April 2010

Addressing Climate Change in Asia and the Pacific: Priorities for Action

Asian Development Bank

ABBREVIATIONS

ADB	–	Asian Development Bank
ADF	–	Asian Development Fund
CCIP	–	climate change implementation plan
CEFPF	–	Clean Energy Financing Partnership Facility
CIF	–	Climate Investment Funds
CO_2	–	carbon dioxide
CSO	–	civil society organization
DMC	–	developing member country
DRF	–	disaster risk finance
DRR	–	disaster risk reduction
GDP	–	gross domestic product
GEF	–	Global Environment Facility
GHG	–	greenhouse gas
GCM	–	general circulation model
OCR	–	ordinary capital resources
REDD	–	reducing emissions from deforestation and forest degradation
SLR	–	sea level rise
STI	–	Sustainable Transport Initiative
UNFCCC	–	United Nations Framework Convention on Climate Change

NOTE

In this report, "$" refers to US dollars.

Vice-President	Ursula Schaefer-Preuss, Knowledge Management and Sustainable Development
Director General	Xianbin Yao, Regional and Sustainable Development Department (RSDD)
Team leader	Robert J. Dobias, Senior Advisor, Climate Change Program Coordination Unit, RSDD
Team members	Woochong Um, Deputy Director General, RSDD David McCauley, Principal Climate Change Specialist, RSDD Toru Kubo, Senior Clean Energy and Climate Change Specialist, RSDD Daniele Ponzi, Lead Professional (Environment) RSDD

CONTENTS

EXECUTIVE SUMMARY

Pursuing environmentally sustainable growth. Under its vision of Asia and the Pacific being free of poverty, the Asian Development Bank (ADB) is actively supporting its developing member countries (DMCs) to reduce poverty and help the region achieve the Millennium Development Goals. Over the past two decades, rapid economic growth in Asia and the Pacific has helped to lift hundreds of millions of people out of poverty. However, this remarkable achievement has been undermined somewhat by a notable decline in environmental quality that may jeopardize continued poverty reduction and improved quality of life. In its Strategy 2020 plan for assistance to the region, ADB acknowledges the need to pursue poverty reduction through environmentally sustainable economic growth. While most of the adverse environmental consequences of current growth patterns are local in nature—such as urban air and water pollution or the degradation of natural resources—regional and global impacts include the loss of biological diversity and increasing emissions of climate-altering greenhouse gases.

The climate change challenge. The countries of Asia and the Pacific are highly vulnerable to the adverse impacts of climate change, with more people at risk than any other region of the world. This places the need to address climate change firmly on the region's economic development agenda. Continued poverty reduction in Asia and the Pacific will not be possible without proactive efforts to mitigate the causes of global warming and help the region—especially its most vulnerable citizens in both rural and urban settings, the poor, women, children, and the elderly—to adapt to the impacts of climate change. Because of the tremendous diversity of conditions across the region, differentiated responses will be required that are based on the degree and type of country vulnerabilities as well as contributions of greenhouse gas emissions. With the international community now responding to threats from climate change, the financing needs for adaptation and mitigation measures as well as knowledge innovations in a range of sectors and thematic areas will be enormous. Multilateral development banks such as ADB must play a key role in mobilizing and channeling the necessary resources through the pursuit of innovative financing and financing for innovation. ADB can succeed in helping the region in its transition to low-carbon and climate-resilient growth only by forging and maintaining strong partnerships with civil society, governments, private sector entities, and other development agencies.

Strategic priorities in Asia and the Pacific. Development patterns need to shift to simultaneously respond to the causes and consequences of climate change. Consequently, ADB will adopt an integrated approach—addressing climate change mitigation and adaptation, facilitated by financing, knowledge generation, and partnerships. ADB has identified five priority areas for support:

(i) Expanding the use of clean energy. ADB will continue to expand its support for clean energy, including energy efficiency improvements and the development of renewable energy supplies, increasing the current $1 billion annual spending target to $2 billion per year by 2013. Enhanced attention will be given to removing barriers to the introduction of low-carbon technologies and to supporting the transfer, development, and dissemination of low-carbon and climate-resilient technologies.

(ii) Encouraging sustainable transport and urban development. ADB's policy work and investments in the transport and urban sectors will increasingly shift from traditional road and highway projects to developing alternative means for low-

carbon mobility, including modern mass transit systems, more efficient vehicles, cleaner fuels, and sound urban and intra-city transport planning. Transport infrastructure must be made resilient to the adverse impacts of climate change.

(iii) Managing land use and forests for carbon sequestration. The approach of Reducing Emissions from Deforestation and Forest Degradation (REDD-plus) advocated as part of a post-2012 climate change agreement promises new market partnership incentives for forest conservation. ADB will provide targeted support in collaboration with other development partners to mobilize resources for sustainable forest management and conservation initiatives, as well as other land use changes to enhance carbon sequestration.

(iv) Promoting climate-resilient development. ADB will support country-driven climate change adaptation programs by promoting the mainstreaming of adaptation and disaster risk reduction into national development plans. ADB will ensure that its operations help build the climate resilience of vulnerable sectors such as agriculture, energy, transport, and health, including preparation of climate-resilient sector road maps and the climate proofing of projects. Climate change is expected to have gender-specific impacts; therefore, ADB will help ensure that gender concerns are properly incorporated into development plans.

(v) Strengthening policies, governance, and capacities. ADB will use its development policy and poverty reduction dialogue, as well as targeted policy and institutional interventions to support this process regionally, nationally, and locally.

Supporting modalities. Three primary modalities will be employed to support ADB work:

(i) Mobilizing and innovating to meet financing needs. ADB can help mobilize and channel public concessional funds to its DMCs, significantly facilitating the increased flow of private capital into low-carbon and climate-resilient investments. The global carbon market is expected to expand, and ADB will continue and deepen its leadership in helping the DMCs in Asia and the Pacific region gain access to these resources.

(ii) Generating and disseminating knowledge. Strong programs of technical assistance in the sectors to be most affected by climate change will be used as platforms for developing and disseminating knowledge about effective responses to the climate change challenge.

(iii) Cultivating and fostering partnerships. ADB will continue to work closely with international and bilateral partners, government, private sector, and civil society to expand its capacities and outreach in achieving its climate change objectives. Mitigation and adaptation programs will function best if stakeholders, especially intended beneficiaries, are closely involved in the entire program cycle, from identification through to design, implementation, monitoring, and evaluation.

I. INTRODUCTION

1. In response to the dire social and economic consequences predicted to result from climate change—especially for the most vulnerable populations in developing countries—policy makers around the world are working toward a new long-term international framework to address this global challenge. Asia and the Pacific has the world's most dynamic economies but also the greatest number of people at risk from climate change and the fastest growing emissions of greenhouse gases (GHGs)—the cause of global warming. The region's rapid economic expansion has clearly brought substantial benefits to its poor. This would not have been possible without increased access to energy, which remains essential in the effort to reduce poverty—the goal of the Asian Development Bank (ADB). However, present energy production and use trends—coupled with overexploitation of water resources, deforestation, air and water pollution, and other negative side effects of current growth patterns—are exacting an increasingly high price on the region's environment, security, and people. These impacts are on such a massive scale that they are of global significance.

2. The 2009 Copenhagen Accord [1] identifies the goal of limiting the average global temperature increase to no more than 2ºC. The G-20[2] associated that with a target of stabilizing atmospheric concentrations of climate-altering GHGs to no more than 450 parts per million in carbon dioxide (CO_2) equivalent. Developed countries accept that they have a responsibility to decrease their GHG emissions. But if trends continue GHG emissions from Asia and the Pacific—whether from the energy and transport sectors, deforestation, or other sources—will soon be comparable to those of Europe and North America, with the region on track to be responsible for some 45% of all global energy-related emissions by 2030. If the region's production and consumption patterns remain highly carbon intensive, the combination of adverse local and global consequences could put continued economic growth and poverty reduction in serious jeopardy. An alternative path is thus needed that will improve both the efficiency of the region's economies and its citizens' quality of life.

3. The 2007 *Fourth Assessment Report* of the United Nations Intergovernmental Panel on Climate Change;[3] *Economics of Climate Change: the Stern Review;*[4] and ADB's *Economics of Climate Change in Southeast Asia: A Regional Review,* [5] supports the need for such adjustments to development patterns. The Stern review, for example, predicts about a 6% drop in the gross domestic product (GDP) of South and Southeast Asian countries as a result of climate change by 2100; this is supported by more recent ADB analysis. Unless Asia and the rest of the world act to stabilize GHG emissions, poverty reduction efforts will experience multiple threats from climate-induced risks to the health, safety, and productivity of the poor. Such impacts are already affecting populations across Asia and the Pacific, so even with aggressive mitigation actions, measures are needed to protect the most vulnerable from the adverse effects of sea level rise, melting glaciers, more frequent and severe climate-related natural disasters, greater variability of rainfall, and other predicted consequences of climate change.

---

[1] The Copenhagen Accord (FCCC/CP/2009/L.7) was noted by Conference of the Parties of the United Nations Framework Convention on Climate Change held in Copenhagen, Denmark in 2009.

[2] The G-20 countries comprise Argentina, Australia, Brazil, Canada, People's Republic of China, France, European Union, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, United Kingdom, and United States.

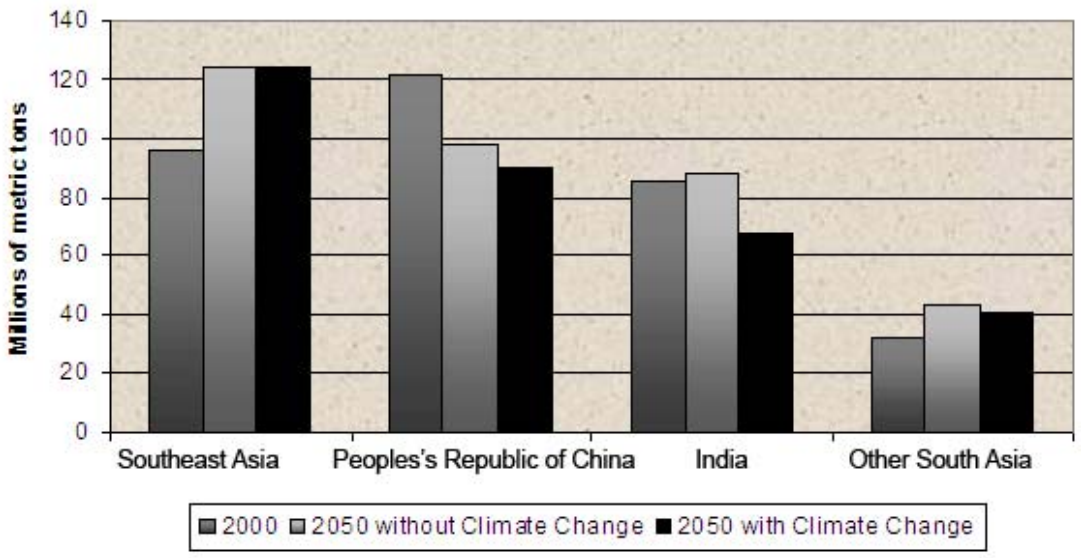
[3] United Nations Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Bonn.

[4] N. Stern. 2007. *The Economics of Climate Change: The Stern Review.* Cambridge: Cambridge University Press.

[5] ADB. 2009. *The Economics of Climate Change in Southeast Asia: A Regional Review.* Manila.

4. For example, the 2009 study, *Building Climate Resilience in the Agriculture Sector in Asia,* indicates that current trends will lead to significant decreases in the yield of staple crops in the region over the next 40 years (Figure 1) with potentially devastating impacts on food prices and child nutrition.[6] Communities and ecosystems—even entire island nations—could vanish. In human terms, people who already struggle day-to-day and season-to-season just to survive will find themselves coping with even worse insecurities. Millions could become climate-induced migrants, with the poorest people in the poorest countries likely to experience the earliest and greatest suffering.

Figure 1: Likely Impact of Climate Change on Asian Rice Production



Source: Asian Development Bank and International Food Policy Research Institute. 2009. *Building Climate Resilience in the Agriculture Sector in Asia and the Pacific.* Manila and Washington, DC.

5. Across the region, current economic growth patterns are acknowledged to have become environmentally unsustainable. The "grow now, clean up later" philosophy is giving place to a desire for simultaneous achievement of high economic growth and improved environmental quality. Attention to addressing the causes and consequences of climate change is part of this transition in priorities—emphasizing opportunities to simultaneously generate local and global "cobenefits." These include improved energy security from clean energy investments, sustainable development of forest communities, and biodiversity conservation, while promoting forest carbon sequestration, and better urban air quality alongside lower GHG emissions by introducing public transport systems and cleaner vehicles.

6. With this challenge facing our region and planet, ADB is responding to growing demand from its DMCs for policies, institutions, and investments to place them on paths to achieve environmentally sustainable economic growth. Estimating the cost of reducing the emission of GHGs associated with economic growth and integrating climate change adaptation measures into development planning and investments is difficult. The G-20 assumes that to stabilize CO_2

[6] ADB and International Food Policy Research Institute. 2009. *Building Climate Resilience in the Agriculture Sector of Asia and the Pacific*. Manila and Washington, DC.

equivalent emissions at atmospheric concentrations of 450 parts per million, from $240 billion to $600 billion will be needed annually for mitigation investments accompanied by from $10 billion to $90 billion per year to support adaptation measures in the developing world.[7] In the 2009 Copenhagen Accord, developed countries make a collective commitment to provide $30 billion during 2010–2012, and have a goal of mobilizing $100 billion per year by 2020 with a balanced allocation between adaptation and mitigation (Footnote 1). Such financing provisions will be important elements of the new post-2012 climate regime being negotiated under the United Nations Framework Convention on Climate Change (UNFCCC). The multilateral development banks must play a key role in channeling these funds to developing countries.[8] ADB is well prepared to contribute. It has been working to build understanding about climate change response options in the region for nearly two decades, and the proportion of the ADB assistance portfolio dedicated to addressing climate change is expected to grow steadily.

7. Understanding of climate change challenges and the international context affecting responses have evolved significantly over the past few years. In 2009, ADB's operations departments completed an institutionwide exercise to prepare, on a subregional basis, climate change implementation plans (CCIPs) to identify high priority areas for climate change assistance to the DMCs. More importantly, the DMCs are taking active steps to achieve full convergence in addressing global climate change concerns and national sustainable development imperatives. Consequently, ADB needs to realign and redefine its strategic priorities in addressing climate change—consistent with Strategy 2020[9]—to provide guidance for all operations. Intergovernmental negotiations continue on a post-2012 agreement under the UNFCCC. Despite associated uncertainties, ADB must push ahead in recognition of the magnitude and urgency of the challenge facing the region.

II. PROGRESS WITH THE ADB CLIMATE CHANGE PROGRAM

A. Broadening External Engagement

8. ADB has provided fundamental preparatory support to its DMCs to improve understanding and address climate change threats and response options. Most recently, ADB has focused on increasing its support for clean energy investments in the region, while expanding its external partnerships on a range of climate change issues (Appendix 1). Initiatives such as the 1992 technical assistance study, *Climate Change in Asia*,[10] and the *Asia Least-Cost Greenhouse Gas Abatement Strategy*,[11] implemented from 1995 to 2001, significantly enhanced understanding of the region's GHG emissions and the capacity of the DMCs to cost-effectively meet their mitigation objectives under the UNFCCC. The lessons derived from this experience call for transformational change in the way development will be pursued in the future.

9. Poverty reduction efforts and measures to achieve the Millennium Development Goals must include an expansion of support to the DMCs to help them cope with the many challenges brought on by global warming—whether adapting to the adverse impacts of climate change or shifting their economies to less carbon-intensive growth paths. Energy efficiency and renewable

[7] G-20 Climate Finance Experts Group. 2009. *Providing Public Revenue to Address Global Climate Change.* Pittsburg.
[8] *Joint Statement of the Multilateral Development Banks for the Copenhagen Climate Change Conference.* 2009.
[9] ADB. 2008*. Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020.* Manila.
[10] ADB. 1992. *TA 5463-REG: Regional Global Environmental Issues*, Manila.
[11] ADB. 2001. *TA 5592-REG: Asia Least-Cost Greenhouse Gas Abatement Strategy*, Manila.

energy investments reached almost $1.7 billion in 2008, exceeding ADB's self-imposed $1 billion annual target. The Sustainable Transport Initiative[12] and the Cities Development Initiative for Asia[13] widen support for climate-sensitive transport and urban development. An initiative on building a climate-resilient Asia and Pacific region will serve as the centerpiece of ADB's efforts to strengthen the region's adaptation to climate change. While most financing currently is drawn from ADB's ordinary capital resources (OCR) and the Asian Development Fund (ADF), developed countries are making increasing amounts of dedicated and concessionary climate change financing available to developing countries. This includes through internally managed funds—such as the Clean Energy Financing Partnership Facility, the Climate Change Fund, and two carbon funds—as well as through external funds such as the Global Environment Facility (GEF) and the Climate Investment Funds (CIF). ADB projects with GEF support that address adaptation and mitigation objectives are expanding, and ADB expects to channel in excess of $600 million to its DMCs programmed through the CIF windows covering clean technology, climate resilience, forest carbon conservation, and expanded access to clean energy.

10. ADB is actively identifying knowledge gaps and taking leadership to develop better understanding of what is at stake and how best to cope with the development challenges presented by climate change. ADB analyses in areas such as the economics of climate change in Southeast Asia, the consequences of climate change for Asian agriculture, the climate resilience of Ho Chi Minh City, and the potential for climate-induced migration in Asia and the Pacific are serving as important reference points in setting the agenda for climate-related actions across the region.[14] In the conduct of these analyses and through its operations, ADB has formed a range of valuable partnerships that are widening access to funding and specialized expertise as well as the scope of outreach.

