

CLIMATE ALERT

Volume 7, Number 4

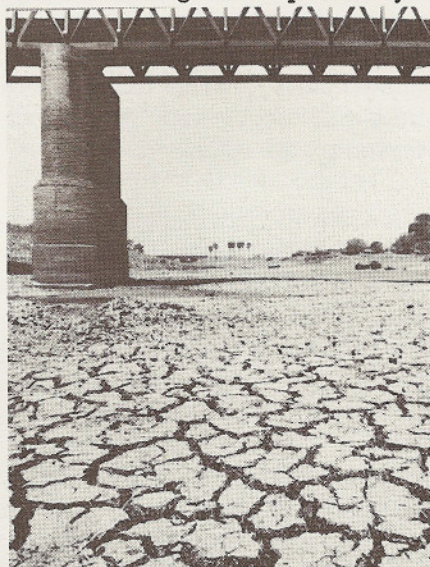
July-August 1994

Pioneering Study of 8 Asian Nations Examines Implications of Climate Change for Region

Nations in Asia and the Pacific are especially concerned about the buildup of greenhouse gases in the atmosphere because of the potential effect on the region from climate change related shifts in patterns of storms, floods and droughts as well as a rise in sea level. As this region has been historically vulnerable to fluctuations in the monsoons, the El Nino Southern Oscillations and tropical cyclones, Asian policymakers have shown considerable interest in the implications of climate change. A \$1.45 million cooperative eight-nation study, funded by the Asian Development Bank (ADB), the Governments of Australia, Japan and Norway, and organized by the Climate Institute, was published August 11. It details the possibly profound impacts of greenhouse-induced climate change and sets forth a wide range of cost effective measures to deal with them.

The eight countries participating in the massive ADB international project — Bangladesh, India, Indonesia, Malaysia, Pakistan, the Philippines, Sri Lanka and Viet Nam — contain one-fourth of the world's population and probably an even larger portion of those most vulnerable to climate change. Large numbers of residents live in low coastal areas or river deltas where sea level rise and flooding are the likeliest devastating consequences of rises in global temperatures as the climate shifts.

A remarkable spirit of cooperation imbued this project initiated by the Office of the Environment of the ADB and carried out by the Climate Institute and its 12-nation team of over 60 experts. Each country team identified the significant, potentially



USAID PHOTO

River bed during drought in India

disruptive impacts of climate change, chose policy options to combat sea level rise, depletion of forests, etc., and national strategies for implementing the options. Each government approved the scope of the country study. These study findings and recommendations were presented at national workshops and accepted. At two regionwide meetings — in Manila in July 1992 and Bangkok in March 1993 — Regional

Study team members and officials of participating governments and international agencies discussed common methodologies and strategies. Developed over 27 months the study findings have been presented to and endorsed by the governments of the eight participating nations.

Despite differing vulnerabilities to climate change and differing resources to respond, the country studies all underscore the importance of cooperative action among the nations of Asia to address the common challenge — by improved monitoring of climate change and early warning signs of key environmental indicators and by cooperative research on monsoons, ENSOs (El Nino/Southern Oscillations), tropical cyclones. Significant progress is already underway on these and other fronts: studying how crops are affected and how they can be bred for improvement, sharing information on technological options to limit greenhouse gas emissions and developing cooperative strategies to respond to natural disasters.

A team of 17 international experts assisted national teams from each of the eight nations which carried out the individual core studies of climate change implications — such as reduced harvests, changes in availability of water — and responses.

(Continued on page 3)

The Need for Radical Technological Innovations

Commentary by John C. Topping, Jr., President, Climate Institute

The eight country Asian Regional Study on Global Environmental Issues and two parallel Asian Development Bank (ADB) funded studies of China

and Thailand soon to be completed may be the most significant regional initiative on climate change since the signing of the Framework Convention in 1992 in Rio de Janeiro. Thanks to the foresight of the Office of the Environment of the ADB and three sponsoring governments — Australia, Japan and Norway — and remarkable support by governments of all participating countries Asian policymakers now have a realistic assessment of the implications of climate change.



John Topping

The eight recently published country studies of Bangladesh, India, Indonesia, Malaysia, Pakistan, the Philippines, Sri Lanka and Viet Nam underscore the potential for climate change to prove quite disruptive to human society and ecosystems in the most densely populated regions of the world.

Each of the eight studies carried out an inventory of national greenhouse emissions and seven studies examined options for limiting emissions and enhancing sinks. The findings here are instructive as the Asia Pacific is currently the region with the most dynamic growth.

Four country studies, India, Indonesia, Sri Lanka and Viet Nam, sought to project energy sector emissions trends into the future, some as far as 2070. Even with aggressive use of existing energy efficiency measures all four countries would see a sharp rise in emissions, although still not

to current OECD per capita levels. These results suggest that any successful global effort to stabilize greenhouse emissions and eventually concentrations is likely to require introduction of radically improved energy technologies. A high priority of global policymakers over the next decade may ultimately be to foster a partnership between governments across the world and the private sector to accelerate the arrival of such technologies — low greenhouse emissions vehicles, decentralized renewable energy systems, radically improved energy efficiency and extensive use of biomass energy systems. Some encouraging initiatives are underway, particularly US Energy Secretary Hazel O'Leary's Climate Challenge program with the electric utility industry and her recent visits to India and Pakistan to foster collaboration on energy issues.

