

DISCUSSION PAPER

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Adaptation and Mitigation

A Tool to Counter Climate Change in Developing Countries

Introduction

Climate change refers to any long term significant change in expected pattern of average weather of a specific region or the earth as a whole over a significant period of time. Climate change is associated with a gradual, but sustained, rise in annual average global temperatures and leads to global warming. Climate change is reinforced by interplay of various factors – both manmade and natural. It has now emerged as an issue of immediate concern within the international development community. Though some of the earlier research conducted on this phenomenon had emerged during the 1930s, it was not until the 1970's that scientists were convinced that global temperatures had actually begun to rise at critical rates and mostly as a result of human activity. International research conducted by the Intergovernmental Panel on Climate Change (IPCC) and the National Aeronautics and Space Administration (NASA) has concluded that the global average temperature has increased approximately 0.7 to 1.4 degrees Fahrenheit (0.4 to 0.8 degrees Celsius) since the 1850's and that it continues to increase at a dangerously alarming rate.

According to IPCC scientists and international climatologists, global warming is occurring as a result of human activity which has enhanced the earth's natural greenhouse gas emissions by increasing the presence of three main greenhouse gases in the atmosphere. The burning of fossil fuels, (coal, oil and natural gas) through the use of automobiles, factories and electricity power plants, leading to increased presence of carbon dioxide, methane and nitrous oxide within the earth's atmosphere. Deforestation and intensive farming have also contributed to the rapid increase in the atmospheric presence of greenhouse gases by decreasing the rate at which gas is removed from the atmosphere. Earlier research had found that carbon dioxide's atmospheric presence has increased by 35 percent since the 1850's, while that of methane and nitrous oxide has increased by 144.6 percent and 18 percent, respectively. While some may argue that these numbers are insignificant, recent environmental changes and natural disasters are evidence that climate change is reinforcing itself at an alarming rate and, therefore, taking remedial action has become indispensable.

An important characteristic of global warming is more frequent occurrence of extreme and unpredictable weather. Increase in average global temperature ultimately leads to frequent heat waves, droughts, floods and other devastating natural disasters. The number of category four and five hurricanes has increased by 75 percent since the 1970's and similar increases have been observed in other natural calamities. Global warming has also evidently had detrimental effects on polar icecaps and oceanic ecosystems. Permafrost and glaciers have been melting at a progressively higher rate since the 1970's as a result of warmer weather. According to IPCC climatologists, the Arctic ice peak has shrunk by as much as six percent in the last quarter century. The melting of sea ice and changes in atmospheric temperature are expected to lead to higher sea levels and oceanic temperatures, with damaging effects on coastal populations and also on diverse oceanic ecosystems.

Human activity has increased the presence of greenhouse gases within the atmosphere, resulting in the gradual destruction of earth's natural habitats. To prevent global warming, human activity must find ways and means to limit emission of greenhouse gases – by using fossil fuels more efficiently as well as replacing these with renewable energy sources. These renewable energy sources include wind, solar, nuclear and underground steam (associated with geothermal power). The process of carbon sequestration¹ is another method that can be used to prevent and control global warming, currently one of the most important global responsibilities recognised by the international community.

While developed nations have been responsible for the bulk of greenhouse gas emissions till date, developing nations have also in the recent past contributed to climate change, through rapid industrialisation and economic growth. Furthermore, while all nations are vulnerable to the effects of climate change, developing countries are far more vulnerable than developed ones. This impact is primarily due to geographic location of a majority of developing countries in the tropical zone which is more vulnerable to climate change than other parts of the globe. Such vulnerability is enhanced by dependence on natural systems and agriculture, as well as lack of resources and high incidence of poverty. These factors are indicative of the

higher losses imposed on developing countries relative to developed countries by climate change.

Developing nations are expected to face food insecurity as crops and livestock sensitive to climate change struggle to survive. Moreover, the spread of tropical diseases such as malaria and dengue would become more likely with a rise in water temperature. These are only a few of the various indirect effects of climate change on developing countries.

Awareness about vulnerability to climate change has led to action by the international community to take action and develop frameworks specific to local threats. Two forms of combating climate change have emerged: adaptive and mitigating frameworks. Adaptive innovations have been implemented in some countries to minimise the negative effects of warming and allow society to adjust and take advantage of its benefits. These include building infrastructure, creating disaster risk management and crop resilience development programmes, not to mention provision of further education and information on ways to adapt to climate change.

