

Development Research Group

Knowledge in Development Note 13

Climate Change and Development

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The concentration of greenhouse gases in the atmosphere continues to be elevated at levels that threaten to change the climate of planet earth in the 21st century. Evidence indicates that climate has already been changing in the 20st century.¹ Science suggests that the coming decades will experience higher temperature everywhere; changes in the rate and timing of snow and ice; changes in seasons in some regions, increased prevalence of dry days; intensification in extreme precipitation events; increased (10-40 percent) runoff in some regions; and decreased (10-30 percent) runoff in other regions.²

An independent review of the economics of climate change suggests that the benefits of strong and early action far outweigh the economic costs of inaction. The review suggests that climate change will affect the basic elements of life for people around the world—access to water, food production, health, and the environment. Hundreds of millions of people could suffer hunger, water shortages, and coastal flooding as the world warms. Estimates indicate that overall costs and risks of climate change will be equivalent to losing at least 5-20 percent of global GDP annually, while the costs of action can be limited to around 1 percent of global GDP each year.³

While climate change is clearly a global problem—all countries will be affected—the most vulnerable, the poorest countries and populations, will suffer the most, although they have contributed the least to the causes of global warming.⁴ This extreme inequality in externality impacts warrants special attention in developing policies that would (1) allow developing countries to assess their economies' ability to cope with climate change; (2) help vulnerable sectors in developing countries adapt to climate change; (3) develop and apply national policies to mitigate emissions in various polluting sectors; and (4) promote mechanisms to let developed and developing countries interact in joint mitigation projects that benefit both.

What does our past research tell us?

Agriculture is an important, yet vulnerable, sector in developing countries

A recent set of Bank studies in Africa⁵ and South America⁶ suggests that under various uniform scenarios the likely impact of changes in temperature and precipitation on a continent-wide scale will be quite substantial. It is estimated that by 2100 per hectare net income of farmers would be reduced by up to 25 percent in Africa and up to 66 percent in South America, depending on the climate change scenario and Global Climate Model used. As can be expected, rainfed areas are much more vulnerable than irrigated areas.

The impacts of warming, however, could vary a great deal across the landscape. Some areas may be especially hard hit and some areas may benefit, depending on the climate scenario and on existing land cover, production practices, and the present climate in each location.

Small and large farmers face different impacts in Africa, due to differences in cropping patterns and technologies, but in South America small and large farmers face very similar impacts. Warming will cause relatively larger losses in net income to large farmers in Africa, but about the same percentage loss in land value and net income for both small and large farms in South America.

Adaptation is undertaken by farmers as conditions and availability of technologies allow

Farmers make different choices in different climates. The studies found that decisions farmers make about whether they plant crops, grow livestock, or raise both crops and livestock, depend on the climate. Farmers in places that are temperate and wet tend to raise crops. Farmers in places that turn drier tend to raise livestock. Farmers in places that grow hotter tend to raise both crops and livestock.

Another choice that depends upon climate is irrigation. Farmers are more likely to choose and rely on irrigation if their farm is in a cool and dry location.

The results provide strong evidence that farmers will make adjustments in how they grow crops and raise livestock to cope with global warming, depending on the extent to which public policies make such adjustments feasible.

Sea-level rise (SLR) is likely to affect a large number of people

Scientific evidence suggests that increase in greenhouse gas emissions and associated global warming could raise sea level by more than 1 meter in this century. A rapid breakup of the Greenland and West Antarctic ice sheets might even produce a 5 meter rise, but the probability of this taking place within the current century is low.

A recent study⁷ assessed the consequences of continued SLR on land, population, agriculture, urban extent, wetlands, and GDP for 84 developing countries. Results indicate that tens of millions of people in the developing world may be displaced by SLR within this century; and that the accompanying economic dislocation and ecological damage may be severe for many.

At the country-level, results are extremely skewed, with severe impacts limited to a handful of countries (e.g., Vietnam, Bangladesh, Egypt, Bahamas). For these countries, the consequences of SLR are potentially catastrophic. For others, including some of the largest (e.g., China), the absolute magnitude of potential impacts is very large.