It is also important that global change research be focused more on answering issues of acute concern in the Asia Pacific region. These include simulating ENSO under present and enhanced greenhouse conditions, understanding how the frequency, intensity or storm track of tropical cyclones may change under enhanced greenhouse conditions, understanding how climate change may affect the interannual and interseasonal variability of the monsoons, and addressing such multi-region concerns as improving the resolution of climate models to make reliable sub-regional projections, developing a better understanding of likely crop response to climate change, and developing cost-effective adaptation responses to sea level rise. Regional study participants and representatives of the eight study countries and eleven other Asian nations endorsed these research priorities during the Bangkok Seminar. Region-wide cooperation is already underway on these issues and may grow on

such matters as shared water resources, flood and irrigation management, and sharing of meteorological and environmental data.

The promising joint research activity occurring in Asia, if coupled with a successful global partnership to hasten the arrival of low greenhouse technologies, can help ensure that future rates of climate change do not overwhelm human capacity to cope.

The remarkable international success in rapidly phasing out CFCs and other stratospheric depleting compounds (See the May/June 1994 issue of *Climate Alert*) was made possible by technological innovation that resulted from unprecedented teamwork between industry and government. Success in stabilizing greenhouse concentrations and containing climate change may depend on whether we emulate this course rather than seeking to erect a command and control global regulatory apparatus that frustrates the dramatic technological change humanity may require.

CLIMATE ALERT

Published 6 times a year by the
Climate Institute — © Copyright 1994
ISSN 1071-3271

Sir Crispin Tickell, *Chairman*
Stephen Leatherman, *Co-Chairman*
John C. Topping, Jr., *President*
Mark Goldberg, *Publications Chairman*
Nancy C. Wilson, *Editor*

324 Fourth Street, NE
Washington, D.C. 20002
Phone: (202) 547-0104
FAX: (202) 547-0111
E-Mail: climateinst@igc.apc.org

(Continued from page 1)

The impacts tend to be quite substantial and, on balance, generally adverse, particularly by 2070, when it is expected that the full impact of an effective doubling of atmospheric CO₂ will strike the earth. Sea level rise, the likeliest consequence of global warming, is projected to produce especially severe effects for seven of the eight countries involved.

Each country team working closely with its government developed detailed analyses of vulnerability to climatic or weather-related events, potential impacts of climate change in 2010 (a period within the scope of long-range national plans) and 2070, and estimates of national emissions of greenhouse gases. The Atmospheric Research Division of Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO) developed low, mid and high climate change scenarios as a foundation for impact assessments in each country study, using available simulated data from a number of high resolution general circulation models and CSIRO's own model.

The impact studies assessed options to cope with climate change and proposed national response strategies, undergirded by climate scenarios and impacts methodologies provided by the international team led by the Climate Institute and by population and economic growth estimates developed by the country teams.

Using Intergovernmental Panel on Climate Change (IPCC) emission inventory guidelines and working with ICF, a Washington-based consulting firm, each country provided greenhouse gas estimates focused on 1990. In some cases, inventories were not exhaustive; only partial data were available, and actual totals might be higher.

Energy-related emissions are expected to grow most rapidly, with significant increases in the next 20 years. While burning of fossil fuels is overall the largest single emissions source, in three countries agricultural emissions predominate. Besides energy and agriculture, the emissions — carbon dioxide, methane, and nitrous oxide — come from forests

converted to farms, waste management, and industrial processes.

The teams evaluated the technical and economic feasibility of their options: to adapt to climate change and limit emissions or enhance sinks.

Dr. Kazi F. Jalal, ADB Chief of the Office of the Environment, calls one of the most significant challenges of our time: devising a response to global concerns without hampering progress and growth in the Asian developing countries. They are understandably unwilling to sacrifice their goals for a problem largely caused elsewhere. More efficient energy technologies, up-to-date transit systems, sustainable techniques for forestry and land-use may advance development without contributing to a critical global problem.

Strong support for such measures is provided in the eight country studies which generally rely on options and strategies for development that emphasize a "no regrets" framework, taking measures now that yield benefits even if climate changes do not occur. Immediate improvement of energy efficiency is high on the list of options as it promotes development goals.

The 10-volume study includes an executive summary, Climate Change in Asia, eight country reports and a thematic report covering agriculture, water resources, coastal areas, forestry and land use, greenhouse gas emission inventories, mitigation strategies, and economic implications. It was edited by Dr. Ata Qureshi and David Hobbie. Dr. Qureshi served as team leader for the study. For further information, please contact: Chief, Office of the Environment, Asian Development Bank, P.O. Box 789, 1099 Manila, Philippines; FAX 632/741-7961 or Dr. Ata Qureshi, FAX: 202/547-0111.

POTENTIAL IMPACTS OF CLIMATE CHANGE

Huge populations will be displaced, potentially producing millions of environmental refugees:

- 3.3 million people by 2070 from flooding and inundation of settlements in low-lying areas in Indonesia. Jakarta, where excessive pumping of ground water has caused the land to subside alarmingly, is in particular danger, with the prospect of more than a one meter sea level rise by 2070.
- 7.1 million at risk in India
- large-scale displacement in Bangladesh
- submergence of parts of Manila and other areas in the Philippines
- large populations living on river deltas in Viet Nam where nearly 5,000 km of dikes need to be constructed or strengthened

The effects on mangrove forests are stark. The Sundarbans, Bangladesh's rich mangrove cover, is likely to be destroyed as would much of Malaysia's. Pakistan, least affected by sea level rise, would face the loss of the mangrove forests which are the source of fuel wood and food to local inhabitants and breeding ground for 90 percent of Pakistan shrimp, its main fisheries export.