The ability of a nation to adapt to climate change depends highly on its capability to counter the vulnerability of its people and environment, the development of which has, therefore, become the focus of governmental efforts. Mitigation measures have also been implemented to minimise further climate change in the form of low emission-based industrialisation and low carbon development.

In the past decade, developing nations have begun to implement mitigating and adaptive programmes at many levels. Implementing national policies and engaging in bilateral cooperation to counter climate change has been the principal method employed by most developed countries. While some developing nations have interacted and replicated the methodology used by developed countries, some original developments at the grassroots and community level have also taken place to counter climate change.

The purpose of this discussion is to describe the various mitigation and adaptive measures implemented by developing countries to counter the negative effects of climate change at these various levels.

Adaptation and Mitigation in Some LDCs

A number of thorough research and development efforts have been initiated within the field of adaptation and mitigation to counter climate change. A majority of supranational organisations have created forums to counter climate change. Both developing and developed nations have interacted to form intergovernmental programmes, leading to formation of frameworks specific to the targeted effects of climate change.

The United Nations Framework Convention on Climate Change (UNFCCC) is a framework established over a decade

ago through which nations have made a commitment for undertaking research and implementation of action plans to counter climate change. The UNFCCC opened the door for the implementation of the Kyoto Protocol in 1997, through which nations (mostly developed) have approved and committed to emission targets. Though the Kyoto Protocol was primarily implemented to reduce overall greenhouse gas emissions, it has also provided means for adaptation and enhancement of resilience to the impacts of climate change, through an adaptation fund.

The Kyoto Protocol, however, has addressed one side of climate change and it has not recognised the needs of the developing nations. While developed nations are vulnerable to climate change, they possess sufficient resources to adjust and adapt, on the other hand, developing nations face problems mainly relating to mobilisation of sufficient resources and generation of adequate physical capability for enhancement of resilience to effects of climate change.

The UNFCCC has been a common ground for intergovernmental participation in presenting information on greenhouse gas emissions, national policies and best practices implemented, while also paying attention to the specific needs of developing countries. Under the UNFCCC, two specific programmes have been mandated to facilitate and document adaptation measures for countering climate change in developing countries. The first is the National Adaptation Plan of Action (NAPA). The NAPA has been developed to encourage less developed nations to examine vulnerable sectors and design national plans to cope with the impacts of climate change. The NAPA programme builds upon existing grassroots strategies for coping with climate change in order to prioritise activities with the help of stakeholders. These are designed to be action-oriented and country-driven. National Adaptation Plans of Action are submitted to the UNFCCC and, if approved, can be implemented under the Least Developed Country (LDC) fund, which is managed and facilitated by the Global Environment Facility (GEF).

The Nairobi Work Programme is an intergovernmental programme implemented by inter-governmental, non-governmental and private sector organisations as well as the community and other stakeholders. Its basic purpose is to improve country ability to assess and evaluate the impacts of climate change and make informed decisions on adaptation strategies.

Many developing countries have been incorporating the NAPA programme in their initiatives to counter climate change. While all continents are at risk, Africa can be considered as the continent most vulnerable to climate change. The vulnerability of many African nations is not only due to their geographical location but also their low adaptive capacity. Their inability to adapt is the result of various developmental challenges as well as macro-level processes which directly affect their economic and social development.

Box 1: Mitigation Projects Implemented under the NAPA Programs
(some selected LDCs)