B. Enhancing Internal Capacity

11. To support those efforts and to further integrate climate change considerations into ADB operations, all regional departments have formulated CCIPs that identify fast-start opportunities to expand ADB's engagement with the DMCs on climate change and provide the foundation for more systematic attention to such programming through regular updates of regional and country partnership strategies.[15] Across ADB, new or redesignated staff, in-house training programs, and revised organizational arrangements focusing on climate change are better positioning the organization to implement these operations. The Climate Change Program Coordination Unit, established in the Regional and Sustainable Development Department in 2009, is promoting internal and external awareness of and coherence in ADB's climate-related responses. Efforts to reduce ADB's corporate environmental footprint also continue, so that it can "walk the talk" in all of its actions.[16]

12. Increasingly ADB staffs are recognizing the magnitude of the threats to development posed by climate change, and the necessity of people-centered considerations in any response. These include the need to deal with adverse impacts on health, education, and access to social

[12] ADB Draft . April 2010. Sustainable Transport Initiative Operational Plan. Manila
[13] See, http://www.germany-wuf.de/upload/CDIA_leaflet-October2008.pdf
[14] See, for example: ADB. 2009. *Climate Change—ADB Programs: Strengthening Adaptation and Mitigation in Asia and the Pacific.* Manila; ADB. 2009. *The Economics of Climate Change in Southeast Asia: A Regional Review*, Manila; ADB and International Center for Environmental Management. 2009. *Understanding Climate Change Impacts Affecting Ho Chi Minh City.* Manila and Ho Chi Minh City; and ADB. 2009. *Under the Weather and the Rising Tide: Adapting to a Changing Climate in Asia and the Pacific.* Manila.
[15] ADB. 2009. *Understanding and Responding to Climate Change in Developing Asia.* Manila.
[16] ADB. 2009. *ADB Sustainability Report 2009.* Manila

services, and the possibility of climate-induced migration. They are giving special consideration to the needs of the least-developed countries and of highly vulnerable groups—such as women, children, and the poor—and the need to give those most vulnerable a voice in formulating and implementing responses. In addition, realization is increasing of the imperative to understand and respond to long-term food security risks implied by threats to the region's agricultural production from climate change and variability.

III. PRIORITIES IN THE REGION AND ADB RESPONSES

13. ADB's climate change program has emphasized climate change adaptation and mitigation actions—all facilitated by financing. While distinctions between adaptation and mitigation remain useful in organizing responses and measuring results, many interventions—such as those in urban areas or associated with forest management—may simultaneously reduce GHG emissions and increase climate resilience. The shifts in development patterns required to ensure that growth is environmentally sustainable will involve addressing both the causes and consequences of climate change, so in many cases a more integrated approach will be warranted. In this context, ADB interventions will increasingly shift from project interventions to greater use of program and sectorwide instruments to more comprehensively address climate change challenges.

14. Five regionwide priorities are identified for attention, each with a corresponding and appropriate degree of ADB response. These priorities were chosen on the basis of ADB's comparative advantage, consistency with Strategy 2020, opportunities for generating cost-effective results, and the unique needs and capabilities of the DMCs. In some areas, such as clean energy, ADB already has a strong foundation upon which to build. Others will require greater program and capacity development, both within ADB and in the DMCs. Responses will be differentiated according to the needs of each DMC. The five priority areas are (i) expanding the use of clean energy, (ii) encouraging sustainable transport and urban development, (iii) managing land use and forests for carbon sequestration, (iv) building climate resilience, and (v) strengthening related policies and institutions.

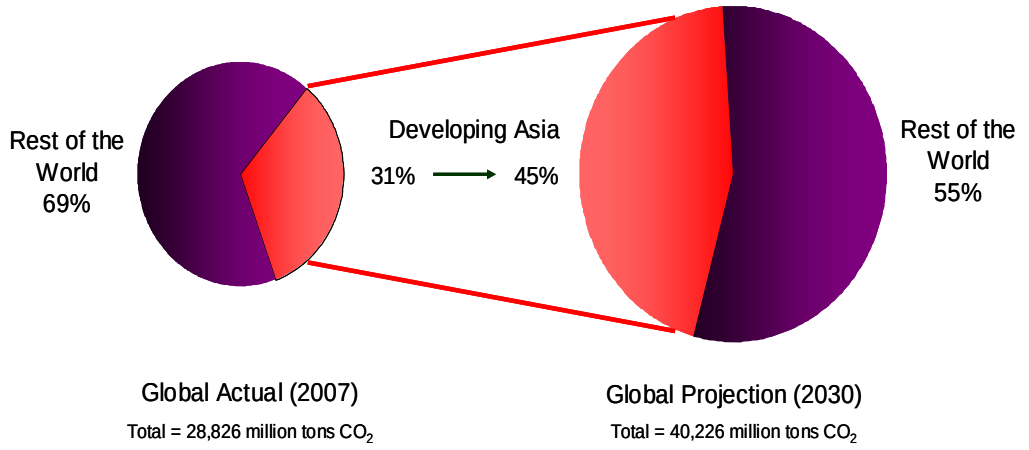
A. Expanding the Use of Clean Energy

15. **Issues.** Energy and transport account for about one-half of global GHG emissions, which are increasing rapidly in Asian economies. If current patterns continue, Asia is projected to account for 45% of all global energy-related emissions by 2030 (Figure 2).[17] A massive shift to clean and efficient energy production and consumption will be needed if Asian and Pacific DMCs are to move their economic growth trajectories to less carbon-intensive paths.

16. **Responses.** Guided by its Energy Policy[18] and building on its considerable experience (Appendix 2), ADB will expand its support for clean energy, including energy efficiency improvements and the development of renewable energy supplies from, for example, solar, wind, small hydropower, biogas, and geothermal power sources. The current target of allocating at least $1 billion per year to new clean energy actions will be elevated to an annual $2 billion target starting in 2013. This will entail a much more aggressive pursuit of opportunities to further the region's transition to a low-carbon energy economy.

[17] International Energy Agency. 2009. *World Energy Outlook 2009.* Paris.
[18] ADB. 2009. *Energy Policy*. Manila.

Figure 2: Global Carbon Dioxide Emissions from Energy Consumption: the Increasing Share of Developing Asia



Source: International Energy Agency. 2009. *World Energy Outlook,* Paris.

17. Demand-side energy efficiency improvements are the most cost-effective GHG emission reduction interventions; in many cases they pay for themselves in energy savings. They can also greatly improve the efficiency of economic production and free up business and consumer resources through lower energy costs. Such opportunities will continue to be promoted—across the industrial, commercial, and municipal sectors—through activities such as the introduction of less energy-intensive lighting, cooling, heating, appliances, and production systems.

18. On the supply side, emphasis will be placed on rapidly expanding the proportion of power supplied by renewable energy sources through appropriate policy, institutional, and investment measures. Ensuring that the majority of new energy supply expansion in the region is from renewable sources is an important goal, and ADB will actively work with its DMCs and other partners to realize this. Explicit attention will be directed to increasing people's access to energy in ways that contribute to economic growth that is both inclusive and environmentally sustainable. At the same time, ADB will continue to promote more efficient power generation, transmission, and distribution—especially where smart grids or other new and promising clean technologies can be demonstrated.

19. Two important elements of the clean energy push will be (i) the removal of regulatory, trade, pricing, information, and other barriers to the introduction of low-carbon technologies; and (ii) active support for the transfer, development, and dissemination of low-carbon and climate-resilient technologies to support sustainable economic growth. These are core elements of the global response to climate change, and will become a key part of ADB efforts. The transfer and diffusion of existing clean technologies and associated know-how will always be dominated by market transactions, but measures to induce private investment facilitated by well-targeted public financing—especially on concessionary terms, such as those offered through the CIF Clean Technology Fund—will hasten the technology transition.

20. ADB's strategy, therefore, will be to first identify and promote highly cost-effective energy efficiency improvements to expand the use of renewable energy, and finally to facilitate the introduction of new clean energy technologies. To take this last step, ADB will move upstream in

the technology development process. This will involve working with governments, venture funds, and other partners to mobilize adequate funding for the deployment and dissemination of promising technologies. Such efforts will reduce the costs of these technologies through economies of scale and by lowering uncertainties associated with technology adoption. Because projects that employ new technologies often carry higher risks, ADB must continue to extend incentives for the public and private sectors to invest in such projects. As a part of this process, ADB will review how it assesses its own project risks and determine whether adjustments can be made to increase support for technological innovations in the climate change field.

B. Encouraging Sustainable Transport and Urban Development

21. **Issues.** Asia's remarkable economic growth has been accompanied by rapid expansion of the transport sector, largely as a result of urban development. But the region's transport and urban growth have followed an unsustainable path, generating adverse environmental consequences locally and globally. Asia's cities are the world's single largest contributor of new GHG emissions, with transport being the fastest growing source (Appendix 3). Air, water, and land pollution choke many urban areas, contributing to health problems and decreasing quality of life. Shifting Asia's transport and urban development onto a more sustainable path will thus entail lowering the currently associated local and global environmental costs, with special attention to reducing future reliance on vehicles powered by fossil fuels. The motivation of the DMCs to make these policy shifts and investments will largely be driven by the opportunity to generate local cobenefits, such as improved air quality, energy security, or transport safety. It will also provide an opportunity to address in this context other social dimensions of transport, including gender mainstreaming, participation, and social risks in addition to those covered by ADB's safeguard policies, such as HIV/AIDS, core labor standards, and human trafficking. The expanded availability of financing for climate change responses is expected to make such transformational investments in the transport and urban sectors even more attractive.

22. So-called fugitive GHGs—especially methane released from landfills and wastewater treatment facilities—are significant contributors to global emissions. With the largest and fastest growing cities in the world, these emissions are also rising rapidly across the region. While strides have been made in developing technologies such as those used to capture methane from landfills, their application is lagging—despite the economic opportunities presented by the use of methane gas as an energy source.

23. **Responses.** Climate-friendly transport and urban development is emerging as a new growth area for ADB operations. Holistic strategies will need to be developed for low-carbon transport that will guide national and municipal investments and associated policy interventions. Consistent with the Sustainable Transport Initiative, ADB support to the DMCs will increasingly shift from traditional urban development and transport projects, including roads and highways, to projects and programs that will help make modern mass transit systems more widely available across Asia's growing cities and introduce more efficient vehicles, biofuels, and other fuel-switching approaches, other low-carbon technologies, and sound urban planning to facilitate mobility. Corresponding support will be provided to create strong integration between urban sector planning and the development of new public transport products for the national and subnational governments —often involving public–private partnerships. In designing such integrated systems broad-based inputs will be sought from diverse user groups, such as women, the disabled, low-income households, and small business operators in order to make these systems truly accessible and affordable. ADB also expects to support efficient and low-carbon intercity transport, particularly by shifting the emphasis for cargo transport away from highways in favor of shipping by rail and sea.

24. The transport and urban sectors will be adversely affected by the impacts of climate change, so future infrastructure development must also take account of these growing risks. Special efforts will be made to ensure that the benefits derived from transport and urban development investments are resilient to floods, heat waves, and other extreme weather events, which are expected to become more common. Water supply and wastewater treatment investments also need to be resilient to climate change.

25. To help curb the growth of fugitive GHG emissions, ADB will encourage the use of technologies that reduce their generation and expand the capture of methane released from landfills and wastewater treatment facilities. Looking ahead, ADB will devise more systematic responses to the growing demands for greener cities across the region, including efforts to improve their climate resilience and lower their carbon footprint.

C. Managing Land Use and Forests for Carbon Sequestration

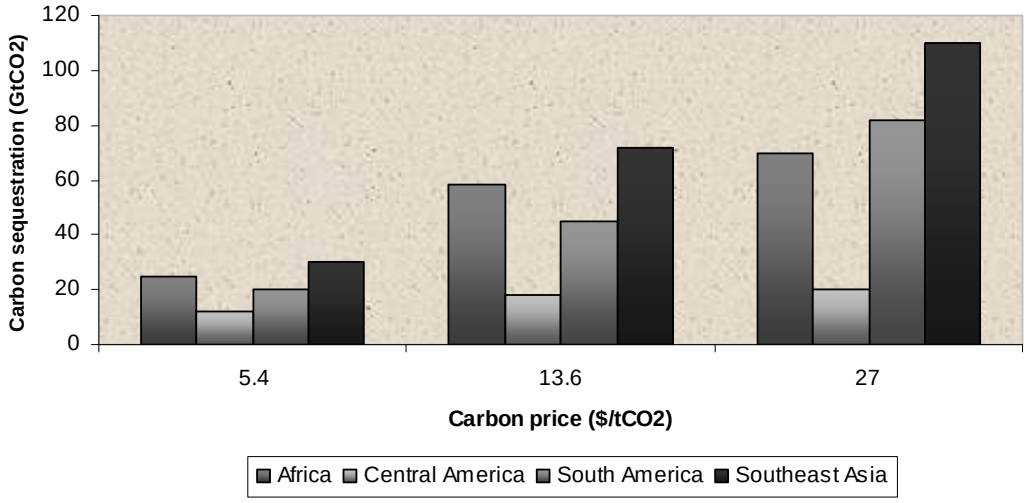
26. **Issues.** From 15% to 20% of global GHG emissions are derived from land use change, especially tropical deforestation.[19] Managing land use and forests to maintain or sequester carbon is a major climate change issue for Asia and the Pacific (Appendix 4). Recent ADB analysis indicates that as much as 75% of Southeast Asia's emissions are derived from this source, mostly from deforestation in Indonesia (footnote 5). Several Pacific DMCs are also rapidly losing their forests. ADB's Strategy 2020 acknowledges that arresting tropical deforestation must be part of the region's approach to reducing GHG emissions, with the sustainable management of forest and other natural resources also providing the basis for local livelihoods, clean water supplies, and protection of biological diversity.

27. The Parties to the UNFCCC are defining the Reducing Emissions from Deforestation and Forest Degradation (REDD) approach to create new incentives for forest conservation, driven by the global benefits they provide in regulating carbon dioxide in the atmosphere. REDD, when combined with enhancement of forest carbon stocks along with sustainable forest management, biodiversity conservation, and community development, is referred to collectively as REDD-plus. It is expected to constitute a major new provision of the post-2012 global climate regime. With Southeast Asian forests holding the highest global potential (Figure 3), REDD-plus could generate tens of billions of dollars in new financing for rural development and improved environmental management in the DMCs.

28. **Responses.** ADB will support the region's sustainable forest management and conservation, as well as agricultural land use improvements to promote soil carbon sequestration. This will help targeted DMCs prepare for and gain access to this potentially significant new source of concessionary and carbon market financing for their development and improved environmental management. Efforts will focus on Indonesia, the countries of the Mekong Basin, Papua New Guinea, Solomon Islands, and Vanuatu, which are particularly well placed to be major participants in REDD-plus financing and the new forest carbon market. Support will be programmed in coordination with other multilateral and bilateral programs—such as the World Bank’s Forest Carbon Partnership Facility, the United Nations REDD Program, and the CIF's Forest Investment Program. It will include development of national and provincial REDD-plus strategies as well as REDD-plus pilots for communities, districts, and provinces to test approaches for the establishment of reference baselines and to help the DMCs determine how to fulfill carbon market requirements for measurement, reporting, and verification of their actions.

[19] Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report.* Bonn.

Figure 3: Cumulative Carbon Sequestered through Avoided Deforestation in 2050 by Tropical Region Assuming Various Carbon Prices

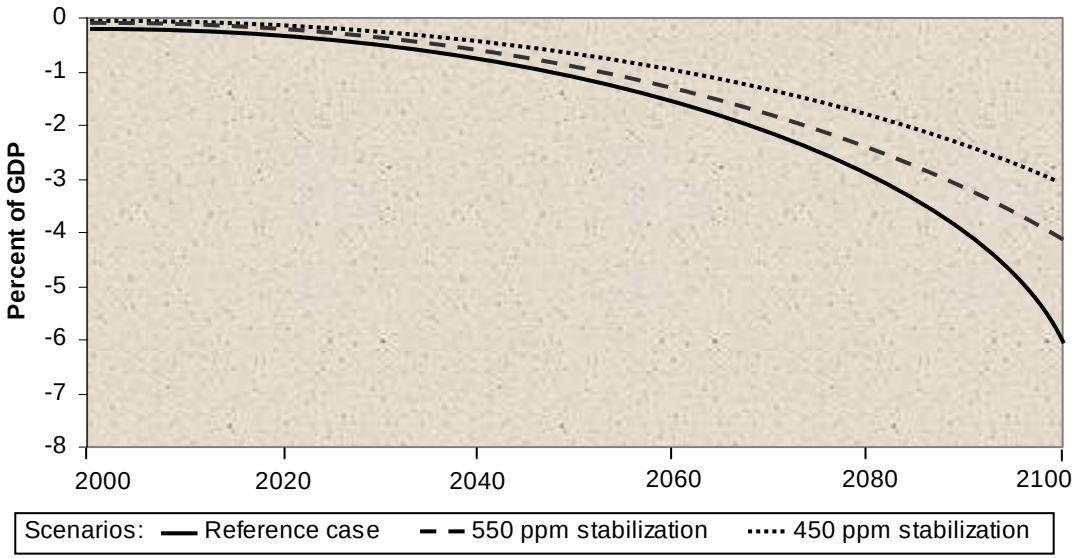


Source: B. Sohngen and R. Sedjo. 2006. Carbon Sequestration Costs in Global Forests, *Energy Journal* Special Issue, pp. 109–126.

D. Promoting Climate-Resilient Development

29. **Issues.** The need to adapt to climate change impacts that are already happening—and the sense that much worse is still to come—has become a defining concern across Asia and the Pacific (Appendix 5). More people are at risk from adverse climate change impacts in this region than in any other, and those who are already the most economically or socially vulnerable, including women and children, will suffer first and the most. Climate change will have adverse effects on water, food, fuel, health, education, and access to social services. Those stripped of their basic livelihoods will be forced to migrate. Countries such as the Maldives, Kiribati, Tuvalu, and the Federated States of Micronesia see their very existence under threat from sea level rise. Asian and Pacific countries must devise appropriate adaptation measures to respond to projected increases in the intensity of weather events across the region, such as typhoons, droughts, and heat waves, as well as floods, forest fires, sea level rise, higher ocean temperatures and acidity, and receding glaciers. Failure to do so will result in severe social costs and threaten poverty reduction efforts. Staple food crop yields are projected to decrease in parts of Asia, with estimates ranging from 2% to 10% in the 2020s and 16% to 42% by 2050 (footnotes 7 and 21). This could have catastrophic impacts on social welfare and stability and is a contributing factor to predictions of significant GDP losses as the result of climate change impacts estimated to be about 6% by 2100 for the major Southeast Asian economies under the business as usual scenario (Figure 4). Many of the adverse impacts of climate change, such as reduced fresh water supply and spread of disease, are predicted to have gender-specific impacts and must be properly addressed in adaptation strategies and actions.

Figure 4: Mean Gross Domestic Product Loss Due to Climate Change in Four Southeast Asian Countries[a]



[a] Indonesia, Philippines, Thailand, and Viet Nam.
Source: Asian Development Bank. 2009. *The Economics of Climate Change in Southeast Asia: A Regional Review.* Manila.