Inundation of much of the Red River and Mekong Delta in Viet Nam would seriously threaten rice production and food security. In Bangladesh, where the vast majority of the population of over 100 million is engaged in agriculture, large losses in farmlands are likely.

Sri Lanka would lose significant revenue from tourism and fisheries.

BANGLADESH COUNTRY REPORT

A definite trend toward increasing rainfall is expected to accompany climate change in Bangladesh, an ominous development in a country with such large areas of low eleva-



Artificial Lagoon

JCTOPPING PHOTO

tion. Considering the possibility of greater variability in precipitation, water management is a key adaptation issue, especially improved irrigation facilities to stabilize food grain production. High priority is suggested for a national system of tradable water rights. Since many of Bangladesh's rivers arise in the Himalayas of Nepal and India, regional cooperation in water management and water sharing is accorded front rank.

The consequence of much more rain would be severe flooding; a 10 percent increase in rainfall would be followed by an increase in runoff depth of around 20 percent. With a one meter rise in sea level, one fifth of the nation's land and nearly 15 percent of the population would be threatened by inundation. The Sundarbans, one of the world's richest mangrove forests, would disappear, leading to a major loss in biodiversity, loss of a natural sink for greenhouse gases, and loss of biomass which is a major energy source in the country.

The impact of climate change on the Bangladesh economy would be extremely adverse: an annual loss of

\$1 billion of GDP by 2010, \$5 billion by 2070.

Despite these implications, the Bangladesh country report stresses a consideration that is probably true in most developing countries: eradication of poverty is the nation's highest priority, with climate change issues occupying a distinctly lower level of importance.

At highest priority are "no regrets" measures such as distribution of improved cooking stoves, participation in forestry ac-

tion programs, more efficient water management in the dry period, construction of coastal shelters from rising seas, and planting of more trees. Reforming of forestry and energy prices, also a "no regrets" strategy, takes second priority with a particular focus on energy efficiency in appliances, equipment and industrial processes. These recommendations have already been approved and are under consideration.

In third place come water management during monsoons, strengthening coastal embankments, reducing methane emissions from rice fields and livestock, and more emphasis on future forestry development to replace the biomass that may be lost in the Sundarbans.

Development of high-yielding crop varieties resistant to salt, submergence and drought as well as close observation of the behavior of crops in a changing climate rank high on Bangladesh's research agenda.

Monitoring sea level rise is a crucial concern for a nation with vast, heavily populated river deltas, and

Bangladesh plans to keep a close sea rise check on a national basis and join others for regionwide observations. A high priority is put on regional cooperation in water management and water-sharing, which the report states has a "lackluster record." The national flood control policy comes under severe criticism for lack of consideration of environmental impacts in planning, design and operation.

A newly developed storm alert system, plus the country's storm shelter program, are invaluable for this country with a long history of recurrent losses of hundreds of thousands of lives in cyclones and



JCTOPPING PHOTO

Coastal Land

tidal waves. The new system is credited with probably keeping the death toll below 500 in a May 1994 storm in sharp contrast to the death of more than 130,000 in a major cyclone in 1991.

Because of the nation's low energy use and predominantly agricultural sources of greenhouse gases, emissions are less important than in many of the other participating countries. But the Bangladesh report expresses an interest in developing tradable rights in greenhouse gas emissions.

Team Leader: Dr. M. Asaduzzaman
FAX: (880) 2 813 023

Study Conducted By: Bangladesh Institute of Development Studies
Implementing Agency: Ministry of Forests and Environment

INDIA COUNTRY REPORT

There are 6500 kms of low-lying, densely-populated coastline in India, placing the lives and livelihood of more than seven million people at risk if the sea level rises by one meter. The economic costs of sea level rise are large, amounting to 43 percent of the 1988 GNP, mostly from loss of land, according to the India country study which was conducted by a well-qualified national team led by the Tata Energy Research Institute. Estimates of the average cost of protections, such as bulkheads, dikes, island elevation and beach nourishment, spread over 40 years, come to roughly 0.1 percent of the GNP.

Projections of climate change seem to show no significant shift in summer monsoons or cyclones in India at least during the next few decades, and therefore little effect on water supply is expected, according to this country report. However, the country's growing population and the demands for more water by the agriculture, industry and power sectors will put stress on water resources. Since it is estimated that the country uses only a fraction of its rainfall at present, conservation and effective use of water could help supply future needs.

With the rise in rainfall foreseen by CSIRO models, wheat yields would be likely to increase, but higher temperatures would depress yields of both wheat and rice.



USAID PHOTO

Experimental farm staff member examining millet crop

The study reports uncertainty about data on the source of greenhouse gas emissions and the rate at which they are produced by specific activities. It advocates ensuring that specific greenhouse gas inventories draw on local expertise and country specific research data. Standard methodologies for developed countries yield estimates that are too rough for calculating Indian emissions from agricultural or industrial sources and the effectiveness of particular sinks.

India can employ both coastal and forestry adaptations in its response to climate change. It can:

- discourage development in areas vulnerable to flooding and manage coastal areas to preserve critical ecosystems
- conserve existing forests, plant trees on degraded lands, establish protected areas for biodiversity. (Already 12.7 million hectares are in nature reserves.)