Niger	Senegal	Ethiopia	Bangladesh
1. Introduction of fodder crop species in pastoral areas	1. Implementation of agro-forestry in: A) North Region, B) Basin Arachidier Region, and C) South Region Tambacounda, Kolda, Ziguinchor, D) Niayve Region	1. Promotion of drought/crop insurance programme	1. Reduction of climate change hazards through coastal afforestation with community participation
2. Creation of Livestock Food Banks		2. Strengthening/enhancing drought and flood early warning systems	2. Provision for drinking water to coastal communities to combat enhanced salinity due to sea level rise
3. Restoration of basins for crop irrigation	2. Sustainable use of water through: A) Revitalisation of lowland water system, temporary ponds and artificial lakes to support the retention basin programme. B) Promotion of drip irrigation.	3. Development of small-scale irrigation and water harvesting schemes in arid, semi-arid and dry sub-humid areas	3. Capacity building for integrating climate change in planning, design of infrastructure, conflict management and land-water zoning for water management institutions
4. Diversification and intensification of crop irrigation		4. Improvement/enhancement of rangeland resource management practices in the pastoral areas	4. Climate change and adaptation related information dissemination to vulnerable communities
5. Promotion of peri-urban market gardening and livestock farming	3. Protection of the coastal region through: A) Reforestation of coastal sites, B) Implementation of technical infrastructure, C) Restoration of mangrove vegetation, D) Implementation of alternative measures for the exploitation of coastal areas and E) Implementation of institutional measures	5. Utilisation and management of wet lands by community-based programmes/ activities	5. Construction of flood shelters, and information and assistance centres to cope with enhanced recurrent floods in major floodplains
6. Promotion of income-generating activities and development of mutually beneficial societies		6. Capacity building programme for climate change adaptation	6. Mainstreaming adaptation to climate change into policies and programmes in different sectors (focusing on disaster management, water, agriculture, health and industry)
7. Exploitation of surface and ground water	4. Creation of awareness about climate change mitigation by raising the level of education	7. Realisation of food security through multi-purpose large-scale development of water projects in Genale-Dawa Basin	7. Inclusion of climate change issues in curricula at secondary and tertiary educational institutions
8. Production and dissemination of meteorological data		8. Community-based carbon sequestration project in the Rift Valley System	8. Enhancement of resilience of urban infrastructure and industries to impacts of climate change
9. Creation of Food Banks		9. Establishment of a national research and development (R&D) centre for climate change	9. Development of eco-specific adaptive knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity to cope with future climate change
10. Contribution to fight against climate-related diseases		10. Strengthening malaria containment program (MCP) in selected areas	10. Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future
11. Improvement in erosion control actions (CES/DRS) for agricultural, forestry and pastoral purposes		11. Promotion of on-farm and homestead forestry and agro-forestry practices in arid, semi-arid and dry sub-humid parts	11. Promotion of coastal crop agriculture to combat increased salinity
12. Dissemination of animal and crop species that are most adapted to climatic conditions			12. Adaptation of agriculture systems in areas prone to enhanced flash flooding – North East and Central Region
13. Watershed protection and rehabilitation of dump-off ponds			13. Adaptation of fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices
14. Building of material, technical and organisational capacities of rural producers			14. Promotion and adaptation of coastal fisheries through culture of salt tolerant fish species in coastal areas
			15. Exploring options for insurance to cope with enhanced climatic disasters

Many nations in Africa struggle with endemic poverty and complex governance and institutional issues, such as limited access to capital, markets, infrastructure and technology, as well as high prevalence of diseases and ecosystem degradation. Many also are experiencing complex disasters and societal conflicts. While these factors have hindered their ability to develop and adapt, their geographical location has intensified their vulnerability to the effects of climate change.

Environmental change along with human drivers such as deforestation and forest fires have jeopardised Africa's forest ecosystem, agriculture, aquaculture and the livelihoods of millions of people. The number of endangered mammal species in the national parks of sub-Saharan Africa (SSA) has shown an annual decrease of 25-40 percent. Additionally, climate change has increased Africa's vulnerability to desertification to almost half (46 percent) of the total area.

Climate change poses threats to agricultural production and food security. According to the IPCC Fourth Assessment Report on Climate change, the decline in production could be as much as 50 percent by 2020, while net crop revenue is projected to decrease by as much as 90 percent. For most African nations, their ability to adapt to the effects of climate change, to which they have contributed insignificantly, will determine if they can encounter the adverse impact of resulting environmental degradation and continue to develop in future.

For most LDCs and especially African nations, the NAPA has been the only documented adaptation measure taken. Countries like Niger, Bangladesh, Senegal, Ethiopia and Cambodia have all submitted action plans and are working with the GEF to implement their projects. A list of implemented projects in some LDCs under the NAPA is given in Box 1.