30. Virtually all of the DMCs have prepared preliminary plans to respond to these threats, but systemic attention to climate change adaptation at the regional, national, sectoral, and project levels is still to come. Adjusting to the need for climate-resilient development will mean building responses to the physical, social, and economic impacts of climate change into all aspects of development planning and investment. Greatly improved and down-scaled analysis and understanding of the risks imposed by climate change will be a cornerstone of this transition. In the short run, significant new flows of grant financing to cover the incremental costs of climate-proofing projects will be required. Early experience and lessons show that solutions will range from the enhancement of natural systems (ecosystem-based approaches) to infrastructure and agricultural technology shifts that can maintain agricultural production in the face of heat, drought, and floods. Improved urban planning and coastal protection technologies to take account of sea level rise will also be deployed. The long experience of the disaster risk management community, which provides many applicable approaches, should be tapped to fast-track integrated disaster and climate risk management responses.

31. **Responses.** ADB will support country-driven climate change adaptation programs primarily by (i) promoting the mainstreaming of adaptation and disaster risk reduction into national development plans and ADB country partnership strategies; (ii) helping build the climate resilience of vulnerable sectors such as agriculture, energy, transport, and health, including preparation of climate-resilient sector road maps; and (iii) assisting the DMCs in climate proofing projects—including those financed by ADB—to ensure their outcomes are not compromised by climate change and variability or by natural hazards in general. Priority will be given to the least-developed countries and to addressing threats to highly vulnerable segments of society. All of these efforts will be accompanied by training, awareness raising, and education measures to help weave climate change adaptation into the fabric of economic development. In addition, ADB will help to ensure that the DMCs' poverty reduction strategies and targets—

including gender equality and other social development objectives—take better account of climatic conditions and disaster risks, and build measures to enhance the resiliency of poor communities, women, and other vulnerable groups. Since water is the principal medium through which climate change is manifested, special attention will be given to improving DMC capacities for climate-resilient water management in urban, rural, and river basin settings through investments and technical assistance. ADB also will join with partners to understand and respond to long-term food security risks from climate change threats to agricultural production and food prices, potentially including support for more resilient cropping systems.

32. Climate change adaptation is a relatively new concern in economic development, and new knowledge will continue to be needed to help the DMCs effectively address the threats imposed by climate change on their poverty reduction efforts (Table 1). Tools and methods to help the DMCs better address current climate variability risks and to anticipate and adapt to future climatic conditions are needed. To guide its adaptation interventions, ADB will support and join in the development of relevant adaptation methods, tools, practices, and cost-effective responses as well as assessments of physical, economic, and social vulnerabilities and impacts. Approaches must be fine tuned to meet the needs and match the capacities of individual countries. ADB will develop innovative financing and risk-sharing approaches and associated institutional arrangements to promote the integration of adaptation and disaster risk reduction, including through insurance and other disaster risk finance instruments.

E. Strengthening Policies, Governance, and Capacities

33. **Issues.** ADB's DMCs have been working to develop various forms of national climate change action plans, strategies, and policies—a clear indication of the high degree of attention now being given to this development challenge across the region. In response to the Copenhagen Accord, a significant number of Asian and Pacific countries have made pledges to reduce GHG emissions associated with their economic growth as precursors to nationally appropriate mitigation actions, which are expected to be recognized and monitored under the post-2012 climate change regime. Likewise, many least-developed countries have prepared national adaptation programs of action, with other countries having produced equivalent plans. Access to concessional financing such as the fast-track funding pledged by developed countries in Copenhagen is expected to be conditional on having these and other such plans in place, including the ability to measure results.

34. An enormous amount of policy, governance, and institutional work will be needed to mainstream these initial plans and pledges into the development process and translate them into action. Many DMCs have requested ADB assistance in refining these policies as well as building associated capacities and identifying the substance and financing for project and program interventions needed to implement them. This fits well with ADB's role and comparative advantage as a development partner in the region, and support to build national and subnational policies and institutions for climate-resilient and low-carbon development should be a priority area of action.

35. **Responses.** ADB will use its development policy and poverty reduction dialogue as well as targeted policy and institutional interventions in the DMCs to support the integration of climate change considerations into regional, national, and local development plans and actions, including ADB's own regional and country partnership strategies. Institutional capacities will be assessed and strengthened across the high priority areas for ADB interventions.

36. In some cases, this will be furthered through regional cooperation activities, to allow the DMCs to address transboundary issues or to share experience in tackling common challenges brought about by climate change. The role of the private sector in addressing climate change is only weakly appreciated at present—including as a source of financing and know-how—so this must be assessed, developed, and better integrated into ADB actions. Policy and institutional support will build upon the CCIP process already initiated, with the implementation of CCIPs and priority actions monitored and periodic updates prepared to further the mainstreaming of climate change considerations into all aspects of ADB support to the DMCs.

Climate Change Adaptation Types and Examples by Sector

Sector	Type and Category of Adaptation	Example of Adaptation Options
Agriculture	Share the loss	Crop insurance
	Prevent the loss (structural, technological)	Investment in new capital
	Prevent the loss (market-based)	Removal of market distortions (e.g., water pricing) Liberalization of agricultural trade to buffer regionalized losses
	Change use	Change crops, promote crop diversification Alter planting dates Alter learning practices
	Research	Development of heat- and drought-resistant crops
Coastal zones	Prevent the loss (structural, technological)	Coastal defenses and sea walls Surge barriers Upgrade drainage systems, salt water intrusion barriers
	Prevent the loss (on-site operations)	Sediment managements Beach nourishment Habitat protection (e.g., wetlands, mangroves)
	Prevent the loss (institutional, administrative)	Land use planning
Water	Prevent the loss (structural, technological)	Loss reduction (leakage control, conservation plumbing) Capacity increase (new reservoirs, desalination facilities)
	Prevent the loss (institutional, administrative)	Water allocation (e.g., municipal versus agricultural) Risk management to deal with rainfall variability
	Prevent the loss (market-based) Education and behavioral	Water permits Water pricing Rational water use Rainwater collection
Health	Prevent the loss (structural, technological)	Air-conditioning Building standards
	Prevent the loss (institutional, administrative)	Improvement in public health Vector control programs Disease eradication programs
	Research	Research and development on vector control Vaccines Disease eradication

Source: Organization for Economic Cooperation and Development (OECD). 2009. *Integrating Climate Change Adaptation into Development Cooperation.* Paris.

IV. MODALITIES TO SUPPORT THE AGENDA FOR ACTION

A. Mobilizing and Innovating to Meet Financing Needs

37. ADB's role in pioneering innovative financing and resource mobilization for responses to climate change is likely to expand, and ADB's strong fiduciary standards can help to ensure that this financing is used effectively in Asia and the Pacific, while developing capacity for direct national and local action. The provision of public financing to support policy and institutional strengthening and to help the DMCs meet the capital requirements of climate-related investments—especially in the five priority areas of ADB's climate action agenda (paras. 15–36)—is ADB's primary role in helping its DMCs successfully address the climate challenge (Appendix 6). The financial requirements to meet the adaptation and mitigation objectives of developing countries are enormous. Under the terms of the Copenhagen Accord, the international community is organizing new and additional concessionary financing for these purposes. While the allocation of OCR, ADF, and technical assistance financing will remain central, ADB will increasingly be in a position to help its DMCs gain access to concessionary and innovative financing for both adaptation and mitigation actions that in turn will help them leverage private sector and community resources. Experience with CIF financing gives an indication of how significantly larger public financial flows of this type can be mobilized and handled by multilateral development banks in partnership with their DMCs. ADB will help channel such resources to its DMCs as they become available.

38. Because public financing alone will not be adequate to the task of transforming Asian and Pacific economies, significantly increased flows of private capital must be mobilized and channeled into low-carbon and climate-resilient investments in the DMCs and in support of regional initiatives. Building on a widening range of experience, ADB will make use of innovative instruments such as the carbon market, private capital seed funds for low-carbon infrastructure, and risk mitigation products, including economic and political risk guarantees. These will help to lessen public and private capital credit risks, and thus facilitate project and asset financing—through bonds and equities—for climate-friendly technology deployment at scale on favorable terms. Project developers and investors alike will be targeted to stimulate stronger deal flows of bankable low-carbon and climate-resilient projects in the DMCs. The experience of ADB’s Private Sector Operations Department with private equity funds to promote clean energy investment is instructive, and the department's future role will widen substantially to help fill the financing gap.

39. The global carbon market is expected to expand under a post-2012 climate change regime; ADB has been an innovator in helping the DMCs gain access to these resources in support of clean energy investments. Based on this experience, and in full anticipation that a wide range of market mechanisms will emerge from the UNFCCC negotiations, ADB will deepen its efforts to facilitate the region's access to the carbon market with special emphasis on least-developed countries. This will include expanded attention to opportunities in the urban and transport sectors as well as through REDD. Support will also be offered for the development of domestic carbon markets in the larger economies of the region, as appropriate.

B. Generating and Disseminating Knowledge

40. Knowledge and capacity development are essential components of ADB's climate change program. The widespread internal and external interest in recent ADB climate change knowledge products illustrates the importance of ADB continuing to serve as a leader for knowledge, research, and capacity building in this field (Appendix 7). ADB's strong programs of

technical assistance in the sectors to be most affected by climate change will also be used as platforms for developing and disseminating knowledge about effective responses to this challenge.

41. While broader analyses will continue, increased emphasis will be placed on developing guidelines for key sectors, covering mitigation and adaptation actions. This will strengthen understanding of how to achieve synergies across the five priority areas for ADB interventions. Focus will be placed on developing project designs in transport and other sectors that clearly show the benefits of fully incorporating climate change considerations into traditional sectors of ADB support. These project designs will be used as good practice examples to promote replication, and will be widely disseminated internally to sector managers and team leaders, as well as externally to concerned line ministries in the DMCs. As the application of program and sector-based approaches to address climate change expands, designs will also need to be developed for these instruments.

C. Cultivating and Fostering Partnerships

42. The importance of strong partnerships to achieving ADB's climate change objectives cannot be overstated. In addition to developing and developed member governments, key partners will include other multilateral and bilateral development agencies, the UNFCCC and the United Nations community in general, national and regional centers of excellence, civil society organizations, and the private sector. Partnerships are essential to meet gaps in ADB's own capacity, and they are particularly crucial in furthering regional cooperation on climate change analysis and responses. These institutional arrangements will vary in scope, objectives, and duration, but all will reflect an intention to work with common purpose to effectively address climate change challenges in the region.

43. Among ADB's most important partners, especially in climate change adaptation efforts, will be communities and local government units. Adaptation programs will only function well if the intended beneficiaries are closely involved in the entire program cycle, from identification through to design, implementation, monitoring, and evaluation.

V. CONCLUSION

44. ADB's corporate mandate is to help achieve an Asia and Pacific region that is free from poverty. During more than 40 years of operation, ADB has successfully addressed this challenge by providing projects and programs to its DMCs focusing on economic growth as the foundation of poverty reduction efforts. As ADB's development work in the region approaches the half century mark, countries within the region need stronger support for their pursuit of sustainable development. Continued poverty reduction will not be possible without proactive efforts to address environmental sustainability, including mitigating the causes of global warming and helping the most vulnerable citizens adapt to the already unavoidable impacts of climate change. In the new millennium, the climate change agenda has become one of the defining challenges that ADB—and the entire development community—must face in achieving further progress in poverty reduction.

45. Recognizing this, ADB has developed these strategic priorities to promote an Asia and Pacific region that is more resilient to the adverse impacts of climate change and will contribute to the global reduction of GHG emissions by helping the region follow a low-carbon path for economic growth and poverty reduction. ADB will devote increased attention and resources to the five strategic priorities of (i) expanding the use of clean energy; (ii) promoting sustainable

transport and urban development; (iii) managing land use and forests for carbon sequestration; (iv) building the climate resilience of the DMCs and the region; and (v) strengthening related policies, governance, and capacities.

46. To successfully achieve these ambitions, ADB has stepped up its efforts to mobilize the necessary resources—financial, technical, and human—in support of its client countries. Under Strategy 2020 and its human resources strategy,[20] ADB will (i) enhance in-house training and widen staff resources to achieve an increased allocation of staff time devoted to these efforts; (ii) expand the use of technical assistance resources targeted to these priorities; and (iii) increase the allocation of project and program investments in these areas, consistent with DMC demands. To supplement its own resources, ADB will continue to mobilize and leverage additional public and private financial resources, and to actively develop partnerships to provide access to complementary knowledge and expertise. ADB will work with civil society to raise awareness of climate change impacts and of high priority adaptation and mitigation measures.

47. ADB will make every effort to help Asia and the Pacific achieve these goals. This includes the transition to increased climate resilience for national economies, sectors, and vulnerable groups as measured by indicators developed under the UNFCCC as well as measurable and significant reductions in the region's carbon intensity (i.e., CO_2 equivalent emissions per unit of GDP). When combined with actions to simultaneously generate local environmental and social cobenefits—such as from cleaner cities, well-managed forests, more productive coastal ecosystems, and enhanced energy security—the DMCs should be able to place themselves onto sustainable development paths that will ensure continued poverty reduction and an improved quality of life for all of their citizens.

[20] ADB. 2010. *Our People, Skills, and Passion to Improve Lives in Asia and the Pacific.* Manila.

CLIMATE CHANGE PROGRAM EVOLUTION AND PARTNERSHIPS

Summary: The Asian Development Bank (ADB) has been working with its developing member countries (DMCs) on climate change concerns for nearly two decades. Knowledge development activities have informed policymakers and investors across the region on climate change impacts and cost-effective responses. In 2008, ADB realigned and sharpened its climate change program as part of a broader agenda to promote inclusive and environmentally sustainable growth as well as regional economic integration under its new long-term strategic framework, Strategy 2020*. As efforts to address climate change are further strengthened, ADB is cultivating strategic partnerships to enhance its operations. In doing so, it is working with other development agencies, especially the multilateral development banks, to mobilize and channel climate financing for the DMCs. Bilateral partners are providing dedicated funds managed by ADB to increase investments in low-carbon and climate-resilient development. ADB also participates in and actively contributes to regional and global partnerships, such as the Coral Triangle Initiative, ADB–Australia support for the Global Carbon Capture and Storage Institute, the Sustainable, Low-Carbon Transport partnership, the Adaptation Network for Asia and the Pacific, and cooperation on knowledge products and awareness raising, such as ADB's partnering with the International Food and Policy Research Institute to analyze the impacts of climate change on the region's agriculture sector and working with the Worldwide Fund for Nature to develop REDD+ approaches for conservation and management of forests. The annual Asia Clean Energy and Climate Forum, organized by and held at ADB, provides an important platform for development of partnerships to promote the region's low-carbon transition.*

1. Starting with the drafting of the United Nations Framework Convention on Climate Change in 1992, climate change has been widely understood as a core issue, central to the operation of development organizations. The Asian Development Bank (ADB) has been engaged with its developing member countries (DMCs) on the issue of climate change for well over a decade (Figure A1). In 1995, for instance, ADB initiated a broad and detailed study on GHG mitigation opportunities across 18 Asian countries. More recently, ADB has launched initiatives targeted to meet the unique climate and development needs of its DMCs by: expanding the energy efficiency and clean energy portfolio; reducing DMC vulnerability to climate change by mainstreaming climate considerations into development planning; helping leverage funds for low-carbon growth through emissions trading; promoting sustainable and energy efficient modes of transportation and urban development; increasing access of rural and urban poor to modern and cleaner forms of energy, and so on.

2. ADB's knowledge development activities, including the 2005 climate-proofing analysis[1] and studies on climate change and agriculture, energy, and migration in 2009, have informed policymakers and investors across the region. In 2008, ADB realigned and sharpened its climate change program as part of the broader agenda of inclusive and environmentally sustainable growth under its long-term strategic framework, Strategy 2020.[2]

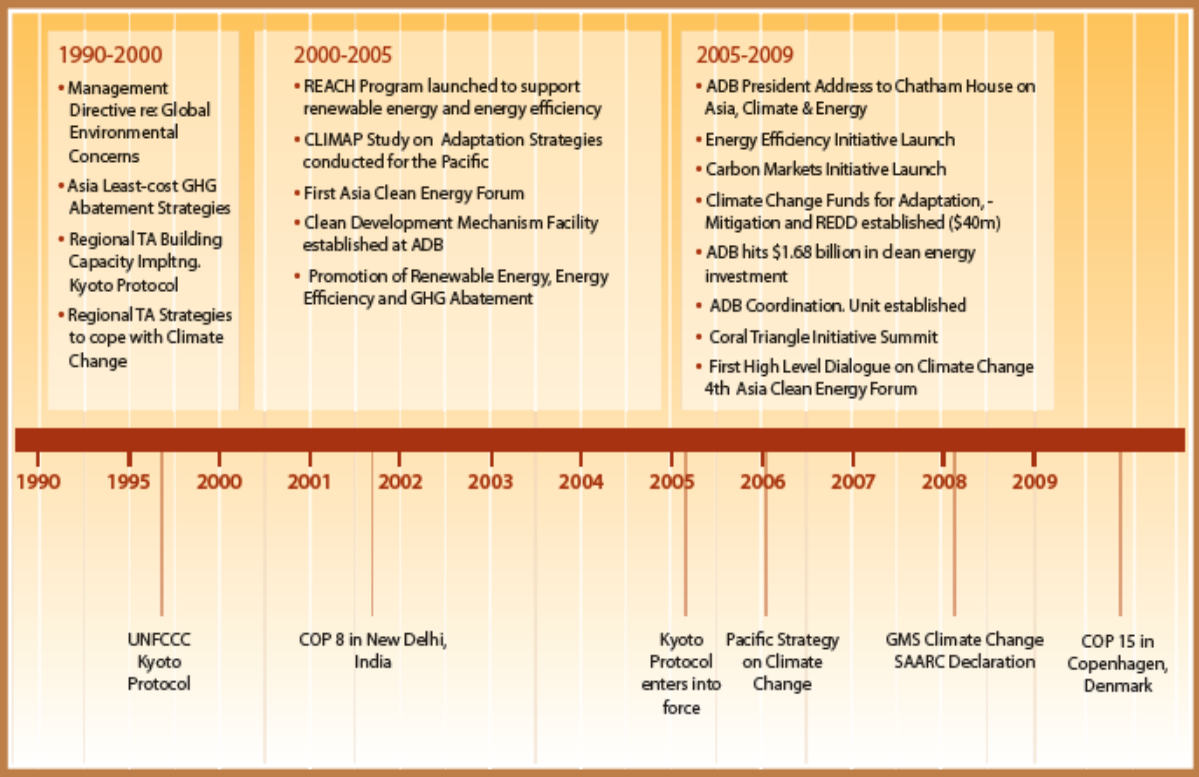
3. As ADB intensifies its efforts to promote adaptation and mitigation actions, it is cultivating strategic partnerships to complement its operations. These partnerships allow ADB to remain engaged on key topics—such as community-based adaptation, sustainable forest management, and technology development for clean energy—that lie outside of its immediate areas of competence.