Biomass makes up 40 percent of energy consumption in the country. Up to 1990, India had begun tree plantations on nearly 18 million hectares of land, and the study team chose afforestation as the "no regrets" alternative with the largest potential for reducing CO₂ emissions. A large afforestation program, planting two million hectares per year, is proposed. Five forestry scenarios, each under potential, feasible, or business-as-usual conditions, yield varying returns on investment for carbon

sequestration options and demonstrate there is no conflict between obtaining local benefits, such as biomass production and soil conservation, and carbon sequestration:

1. Natural regeneration recommended for partially degraded forests lands would cover about 25 million

hectares.

2. Enhanced natural regeneration for totally degraded forest lands would target about 11 million hectares. This would include biodiversity and watershed management and provision of non-timber forest products and small timber to local communities.

3. Community woodlots — permanent pasture lands to meet local biomass needs in a sustainable way, raising trees for firewood, timber and non-timber forest products

4. Softwood — clear-cutting part of tree plantations for firewood and for the softwood used in such products as paper, rayon, packaging and matches. Under this option, some land would still be degraded.

5. Agro-forestry — growing trees to meet individual farm biomass needs and possibly for sale of wood or non timber forest products.

Investment under a "feasible" scenario would total 59 million rupees a year.

Besides planting trees, India can mitigate emissions by:

- increasing energy efficiency in the electric, industrial, transportation and domestic sectors, raising fuel efficiency and making fuel substitutes
- promoting renewable energy technologies

Beyond the nation's borders, the report notes, it is important that a cooperative research program tackle vulnerabilities of the region and develop methods for measuring climate impact and assessing risk. A special effort must be made to ensure that scientific assessments reach policy makers and the public.

Team Leader: Dr. R. K. Pachauri
FAX: (91-11) 462 1770

Report Prepared By: National Team led by Tata Energy Research Institute
Implementing Agency: Ministry of Environment and Forests, India

INDONESIA COUNTRY REPORT

(Excerpted from the report)

Climate change will alter the daily lives of millions of Indonesians by threatening everything from adequate food and water supplies to ecotourism revenues. Reverberating throughout the natural and socioeconomic environments, sea level rise, increased temperatures, and disrupted rain cycles will affect coasts, river basins, and upland areas.

As an archipelago of nearly 17,000 islands with a total coastline exceeding 81,000 km, Indonesia will suffer significantly from even very small rises in sea level. Industry, infrastructure, and urban populations are concentrated in low-lying coastal areas. Of a total population of 179.4 million, approximately 110 million live near the shore. The inundation of seaports, beach resorts, and inland or coastal fisheries, intrusion of saltwater into coastal freshwater aquifers and shallow ground water, and changed tidal ranges would severely affect millions of Indonesians, if not by directly displacing them, by eliminating the industrial or agricultural zones or fisheries upon which their livelihoods and welfare depend, salinating their drinking water, overwhelming flood control and sewer systems, or disrupting marketing and transportation networks and their access to goods.

Changes in temperature and precipitation patterns will depress agricul-

tural productivity, eliminate possibilities for continuing cultivation of some upland crops, accelerate soil erosion and siltation of waterways, disrupt fisheries, cause biodiversity loss, and raise the incidence of water- and mosquito-borne diseases. While changes in the atmospheric concentrations of certain gases may enhance tree growth, the net effect of climate change will hardly be positive. The adaptation measures required and economic opportunities foregone would cost Indonesia tens of billions of dollars annually.

In 1990, there were just over two million people living within a two-meter elevation of the sea in settlements along the shore. Demographic projections suggest that 3.3 million people may be displaced by flooding and inundation of these low-lying settlements by the year 2070. The cost of replacing or rehabilitating their 800,000 homes and resettling them is estimated at US\$ 8 billion.

Sea level rise is of particular concern in Jakarta because parts of the city are already subsiding rapidly, apparently because of excessive exploitation of ground water, soil compression due to heavy construction and tectonic subsidence of northern Java. Very conservative estimates of these combined effects plus climate change suggest that sea level will rise to 2.0 meters above the current reference point, which is already submerged by 60 cm of water. Tens of thousands of structures would be inundated: homes, schools, industrial facilities, hospitals, office buildings.

In the energy sector, unless advanced CO₂ scrubbing technology is applied, emissions from solid fossil fuels will grow due to future massive use of coal. Emissions from liquid

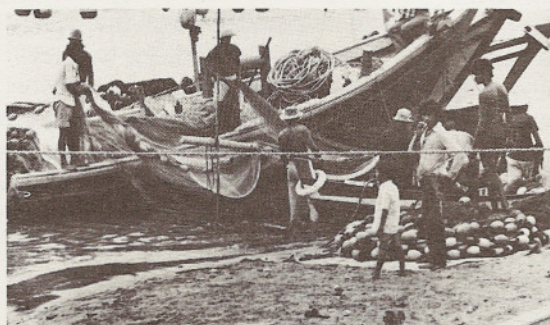
fossil fuels will likely decrease significantly as Indonesia runs out of oil. Altogether, energy-derived GHG emissions are expected to increase three- to eight-fold over 1988 levels. Emissions from the transportation sector, which already accounts for 30% of Indonesia's energy consumption, are particularly alarming because of their rapid growth. Expanded rice cultivation may increase harvest areas, biomass, yields — and CH₄ emissions.