While the NAPA programme focuses on the adaptation initiatives taken in less developed countries, the UNFCCC's Nairobi Programme is a framework for initiatives across all levels – inter-governmental, non-governmental and regional. The framework was initiated with the specific purpose of helping developing countries improve their level of participation in the Clean Development Mechanism (CDM). Under the Nairobi Programme, many countries have submitted adaptation plans and implemented sector-specific activities. The types of programmes can range from development of new technology, implementation of activities and determination of approaches and strategies to countering climate change. While many of the submissions are similar in objectives, some are more elaborate and detailed than others. Some others provide minimal information on the actual programmes.

Climate Change Mitigation in Some Selected Developing Countries

Lack of resources and prevalence of poverty are major sources of vulnerability in developing countries. By providing disaster relief and insurance, countries can limit vulnerability. In India, the United Nations International Strategy for Disaster Reduction, along with the government, has established a programme which involves providing a disaster Micro-Insurance Scheme for low-income groups, in response to the effects of climate change. It covers over 19 different types of disasters including floods, cyclones and storms. This is one of many schemes adopted to reduce the vulnerability of people and protect those at risk from the effects of global warming.

Another project taking place in Kenya under the Nairobi Programme is the development of sand dams for capturing water from seasonal rivers in arid and semi-arid areas. Drought is one of the most serious natural disasters brought about by climate change, jeopardising agriculture and the livelihoods of many around the world, especially in eastern Africa. Water harvesting technology has played a major role in adapting to unreliable rainfall.

According to the International Centre for Trade and Sustainable Development, climate change has triggered a surge in Genetically Modified (GM) crop testing and development. Brazil's agricultural sector has been jeopardised by climate change and crop production has been pushed southward. Climate change has decreased the productivity and quality of primary crops such as beans and coffee. Using GM technology, Brazilian scientists have been studying ways to enhance crop durability and resilience to the predicted change in climate. During 2008, GM crop production accounted for 9.4 percent of the total crop production worldwide and, with the onset of climate change, many countries have resorted to use of this alternative.

Some findings of studies² for Brazil, India, Mexico and South Africa – four countries that produce large greenhouse gas (GHG) emissions and are heavily engaged in the debate on climate change projects under the Kyoto Protocol – are enumerated below (see Box 2).

Climate Change Mitigation Initiatives in China

Today, China is the largest emitter of GHG in the world. It has surpassed the US as the largest emitter of GHGs in the world. However, its emissions per capita still rank at 99th in the world. China's rapidly growing economic activities and population and its geographical location has increased its vulnerability to climate change. The country, therefore, needs to be more forthcoming with innovative initiatives to counter climate change. Its world ranking in terms of per capita GHG emissions apparently does not appear to be a reasonable indicator of its responsibility to counter climate change. Being the most populous country, it has long term

Box 2: Climate Change Adaptation and Mitigation Programmes in Some Selected Countries

Case Study	GHG Benefits	Economic Benefits	Social & Institutional Benefits	Environmental Benefits
Brazil: Forest Conservation to slow Amazon deforestation	Not estimated	Positive income from carbon offsets; possible rural job loss	Complex interplay among social costs & benefits	Reduced deforestation & soil erosion; biodiversity protection
Brazil: Charcoal production from renewable sources of wood	90 Mt C/yr in 2025 for FLORAM project	Minimal incremental cost over imported coke; local jobs generated	Aids transition to sustainable steel industry	Reduced natural forest harvest & soil erosion; reclamation of land
Brazil: Ethanol production for vehicles	188-209 Mt C per year by 2010	Negative net cost over imported oil base case	Rural job retention until mechanisation	Significant air quality improvements
Brazil: End-use energy-efficiency increases	2.6 Mt C by 2010 in abatement scenario 1	Increased employment	Not addressed	Reduced air pollution
India: Teak plantations for carbon sequestration	145,000 t C cumulative by 2040	Jobs and income generated; reduced wood imports; reduced need for foreign exchange	Capacity building	Land reclamation via soil & water conservation; reduced pressure on natural forests
India: Agro-forestry, raising tamarind trees	119,000 t C cumulative by 2040	Income generated	Capacity building: technical assistance introduced	Land reclamation via soil & water conservation; reduced pressure on natural forests
India: Bio-energy for rural electricity	62,000 Mt C by 2040	Local employment & income generated	Capacity building.	Reduced air pollution; land reclamation.
Mexico: High-efficiency household lighting (ILUMEX CFL pilot project)	198,308 t C by 2005	Urban jobs created in CFL manufacturing; local jobs and income generated	Higher lighting level at reduced cost for consumers; avoided investment in 100 MW power generation	Reduced NO _x (206 t/yr), SO ₂ (959 t/y), particulate matter (470 t/y) & hydrocarbons (66 t/y)
Mexico: Carbon sequestration/sustainable forest management	Chiapas agro-forestry project 330,000 t C by 2030	Increased income for farmers; development of forest-based enterprises	Capacity building; farmers' credit union strengthened; improved women's welfare	Reduced deforestation from migration; biodiversity conservation
Mexico: Carbon sequestration/halophyte plantation: Salicornia	660 TC in Phase I; Phase II (Not yet in place)	Fiberboard industry created in Phase II; food products for export livestock feed	Not addressed	Increased soil carbon
South Africa: High-efficiency lighting (CFLs)	Range is 0-244,000 MTC, depending on type of power backed out	Net economic value is US\$119-135mn NPV over 5 years	Reduced operating costs of CFLs; Build CFL industry in country eventually	Reduces emissions from coal power plants
South Africa: Eco Housing Efficiency	40-50 thousand t C saved from 6000 homes over 50-year project period	US\$2.6mn project incremental cost	Local firms and community training to create jobs; Increased occupant comfort	Reduced fatalities from house fires; and indoor air pollutants and respiratory infections

