. Rise in mean temperatures could change disease patterns and affect agricultural productivity. More frequent and intense coastal storms could cause enormous damage to human settlements, coastal ecosystems, and result in loss of life.

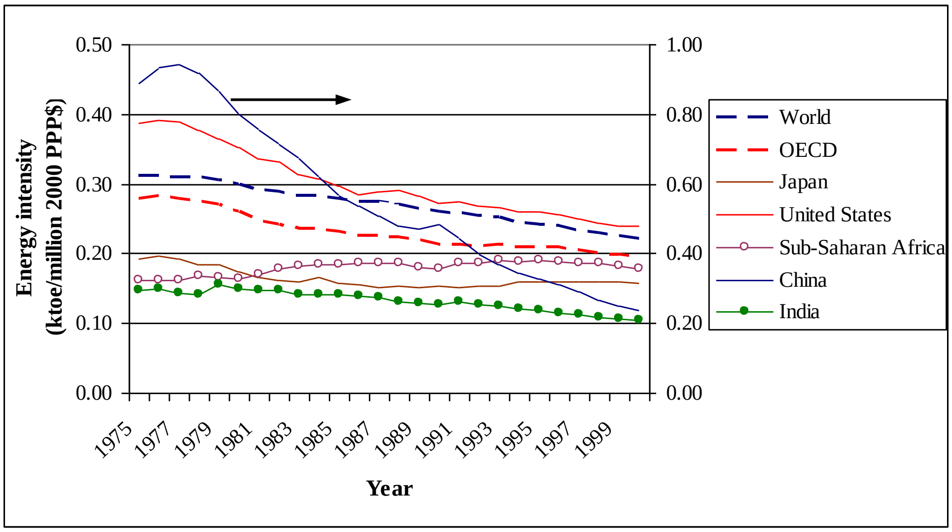
A particularly important aspect of a changing climate is the geographic variability of the impacts. Northern latitudes, for example, have seen an increase in precipitation over the last century while many tropical areas, especially in Africa, have seen significant decreases. [vi] Thus different countries (or areas within countries) will see different kinds of changes, and even for a particular category of change, different areas will see different magnitudes of changes.

Developing countries may experience particularly problematic changes (such as reduced precipitation that could lead to droughts). At the same time, humans and natural systems in these countries are often already weak or under stress. This combined with a lack of adaptive capacity to respond proactively to reduce the potential for impacts or reactively to limit the damages from any specific events leads to significant vulnerability to climate change. As the IPCC states, "the impacts of climate change will fall disproportionately upon developing countries and the poor persons within all countries…. Populations in developing countries are generally exposed to relatively high risks of adverse impacts from climate change. In addition, poverty and other factors create conditions of low adaptive capacity in most developing countries." [vii] The role of scientific research in understanding the global climate system, how it might respond to increased GHG concentrations, and what of kind climate impacts might ensue cannot be understated. Such understanding is critical to try and understand what kind of adpatation activities should be undertaken.

At the same time, there is also an increasing recognition of the need to stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." [viii] Given that the emissions from the combustion of fossil fuels (mostly from the energy sector) are a major contributor to climate change and that fossil fuels account for almost 80% of the global energy supply, stabilizing GHG concentrations will require a significant reorientation of energy systems.

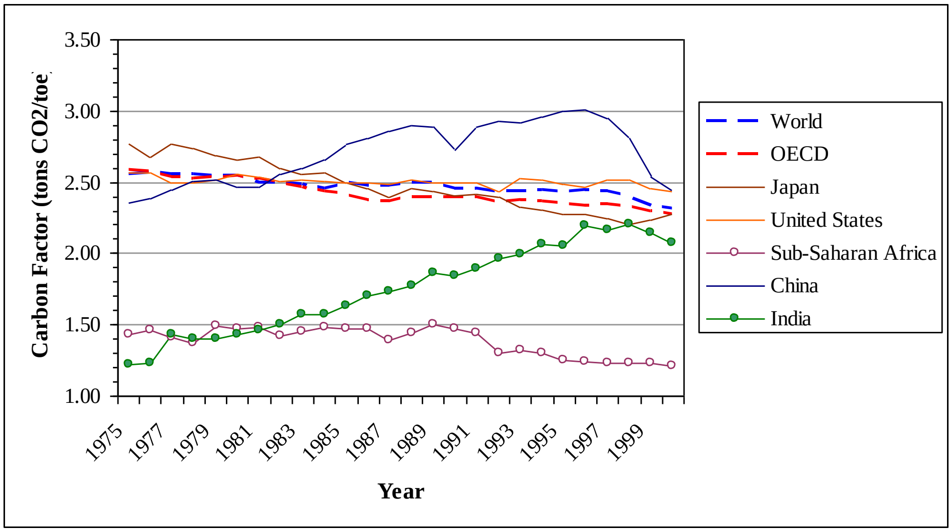
There has already been a decline in the energy intensity (i.e., energy use per unit GDP) worldwide, although with significant differences among countries (as illustrated in Figure 1a). While energy intensity worldwide has declined at over 1.3% per year over the last three decades (with the oil crises of the 1970s being a major driver of the enhancement of the rates of these declines), [ix] the carbon factor (i.e., carbon emissions per unit energy used) has declined by only 0.4% per year over the same period (Figure 1b). [x]

Figure 1a: Energy-intensity trends for key countries/groups, 1975-2000



Source: World Bank, *World Development Indicators*.

Figure 1b: Carbon-factor trends for key countries/groups, 1975-2000



Source: World Bank, *World Development Indicators*.