Many emission-reducing actions available to Indonesia also have other benefits for the country's economy. Using least-cost mitigation options, the additional costs involved in installing the technologies to reduce emissions from transportation, industry, and electricity generation have been roughly estimated at \$1 billion annually in 2001, increasing to \$3 billion annually by 2021.

The country team suggests that national strategies favor adaptation over mitigation and preventative over curative action.

Since climate change originates from the development of industrialized countries, they should be prepared to help Indonesia field the considerable financial and technical resources to implement adaptation or mitigation responses, the report states. Indonesia should seek to collaborate more intensively with other developing countries, particularly members of the Association of Southeast Asian Nations, in exchanging information and strengthening collective bargaining positions in international negotiations concerning climate change.

Team Leader: Agus P. Sari
FAX: (62-21) 292 6163
Study Conducted By: Wahana
Lingkungan Hidup Indonesia (WALHI)
and Pelangi Indonesia
Implementing Agency: State Ministry
for the Environment, Indonesia



USAID PHOTO

Climate change may force millions of fishermen like those above to seek new livelihoods

MALAYSIA COUNTRY REPORT

Climate change could cause the collapse of essential industries — coastal tourism, mangrove products and fisheries — along Malaysia's extended shoreline which is now devoted either to agriculture or dense cities. Beaches may retreat up to 100 meters inland and beach hotels may be ruined. Bunds may be overtopped and abandoned, and the sea may advance 2.5 km inland, causing widespread destruction of agricultural land and facilities.

The population density is now 860 persons per square kilometer in the state of Penang, making it comparable to some of the most densely settled parts of The Netherlands, and an upward trend is likely to endure. As the population expands, the coastal zone deteriorates.

In developing a program to adapt to climate change, the Malaysian team recognized that the 4800 km coastline cannot be lined with embankments. Desperate attempts to keep out the invading seas will be largely unsuccessful. While undeveloped coastal areas may be allowed to retreat without adverse effect, urban centers and agricultural areas with their rural settlements may have to be defended. Urban land may be reclaimed through land-fill operations, but only if environmental impact assessments have shown them to be environmentally acceptable. Unless significant coastal protection measures are initiated, a large-scale relocation program for displaced people will be needed.

A large range of impacts is predicted for the two time frames, 2010 and 2070. Model simulations forecast that floods will be more frequent and inundate larger areas as flood peaks may increase 9 percent when banks spill over. Additional impacts — frequency and intensity of storm surges, runoff from

ivers, the impact on sedimentation, the rate and direction of littoral drift and the occurrence of extreme events — complicate matters. The varying magnitudes of all these effects on mangrove and coral systems are nonlinear, and the response of mangroves to rising seas is not well understood. Some preliminary results show that, although more information is needed, the mangrove coastline is actually advancing despite severe erosion in some localities. However, under a "do nothing" approach, by 2070 mangroves are headed for massive destruction. If no allowance is made for their migration landward they will be severely depleted, and all mangrove islands will have disappeared.

Under climate change, rainfall may rise but less water is likely to be available as an expected rise in temperatures — up to 3° C by 2030 — will increase the rate of evapotranspiration. An expanding population will place heavier demands for supplies of domestic, industrial and irrigation water at the same time as potential water resources decline. Agriculture has already encroached on some areas previously considered unfit for cultivation. The water deficit in the dry season may increase 30-35 percent, exacerbating the irrigation shortage and reducing the area under cultivation. Water prices may rise.

Tourism is now the third largest earner of foreign exchange for Malaysia, but without careful management, beaches may become narrower and disappear. A lack of guidelines encourages over-exploitation. Although there are excellent opportunities for eco-tourism, the industry has concentrated on luxury hotels and beach/island resorts which entail large changes in the natural environment.

No national effort has been made to calculate total carbon emissions; instead the emissions inventory includes only estimates of carbon emissions from fuel burning in



JCTOPPING PHOTO

Kuala Lumpur bustles with economic activity

1990. Data show that power stations consume approximately 45 percent of energy used, industry another 45 percent, and domestic and commercial uses a final 10 percent.

Policymakers will have to compare the costs and benefits of adaptation and mitigation options with a "do nothing" approach. Because sea level rise is gradual and unspectacular and decisions makers need "concrete" evidence before acting — and the evidence is difficult to present — it is easy to put off making the necessary plans, setting aside land and committing funds for structures. It is also tempting to search for technical solutions such as massive sea walls or pump drainage schemes. But social and political implications must be addressed and planning in anticipation of change must be done.

Team Leader: Dr. Chan Huan Chiang
FAX: (603) 292 6163

Study Conducted By: Malaysian
Institute of Economic Research
Implementing Agencies: Economic
Planning Unit of the Prime Minister's
Department, Malaysia; Ministry of
Science, Technology and Environment,
Malaysian Meteorological Service



PAKISTAN COUNTRY REPORT

The most significant impact of climate change on Pakistan is likely to come from the increased variation of the monsoons. Models vary on the impact of doubling atmospheric CO₂. According to some models, it could increase average summer monsoon rains by up to 60 percent. Resulting floods would hit the densely populated areas which produce most of the food, fiber and fodder in the country and would destroy irrigation systems and crops, especially cotton which is the main cash crop of Pakistan. Erosion and landslides from the aggravated rains would jeopardize the fragile livelihoods of people in the mountain ecosystems. Another frequently used model, by contrast, foresees summer monsoon rains decreasing, placing heavy stress on winter wheat, the main food staple. In either case, changes in agriculture and redesign of irrigation will be essential.