Markets direct investments under the Kyoto Protocol, but not fully

The Kyoto Protocol allows countries to meet treaty obligations by investing in projects that reduce or sequester greenhouse gases elsewhere. Prior to ratification, treaty participants agreed to launch country-based pilot projects, referred to collectively as Activities Implemented Jointly (AIJ), to test novel aspects of project-related provisions. Relying on a 10-year history of jointly implemented projects, a recent study⁸ investigated the determinants of AIJ investment.

Findings suggest that foreign direct investment (FDI), as a proxy for countries' cooperation, can explain higher levels of joint implementation of AIJ programs. But national political objectives and possibly deeper cultural ties influence project selection. This characterization differs from the market-based assumptions that underlie well-known estimates of cost-savings related to the Protocol's flexibility mechanisms. It was concluded that if approaches developed under the AIJ programs for projects approvals are retained, benefits from Kyoto's flexibility provisions will be lower than anticipated.

Vulnerability to climate change and availability of resources affect country's climate change negotiation position

According to a broad survey of countries, wide variation in resource availability and impact vulnerability will make negotiations to control greenhouse gases very complex.⁹ Resource availability includes renewable energy resources, potential for carbon sequestration, nonrenewable energy resources, and employment vulnerability. Impact vulnerability varies with exposure to sea-level rise and weather-related damage.

Neighboring states in the same region can have very different orientations toward a global protocol, due to different combinations of resource availability and level of vulnerability. Even with good information and programs tailored to country conditions, the results suggest that many countries will resist a global protocol unless they are compensated for any disadvantages it entails. This research helps to quantify developing countries' vulnerability and resource availability and so provides objective information to help them assess their interests in any negotiated agreements.

The current research agenda

Research on climate change is extensive globally, but little is devoted to poverty/development dimensions. These are the focus of Bank research. As the Bank and IMF stated in 2006, "failure to effectively address increasingly severe weather variability patterns and climate variability into development activities is a major threat to poverty alleviation."¹⁰

National and global institutions for adaptation

Income transfer mechanisms for adaptation to climate change and its consequences for development paths will require national and global institutions to work in concert. Research suggests that when the benefits of adaptation are local, adaptation

should be financed locally whether in developed or in developing countries. However, in developing countries, where damages are likely to be more severe, large vulnerable populations are less able to pay for mitigation. Hence the need for transfer mechanisms from developed to developing countries. When the benefits of adaptation are regional or even global, adaptation measures should be financed accordingly, namely by transfer from developed to developing countries.

Parallel analytical work is under way to identify channels through which climate change might affect economic growth in developing countries and to devise policies that will integrate both adaptation and mitigation measures in one analytical framework that addresses a country's growth.

The role of development assistance in reducing vulnerability to climate variability and change

Research on mainstreaming climate adaptation into development assistance is being studied in Mozambique where a supportive legislative environment and high awareness of climate risks among donors exist. However, mainstreaming initiatives are hampered by limited institutional, technical, and financial capacities in several government agencies. The work seeks to identify barriers to and opportunities for integrating adaptation to climate impacts into development initiatives.

Economics of urban development, energy consumption, and pollution emission in large cities: the case of Beijing

The movement of population from rural to urban areas raises several important questions regarding the patterns of urban development, the choice of alternative transportation infrastructure networks, and resulting energy consumption and spatial patterns of local air pollution.

This research captures key features of urban development in large Chinese cities, such as Beijing, in a tractable analytical and simulation-based dynamic general equilibrium model to study the effects of alternative paths of network infrastructure—roads and rail—on the pattern of urban development and, consequently, energy consumption and air pollution.

The framework will be used to evaluate the cost-effectiveness of policies aimed at reducing carbon emissions from the transportation sector. Policies are grouped into: (1) demand-side policies, such as taxes to alter both the purchase and operating costs of vehicles as well as subsidies for rail use; (2) infrastructure supply policies, which include investments over time in roads and public transit; and (3) fuel-related policies, such as mandates for cleaner fuels (e.g., ethanol and bio-diesel).

Local activities to flexible mechanisms for reducing global greenhouse gases

While the impacts of climate variability and the ability to adapt to climate varies widely across regions of the globe, the global warming impact of greenhouse gases

(GHG) is the same everywhere. This global commons aspect of greenhouse gas emissions is the basic justification for an international management scheme to mitigate GHG emissions. Entities currently seeking to reduce GHG emissions—either for compliance purposes or on a voluntary basis—may either undertake internal abatement measures or acquire credits to offset the excess emissions.