obligations to protect the lives of more than a billion people. Evidence supporting the seriousness of climate change events was found by the Chinese meteorological centre – floods and landslides have been at their worst since November 2008 in over eight different provinces of China. The retreat of glaciers and permafrost has also caused not

only sea levels to rise but also disrupted the natural flows of rivers, compromising the aquaculture industry and the availability of freshwater. There is also evidence supporting a decline in summer precipitation over central parts of arid and semi-arid Asia, leading to the expansion of deserts and frequent and severe water stress.

The impacts brought about by climate change have increased the vulnerability and jeopardised many sectors of China's economy, especially aquaculture and agricultural sectors. These sectors have become substantially more vulnerable to climate change. China's agricultural sector faces a severe decline in productivity because of high temperatures, severe droughts, flood conditions and soil degradation. As a result of global warming, marine fishery in China faces threats due to over-fishing, pollution, red tide and other environmental changes. The effects that climate change will have on oceanic ecosystems will alter fish breeding habitats and food supply for fish and lead to a decline in fish populations in Asian waters.

China has implemented the "Green Strategy", which involves increasing resource use efficiency, clean production, reduction of pollution cost in production processes and the ecological impact of consumption, development of renewable energy and alternative energy sources and reform of production methods.

China reforestation programmes have been responsible for preserving 53.84 million hectares of forest land and reforesting 13.33 hectare of over-cultivated land. China hopes to reach 28 percent forest coverage by 2050. Also, as a result of climate change, desertification has become a major concern for the Chinese government: in certain areas of China, desert expansion is occurring at an approximate rate of 3,000 sq km per year. In response, the State Forestry Administration has implemented a nationwide programme which hopes to bring all sources of desertification under control by 2050 and promote reforestation of the land lost to desertification. Some government agencies have also come up and begun to implement an electronic waste management programme, which requires the producer to take partial or even full responsibility for the environmental wastes it produces.

China has also made investments in thermal, nuclear and hydro-power industries to counter climate change. Besides, some progress has been made in developing wind power. China has established a renewable energy standard (RES) mechanism to replace high carbon fuels with ones which produce zero emissions. The RES hopes to generate 15 percent of primary energy needs by 2020. Chinese plans also involve a 20-percent reduction in emission intensity from 2005 levels by 2010 and a target of 20 percent of energy from hydro-power by 2020. Other mitigating strategies taken by China include levy of export taxes on energy-intensive products and provision of incentives for solar photovoltaic industries.

Adaptation and Mitigation at the Bilateral Level

Most of the progress in adaptation and mitigation has been made at the bilateral level through various organisations. Germany-based GTZ is one of the world's leading international cooperation enterprises facilitating sustainable development globally. While GTZ operates in over 120 countries, many of its projects are implemented in

developing countries and deal with both adaptation and mitigation to counter climate change. In India, it has developed an *Enhanced Protection of the Environment and Material Resources Programme*, which serves as an advisory service in the field of environment management. It has also implemented a sustainable watershed management programme and a programme for energy efficiency labelling of electronic household appliances, in order to raise consumer awareness and promote energy saving.