With projected doubling of heavy rainfall, adaptation to more frequent flooding is a very high priority. The current bias is for large civil works, but the country team suggests a focus on experience gained from on-farm water management and farmers' field drainage.

Survival of the people in this densely settled, mostly arid land is critically dependent on irrigation supported by the Indus River and its tributaries. Cereal crops are already under stress. If average temperature increased by 2.5° C, heat stress might reduce wheat yields by as much as 60 percent. Pakistan already has most of its arable land under cultivation, and agriculture now produces one-fourth of the GDP and employs one half of the labor force. Although these shares may shrink, wheat harvest yields will have to more than double to feed the nation's large and rapidly growing population; farmland will have to be

protected and allowed to expand. A high priority is research: to provide a clearer understanding of how forecasted heat stress will affect crops, investigations to develop heat resistant crop varieties and experiments with changed planting dates.

Even though average rainfall may increase there may also be more drought, although glaciers in the northern mountains could moderate this effect. Semi-desert areas outside the Indus Basin may suffer most severely if drought appears. Rangelands are overgrazed and producing only one-third of the potential nutrients they might yield. If there are variations in river flow as a result of changes in precipitation,



WFP/FAO PHOTO

Boys readying tree seedlings for transplanting

the generation of hydropower might also be impaired.

Although Pakistan is less vulnerable to sea level rise than some of its South Asia neighbors, the shoreline of Karachi has retreated in recent decades. More severe monsoons and sea level rise may flood the city's street for longer periods.

The Indus delta, south of Karachi, already retreating because of a

sharply reduced silt load, could lose up to 25 percent of its area if seas rise. Saline water would intrude and mangroves would be destroyed, harming fisheries which account for 30 percent of exports.

Pakistani forests are a dwindling resource, now constituting less than five percent of the nation's area. Small shifts in average temperature would lead to large shifts in latitude of optimal growing zones for many tree species. Climate change may shift the balance of cost effectiveness toward investment in the revival of riverain forests and improvement of forest resources so sustainable usage could be achieved by 2025.

Climate change could increase heat stroke deaths, correlated with temperature spikes and now killing dozens every year. Increased rain would fill more stagnant ponds leading to more waterborne diseases and malaria.

Greenhouse gases in Pakistan are emitted from fossil fuel burning, cement manufacture, rice and livestock production and open dumping, but at present there are not sufficient data for a complete emissions inventory. However, the nation requires large amounts of energy, and the country team has proposed the following options:

- energy conservation
- decreased transmission and distribution losses
- investment in non fossil fuel energies
- reforestation/afforestation programs to create carbon sinks
- methane recovery from landfills
- better livestock feed to reduce methane emissions

Team Leader: Syed Ayub Qutub
FAX: (92-51) 254 024

Study Conducted By: Enterprise and Development Consulting, Limited
Implementing Agency: Urban and Environment Affairs Division, Government of Pakistan

PHILIPPINES COUNTRY REPORT

An average of 19 typhoons now hit the Philippines each year, and three major droughts struck the nation during the 1980s. Under climate change the country can expect even more typhoons, floods, storms and droughts. Sea level rise compounds the risks, leading Filipinos, already concerned about their vulnerability, to view climate change scenarios for 2010 and 2070 with alarm.

About 60 percent of the nation's growing population lives in rural areas. Frequent flooding from typhoons and intensified southwest monsoons will affect about one fourth of the people. Severe risk will be felt by about 5 million, around 7 percent of the inhabitants.

Reclaimed areas of Metro Manila and Metro Cebu may be submerged, along with the bay area outside Manila and the shore of Laguna de Bay, a large lake near Manila. A country of more than 7,000 islands (although only about 10 percent are inhabited), the Philippines will also see some small islands submerged. The study recommends ac-

tion to protect human settlements and to strengthen disaster preparedness and response.

The impact of climate change on agriculture will be serious not only because of typhoons and flooding, but because coastal areas will be subject to storm surge and salt intrusion and wetland crops will be heavily damaged. Furthermore, the dry season is expected to become extremely dry, especially during episodes of ENSO (El Niño/Southern Oscillation). Agricultural adaptation will require development of crop varieties that can endure stress. Farmers will need to protect their land from frequent flooding in the monsoon season and will need to practice intensive soil and water conservation in the dry season.

Flooding is likely to drop more sediment behind dams, increasing the cost of hydroelectric and irrigation dam management. There is still time before 2070 to allow mangrove forests to retreat from rising seas, according to the study. Adoption of a proposed Forestry Master Plan will help to increase the number of CO₂ sinks.

The Philippine team proposes "retreat and accommodation" as an initial adaptation to sea level rise. Analysis of further protection options is still in progress. Greenhouse gas emissions in the Philippines result first from fossil fuel burning for energy, transportation and industry. Forest activity contributes another third of emissions and agriculture adds a substantial share. To mitigate these emissions, the study recommends



USAID PHOTO

Steam, an alternate energy source

efficient use of fuels and promotion of renewables and other non-fossil fuel energy.

Team Leader: Raul E. de Guzman
FAX: (632) 789 256

Study Conducted By: Philippines Consultant, Environmental Primemovers of Asia, Inc.