---

[1] See http://www.adb.org/Documents/Reports/Climate-Proofing/default.asp

[2] ADB. 2008*. Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020.* Manila.

Figure A1: ADB Climate Change Program Evolution



ADB = Asian Development Bank, CLIMAP = Climate: Long range Investigation, Mapping, and Prediction, COP = Conference of the Parties, GHG = greenhouse gas, GMS = Great Mekong Subregion, REDD = reducing emissions from deforestation and forest degradation, REACH = Renewable Energy, Energy Efficiency and Climate Change, SAARC = South Asian Association for Regional Cooperation, TA = technical assistance, UNFCCC = United Nations Framework Convention on Climate Change.
Source: Asian Development Bank.

4. Development partners. ADB is working with other multilateral development banks, consistent with the Clean Energy Investment Framework and the programming of resources through the Global Environment Facility (GEF) and the Climate Investment Funds (CIF). It is also working with bilateral partners on several of its mitigation and adaptation initiatives, including with the Japan International Cooperation Agency and the World Bank on studies of climate change impacts on coastal megacities. It has received fundamental support from the Government of the United Kingdom for the ADB adaptation programs and for regional analyses on the economics of climate change. ADB recently launched a technical assistance program on understanding and reducing the climate change impacts on health with support from the Swedish International Development Cooperation Agency. ADB closely coordinates climate change activities with a number of bilateral partners, including the Australian Agency for International Development, Agence Française de Développement, Canadian International Development Agency, and United States Agency for International Development.

5. Many of ADB's initiatives on climate change mitigation and adaptation are supported by contributions from ADB shareholders. These include all the donors to the CIF and GEF (with the World Bank serving as trustee); the governments of Australia, Japan, Norway, Spain, and

Sweden for the Clean Energy Financing Partnership Facility; Austria, Flemish Region of Belgium, Finland, Japan, Republic of Korea, Luxembourg, Portugal, Spain, Sweden, and Switzerland for the Carbon Market Initiative; Germany and Sweden for the Cities Development Initiative for Asia; Australia, Austria, the Netherlands, Norway, and Spain for the Water Financing Partnership Facility; United Kingdom for knowledge technical assistance products covering economic impact studies and capacity development for adaptation; and Austria for knowledge development on market-based financing to promote low-carbon transport.

6. Low-carbon infrastructure. To meet large-scale investment needs for sustainable infrastructure, ADB is working with private sector firms investing in clean energy and energy efficiency and building climate-resilient infrastructure, as well as with the P-8 group of pension funds.[3] To advance sustainable transport goals, ADB is working with more than 30 organizations under the Sustainable, Low-Carbon Transport Partnership, including International Energy Agency, Inter-American Development Bank, and African Development Bank.

7. Technology research and development. ADB is working to understand the advantages and disadvantages of emerging technologies in order to provide sound policy advice to the DMCs on available adaptation and mitigation options. For example, many DMCs will remain dependent on coal for their base energy supplies for years to come. Carbon capture and storage is a promising option to reduce carbon dioxide emissions from coal use, and ADB is partnering with the Government of Australia to launch the Global Carbon Capture and Storage Institute to establish pilot commercial-scale carbon capture and storage facilities; and promote cooperation between research institutes, governments, and the private sector to advance research, development, and deployment of carbon capture and storage.

8. Strategic adaptation partnerships. ADB is cooperating with a range of development agencies and specialized groups to advance climate resilience in the region. This includes ADB provision of financial and technical support to the United Nations Adaptation Network for Asia and the Pacific. As an active member of the GEF Adaptation Task Force, ADB stays keeps informed and contributes to dialogue on global financing matters and technical developments. Through the Poverty Environment Partnership, ADB and its development partners support environment and climate change experts in Bangladesh, the People's Republic of China, Lao People's Democratic Republic, Pakistan, and Viet Nam, to help these highly vulnerable countries evaluate the impacts of climate change on the environment and guide future investments. ADB is also engaged with experts from the University of Adelaide to develop responses to climate-induced migration, with experts from the World Health Organization on climate and health, and experts from Swiss Reinsurance Company to develop financial mechanisms to encourage private sector investment in climate-risk mitigation.

9. Climate resilience in the agriculture sector. The impacts of climate change will necessitate shifts in crop production and land management for many countries, and precipitate changes in water usage. ADB is working with members of the Consultative Group on International Agricultural Research, including the International Center for Agricultural Research in the Dry Areas, and the International Food Policy Research Institute, to develop regional knowledge on the impacts of climate change for food security and on dry lands management, among other topics.

[3] The P-8 group of pension funds comprises CalPERS, CalSTRS, New York State, British Columbia, AP7, APG, USS, ACSI, Korean National Pension Fund and Norwegian Sovereign Wealth Fund.

10. Land-use, soil carbon sequestration, and reducing emissions from deforestation and forest degradation. ADB has a strong need to supplement its in-house expertise on the rapidly emerging body of knowledge surrounding the United Nations' Reducing Emissions from Deforestation and Forest Degradation (REDD) approach. It is thus developing partnerships with leading institutions, including the Worldwide Fund for Nature, Asian Forest Network, and Center for International Forestry Research, to increase its own capacity as well as that of the DMCs to conserve and better manage forests to decrease their carbon dioxide emissions and to improve their carbon sequestration.

11. Modeling the causes and consequences of climate change. Global climate models are appropriate for understanding the wider impacts of climate change. However, to understand local costs and plan investments, ADB will need to work with partners to generate information appropriate for Asia and the Pacific, specific for individual countries, river basins, and municipalities. In the water sector, ADB is already engaged with a broad network of partners working to strengthen downscaled modeling capacity and adaptation in river basins. The National Hydraulic Research Institute of Malaysia launched a regional knowledge hub for water and climate change under the auspices of the Asia-Pacific Water Forum with the support of ADB and in cooperation with the Network of Asian River Basin Organizations; Ministry of Land, Infrastructure, Transport, and Tourism of Japan; International Centre for Water Hazard and Risk Management; Japan International Cooperation Agency; and University of Tokyo.

12. Strengthening links with civil society. ADB has well-established links and will continue engagement with civil society to address climate change. Efforts include the evaluation and implementation of adaptation and mitigation measures. Cooperation is particularly critical to identify community vulnerabilities and to help ensure bottom-up ownership of climate risk management actions. In several ADB programs, civil society groups are an integral part of service delivery. Recent ADB efforts to protect the Coral Triangle—the so-called Amazon of the Seas—from the impacts of climate change, overfishing, and unsustainable fishing methods, are made possible through partnerships with civil society partners, including Conservation International, The Nature Conservancy, and the Worldwide Fund for Nature, which are working with the governments of Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste to productively utilize more than $300 million in resources pledged by ADB, Australia, GEF, the United States, and other development partners.

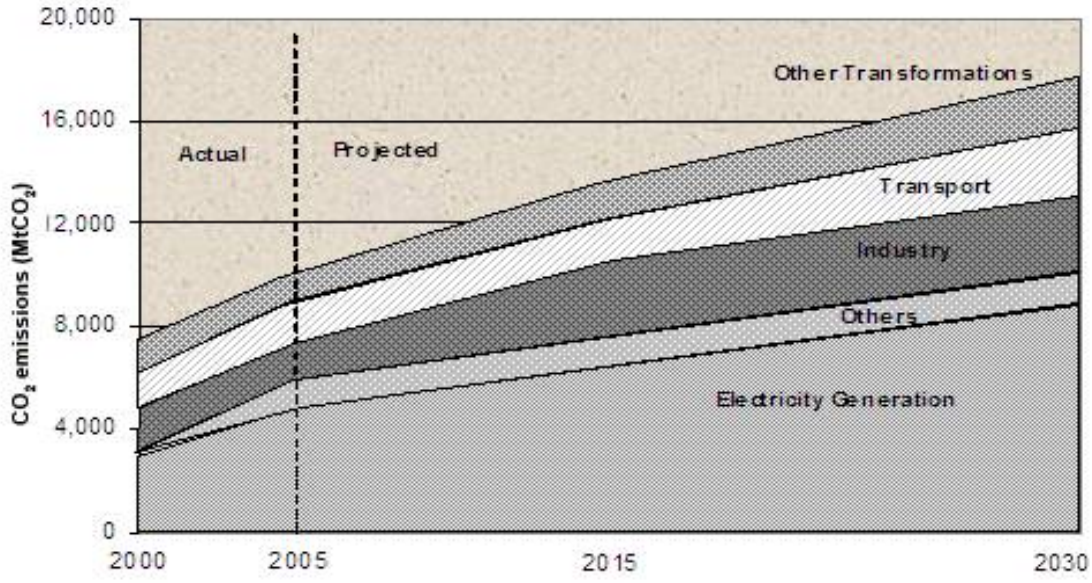
13. Partnerships for outreach and knowledge sharing. In 2009, ADB and the Asia Pacific Broadcasting Union launched a regional training program and multimedia campaign: Climate Change Impacts and Responses. The program trained more than 40 journalists from 12 ADB DMCs about the causes, consequences, and potential solutions to climate change. ADB actively cooperates with the United Nations Framework Convention on Climate Change Secretariat and provides technical and financial support for its efforts in support of the convention's implementation. ADB also shares knowledge on clean energy and climate change solutions through partnerships with The Energy and Resources Institute and United States Agency for International Development, joint organizers of the High-Level Dialogue on Climate Change and the annual Asia Clean Energy and Climate Forum held at ADB. The Asia Clean Energy and Climate Forum has become one of the premiere clean energy and climate events for practitioners in the region with an average attendance of more than 500 participants.

PROMOTION OF CLEAN ENERGY BY THE ASIAN DEVELOPMENT BANK

Summary: Rapid economic growth in Asia and the Pacific drives a greater demand for energy, which translates into significant projected increases in carbon dioxide emissions from the burning of fossil fuels. Utilizing energy efficiently to help meet this demand is one of the key options for the enhancement of energy security and sustainable development in the region, including reduction of greenhouse gas emissions and reducing the region's energy intensity. Introduction of advanced technologies for supply and demand will help slow growth of energy demand. At the same time, increasing the amount of renewable energy in the region's energy mix will help achieve energy security while reducing future greenhouse emissions. The Asian Development Bank is pursuing such a multipronged clean energy agenda in the region. Its clean energy program seeks to increase regional energy efficiency in the energy, transport, and urban sectors; enable greater adoption of renewable energy technologies and their expanded use; and improve access to energy for poor and remote regions consistent with a transition to low-carbon energy development.

1. The projected gross domestic product growth rate for Asian and Pacific economies of 3.5% per year through 2030[1] is the highest in the world. In turn, this economic growth drives a greater demand for energy, with the region's rate of energy demand growth projected at 2.4% annually through 2030; this compares with global growth in demand of 1.5% for this same period.[2] This translates into significant projected increases in carbon dioxide emissions from the burning of fossil fuels (Figure A2.1).

Figure A2.1: Actual and Project Carbon Dioxide Emissions from Energy Consumption

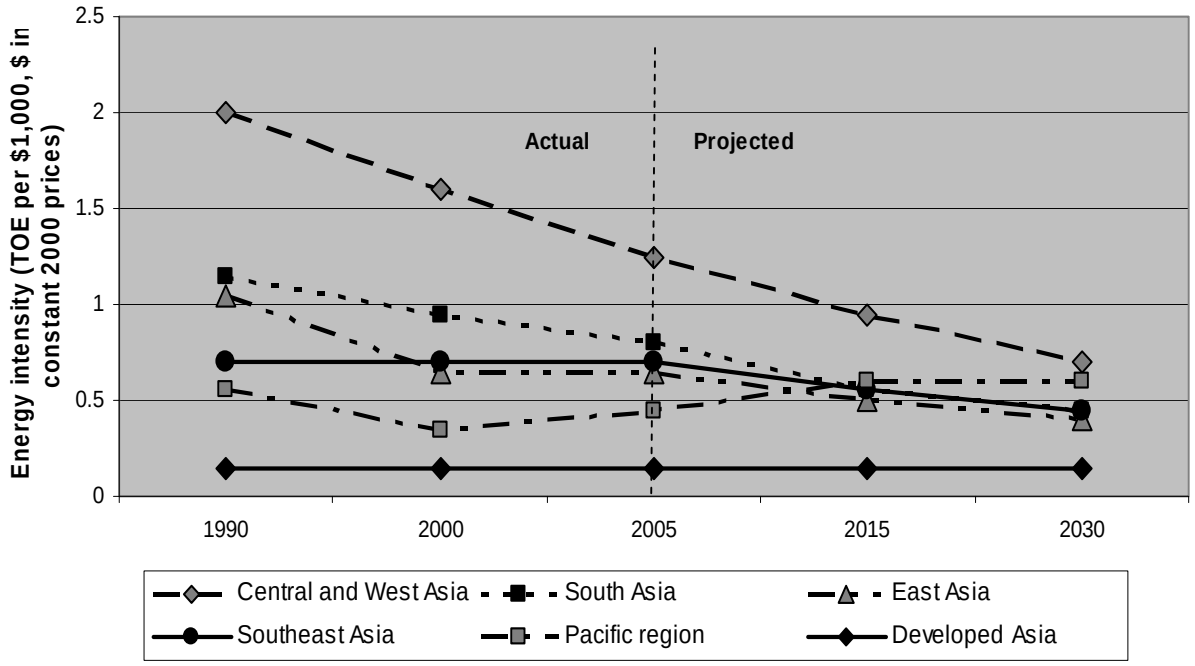


Source: Asia Pacific Energy Research Centre. 2009.

[1] ADB. 2009. *Energy Outlook for Asia and the Pacific.* Manila.
[2] Energy Information Agency. 2009. *International Energy Outlook.* Washington, DC.

2. Utilizing energy efficiently to help meet this demand is one of the key options for enhancing energy security and sustainable development in the region, including reducing greenhouse (GHG) emissions. The region's energy intensity is expected to fall (Figure A2.2). Introduction of advanced technologies for supply and demand will help slow growth of energy demand. At the same time, increasing renewable energy in the region's energy mix will help achieve energy security while reducing future GHG emissions.

Figure A2.2: Actual and Projected Regional Energy Intensity



Source: Asia Pacific Energy Research Centre. 2009.

3. ADB recognizes the crucial importance of promoting a multipronged clean energy agenda in the region. Its clean energy program seeks to increase regional energy efficiency in the energy, transport, and urban sectors; to enable greater adoption and expanded use of renewable energy technologies; and to improve access to energy for poor and remote regions consistent with a transition to low-carbon energy development.

4. ADB uses a variety of financing instruments to support clean energy projects, including grant funding for studies and project preparation, lending and risk enhancement, upfront purchase of certified emission reduction credits, and where necessary, donor-funded grant components of investments to buy down the cost of projects.

A. Evolution of ADB's Clean Energy Program

5. From the early 1990s until 2005, ADB provided fundamental preparatory support to its developing member countries (DMCs) on addressing climate change. This included initiatives such as the 1992 technical assistance study on Climate Change in Asia,[3] and the Asia Least-

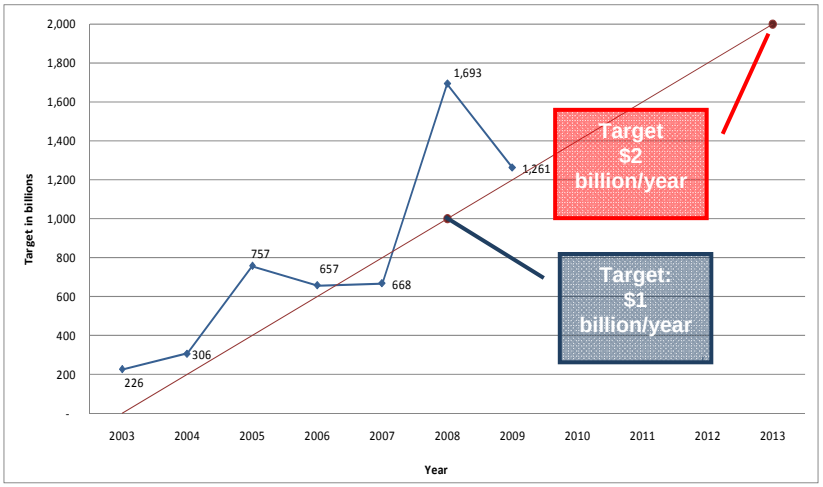
[3] ADB. 1992. *TA 5463-REG*: *Regional Global Environmental Issues*. Manila.

Cost Greenhouse Gas Abatement Strategy,[4] implemented from 1995 to 2001, which enhanced the DMC capacity to prepare baseline inventories of GHG emissions and sinks to meet the standards and requirements of the United Nations Framework Convention on Climate Change.

6. In 2005, ADB launched its Energy Efficiency Initiative to (i) expand ADB's clean energy program, (ii) build greater capacity to develop clean energy projects in ADB's operations departments, and (iii) establish new and innovative financing instruments for clean energy investments. The technical assistance to operations departments increases clean energy investments in the DMCs through capacity-building, planning, policy development, regulatory, and communications support that intends to create an enabling environment for these investments, and through the development of a pipeline of clean energy projects.

7. In 2008, the annual ADB clean energy spending target of $1 billion set by the Energy Efficiency Initiative was surpassed by $693 million (Figure A2.3). This achievement signified the positive outcome of ADB's efforts to expand its clean energy portfolio and is reflected in the 2009 Energy Policy,[5] which has the "promotion of energy efficiency and renewable energy" as one of its pillars, and by an increase in the annual clean energy target to $2 billion by 2013. The current clean energy portfolio of ADB shows that energy sector divisions in operations departments are increasingly incorporating such investments into their portfolios. Clean energy priorities are reflected in the projects of other sectors, notably the transport and urban sectors.

Figure A2.3: Scaling Up ADB Clean Energy Investments



Source: Asian Development Bank.