Meeting the challenge of stabilizing greenhouse gas levels in the atmosphere at levels commensurate with the goals of the United Nations Framework Convention on Climate Change (UNFCCC) will require accelerated improvements in the energy system. For example, it has been estimated that even if global energy intensity of GDP declined at 2 percent per year over the next century, stabilizing CO_2 levels at 550 ppmv (the most discussed number since it corresponds to a rough doubling from the pre-industrial concentration) would still require a 3-fold increase in carbon-free energy supply by 2100. [xi]

GHG mitigation will require the implementation of a range of technologies and practices (e.g., more efficient conversion and use of energy, low GHG-emitting technologies, carbon capture and storage, and improvements in land use, land-use change, and forestry practices), many of which currently exist. In fact it has been pointed out that appropriate use of currently available technologies could realize sufficient gains over the next half century to limit the global emissions trajectory consistent with the goal of avoiding the doubling of pre-industrial concentrations of carbon. [xii]

But the implementation of new, improved, or existing technologies with a lower climate impact is limited by a number of barriers: economic, political, technical, institutional, financial, behavioral, etc. The economics of GHG mitigation are clearly the dominating issue, given that the costs of meeting the appropriate stabilization targets may be substantial (with the exact cost depending on the specific pathway): reaching a stabilization target of 550 ppmv is estimated to be between 100 and 800 trillion dollars over the next century (1990US$, present value discounted at 5% p.a. from 1990-2100); reaching a tighter stabilization target of 450 ppmv, which many are suggesting will be the level required to avoid dangerous climate change, could cost between 350 and 1,750 trillion dollars). [xiii]

These barriers could be overcome by a range of actions: R&D to lower costs of low-climate-impact technologies and make them more competitive with existing options;

the development of suitable policies or incentives for adoption that could help lower costs through technological learning; availability of financing options to make these technologies more accessible to consumers; overcoming institutional barriers such as technology lock-in; efforts to change consumer attitudes and behavior towards the use of energy require technologies; and appropriate political support for such activities. [[xiv]] Realizing the potential of technological options generally requires a number of actions and policies to be undertaken in concert, which is non-trivial in practice. Also, while much attention is paid to implementation of new technologies and systems, modification of consumer attitudes and behavior that guide their energy-use patterns has not received as much attention despite its importance. For example, GHG emissions from transport derive from the vehicle technologies in use as well as the total vehicle-miles traveled. In the arena of passenger cars (whose use dominates the GHG emission from transport), technological improvements have been directed towards improving the performance of vehicles rather than their fuel efficiency, and at the same time the number of vehicle-miles traveled has continued to increase, leading to continued increases in fuel consumption and concomitantly GHG emissions in this sector.

Unfortunately, for developing countries, the GHG-mitigation challenge comes at a time when there are already other more pressing challenges facing the energy sector. At the same time, a climate-based reorientation of the energy sector would require new technologies (such as those for clean-coal-based power generation, carbon capture and storage, and other non-GHG-emitting options such as solar photovoltaic) that will mostly be developed in the industrialized countries, since developing countries do not have the appropriate technological capabilities to do so. Transfer of technologies from industrialized countries to developing countries also has to contend with issues such as poor adaptation, higher costs, and further marginalization of indigenous technology development.

Thus, even as the challenges posed by climate change are daunting, S&T can indeed play a role in helping us meet them through better elucidation of the economic, social, and human impacts that might result from a changing climate and through the development and deployment of technologies that could help mitigate the build-up of GHGs in the atmosphere. But in the end, while S&T can help tackle climate change, it must also be understood that there are no simple fixes to this problem. Real progress on climate change will likely be impossible without concomitant progress on sustainable development. But that’s the discussion for another time...

[[i]] Intergovernmental Panel on Climate Change (IPCC), *Summary for Policymakers: A Report of Working Group I of the Intergovernmental Panel on Climate Change* (2001).

[[ii]] See http://data.giss.nasa.gov/gistemp/2005/.

[[iii]] Intergovernmental Panel on Climate Change (IPCC), *Summary for Policymakers: A Report of Working Group I of the Intergovernmental Panel on Climate Change* (2001).

[iv] *Ibid*.

[v] IPCC, *Summary for Policymakers: A Report of Working Group II of the Intergovernmental Panel on Climate Change* (2001).

[vi] *Ibid.*

[vii] IPCC, *Climate Change 2001: Synthesis Report: Summary for Policymakers* (2001).

[viii] United Nations Framework Convention on Climate Change (UNFCCC, 1992).

[ix] Changes in energy intensity in most countries can be attributed to a combination of two factors: one, structural changes in the economy (whereby a shift away from energy-intensive activities, such as manufacturing, towards the service sector reduces the energy intensity, as has been the case in most industrialized countries over the past few decades; conversely, an increase in the contribution of energy-intensive activities such as manufacturing to the GDP increases the energy intensity of the economy, as in the case of South Korea in the 1970 and 1980s), and two, changes in the efficiency of energy conversion and end-use.

[x] In the case of India and China, an increase in the carbon factor is due to the increasing share of fossil fuels (and decreasing share of biomass) in the energy mix of these countries.

[xi] Holdren, J.P. *U.S. Climate Policy Post-Kyoto: Scientific Underpinnings, Policy History, and the Path Ahead*. 18(3) ASPEN INSTITUTE CONGRESSIONAL PROGRAM, 7-24 (2003).

[xii] Pacala, S. and R. Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, 305 *SCIENCE*, 968-72 (2004).

[xiii] IPCC, *Climate Change 2001: Synthesis Report: Summary for Policymakers* (2001).

[xiv] Ibid.