Implementing Agency: Department of Environment and Natural Resources, The Philippines

Publication References on World Food Supply

The Guest Column by Cynthia Rosenzweig and Ana Iglesias in *Climate Alert*, Vol. 7 #1, on climate change and the world food supply, summarized the research available in the following publications:

Rosenzweig, C. and M.L. Parry. 1994. "Potential impact of climate change on world food supply." *Nature* 367: 133-138.

Rosenzweig, C. and A. Iglesias. 1994. Implications of Climate Change for International Agriculture: Crop Modeling Study. U.S. Environmental Protection Agency. EPA 230-B-94-003. Washington, DC.



USAID PHOTO

Tenant farmer has expanded his harvest with improved rice seed

SRI LANKA COUNTRY REPORT

By the year 2070, climate change in Sri Lanka is likely to have brought average temperatures to their highest level in the past 120 years and extreme weather that will cause high environmental damage. Impacts on the nation's coastal area, site of the largest concentration of people and economic activity, will be most severe, with flooding and storm surges, beaches narrowed by erosion — leading to possible damage to hotels — and salt water invasion of estuaries and aquifers. The coastal population estimated at about 7.5 million in 2000 will have nearly doubled by 2070.

Population growth has already strained the land. In the last century, the amount of land per person has shrunk to one seventh of its former size. Agricultural activity has not declined and the forests have suffered. Pollution and climate change have already affected water resources but measuring the impact is difficult. Although rainfall may increase, if it is due to extreme events, much of the water may be lost through runoff to the sea. Large losses can be expected in paddies which are already affected by flooding, poor water, saline intrusion and iron toxicity. Sri Lanka is already quite vulnerable to drought and an increase in drought is assumed. So although larger harvests to feed an increasing number of mouths will require more water, less will be available and it will need to be managed more efficiently.

In the vital agriculture sector, more than one-fourth of the nation's GNP, projected flooding will ruin some farmland; rising seas and invading salt water will harm more. Sri Lanka's variety of growing zones gives it the ability to diversify and be less dependent on fluctuations of rice and wheat. Crop varieties and cropping patterns can be changed. Yams, tubers, jack and bread fruit

and other nontraditional fruit crops could be tried. However, conservation methods, organic farming and introduction of new crop varieties are hampered by a lack of knowledge and by the prospect of low yields in initial years. Crop intensity is now stagnant; higher intensity is possible.

Rational water pricing would help but some farmers oppose it. As an alternate, farmer participation in managing irrigation is being tested. Other strategies include better use of rain water, growing crops that require less water, planting hillsides and reforestation. Sri Lanka's forest cover has shrunk to a critical level and is currently about one fourth of the country's area.



WORLD BANK PHOTO

Woman collecting sun-dried fish

Few dramatic options are available for limiting greenhouse gas emissions, according to the report, although a large increase in energy demand is projected. Under the base case, steep increases in greenhouse emissions from the energy sector are projected with an increase of more than thirty-fold projected between 1990 and 2070. Through energy conservation, emissions of CO₂ in both 2010 and 2070 could be held about 20 percent below the base case scenario. Industry could improve its biomass fuel conservation and

experiment with alternate energies — wind, small hydropower, and later nuclear energy. New technologies could be introduced, along with more water transport, city planning, improved telecommunications.

Most mitigation strategies are related to vehicles. While Sri Lanka's current contribution to worldwide greenhouse gas emissions is characterized as "insignificant" in the country report, it does state that vehicle emissions in urban areas are already causing problems and are an important target for mitigation.

Creation of a national program is proposed for extreme events such as floods, drought and landslides, with a shift in emphasis from relief to mitigation and a decentralization of disaster management. The program includes enhancement of an early warning system, building of wind resistant structures and use of low cost disaster management technologies. Increased flooding will bring more disease — more contact between host and parasite — and warmer temperatures are conducive to the breeding of malaria and filaria vectors.

Poverty, the Sri Lanka team states, leads to bad land use and degradation, soil erosion, a shortage of water and perpetuation of rural destitution. Minimizing population growth and sustainable use of natural resources are recommended for alleviation. Response to climate change, the team notes, will depend on cooperation among key players on the global, regional and national levels.

Team Leader: Dr. Godfrey Gunatilleke
FAX: (941) 580 585

Study Conducted By: Marga Institute
Implementing Agency: Ministry for
Environmental and Parliamentary
Affairs, Sri Lanka

VIET NAM COUNTRY REPORT

The vast majority of the people of Viet Nam — about 80 percent — are engaged in agriculture, the economic sector most likely to be affected by climate change: increased temperatures and rainfall, sea level rise, more typhoons, floods and other disasters. Because of the potential adverse consequences to so many of its citizens, the country has begun to consider climate change issues actively.

Viet Nam's rapidly growing population is spread along its 3300 km coastline. A tropical monsoon region, abundantly supplied with water which is not however evenly distributed, it is already often threatened by storms and floods. Nearly five typhoons a year strike the country, and the number has been increasing in the last two decades, because of normal variability, changed observation practices or for other reasons.

Under climate change scenarios, higher temperatures and less rain will shrink the water supply by 6 - 20

percent, with some rivers even more severely affected. More extreme daily and monthly rainfall will raise the discharge from floods by 10 to 20 percent. While annual and dry season rainfall have been declining, storm rainfall has increased, and seas have risen slightly, a trend likely to continue. Inundated areas along the coast may increase by 20 - 30 percent. The average temperature has increased by almost 0.1 °C per decade.