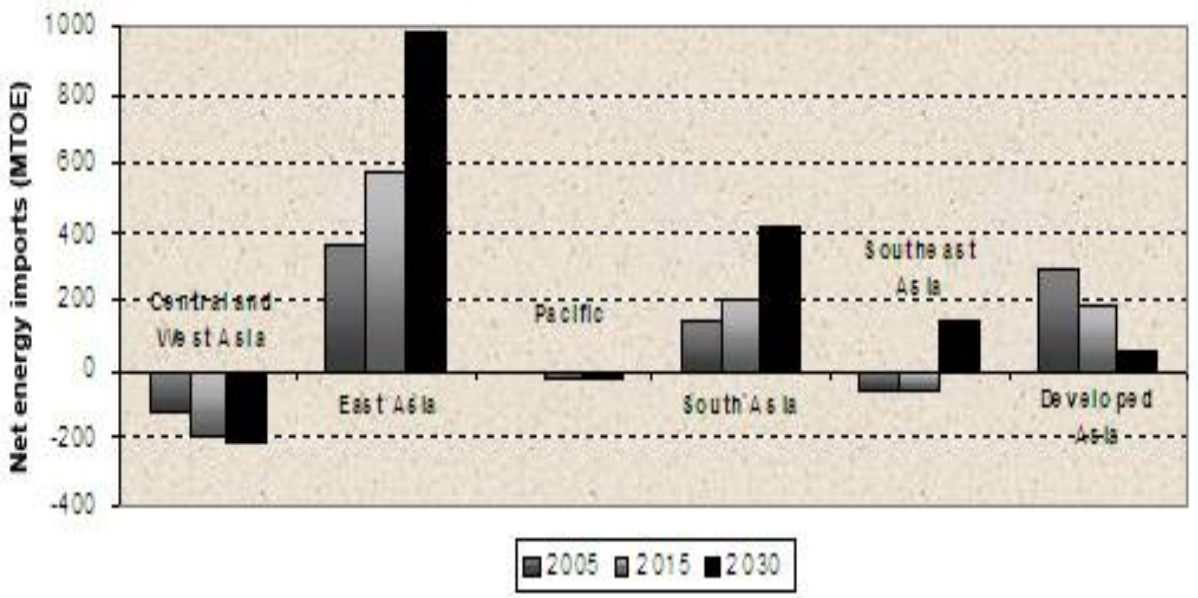
8. The Energy Efficiency Initiative's role and thrusts are now to be redefined as ADB's Clean Energy Program, consistent with implementation of the 2009 Energy Policy and in support of Strategy 2020.[6] The Clean Energy Program will (i) expand ADB's clean energy investments in smaller DMCs; (ii) mainstream clean energy investments in nonenergy sectors; and (iii) track the pipeline of clean energy projects and monitor achievements against Management for Development Results level 2 indicators and the indicators of the Energy Policy.

[4] ADB. 2001. *TA 5592-REG: Asia Least-Cost Greenhouse Gas Abatement Strategy*. Manila.
[5] ADB. 2009 *Energy Policy*. Manila.
[6] ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020.* Manila.

All such investments can reduce GHG emissions while significantly improving energy security in Asian and Pacific countries, which is projected to worsen in much of the region over coming decades (Figure A2.4).

9. A major barrier to the adoption of clean energy technology by the DMCs is the cost of licenses. A way must be found to satisfy intellectual property rights and support innovation while still bringing these important technologies to the region. ADB is very concerned about technology transfer and sees it as a key area in the work to address climate change. ADB seeks to establish a low-carbon technology marketplace that will bring together technology holders and users. An improved platform for interaction will facilitate the quicker take up and adoption of clean technologies in the region.

Figure A2.4: Current and Projected Net Energy Imports by Subregion



Source: Asia Pacific Energy Research Center. 2009.

B. Demand-Side (End-Use) Energy Efficiency

10. ADB is helping its DMCs, including their municipalities, achieve energy efficiency in the commercial, industrial, and residential sectors. By partnering with commercial banks and energy service companies, ADB is helping DMCs like Pakistan achieve greater energy efficiency in the textile industry, the People's Republic of China in the cement industry, and Indonesia in the food industry.

11. For municipalities, ADB is working with the Philippines and Thailand to develop efficient street lighting as well energy efficiency retrofits in government buildings. Similar efforts are under way in the Lao People's Democratic Republic and Viet Nam.

12. ADB has also supported the large-scale adoption of compact fluorescent lamps (CFLs) to improve energy efficiency of lighting. The Philippine Energy Efficiency Project will distribute

13 million CFLs to homeowners over 2 years (2010–2011);[7] in 2008 the Government of the Philippines announced a ban on the sale of low-efficiency incandescent lamps. The expected benefits from this project are impressive—annual savings of up to $100 million in fuel costs and deferment of $450 million in investments needed to produce 450 megawatts of power supply.[8] With cofinancing from the Clean Technology Fund under multilateral development banks' Climate Investment Funds, the Philippine government program is expected to be expanded to include the promotion of more energy efficient buildings and appliances. A similar project in Pakistan will distribute 30 million CFLs resulting in 1,100 megawatts of avoided power generation. The project has high replicability in other DMCs, and efforts are under way in Nepal and Viet Nam to adapt the project design to country conditions.

C. Supply-Side Energy Efficiency

13. Increases in supply-side energy efficiency can be achieved by adopting new and efficient technologies, whether these increase the efficiency at the point of power generation or in the transmission system. ADB has invested in improving municipal district energy infrastructure, and reducing losses in power lines. Gains of energy efficiency from reduced technical losses during generation, transmission, and distribution can lead to the avoidance of the construction of new power plants, removing an added source of GHG emissions.

14. As coal is expected to be a major source of Asia's energy for many years to come, the challenge is to make this highly polluting source of energy as clean as possible. In the context of national strategies to reduce the carbon intensity of the energy sector, ADB supports the construction of supercritical and ultra-supercritical coal-fired power plants that have higher efficiency resulting in much fewer emissions than from conventional subcritical plants common throughout the region. ADB has invested in integrated gasification combined-cycle technology, which is characterized by high electricity production efficiency and significant CO_2 emission reductions compared with traditional coal power plants. It can be combined with carbon capture and storage technology due to the relatively high CO_2 concentration of the exhaust flue.

D. Renewable Energy, Fuel Switching, and Expanded Access to Low-Carbon Energy

15. ADB is working with the DMCs to increase the proportion of renewable energy sources in their energy mix. More and more countries are mainstreaming clean energy and establishing the principle of priority dispatch—so that transmission systems give priority to renewable energy resources when dispatching energy. ADB has invested in dedicated power lines for renewable sources, especially for lines linking hydropower to the main grid.

16. As part of the agenda set by its 2009 Energy Policy, ADB is looking to increase people's access to energy in ways that will contribute to inclusive and sustainable economic growth, including the dimension of low-carbon intensity. ADB's Energy for All Partnership aims to increase access to affordable, clean, and reliable energy for 100 million people in Asia and the Pacific by 2015.[9] For instance, in the People's Republic of China, ADB has invested along with the government in small- and medium-scale biogas generation for rural areas. In Indonesia, the use of agricultural waste to power palm oil mills and surrounding communities is being explored.

---

[7] ADB. 2009. Report and Recommendation of the President (ADF Grant): Grant 0142 Philippine Energy Efficiency Project. Manila.

[8] ADB. 2009. Philippine Energy Efficiency Project. http://www.adb.org/Media/Articles/2009/13006-philippines-energies-projects/fast-facts.pdf

[9] ADB. 2009. *Energy for All Partnership Establishment Plan.* Manila.

CLIMATE CHANGE IMPLICATIONS FOR THE URBAN AND TRANSPORT SECTORS

Summary: Rapid urbanization is a defining characteristic of Asia's development, with the region's urban population forecast to grow by an additional 1.1 billion over the next 20 years, and Asia already having 10 of the world's 25 largest cities. Motorized transport in urban areas has become a leading contributor to local air pollution and greenhouse gas emissions. Global climate change responses will fail unless adjustments are made to transport development in Asia. A more holistic and systematic approach is needed for transport that puts a greater focus on environmental, social, and economic sustainability. Guided by its Sustainable Transport Initiative, the Asian Development Bank will increase efforts to support a range of approaches for shifting the focus of its urban transport operations from its traditional emphasis on roads and highways to new investments, including (i) public transport systems; (ii) nonmotorized transport, together with pedestrian zones and walkways, segregated cycle paths, and bicycle parking programs; (iii) integrated urban transport and land use planning; and (iv) demand management to restrain private vehicle use in busy urban areas. An "avoid–shift–improve" approach will be adopted, where "avoid" refers to reducing the need to travel, "shift" means changing to other more energy-efficient modes, and "improve" relates to using technologies that will make engines and fuels less carbon intensive.

A. Regional Trends and Challenges

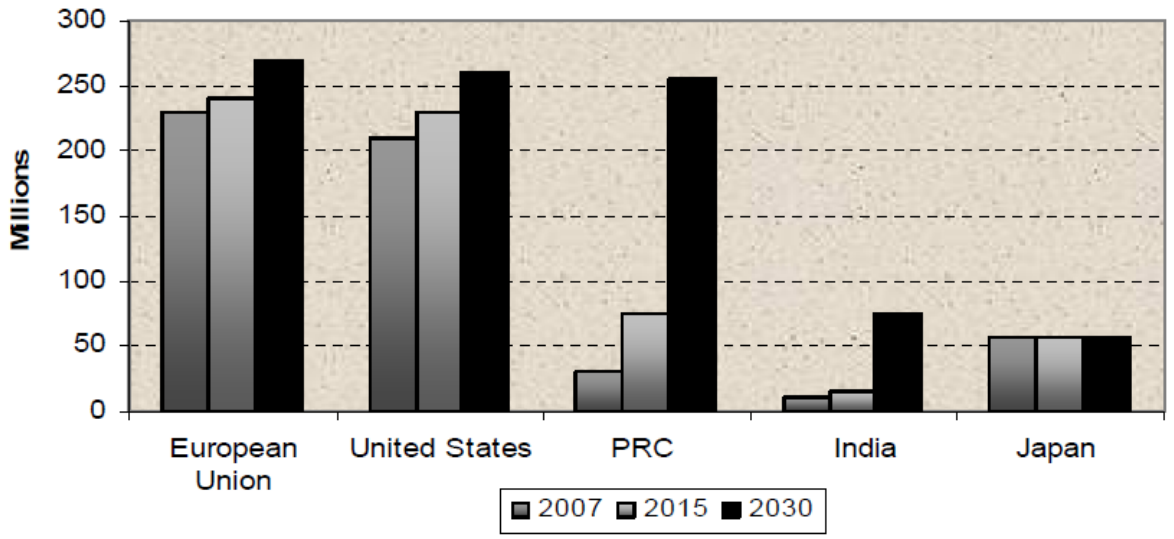
1. Urbanization is rapidly increasing in Asia. The region's urban population is forecast to grow by an additional 1.1 billion over the next 20 years, or an average annual increase of 44 million people. Cities and megacities have grown larger and expanded their suburban areas. Currently Asia contains 10 of the world's 25 largest cities, and they are among the fastest growing.[1] The Asian Development Bank (ADB) estimates that 80% of Asia's new economic growth will be generated in its urban economies, where most jobs and employment opportunities are located. Despite this, a large number of urban residents will remain poor. About 70% of the world's poor live in Asia, and between 240 million and 260 million poor people reside in urban areas under high-density conditions and a degraded environment.

2. These trends are placing significant strains on the cities' ability to support continued economic growth as the demand for urban services and infrastructure continue to rise and the negative externalities associated with urban growth expand. Road congestion already costs Asian economies an estimated 2% to 5% of gross domestic product every year due to lost time and higher transport costs.

3. Unless the patterns established in Europe and North America are broken, as per capita real income of urban dwellers increases, passenger vehicle ownership and use will likewise increase (Figure A3), although Asia has a higher percentage of bicycles and motorcycles than most developed economies. In some cases, motor vehicle fleets are already doubling every 5 to 7 years. The 10 countries in the world with the highest private vehicle future demand index are in Asia, including the People's Republic of China (PRC), India, and Indonesia—three of the four most populous countries in the world. Emerging Asian countries are estimated to have added 35 million vehicles (excluding 2- and 3-wheeled vehicles) to their fleets between 2006 and 2009, with the PRC alone accounting for around 80% of that increase.

[1] By 2015, projected populations of the largest cities show four (Mumbai, Shanghai, Jakarta, and Karachi) in the 20 million–30 million range and a further nine cities with 10 million–20 million inhabitants.

Figure A3: Current and Projected Passenger Vehicles in Selected Countries



Source: Adapted from International Energy Agency. *World Energy Outlook 2009*. Paris.

4. Motorized transport has become a leading contributor to greenhouse gas (GHG) emissions, which cause climate change. Global efforts to stabilize atmospheric concentrations of GHGs will fail if adjustments are not made to transport development in Asia. Over the last 30 years, the transport sector's direct emissions from combustion of fuels represent a rising significant share of total global emissions, accounting for 13% of worldwide emissions with 23% of global carbon dioxide emissions (CO_2) from transport-related fuel combustion.[2] Of the 6 billion tons of transport-sector related CO_2 emissions, 1 billion tons came from Asia. Unless shifts are made in transport development patterns, transport-related CO_2 emissions from Asia are expected to double by 2030, reaching 2.3 billion tons. The PRC and India are expected to account for 56% of this increase. In the case of the PRC, transport-related CO_2 emissions are expected to increase fourfold from 2005 to 3030, from 19% of total emissions to 27%. For India, business-as-usual in the same period would increase GHG emissions from 8% to 13% of the total. Awareness is growing that addressing transport emissions in Asia is crucial to the global CO_2 mitigation effort.

5. Under the business as usual scenario, developing Asia, including the PRC and India, is expected to account for around 45% of the total world increase in oil use through to 2025—the vast majority for transport.[3] This in turn will have significant implications for pollution and energy security across the region. Most Asian countries are importers of fossil fuels, and price volatilities have clearly demonstrated the devastating impact these can have on an economy and the consequent impact on the lives of poor and low-income households. Oil dependence and price volatility are placing an increasing strain on national and personal finances. While the expanded use of biofuels and other fuel-switching approaches have been offered as solutions, these options need to be weighed carefully for their economic and environmental implications.

[2] International Energy Agency. 2008. Paris.
[3] ADB. 2006. *Energy Efficiency and Climate Change Considerations for On-Road Transport in Asia*. Manila.

B. ADB's Response: Building Sustainable Cities and Transport Systems

6. The rapid pace of urban development brings Asian cities to the forefront of the massive challenges threatening the region's sustainable development. To address the challenges, a more holistic and systematic approach to transport is needed—placing a greater focus on environmental, social, and economic sustainability. Guided by the Sustainable Transport Initiative, ADB will scale up its efforts to support sustainable urban transport. ADB has studied and already pilot tested a range of approaches to shift urban transport operations, including support for mass transit systems. While the scope of ADB urban transport operations will depend on DMC needs, ADB will build on good practice and lessons from experience. Key areas of focus will include (i) public transport systems, such as bus rapid transit and rail-based public transport systems to provide urban populations with affordable, safe, secure, accessible, rapid, efficient, and user-friendly transport that will reduce the negative externalities of global and local pollution, congestion, and accidents; (ii) nonmotorized transport, together with pedestrian zones and walkways, segregated cycle paths, and bicycle parking programs; (iii) integrated urban transport and land use planning; and (iv) demand management to restrain private vehicle use in busy urban areas.

7. The Sustainable Transport Initiative adopts an "avoid–shift–improve" approach to promote a new transport paradigm: "avoid" refers to reducing the need to travel, "shift" means changing to other more energy efficient modes, and "improve" relates to using technologies that will make engines and fuels less carbon intensive (Table A3). ADB will introduce high-quality projects to establish competitive long-distance railways and inland waterways, and to reduce emissions and energy consumption by shortening travel distances. A key part of ADB support will involve assisting countries and cities in developing holistic strategies for low-carbon transport that will become the basis for prioritizing related investments and policy interventions.

Table A3: Avoid-Shift-Improve Approach

Principles	Actions
Avoid	Avoid unnecessary generation of travel through land use planning, integrated land use, and traffic management.
Shift	Shift investment focus to nonmotorized transport, public transport, and long-distance rail or water transport.
Improve	Improve existing forms of transport and fuels.

Source: Asian Development Bank.

8. As noted in ADB's Energy Policy,[4] biofuels are attracting increasing interest for their potential in addressing energy security and climate change, especially by offering substitutes for gasoline and diesel in the transport sector. The DMCs also see biofuels as a way to stimulate rural development, create jobs, and save foreign exchange. Advances in biofuel-related technologies are expected to offer new options for fuel switching that could influence the cost-effectiveness, efficiency, and GHG reduction potential of transport policy options. However, the development of biofuels raises issues that must be addressed. Because of rising demand and prices for biofuels, farmers may be encouraged by incentives to grow crops for biofuel production instead of for food production, which could contribute to food insecurity. The net impact on energy use and GHG emissions of replacing fossil fuels with biofuels also needs to

[4] ADB. 2009. *Energy Policy*. Manila.

be examined, along with potentially adverse impacts on natural systems from induced land-use change. Considering the interest in biofuels, ADB will support further analysis of the costs and benefits associated with sustainable biofuel production and use. Where the net benefits indicate that it is appropriate, ADB will support their development.

9. ADB will also mainstream climate change adaptation measures into its transport operations. These will include making adjustments to designs for added climate resilience through engineering specifications, alignments, and master planning; incorporating associated environmental measures; and adjusting maintenance and contract scheduling.

REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION AND FINDING NEW OPPORTUNITIES TO ADDRESS DEFORESTATION

Summary: Between 15% and 20% of global greenhouse gas (GHG) emissions come from land use change—with the largest source being tropical deforestation. This is the primary source of GHG missions in several developing member countries (DMCs), with approximately 75% of Southeast Asian emissions derived from forest loss and other land use change, mostly deforestation in Indonesia. In acknowledgement of this, Strategy 2020 *calls for the Asian Development Bank (ADB) to become involved in promoting sustainable forest management, especially to help its DMCs access opportunities for financing GHG mitigation created by the likely inclusion of the Reduced Emissions from Deforestation and Forest Degradation (REDD) approach in the post-2012 global climate regime. The REDD approach envisions combining performance-based payments by developed to developing countries and a new forest carbon market to create incentives for "avoiding" deforestation that would otherwise have occurred if trends had continued. This is supplemented by measures to enhance forest carbon stocks, to promote sustainable forest management, to support forest-based communities, and to conserve forest biodiversity (referred to as REDD-plus), with all of these arrangements under negotiation in the United Nations Framework Convention on Climate Change process. Demand from the DMCs for such assistance is high, and ADB is responding in partnership with public and private organizations with the requisite knowledge and cofinancing to make REDD-plus a success in the region and to generate new financing for poverty reduction.*

A. Reduced Emissions from Deforestation and Forest Degradation as a Response to Greenhouse Gas Emissions from Deforestation

1. Between 15% and 20% of global greenhouse gas (GHG) emissions are derived from land use change—with the largest source being tropical deforestation. In several countries of Asia and the Pacific, this source dominates national GHG emissions. A recent Asian Development Bank (ADB) study, for example, found that approximately 75% of the emissions in Southeast Asia are derived from forest loss and other land use change, mostly from deforestation in Indonesia. The same study notes that Southeast Asia holds 40% of the global potential for reducing GHGs from forest loss and other land use changes.[1]

2. In acknowledgement of the significant role that forest and land use management will play in local and global responses to the causes of climate change, Strategy 2020[2] calls for ADB to become involved in promoting sustainable forest management, especially to help the developing member countries (DMCs) access opportunities for financing for mitigation created by the likely inclusion of the Reduced Emissions from Deforestation and Forest Degradation *(*REDD) approach in the post-2012 global climate regime. While afforestation and reforestation have been eligible to generate emission reduction credits under the Kyoto Protocol's Clean Development Mechanism, only a few projects have been approved during the first commitment period to 2012.