In China, GTZ has worked with the state and municipal forestry operations to develop, establish and maintain sustainable forest management in the *Fujian, Hainan and Hunan* provinces. Also, along with China's Ministry of Agriculture, GTZ has implemented intensive sustainable agricultural practices in North China, through technological packages requiring the reduced usage of water, pesticides and fertilisers.

Another impressive effort, more within the field of mitigation, has been the establishment of a renewable energy and energy efficiency programme in Bangladesh. As a result, more solar energy power plants are now being set up in Bangladesh. Also, micro-credit schemes have been provided to the poor to enable them to invest in solar panels.

The Brazilian government, in association with the GTZ, has made a commitment to reduce deforestation by up to 70 percent by 2017, by implementing preservation programmes. Brazil has recently witnessed depletion of its Amazon rainforest, which along with other depletions, have lead to a 20-percent increase in combined greenhouse gas emissions.

Conclusion

The global community has reached a point where climate change can no longer be ignored. Its impacts are causing destruction of human habitats and the livelihoods of people all around the world, jeopardising food and water security, the survival of millions of animals and, most importantly, humans. Developing countries are extremely vulnerable to climate change, as their geographic location predisposes them to its effects and also because most of those nations are significantly dependent on agricultural systems which are ultimately driven by climate. Their ability to reduce their vulnerability, through adaptive implementations, will determine further economic growth and human development. As developing nations deal with population growth and the pressure to industrialise and modernise, the global community has been forced to prevent further climate damage by decreasing greenhouse gas emissions and promoting environmental-friendly sustainable development. While there is sufficient literature on climate change and related adaptation, nothing really captures the role developing nations have played.

Many nations have cooperated at the supranational level to discuss ways to counter the effects of climate change. The United Nations Framework Convention on Climate

Change (UNFCCC) has been a great resource for sustainable development. The UNFCCC has established the NAPA programme, thus providing less developed nations the means to discuss and implement national plans or action plans. The NAPA programme provides initiatives at the grass-roots level, implementing projects needed by people which involve the community. For many developing nations, targeting sustainable development at the grassroots level is crucial, because local communities are the most vulnerable. Implementation at the grass roots is one of the most effective ways to adapt to climate change, as it targets the specific vulnerabilities and needs of each community. The UNFCCC has also adopted the Nairobi programme as a platform for all stakeholders to share their actions in the field of climate change and related developments.

Bilateral cooperation and investment has also provided developing countries with the means to implement adaptive and mitigating innovations. Private organisations from developed countries have funded projects in developing countries to counter the impacts of climate change. In terms of bilaterals, GTZ, Department for International Development (DFID) and Swedish International Development Agency (SIDA) have been relatively ahead as donors.

When it comes to mitigation, most nations have realised the importance of reducing greenhouse gas emissions and promoting alternative energy sources. The Kyoto Protocol, developed by the UNFCCC, has served to enforce emission standards and mitigate further climate change. However, it continues to be a forum involving mostly developed nations because these have been the major emitters of greenhouse gases. Many nations have adopted domestic programmes to decrease GHG emissions and increase usage of renewable energy sources. These have promoted low emission-based industrialisation by providing incentives and taxing carbon intensive products.

While climate change has created a challenge for development, it has also provided a new perspective for developing countries. Vulnerability has made developing countries environmentally conscious, forcing them to reconsider their development strategies and adopt methods for adapting to the irreversible effects of climate change. Economic growth and human development in developing communities will increasingly depend on their ability to address the issues of climate change through mitigation and adaptation.

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Endnotes

- 1 Carbon sequestration is process which involves preventing carbon dioxide from entering the atmosphere and removing carbon dioxide already present in the atmosphere and storing it in either underground or underwater storage systems or within living plants.
- 2 *Concerns About Climate Change Mitigation Projects: Summary of Findings from Case Studies in Brazil, India, Mexico and South Africa*, Jayant A. Sathaye, Kenneth Andrasko, Willy Makundi, Emilio Lèbre La Rovere, N.H. Ravindranath, Anandi Melli, Anita Rangachari, Mireya Imaz, Carlos Gay, Rafael Friedmann, Beth Goldberg, Clive van Horen, Gillian Simmonds and Gretchen Parker, Ernest Orlando Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division.

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