Whether droughts will occur more often is not clear, but they could appear once every two or three years. If protective measures are not taken by 2070, drought and flood damage could be worse than record events in 1970 and 1981.

The study recommends research on El Niños and its potential links to rises in temperature, changes in the seasonal pattern and volume of rainfall as well as the number of typhoons. One effect of El Nino is to make the sea more salty and shift areas of upwelling and downwelling.

As the center of downwelling moves away from the coast, fishing grounds become more remote.

Viet Nam's highest adaptation priorities include reservoirs, afforestation, sea dikes and other coastal protections. Upstream storage reservoirs will reduce flooding, increase dry season flow and generate electricity. Reservoirs along the Mekong River, however, can only be constructed by agreement with neighboring countries.

Afforestation will contain soil erosion, provide CO₂ sinks, and conserve habitats. By 2010, Viet Nam has plans to grow three million hectares of new forest and plant five billion trees. The program will also include protection of nine million hectares of existing forest, leading to forest cover of more than one-third of the land area. Existing species of mangroves may need to be replaced by species with larger roots.

(Continued next page)

MEMBERSHIP

_____ Please enroll me as a member of the Climate Institute: \$95, includes subscription to *Climate Alert*, 6 issues a year.

PUBLICATIONS ORDER FORM

Our printed copies of *Coping with Climate Change* are exhausted. Due to popular demand, we now have reproduced, spiral bound copies.

_____ Please send me _____ copy/copies of *Coping With Climate Change*, Proceedings of the Second North American Conference on Preparing for Climate Change. December 6-8, 1988, Washington, D.C. Cost: \$42 includes postage and handling.

NOW AVAILABLE:

_____ Please send me _____ copy/copies of *Global Change and Cities*, Proceedings of the International Conference on Cities and Global Change, Toronto, Canada, June 12-14, 1991. Cost: \$35, including postage and handling.

_____ Please send me _____ copy/copies of *Report of the International Workshop on Framework Convention and Associated Protocols: A Nongovernmental Perspective*. February 2-4, 1990, Washington, D.C. Cost: \$10, includes postage and handling.

_____ Please send me _____ copy/copies of *The Arctic and Global Change*, October 25-27, 1989, Ottawa, Ontario, Canada. Cost: \$25 plus \$2 for postage and handling.

_____ Please send me _____ copy/copies of the *Proceedings* of the North American Conference on Forestry Responses to Climate Change, May 15-17, 1990, Washington, D.C. \$35 postpaid.

_____ Please send me _____ set/sets of greenhouse effect slides. Approximately 40 slides with accompanying talking points script. Cost: \$85 plus \$10 shipping and handling.

Circle language(s) you wish to order: English, Spanish, Turkish, Indonesian, Arabic, French, Chinese, Russian, Portuguese

CONTRIBUTIONS

_____ I am making a tax deductible contribution of \$ _____ to support the Institute **TOTAL AMOUNT ENCLOSED: \$ _____**

Make checks payable to *Climate Institute* and send to Climate Institute, 324 Fourth Street, NE, Washington, D.C. 20002

Name _____				
Last	First	Middle Initial		
Address _____				
Street	City	State	Zip Code	Country
Phone _____				
Business	Home	FAX Number (if available)		

Viet Nam

(Continued from preceding page)

The only option for saving Viet Nam's large river deltas from rising oceans are sea dikes which have been protecting the Red River Delta for centuries. The existing 2700 km dikes may require reinforcement; with a 90 cm rise in the seas, another 2000 km of new dikes may need to be built, costing nearly US\$ one billion, approximately US\$13 million per year.

Erosion will cause heavy damage to some beaches, seaports, coastal cities and infrastructure. Protection will have to be carried out selectively as costs will be high.

A clean energy policy which includes plans for medium and large scale hydropower projects is part of the national response strategy to reduce greenhouse gas emissions. In addition to producing electricity, this US\$270 million initiative, to be implemented over the next two

decades, will have the added advantage of protecting the land from flood and augmenting the low flow of rivers in dry spells. It will take careful



USAID PHOTO

Mekong River Scene

planning and expenditure of \$1 billion by 2070 to maintain minimum flow at the same time as developing hydropower. Where it is not possible to build upstream reservoirs, the crop season will have to be modified and

salt resistant crops needing less water will have to be introduced. More efficient stoves and the use of coal briquettes to replace agricultural fuels will also help to lower CO₂ emissions, part of a rural energy program foreseeing expenditures of US\$5 - 10 million a year.

Viet Nam is eager for cooperation with other nations in the region on a number of issues including inventory and control of emissions, monitoring and forecasting climate change, afforestation and watershed management and mitigation of climate change impacts.

Team Leader: Dr. Nguyen Trong Sinh
FAX: (8442) 256 929

Study Conducted By: Viet Nam Consultant, Institute of Water Resource Planning and Management
Implementing Agency: Ministry of Water Resources and General Department of Hydrometeorology in cooperation with the Government of Viet Nam

Climate Institute

324 Fourth Street, NE
Washington, DC 20002

Address correction requested

Issue on Climate Change in Asia

**Non-Profit Org.
U.S. Postage Paid
Washington, D.C.
Permit # 2303**

The Climate Institute is a private nonprofit organization formed to advance public understanding of climate change including the greenhouse effect and of strategies to avert stratospheric ozone depletion.