3. The REDD approach envisions combining performance-based payments by developed to developing countries and a new forest carbon market to create incentives for "avoiding" deforestation that would otherwise have occurred if land use change trends in a given country had continued. In addition, new afforestation and reforestation rules for enhancing forest carbon

[1] ADB. 2009. *The Economics of Climate Change in Southeast Asia: A Regional Review.* Manila

[2] ADB. 2008*. Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020.* Manila.

stocks are being considered to be applied in conjunction with REDD along with measures to promote sustainable forest management, support forest-based communities, and conserve biodiversity (collectively referred to as REDD-plus). These arrangements are under negotiation through the United Nations Framework Convention on Climate Change process and are incorporated into appropriations and pending legislation in Australia, the United States, and other countries. They hold the potential to generate tens of billions of dollars in new financing for rural development and forest conservation in tropical forested countries. In Asia and the Pacific, the countries of the Mekong Basin, Indonesia, Papua New Guinea, Solomon Islands, and Vanuatu are perhaps the best poised to be significant participants in these actions, and among its largest beneficiaries.

B. ADB Support for Sustainable Forest and Land Use Management

4. With this in mind, a grant window of $5 million is included in ADB's Climate Change Fund to support pilot activities meant to develop new REDD and REDD-plus approaches to mitigating GHG emissions while conserving biodiversity and supporting the livelihoods of forest-based communities. Additional support is being provided by the Global Environment Facility as grant cofinancing for investment projects in the People's Republic of China and the Philippines. Further, a regional technical assistance activity,[3] implemented by ADB's Regional and Sustainable Development Department, began in July 2009 to support knowledge exchange across the ADB pilot activities, to form partnerships with others working in this field, and to document lessons from the pilots that can inform future policy and program development in ADB and the cooperating DMCs. Taken together, these actions represent a targeted reengagement of ADB in the forest and land use management sector with direct grant support amounting to approximately $8 million, associated with grant and loan investments of more than $200 million.

5. The first five pilot activities to receive ADB support include two regional cooperation initiatives and three investment projects with REDD-plus dimensions built into them, using Climate Change Fund and Global Environment Facility financing. The regional technical assistance project provides knowledge management functions for these efforts to demonstrate how markets can be created to facilitate payment for the provision of ecological services, especially the global GHG reduction benefits provided by forests by sequestering carbon. ADB is developing its knowledge of this subject, with initial efforts centered in the following pilot areas:

(i) Greater Mekong Subregion (GMS): Reducing Emissions from Deforestation and Forest Degradation in the GMS Biodiversity Conservation Corridors Initiative,
(ii) Heart of Borneo Initiative (Indonesia): Sustainable Forest and Biodiversity Management in the Indonesian Heart of Borneo,
(iii) Philippines: Mainstreaming REDD in the Integrated Natural Resources and Environmental Management Sector Project,
(iv) People's Republic of China: Jiangxi Sustainable Forest Ecosystem Development Project, and
(v) People's Republic of China*:* Silk Road Ecosystem Restoration Project.

C. REDD as a Climate Solution and Major New Source of Rural Development Finance

6. As part of the global solution to rising atmospheric GHG concentrations, developed countries will continue to support mitigation measures in developing countries—as a cost-

[3] ADB. 2005. *Technical Assistance for Capturing Economic Benefits from Ecosystem Services.* Manila.

effective means toward a global end—and to help developing countries shift their economies to lower-carbon paths. REDD is the newest such approach, including both direct performance-based financing of actions and eventually the creation of a new forest carbon market.

7. The REDD incentive system holds the potential to make forests more valuable when left intact than cut—with a range of cobenefits generated in the process. Tropical forests not only capture carbon from the atmosphere, but they serve as regulators of watersheds, storehouses of biodiversity, and income sources for communities that depend upon them for their livelihoods. All of these values have scarcely been captured by the marketplace, so REDD and REDD-plus schemes are meant to create markets to compensate for the provision of global and local ecological services—with poor rural communities sharing the benefits.

8. It will be an enormous task to establish a credible system for organizing REDD actions—determining reference baselines of past trends and forest carbon stocks, channeling financing to appropriate actions, ensuring a fair distribution of the benefits, and monitoring results. However, after due consideration, this approach has emerged as the best—and some would argue the last—hope for arresting the high rate of deforestation in the tropics and associated GHG emissions, while also channeling funds to activities that will support rural development and the conservation of precious biological resources. Demand from DMCs for assistance in this effort is high, and ADB is gearing up to respond in partnership with a range of public and private organizations that will bring the requisite knowledge and cofinancing to make REDD-plus a success in Asia and the Pacific as an important part of the global response to the climate change challenge and a new source of financing for measures to reduce poverty.

CLIMATE CHANGE IMPACTS, COUNTRY PRIORITIES, AND THE ASIAN DEVELOPMENT BANK'S ROLE IN SUPPORTING ADAPTATION

Summary: The Asia and Pacific region has a diverse range of physical and human geographic circumstances, and thus the specific risks from climate change and their timing—and accompanying threats to human societies—vary extensively. The water and agriculture sectors are identified as being most sensitive to climate change, with water serving as the principal medium through which climate change is manifested. All parts of Asia are expected to see threats to agricultural production, with South and Southeast Asia at greatest risk. The developing member countries are already vulnerable to weather-related natural disasters, and climate change will exacerbate such risks. Patterns of settlement in the region place a large percentage of its inhabitants at elevated risk from climate change—with roughly one billion Asians residing in the region's major snowfed river basins and hundreds of millions in coastal megacities. Low-lying small island states are especially vulnerable to sea level rise, and arid regions of Central and West Asia to drought. Climate change is expected to adversely affect health, with disproportionately large impacts on the poor and vulnerable who are least able to protect themselves, including especially women and children. It also threatens the integrity of critical terrestrial, wetland, coastal, and marine ecosystems and their services. Although international efforts are under way to reduce greenhouse gas emissions, current economic development trends ensure adverse climate change impacts requiring adaptation measures. ADB will target its efforts to build climate resilience in three areas: (i) supporting climate change adaptation in country-led development processes; (ii) mobilizing concessional and innovative finance; and (iii) stepping up policy research, knowledge, and capacity building.

A. Climate Change Impacts in Asia and Pacific

1. The Asia and Pacific region encompasses a diverse range of physical and human geography, and the specific impacts of climate change and their timing will vary extensively within the region. Likewise, the accompanying risks to human societies are diverse, and patterns of vulnerability exhibit significant regional variation. Public awareness and political is important. A summary of many of the most important climate change impacts that have implications for sustainable development within the Asia and Pacific region follows.

2. **Water resources.** Water, along with agriculture, is identified as the sector "most sensitive to climate change-induced impacts in Asia."[1] The developing member countries (DMCs) of the Asian Development Bank (ADB) will experience many of the most significant impacts and risks associated with climate change through alterations in the hydrologic cycle. The projected intensification of the water cycle leads to increased intensity and variability in precipitation and runoff. Higher evaporation rates will lead to drier soils, reduced groundwater infiltration and dry season flows, and an increasing prevalence of droughts. Climate risks exacerbate existing water stress within the Asia and Pacific region brought about by rapid and often poorly planned economic development, demographic changes, and associated increases in water demand and strains on water systems due to their overexploitation. Many large Asian river basins are particularly vulnerable to regional warming given the critical role of glaciers and snowfields that serve as "water towers," supporting dry season and drought year flows on which hundreds of millions of Asians depend. In low-elevation coastal zones, where many of Asia's and all of the Pacific's largest cities are located, sea level rise (SLR) will further degrade coastal aquifers through saline intrusion and threaten urban water supplies. Up to 1 billion of the

[1] Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report* (Working Group II).

region's inhabitants are potentially vulnerable to increased water stress by 2050 as a result of climate change.[2]

3. **Climate-related disasters.** DMC societies are particularly vulnerable to the impacts of climate-related natural disasters, and residents of Asia and the Pacific have long experienced a disproportionate share of global flood events, with proportionately high fatalities and economic damage. Large segments of the populations of South Asia, Southeast Asia, East Asia, and the Pacific live in low-elevation coastal zones, river deltas, or riverine floodplains where exposure to flooding is both high and frequent. Poverty increases vulnerability, leading to more severe consequences when floods occur. Climate change will also cause more intense typhoons, droughts, heat waves, landslides, and other natural hazards. These will exacerbate risks from a range of geophysical hazards, notably earthquakes; volcanic eruptions; and associated secondary hazards such as fires, landslides, and tsunami.

4. **Human settlement.** Patterns of settlement in Asia and the Pacific place a large percentage of the region's inhabitants at elevated risk from the impacts of climate change. Roughly one billion Asians residing in the region's major snow-fed river basins are at increasing risk from decreased water security and increasing flood risks. In coastal megacities, millions of people and billions in infrastructure investments are at risk from the combined impacts of SLR, typhoons, flooding, and water stress. Low-lying small island states are highly vulnerable to SLR; and arid regions of Central and West Asia to drought. Impacts on communities are likely to be largely incremental but at times catastrophic. In the absence of significant improvements in adaptive capacity, large-scale climate-induced migrations will become an increasingly likely phenomenon, leading potentially to the exacerbation of conflicts and the spread of epidemics. Studies show that these events, should they occur, will disproportionately affect the poor, along with females, the young and elderly, who currently inhabit the most disaster-prone settings and who will often be left behind to cope with the harsh elements, with limited coping capacity,.

5. **Health.** Climate change is likely to adversely affect health, with disproportionately large impacts on the poor and vulnerable who are least able to protect themselves. Climate change is likely to affect health through three main pathways. First, agriculture: ADB studies[3] find that, with no climate change, all parts of Asia will see relatively large declines in the number of malnourished children by 2050, driven by rapid income and agricultural productivity growth. However, climate change eliminates much of that improvement through, among other things, higher cereal prices. More specifically, in East Asia, instead of 2.3 million malnourished children in 2050, the studies find an estimated 4.9 million to 5.3 million malnourished children. In South Asia, instead of 52.3 million children in 2050, predictions indicate from 57.2 million to 58.2 million. A second pathway through which climate change affects health is water. Adequate and clean water resources are vulnerable to climate change stress, which in turn heightens the risk of diarrhea, cholera, and other water-borne diseases in rural and urban areas. Greater rainfall and warmer temperatures in certain areas are likely to expand the vectors for water-borne communicable diseases including malaria and dengue fever. A third pathway by which climate change can affect health is household energy emissions. A recent study found that almost 1 million children globally are currently dying each year of respiratory infections induced or exacerbated by the inefficient burning of solid fuels.[4] The study found that introducing a low-emission, fuel-efficient, cook stove in India would lower the national burden of disease of

[2] Intergovernmental Panel on Climate Change. 2008. *Climate Change and Water*, Technical Paper, Bonn.
[3] ADB and International Food Policy Research Institute. 2009. *Building Climate Resilience in the Agriculture Sector of Asia and the Pacific*. Manila and Washington, DC.
[4] *The Lancet*. 2009. The Health Benefits of Tackling Climate Change: An Executive Summary for The Lancet Series. 374 (September).

respiratory tract infections and heart disease by a sixth (equivalent to eliminating nearly half the country's entire cancer burden). Furthermore, the study found that changing methods of electricity generation to reduce carbon dioxide emissions would reduce particulate air pollution and deaths, especially in developing countries. A best-case scenario for reducing such pollutants would save an extra 1,500 life years per million people in India in 1 year, and save an estimated extra 500 life years per million people in the People's Republic of China. An important overall policy conclusion from the analysis is therefore that measures to restrict output of greenhouse gases (GHGs) also have additional, independent, and generally positive effects on health. These cobenefits, including averted deaths of young and working age people, will offset at least to some degree the costs of climate change mitigation.

6. **Agriculture and food security.** The extensive reliance of many DMC economies—and the poorest segments of their societies—on agriculture, and the resulting competition for water and land resources, exposes large portions of their populations to significant risks from increased climatic variability, in particular floods and droughts. More than 60% of the economically active population in Asia and the Pacific is dependent on agriculture for their livelihoods. Water stress associated with increasingly frequent and severe El Nino events has already resulted in declining production of rice, maize, and wheat in many parts of the region. Net production of these crops is predicted to decline across the region as a result of climate change (footnote 3). In combination with current land degradation trends, climate change therefore poses a major threat to the region's food security.

7. **Energy security and clean development.** Water and energy are closely linked. Climate change-driven alterations in snowpack hydrology lead to unfavorable changes in seasonal discharge patterns, reducing the capacity and dependability of run-of-the-river hydroelectric generation. In many regions, water withdrawals for cooling of thermoelectric generating facilities approach or exceed withdrawals for irrigation in volume. Extended periods of reduced low river flows, combined with water temperature increases, can thus reduce thermoelectric generation capacity. Water and wastewater treatment are highly energy-intensive activities. As conventional water supplies (including coastal aquifers) serving domestic needs become unreliable or contaminated due to the impacts of climate change, increasing demand for filtration, treatment, and in some settings desalinization will be required, each involving increasing energy consumption.

8. **Ecosystems and biodiversity.** Critical terrestrial, wetland, coastal, and marine ecosystems and services—already at risk from fragmentation, pollution, and overharvesting—will be increasingly strained by climate change. From 24% to 34% of coral reefs are likely to be lost by 2050, with dire consequences for fisheries and livelihoods.[5] Wetlands and mangroves, which buffer coastal communities from storm surges and support fisheries production, are also threatened; and brackish water intrusion will affect aquaculture. Plants and animals will face higher temperatures, forest fires, and shifting habitats, which will threaten some species with extinction unless they are able to migrate to more suitable habitats.

9. **Economic impacts.** Climate-related natural disasters routinely erode significant percentages of gross domestic product, dislocate fiscal planning, and cause liquidity constraints. Economic losses from flooding in the region, estimated to exceed $300 billion from 1960 to 2008, represent resources diverted from productive investments, compromising progress toward the Millennium Development Goals.[6] Similarly, investments required to increase (or even to

[5] Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report*. Bonn.
[6] Based on data provided by the International Center for Water Hazard Risk Management, 2010.

maintain) food production in the face of climate change are estimated to be from $4.9 billion and $5.8 billion per year (footnote 3). On the basis of integrated assessments, ADB estimates the economic impacts of climate change in the absence of adaptation and mitigation investments to exceed 6% of combined gross domestic product in four Southeast Asian countries by 2100.[7]

B. Building a Climate-Resilient Future: DMC Needs and Responses

10. In recent years, recognition has been increasing that adaptation measures to the likely impacts of climate change must be taken if the region's economic development is to be sustained. Although international efforts are under way to reduce GHG emissions, even under best case scenarios of global GHG mitigation, current economic development trends ensure that atmospheric GHGs will continue to increase before they can be stabilized and eventually reduced. As these increases will bring about adverse climate change, Asian and Pacific societies will need to identify and implement a range of strategies for adapting to altered climatic conditions. Unlike many mitigation efforts, adaptation is a highly localized response with local benefits.

11. A growing body of experience and lessons is available to guide adaptation efforts. Examples include applying new and existing technologies to maintain agricultural production in the face of increased drought; applying nonstructural, ecosystem-based approaches to reduce the occurrence of flooding; and improving urban planning to adapt to SLR. Financial resources are beginning to materialize to support these efforts, although greater integration of development and private sector efforts will be needed to meet the growing demand. While virtually all of the DMCs have developed some form of national climate change action plans, strategies, or policies—indicating the increasing priority accorded to climate change—implementing and sustainably financing this work will be a long-term challenge. Lessons from the disaster risk management community, which has faced similar challenges for decades, could enable rapid progress toward effective adaptation strategies. Participation of civil society and civil society organizations (CSOs) in policy formation and project design and implementation will improve the relevance, effectiveness, governance, and sustainability. A summary of key DMC adaptation needs follows.

12. **Improved impact and vulnerability assessment.** Climate impact (risk) assessment seeks to understand, and to the extent possible quantify, the likely changes in regional climate and hydrology that are the expressions of climate change in the river basin or project area. Although the science of global general circulation models (GCMs) continues to improve, a significant gap still remains between the quality and resolution of GCM outputs and the downscaled needs of planners and decision-makers. In particular, scientific tools (including GCMs, regional climate models, and sector response models) are required that can accurately simulate the monsoon-dominated climates characteristic of much of Asia and the Pacific. The focus of the vulnerability assessment, by contrast, is on the project (or river basin or city); and examines the range of conditions under which the system can perform effectively (the “coping range”). An important output of the vulnerability assessment process is the identification of critical thresholds beyond which the system is vulnerable to failure, and the likelihood of failure can be evaluated given climate change projections. Vulnerability analysis is particularly critical in disaster risk management, since the magnitude of disaster risk reflects both the magnitude of the hazard and local vulnerabilities. Improved methods of vulnerability assessment are urgently required to support adaptation planning, in particular those that can be applied under data-limited conditions, and which can be tailored to each country’s unique circumstances and needs.

[7] ADB. 2009. *The Economics of Climate Change in Southeast Asia: A Regional Review.* Manila.

Improving the knowledge base (e.g., climate, hydrological and socioeconomic data, hazard mapping) required to employ technical tools and enhance decision making will also be critical, and will require substantial capacity building in many settings.

13. **Comprehensive adaptation planning.** Adaptation planning involves the identification and preparation of measures to reduce the vulnerability of the river basin, city, or project to the likely impacts of climate change. Design and evaluation of effective interventions, both structural and nonstructural (e.g., demand management, ecosystem-based approaches) is an urgent regional priority. Economic analysis of adaptation measures is an important component of the adaptation planning process, and each option must be evaluated with respect to financial costs, economic (opportunity) costs, and feasibility (technical difficulty). In the framework of climate change adaptation, in which uncertainty is inherent, identification of optimal interventions is less relevant than the identification of adaptation measures that are robust to uncertain future conditions. Adaptation planning seeks to identify "no regrets" and "low regrets" interventions.[8]

14. **Financing.** Recent estimates indicate that financing the global costs of adaptation could require $75 billion to $100 billion annually.[9] While the DMCs increasingly recognize the need to integrate adaptation and disaster risk reduction efforts into development planning, many of the associated costs will require external funding, via adequate, reliable, and sustainable funding mechanisms and combined with technology and capacity building. Given the time sensitivity of adaptation needs, existing gaps in adaptation funding must be resolved in the next few years. This will require new and additional resources such as those recently committed under the Copenhagen Accord,[10] with financing available through existing sources such as the Global Environment Facility, Climate Investment Funds, and the Adaptation Fund leading the way. More effective and efficient funding arrangements are needed to reduce transaction costs, induce private sector investments, enhance access, and provide equitable governance.