Estimates suggest that the lowest-cost carbon emission reduction credits are to be found in developing countries. Participation by developing countries in the global carbon market can bring both real emissions reduction in return for (mostly private) additional capital. However, most Clean Development Mechanism (CDM) projects are concentrated in a handful of countries (China, India, Brazil and Mexico) and these focus mostly on the reduction of industrial gases.

Given the dual benefit from the CDM market of cost-effective GHG emission reduction and funds for sustainable growth in developing countries, it is a missed opportunity that the market is not distributed over more developing countries. Our research aims at providing a better assessment of the potential of joint project-based mechanisms and an economic assessment of their likely future direction. In particular, the study makes use of a combined dataset of the Kyoto-eligible project transactions along with data on previous and current pilots that have taken place since 1992. It also includes transactions funded by other existing mechanisms.

Intervention measures to increase energy efficiency in transportation systems in India

Efficient transportation technologies are typically the lowest-cost means of reducing carbon emissions, but are often not adopted. Reasons for non-adoption vary and could be different for supply companies and demanding passengers, but include, price, speed, reliability etc. Once these factors are identified and quantified, intervention policies to remove such barriers could be designed.

The work will examine the role of price and other factors such as speed and reliability in the choice between road vs. rail transport for intercity freight, and in the choice between public and private transport within cities. This will shed light on the role that changes in price vs. improvements in service (e.g., faster travel times) could play in maintaining (or increasing) the share of rail in freight transport or the public transport share in urban passenger transport. The research will also investigate the extent to which information regarding fuel efficiency alone is sufficient to induce people to purchase more fuel-efficient vehicles.

Barriers to expanding access to electricity in underserved poor (mostly rural) areas of Africa while reducing the carbon intensity of energy use

The costs of generating energy using different types of technology, as well as projecting current and future energy demand and the reliability of supply from these sources is not well understood in either developed or developing countries. The work builds on a recently completed global study on country stakes in international climate negotiations and includes a renewable energy component, as well as ongoing geographic

analysis support for the Africa Infrastructure Diagnostic Study. The research will examine options for expanding electricity access to poor and remote rural areas in Africa, considering cost of provision, competitiveness of renewable energy options and reliability of supply (e.g., sustainability of hydropower under various climate change scenarios, and demand management options).

Long term sustainability of hydropower-based energy generation within changing climate scenarios

This study assesses hydropower generation arrangements between states sharing transboundary rivers. The research assesses the vulnerability of existing international institutional arrangements for joint hydropower generation in various basins that may affect the sustainability of electricity and water supply under certain climate change scenarios. Specifically, it will look at how alternative institutional arrangements (e.g., formulas for sharing water flow for hydropower production, joint management of the hydropower facility, and formulas for sharing gains) may be affected. In addition it will look at ways to modify institutional arrangements to address possible vulnerabilities of existing hydropower generation and water supply arrangements in transboundary basins in light of climate change.

Measuring the impact of and adaptation to climate change by farm types and agro-ecological zones in Africa

Physical conditions facing farmers in various locations and their (economic and institutional) ability to implement various adaptation measures differ enormously, and therefore blanket policy interventions may create inequities and may not be efficient. Policy makers could greatly benefit from a tool that is tailored to provide both impact assessment and adaptation options in a “quilt”, rather than a “blanket” approach.

The proposed quilt policy approach will allow much more flexibility and may prove to be both socially preferred and cost effective. Because of the already severe climates and great diversity in agro-climatic conditions and level of economic and institutional capacity of agriculture, Africa is the focus of this study.

The work focuses on a well-known delineation of agricultural production conditions—the Agro-Ecological Zones (AEZ). The analysis takes advantage of existing information dividing the African continent into these AEZs. The objectives of this study are to provide a range of estimated climate impacts on various farm types across AEZs in Africa and estimate the benefits from and (if possible) the cost of policy interventions that would allow farmers to adapt to climate change. The study uses economic farm data from a recently completed GEF/World Bank study.

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Endnotes

Most Bank documents cited in this summary are available through the documents and reports portal of the World Bank <http://www-wds.worldbank.org/>. The word “processed” describes informally reproduced works that may not be commonly available through library systems.

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