15. **Disaster risk management and climate change adaptation.** Even excluding the likely additional burden imposed by climate change, an increasing number of people within the region are at risk from a wide range of climate-related natural hazards. In Asia and the Pacific, recurring floods and storms disrupt agricultural and economic activities, preventing farmers and urban laborers from saving and building assets, and reducing their motivation to recover. Disasters thus have a direct, erosive, and cumulative impact on the lives and livelihoods of the poor. Governments addressed the causes of vulnerability and the elements of disaster risk reduction (DRR) in the 2005 Hyogo Framework of Action.[11] Governments are encouraged to ensure effective implementation of the framework by establishing national platforms where government agencies, civil society, and the private sector can coordinate and exchange information. DRR links directly to several other aspects of human security—food security, water, ecosystems, quality of urban environments, and access to services. Many of the most significant impacts of climate change are currently experienced as natural disasters, and the two should be addressed in a coordinated fashion. DRR and climate change adaptation have some

[8] No regrets interventions are those that provide benefits whether or not projected climate changes materialize. Low regrets interventions are those that provide benefits with minimal financial risk or commitment.

[9] World Bank. 2009. *The Costs to Developing Countries of Adapting to Climate Change—New Methods and Estimates* (consultation draft). Washington, DC.

[10] Under the Copenhagen Accord, developed countries committed to provide $30 billion to support climate change adaptation and mitigation actions in developing countries during 2010–2012 and have set a goal of mobilizing $100 billion per year by 2020, with a balanced allocation between adaptation and mitigation.

[11] United Nations International Strategy for Disaster Reduction. 2005. *Hyogo Framework for Action.* World Conference on Disaster Reduction, Hyogo, Japan.

important overlaps and possibilities for those involved. A comprehensive approach to adaptation will build on elements from national and subnational DRR plans.

16. **Disaster risk finance.** In addition, countries can reduce climate risks by developing proactive, systematic, disaster risk management plans that incorporate various types of risk financing. Disaster risk finance can play a pivotal role in developing active risk management capacity that can reduce the economic impact and vulnerability to climate-related disasters. Financing tools can provide disaster risk reduction capability, emergency credit or liquidity, and access to external risk transfer markets.

17. **Civil society participation.** The impacts of climate change will exacerbate existing patterns of inequality, undermining the premise of fundamental human rights, and reversing progress toward the achievement of the Millennium Development Goals. It is an issue of global justice that those who will suffer most from climate change have contributed the least to its causes. CSOs argue that climate justice is not only an ethical, but also an economic and social imperative. CSOs (including nongovernment organizations) have played a crucial role in shaping the environmental management approaches of several DMCs toward sustainable development. The observed trend toward greater involvement of CSOs and civil society in climate change governance is a positive development.

C. ADB's Role in Helping DMCs Address Climate Challenges

18. Under Strategy 2020, the overall focus of ADB's work is on helping the DMCs establish a sustainable and inclusive pattern of development—one that will enable all people to meet their basic needs and enjoy a better quality of life without compromising the quality of life for future generations.[12] The bulk of global evidence supports the argument that a sustainable pattern of development is also disaster- and climate-resilient. With this in mind, and consistent with the key components of the Bali Action Plan, ADB will target its support to the DMCs for climate-resilient development into three main areas.

1. Support Climate Change Adaptation in Country-Led Development

19. ADB will work to ensure that all its DMCs have operating adaptation action plans by (i) supporting governments in preparing national adaptation action plans and/or programs and ensuring existing plans are operating; (ii) strengthening national planning processes by engaging ministries of finance and planning, along with sector and environment ministries, to integrate climate change adaptation and disaster risk management in broader development planning and policy reform; and (iii) ensuring that stakeholders participate in the decisions that affect them.

20. ADB will assist the DMCs' most vulnerable sectors (e.g., water, agriculture, energy, transport, health) in enhancing their resilience to disaster and climate change risks. ADB will therefore help governments to prepare sector adaptation action plans; and to integrate these plans' recommendations into sector road maps and country partnership strategies, while taking into account the full range of natural hazards and their effects.

21. ADB will help ensure that development project outcomes, including those financed by ADB, are not compromised by the avoidable impacts of climate change and variability, or by

[12] ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020.* Manila.

natural hazards in general. To do this ADB will (i) test and implement tools and cost-effective approaches to reducing disaster and climate risks, (ii) climate-proof vulnerable investments and development programs, and (iii) develop and implement plans to upscale and disseminate climate-proofing and disaster risk management lessons across projects and programs.

22. ADB will help ensure that the DMCs' poverty reduction strategies and targets take into consideration projected climatic conditions and disaster risks, and build measures to enhance the resiliency of poor communities and vulnerable groups. These actions may include migration and gender. (i) Migration: where people decide or are forced to relocate as a result of climate-related factors, ADB will support governments in developing response strategies, with a focus on infrastructure development, education, and regional cooperation, in a manner consistent with Strategy 2020. (ii) Gender: gender-specific impacts and vulnerabilities will be addressed in climate change and disaster risk reduction programs through enhanced assessment and participatory approaches during project design, particularly where ADB and partners are investing in responses to climate change impacts on subsistence sectors characteristically managed by women, such as agriculture, water, and household energy.

2. Mobilize Additional Concessional and Innovative Finance

23. ADB's primary role in supporting the DMCs' adaptation and disaster risk management efforts will be through the mobilization of financing to support capacity building, redirection of policies and/or plans, and knowledge development; and to meet the capital requirements of climate adaptation and disaster risk reduction-related investments.

24. To fulfill this role, ADB will (i) assist the DMCs in accurately assessing the economic and social costs of climate change impacts, and the costs and benefits of adaptation and disaster risk reduction measures, with a focus on the most vulnerable members and sectors of society; (ii) provide active assistance to the DMCs to ensure they are knowledgeable of, and can effectively access—with low transaction costs—existing global climate funds (e.g., Kyoto Protocol Adaptation Fund, Pilot Program for Climate Resilience, Global Environment Facility funds), new climate-related funds, and ADB's internal funds; (iii) mobilize communities to provide cost-effective inputs to adaptation and DRM; and (iv) ensure DMC access to loan financing (e.g., Asian Development Fund and other special funds as well as ordinary capital resources) for adaptation objectives, as appropriate.[13]

25. ADB has reviewed the needs for and is expanding its disaster risk finance (DRF) capability to be linked with disaster risk reduction and climate change adaptation efforts to promote a proactive (in advance) approach to climate risk management in all its DMCs. The DRF initiative will seek to access various sources of funding, including new adaptation funding opportunities, to support the application of financial instruments and skills to better manage, reduce, and transfer climate risk losses. The ADB DRF model will require partnership with private sector participants. The ultimate aim of the DRF is to build capacity and financial market access to reduce natural disaster impacts and vulnerability.

26. Public financing will not be sufficient to meet the adaptation needs in the region. Significantly increased flows of private capital must be mobilized and channeled into climate-resilience and disaster risk reduction investments in the DMCs. Developing effective public–

[13] Recent experience has shown that although the DMCs' position is that they should not bear the costs of adaptation because they are not responsible for climate change, they will accept climate change program loans. For example, Agence Française de Développement and Japan International Cooperation Agency are providing around $600 million to Indonesia through climate change program loans.

private partnerships in adaptation and disaster risk finance is vital. Venture capital and institutional investors may play key roles, which ADB will help to facilitate. Private sector risk redistribution resources (reinsurance and capital market access), data collection, and risk modeling will play important roles, and represent skills that would be uneconomic to develop internally at ADB.

3. Increase Policy Research, Knowledge, and Capacity Building

27. ADB serves not only as a development finance institution but as a knowledge bank. To date, interest in recent ADB climate change knowledge products has been significant—covering such topics as the economics of climate change in Southeast Asia, and the implications of climate change for Asia's energy sector, agriculture, and climate-induced migration.

28. ADB technical assistance will emphasize making the outputs and advances of climate science available to decision-makers in ways that support sound decision-making in the face of climate uncertainty. ADB is currently facilitating these tasks in the water sector in partnership with the Asia-Pacific Water Forum through the Knowledge Hubs initiative.[14] ADB technical assistance will further enable partnerships between DMC water management agencies and international and regional centers of excellence in water, climate change, and disaster management to establish and enhance national capacities for the down-scaling, interpretation, and utilization of outputs of the GCM, regional climate models, remote sensing products, and water resources simulation and management tools.

29. Climate change is one among many drivers of change in Asian and Pacific societies. Others (including large-scale alterations in land use and land cover; demographic trends; and shifts in the level, composition, and location of economic activities) will all influence regional vulnerability and coping capacity with respect to climate change. Accordingly, successful adaptation strategies must encompass such factors as land use planning, demand management, and water governance mechanisms, as embodied in the integrated water resources management (IWRM) approach to river basin management. IWRM is a cornerstone of ADB's existing Water Financing Program, and provides an effective framework for managing the diverse water sector risks associated with climate change. ADB will expand its support for IWRM in Asian and Pacific river basins as an important component of climate change adaptation.

30. Given DMC knowledge and capacity development needs, ADB will increase support to develop and disseminate knowledge products, and provide advisory services related to climate change. In the short term, ADB will focus on (i) improving the quality and quantity of vulnerability and climate impact assessments; (ii) developing and applying adaptation tools and methods (including screening checklists, sector brief sheets, and detailed technical guidance notes); and (iii) strengthening economic analyses of climate impacts and responses. Knowledge will be built through an ADB-wide, coordinated, and resourced adaptation capacity building plan to ensure that the DMCs and ADB improve their knowledge and abilities in the rapidly evolving field of adaptation.

[14] The ADB-supported "knowledge hubs" program aims to create partnerships with the region's leading institutes to produce long-term research and knowledge that will be useful to the public and private sectors of developing Asia.

INNOVATIVE FINANCING AND FINANCING FOR INNOVATION

Summary: Financing needs of developing countries for climate change mitigation is estimated to exceed $100 billion per year by 2030, with adaptation costs ranging from $75 billion to $100 billion per year. Current international financing mechanisms and commitments are considered inadequate to meet this demand. Developed countries have pledged fast-track resources of $30 billion from 2010 to 2012, with a further target of at least $100 billion per year by 2020. The Asian Development Bank (ADB) will scale up its own financing to promote low-carbon and climate-resilient growth. It will assist the developing member countries in accessing additional public concessional climate change funds and help ensure they deliver maximum leveraging of private finance. ADB will also continue its efforts to develop new carbon finance products and increase the flow of these funds to the region, particularly to least-developed countries. ADB will work with development partners and institutional investors to develop climate-related debt instruments that can provide attractive, socially responsible fixed-income investments for institutional investors. Based on a growing track record in clean energy private equity funds, ADB will seek to address "capital gaps" through support for early stage venture capital funding and clean energy infrastructure development funding. ADB will seek to provide risk mitigation products and guarantees to help address country, policy, and in certain instances credit-related risks associated with climate change investments. Finally, more effective and proactive disaster risk management financing needs to be developed as an important element of adaptation efforts.

1. Recent estimates indicate that the mitigation financing needs of developing countries will grow to well over $100 billion per year by 2030, depending on how ambitious the greenhouse gas (GHG) emission reductions targets are. The corresponding estimates for adaptation costs in developing countries range from $75 billion to $100 billion per year. The consensus is that these financing needs will increase over time, with an obvious inverse relationship between mitigation and adaptation costs. Current international financing mechanisms and commitments are inadequate compared with the requirements to address climate change.[1] In partial answer to these concerns, developed countries pledged in the Copenhagen Accord to provide fast-start resources of $30 billion from 2010 to 2012, with a further target of mobilizing at least $100 billion per year by 2020.[2]

2. The Asian Development Bank (ADB) will scale up its investment to promote low-carbon and climate-resilient growth from the ordinary capital resources and Asian Development Fund, and technical assistance financing from its own capital resources.

3. Additionally, ADB's financial support will increasingly see the expansion of two further dimensions:

(i) Assisting the developing member countries (DMCs) in accessing dedicated public concessional development funds that are pledged for by climate change

[1] G-20 Climate Finance Experts Group. 2009. *Providing Public Revenue to Address Global Climate Change.* Pittsburg.

[2] The Copenhagen Accord was approved by the United Nations Climate Change Conference held in Copenhagen, Denmark in 2009.

adaptation and mitigation investment[3] and helping channel these funds into climate change-related investments in the DMCs. ADB is anticipated to play an integral role in assisting the DMCs access and deploy these funds into adaptation and mitigation activities. ADB capacity building in the DMCs will be critical to ensure optimum investment and to build DMC capacity to increasingly manage such funds directly;

(ii) The scale of public finance available from development partners under the various contemplated public finance mechanisms is now generally considered to not be sufficient to satisfy the projected demand for climate adaptation and mitigation financing in the DMCs. Accordingly, ADB will need to ensure that its use of external funds delivers maximum leveraging of private sector finance.

4. Given the respect that ADB has earned for innovative financing, it is well placed to build on existing efforts and assist the DMCs in attracting the necessary capital to finance their investments in climate change adaptation and mitigation.

A. Carbon Finance

5. Building on the success of ADB's existing Carbon Market Initiative and its carbon finance fund mechanisms,[4] ADB will seek opportunities to serve the DMCs' interests by developing new carbon finance products and increasing the flow of carbon finance to the region, particularly to countries not well represented in the carbon market during the Kyoto Protocol's first commitment period. The nature and form of further carbon finance products developed by ADB will be determined by the eventual shape and form of the international climate change policy architecture when finalized.

B. Other Financing

6. The development of financial instruments that scale up climate adaptation and mitigation investment in the DMCs is well aligned with the objectives of Strategy 2020.[5] ADB is presently working with development partners and the institutional investment community[6] to identify new financing modalities and products that comingle publicly available sources of funding (including ADB ordinary capital resources) with investment from private institutions to achieve a greater scale of climate finance for the DMCs in a shorter time frame. A series of pilot public–private partnership investment products are currently contemplated, all of which are based on the hypothesis that, given the scale of investment required, a proportion of the available public funds could be used to help create emerging market climate change-focused investment products that display the risk-versus-return investment characteristics attractive to institutional investors. In creating such pilots, the large pools of institutional capital will hopefully be

[3] Such as funds made available through the Climate Investment Funds as well as the United Nations Framework Convention on Climate Change (UNFCCC). ADB is the executing agency for the Global Event Facility and has been invited to apply for multilateral implementing entity status for the Adaptation Fund established under the Kyoto Protocol of the UNFCCC. The Copenhagen Accord contains express provision for financing of climate change mitigation and adaptation activities in developing countries, including a commitment to "fast start" funding of $10 billion a year up to 2012; a further consensus is to mobilize $100 billion per annum of fund flows to developing countries by 2020.

[4] The Asia Pacific Carbon Fund and the Future Carbon Fund.

[5] ADB. 2008*. Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020.* Manila.

[6] Such as the World Economic Forum's Working Group on Low Carbon Prosperity and the Prince of Wales, P-8 Group of Pension Funds, which represents institutional investors with over $4 trillion of assets under management.

"unlocked" and begin to flow into climate adaptation and mitigation investments in the DMCs at a greater scale. A discussion of examples of the contemplated investment products follows.

7. Debt products: climate bonds. A number of international finance institutions have successfully raised debt from the capital markets to finance climate mitigation, renewable energy, and energy efficiency projects through the issue of bond products to institutional investors.[7] ADB wishes to work with development partners and institutional investors to develop debt instruments that provide attractive fixed-income investments for institutional investors, thus providing a source of debt finance for climate adaptation and mitigation projects in the DMCs. Institutional investors have indicated a strong preference for fixed-income products, and useful precedents exist that can be adopted by ADB and development partners for application in Asia and the Pacific for both climate adaptation and climate mitigation finance.[8]

8. Equity products: climate funds. ADB's Private Sector Operations Department has already created an admirable track record in investing in clean energy sector-focused private equity funds.[9] ADB's technical assistance and dialogue with development partners and institutional investors (footnote 3) indicate that most institutional investors invest in funds because they allow them access to a wide variety of projects in multiple markets permitting diversification of risk. Institutional investors have identified the presence of financial institutions like ADB, as anchor participants in DMC-focused funds, to be a key feature that will attract them to co-invest in low-carbon funds for emerging markets. Two areas, in particular, identified as promising are the "capital gaps" in the clean energy development cycle: (i) early stage venture capital funding, and (ii) clean energy infrastructure development funding.[10]

9. Risk mitigation products: guarantees. Another area where international finance institutions are being asked to increase assistance is through the provision of risk mitigation products and guarantees that help address country, policy, and, in certain instances, credit-related risks associated with climate change investments in the DMCs. ADB is currently exploring development of an Asian clean technology guarantee facility to facilitate the development, deployment, transfer, and diffusion of proprietary technologies into the DMCs. Other risk mitigation tools and products will be explored in collaboration with development partners and DMC host governments.

---

[7] In 2007 the European Investment Bank issued Climate Awareness Bonds to provide debt funding to its existing renewable energy and energy efficiency project pipeline (total €1 billion); in November 2008, the World Bank and the Swedish Bank SEB created a Swedish kronor (SEK) denominated Aaa/AAA "Green Bond" and raised SEK2.325 billion from institutional investors in Sweden seeking fixed-income products. The proceeds were used to fund the World Bank's existing climate change adaptation and mitigation project pipeline. In 2009, the US State of California purchased $300 million in Green Bonds from the World Bank, the funds were used to finance the World Bank's existing climate change mitigation project pipeline.

[8] By way of example, the International Finance Facility for Immunization is a World Bank-managed special purpose vehicle, which has issued $4 billion in AAA-rated bonds into the capital markets for financing vaccines for children in Africa. The Vaccine Bond (as it has become known) was supported by sovereign development partners (France, Italy, Norway, South Africa, Spain, Sweden, and the United Kingdom). This is a useful model for adaptation bonds.

[9] Clean Energy Equity Funds of ADB's Private Sector Operations Department.

[10] World Economic Forum. 2009. *Task Force on Low Carbon Prosperity Recommendations*, Davos; and J. Carmody and D. Ritchie. 2007. *Investing in Clean Energy and Low Carbon Alternatives in Asia*.

10. **Disaster risk finance**.[11] The increase in weather-related natural disasters noted in the region is consistent with predictions for climate change. Development of more effective and proactive disaster risk management capacity is critical. Past emphasis on post-disaster funding has evolved to a more balanced and systematic approach that recognizes the importance and value of properly assessing and managing disaster risk before it happens. This effort is grounded in the belief that an excessive DMC dependency on post-disaster funding has hampered development of risk management tools and techniques that have been shown to reduce disaster impacts and vulnerability.

11. ADB worked with donors to develop the Asia Pacific Disaster Response Fund with the objective of providing incremental grant resources to the DMCs for the restoration of life-preserving services to communities affected by natural disaster (whether climate-related or otherwise). This fund is intended to help bridge the gap between existing ADB arrangements that assist the DMCs to reduce disaster risk through hazard mitigation loans and grants and longer-term post-disaster reconstruction lending.

12. Disaster risk finance (DRF) plays a critical role in developing more proactive disaster risk management policies, programs, and institutions as applied to climate risk. As a form of innovative development finance, DRF creates new applications of traditional financial instruments to provide climate risk solutions. The availability of multiple instruments and risk markets permits the matching of instruments and products to specific natural hazards, each of which may have different degrees of severity and recurrence. Through the analysis of risk exposures and hazard experience, and global climate change modeling, probability models can be built that yield a detailed picture of likely occurrences. Based on such models, financial instruments can be employed to fund disaster losses and in some cases transfer the risk to external markets.

13. Climate change adaptation is a form of proactive disaster risk management. It anticipates the impact of meteorological events by assessing natural hazards, exposure, and vulnerability; and seeks to take remedial steps to attenuate the impact of those events on people, their livelihoods, and the natural environment. There is an obvious, substantial, and growing intersection between disaster risk management and climate change adaptation. Building capacity for disaster risk management needs to be a component of ADB's climate change adaptation strategy, and DRF is a central pillar of that capacity development.

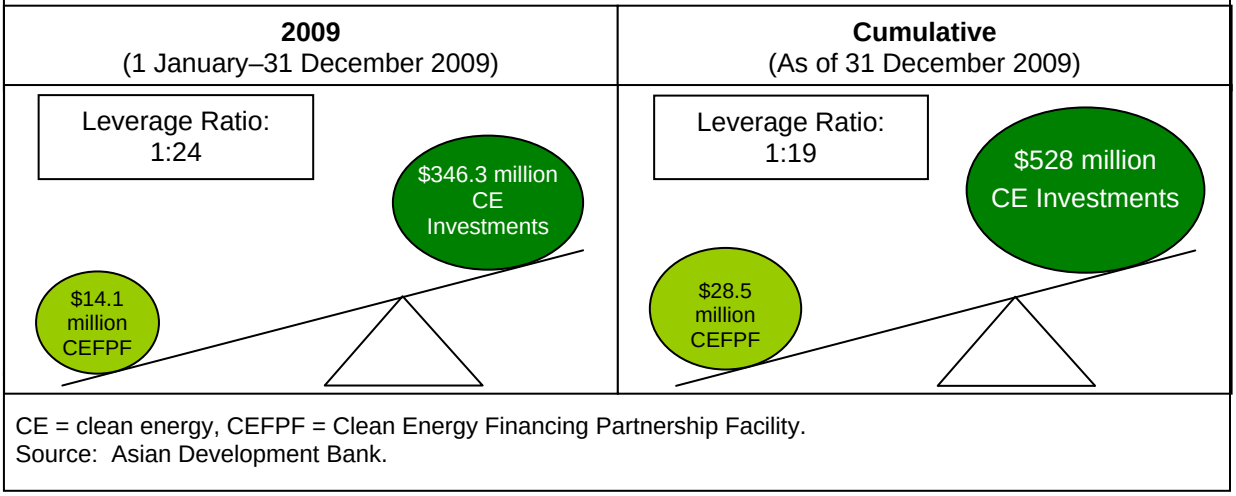
14. By definition therefore, DRF considers the entire continuum of climate risk, past, present, and future, since risk models depend on historic data, and climate risk has always been a constant threat and periodic drain on public resources. As such, DRF takes a "total climate risk" approach to managing natural disasters that plan for anticipated climate change as well as the climate risk that represents a present danger.

15. **Financing partnership facilities.** One of ADB's most important assets in addressing the causes and consequences of climate change are its partners, and some of the best creative solutions in financing result from the shared ideas and close collaboration between ADB and its financing partners. ADB will continue to maintain its partnerships and seek opportunities to build relations with new partners when appropriate. ADB's financing partnership facilities are not only

[11] DRF is the application of financial instruments, used as part of a systematic approach to managing natural disasters to anticipate, plan for, reduce, and transfer natural catastrophe risks before they occur. Examples of DRF initiatives include capacity development of reserving practices and strengthening local insurance markets; sovereign emergency liquidity insurance programs, emergency standby credit lines, development of offshore insurance captives, and development of catastrophe bonds.

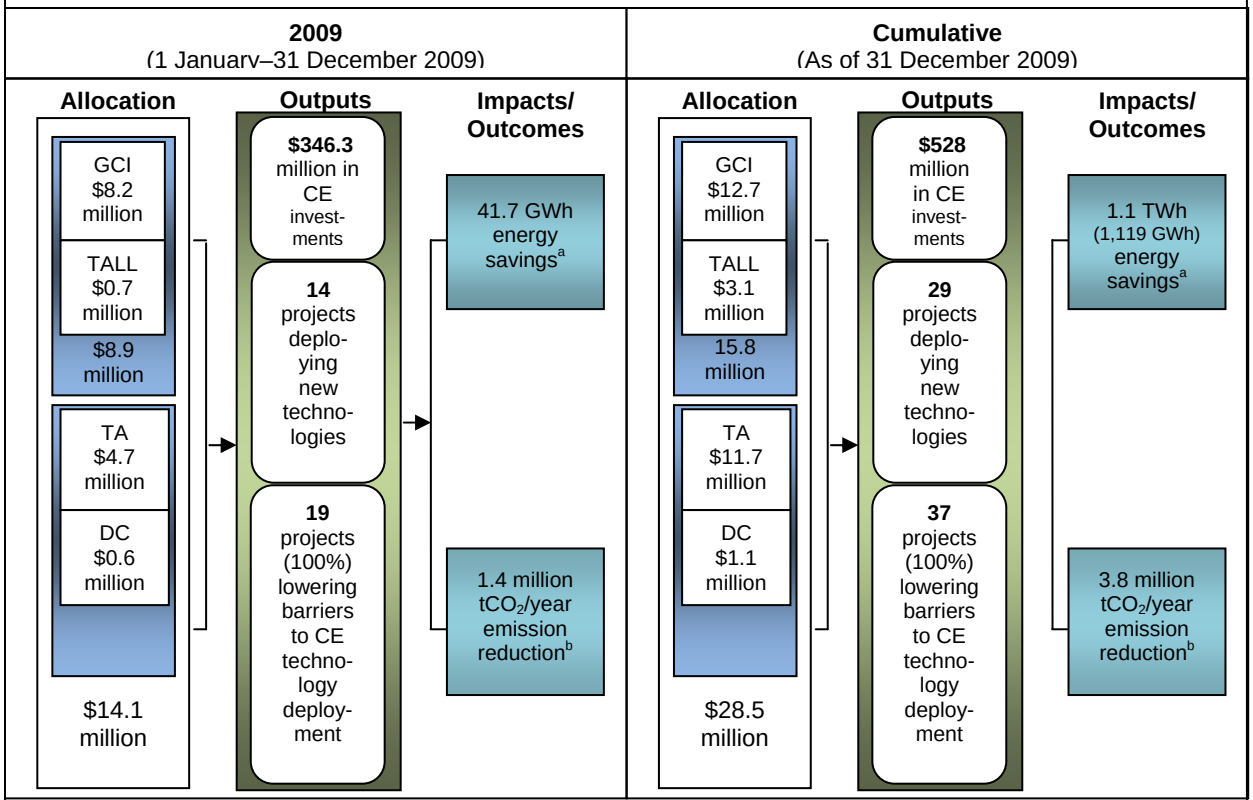
fund resources and financing mechanisms, but also platforms for cooperation between ADB and its financing partners to exchange ideas and information, explore new approaches and technologies, and align with common strategies toward achieving shared goals. The Clean Energy Financing Partnership Facility in particular was established to help finance DMCs' transition to low-carbon economies through cost-effective investment in technologies and practices that result in GHG mitigation, without compromising energy security. By the end of 2009, the facility had supported 37 projects in 34 DMCs, leveraging $528 million (Figure A6.1) in clean energy investments, is expected to mitigate 3.8 million tons of carbon dioxide annually and generate 1.1 terawatt hours (TWh) of energy savings (Figure A6.2). Financing partnership facilities such as the Clean Energy Financing Partnership Facility administered and backed by ADB's institutional capacity, can be very useful to ADB's financing partners seeking to maximize their finite resources in achieving their own targets to address the global climate change problem. Other existing financing partnership facilities in ADB supporting climate change mitigation and adaptation in their specific sectors include the Water Financing Partnership Facility, the Urban Financing Partnership Facility, and the Poverty and Environment Fund. Such arrangements will be consolidated and refined to meet the needs of both developed and developing country partners.

Figure A6.1: Leveraging Clean Energy Financing Partnership Facility Resources



CE = clean energy, CEFPF = Clean Energy Financing Partnership Facility.
Source: Asian Development Bank.

Figure A6.2: Outputs and Impacts and Outcomes from CEFPP Activities



CE = clean energy, CEFPP = CEFPF = Clean Energy Financing Partnership Facility, DC = direct charge, GCI = grant component of investment, GWh = gigawatt-hour, TWh = terawatt-hour, TA = technical assistance, TALL = technical assistance linked to loan, tCO_2 = ton of carbon dioxide.

[a] Covers only energy efficiency investments attributed to CEFPF financing.

[b] Covers all clean energy investments attributed to CEFPF financing.

Source: Asian Development Bank.

REGIONAL CONSEQUENCES OF CLIMATE CHANGE: KEY IMPLICATIONS

Summary: Climate change presents major threats to development and poverty reduction in Asia and the Pacific. The adverse impacts from climate change will require incorporation of measures to build resilience into patterns of development. With respect to reducing carbon intensity, it demands a shift to new patterns of economic growth to reduce the carbon footprint of the energy, transport, urban, forestry, and other sectors. As these are fundamental development concerns, region-specific knowledge of the challenges and opportunities they present must be improved. The Asian Development Bank (ADB) has supported studies on the economics of climate change in Southeast Asia, improving energy security and reducing the carbon intensity of the energy sector, climate change impacts and the need to build resilience in the agriculture sector, and the potential for climate-induced migration in the region. These and other analyses reinforce the case for ADB and its partners to give strong attention to addressing climate change in the region as a key development issue. ADB will continue to meet demands for timely knowledge, policy advice, and capacity enhancement in the developing member countries through development of such knowledge products.

A. Understanding a Growing Development Challenge

1. Climate change presents major new challenges to development in Asia and the Pacific. It demands a shift to a much less carbon-intensive pattern of economic growth and the incorporation of measures to build resilience to the impacts of climate change. The region-specific knowledge of these challenges must be improved if the region is to tackle them more effectively. The Asian Development Bank (ADB) has therefore supported studies on climate change, including (i) Regional Review of the Economics of Climate Change in Southeast Asia, (ii) Improving Energy Security and Reducing Carbon Intensity, (iii) Building Climate Resilience in the Agriculture Sector, and (iv) Climate Change and Migration. To meet demands for timely knowledge, policy advice, and capacity enhancement in the developing member countries (DMCs) to respond to climate change, ADB continues to invest in knowledge creation and dissemination.

B. Impacts on Economies of the Region

2. The impacts of climate change are greater in developing, than in developed, countries. *The Economics of Climate Change in Southeast Asia: A Regional Review* reports that, on average, Southeast Asia faces a loss equivalent to 6.7% of its annual gross domestic product toward the end of this century if investments in resilience-building measures are not made.[1] The same estimate for the world as a whole is 2.6%. Human settlement in developing Asia is characterized by concentrated populations in low-lying coastal and riverine communities, densely populated and concentrated with economic activity, with hundreds of millions susceptible to sea level rise and weather-related disasters. Moreover, low-income countries are typically less able to adapt to climate change primarily because of the lack of resources and capacity.

C. Impacts on Food, Fuel, and People

3. The studies find that the effects of climate change on these key drivers of the region's development—food, fuel, and people—on their own are striking, but taken together they can be

[1] ADB. 2009. *The Economics of Climate Change in Southeast Asia: A Regional Review.* Manila.

a major deterrent to long-term development in Asia and the Pacific unless policies, institutions, and investments are appropriately adjusted.

1. Climate Change and Food Security

4. The ADB-sponsored agriculture sector study, carried out by the International Food Policy Research Institute, used global climate models to develop scenarios to 2050 for Asia and to derive implications for food security.[2] The study states that current development policies are necessary but not sufficient for the adaptation of agriculture to climate change in this region, where more than 60% of the economically active population depends on agriculture for their livelihoods.

5. A pro-growth, pro-poor development agenda that supports agricultural sustainability, including more targeted assistance for climate change adaptation, improves resilience. International agricultural trade is an important mechanism for sharing climate change risk, and a more open global trading regime would increase resilience to climate change impacts. To offset the negative impacts of climate change in Asia, additional spending in the agriculture sector of $196 billion to $232 billion is needed from 2010 to 2050 over and above planned investments. This translates to an additional $4.9 billion to $5.8 billion needed per year (footnote 2).

6. The agriculture sector can also help mitigate greenhouse gas (GHG) emissions in Asia and the Pacific with appropriate incentive mechanisms and innovative institutions, technologies, and management systems, and by sequestering carbon in soils and vegetation.

2. Improved Energy Security and Reduced Carbon Intensity

7. The energy sector study, carried out by The Energy and Resources Institute, reviews recent experience in end-use energy efficiency, new technologies, and practices for higher efficiency in fossil fuel energy production, as well as expanding energy production from renewable sources.[3]

8. The study finds that energy efficiency improvements could contribute to large reductions in GHG emissions. Retrofitting high-rise residential buildings with energy-efficient technologies when they are refurbished, for example, can yield energy savings of up to 80% and negative life-cycle costs. Energy efficiency improvements in appliances could yield at least 25% savings.

9. The expansion of renewable energy supplies, including solar and biomass technologies, is crucial to establishing a lower-carbon and more energy secure future for the region. The large and rapidly growing markets of the People's Republic of China and India can help increase the access to and affordability of clean energy options for the rest of Asia, by driving down costs through economies of scale. In Southeast Asia particularly, high temperature geothermal resources can be used in electricity generation, while lower temperature geothermal resources can be tapped for a range of direct uses, such as district heating and industrial processing.

---

[2] ADB and International Food Policy Research Institute. 2009. *Building Climate Resilience in the Agriculture Sector of Asia and the Pacific*. Manila and Washington, DC.

[3] ADB and The Energy and Resources Institute. 2009. *Improving Energy Security and Reducing Carbon Intensity in Asia and the Pacific*. Manila and New Delhi.

10. Successful programs and policies such as energy service companies and feed-in tariffs for renewable energy should be expanded and the clean development mechanism used to support more innovative technologies for low-carbon energy in the region.

3. Climate-Induced Migration

11. The study on climate change and human settlements—examining the prospects for climate-induced migration—was done in cooperation with researchers at the University of Adelaide, Australia. The study uses climate change scenarios—covering short-, medium-, and long-term time horizons—to predict likely impacts of climate change on population displacement and migration and how this may affect social conditions in Asia and the Pacific.

12. In Asia and the Pacific, environmental change is currently not the only, or even the most important, driver of migration. Rather, changing one's place of residence on a permanent or temporary basis has long been a widely availed option in the face of declining or lost livelihood prospects. Therefore, climate-induced migration must be considered as a component of overall migration, and not dealt with as a separate issue.

13. Likely migration hotspots in the region include areas affected by sea level rise, cyclones and typhoons, flooding, and water stress, especially at river deltas, in low-lying small island states, and in arid regions of Central and West Asia. The impact of environmental hazards is mediated not only by the severity of the hazard but also through the community's resources to respond to that impact. Nonetheless, these hotspots can serve as reference points for expanded support for climate resilience through targeted, proactive support.

14. Whether or not an event or impact will result in greater population mobility is influenced by the availability of other options and adaptations as well as the community's past experience in dealing with similar environmental hardships. Barriers to safe and legal internal and international migration for those forced to move should be countered by appropriate and effective governance systems and policy mechanisms that maximize positive development outcomes from migration (such as expanded access to new skills and labor for migrants), facilitate migration at minimal cost, and encourage the safe transfer and wise use of remittances from migrant communities to relatives left behind.

15. With rapid urbanization already creating enormous challenges, effective planning approaches are needed to divert investment and economic activity away from vulnerable areas of the region's cities so that they do not attract uncontrolled migration. Migration management, international cooperation, development assistance mechanisms, improved governance, effective resettlement schemes, sound economic development policies, and long-term spatial planning are some strategies that will help deal with the potential for climate-induced migration.

D. Looking Forward

16. Actions must be decisive and informed to transform GHG-intensive and climate-vulnerable business-as-usual practices to new and sustainable patterns. ADB's Strategy 2020[4] recognizes the urgent need for significant progress on policies, institutions, and investments to promote clean energy, to establish migration and trade policies, and to develop the institutional capacity necessary to address climate change across developing Asia and the Pacific to protect future

[4] ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020.* Manila.

generations. Targeted assistance should be directed at those countries most vulnerable to climate change—that is, those with heavy exposure, high sensitivity, and low adaptive capacity to climate change impacts (Table A7).

Table A7: Climate Change Impacts on Food, Fuel, and People in Asia and the Pacific

Climate change consequences	Food security	Fuel and energy	Livelihoods and migration
Increased extreme weather events, such as floods, cyclones and heat waves	Crop damage and storage losses, changes in monsoon rains	Vulnerability of deep sea oil rigs and renewable energy options	Vulnerable communities at further risk, with increased disaster-related displacements
Increased drought incidence	Reduced crop yields, livestock Deaths, and possible famines	Reduced water resources for cooling towers, reduced hydropower and irrigation supplies	Depopulation of arid areas, internal moves to cities, conflicts over land and water access
Increased sea temperatures and Acidity	Coral bleaching and reduced fishery and other coastal and marine production	Possible opportunity for ocean thermal energy conversion	Reduced livelihood opportunities or fishing communities
Sea level rise	Reduced arable, irrigable and aquaculture areas in coastal zones	Relocation of power plants and other infrastructure away from coastal zones.	Migration away from coastal zones and islands
Saline intrusion	Saline damage of river delta irrigation areas	Impact on cooling water for power stations	Risks to water supplies, migration away from river deltas and small island states

Source: Asian Development Bank. 2009.