Adapting to a Changing Climate

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Remembering Stephen Schneider
2010 is a year in which it is hard to remain a climate skeptic unless one is situated on another planet or on Earth closeted in a bunker getting information only from denialist blogs. The first eight months of the year were tied with 1998 as the warmest such period since global temperature records were kept, all the more remarkable as 2010 has seen onset of a La Niña event which is normally associated with cooler temperatures. Although no single weather event is by itself proof of climate change, this year is chock full of developments that seem naturals for a Hollywood script including Los Angeles on September 27 registering 113 F, its highest temperature since humans have kept records. In Moscow, a record summer heat wave that coincided and interacted with wildfires and bog fires doubled death rates to about 700 a day and caused Russian President Dmitry Medvedev to state: “Unfortunately, what is happening now in our central regions is evidence of this global climate change because we never in our history faced such weather conditions in the past ... This means that we need to change the way we work – to change the methods that we used in the past.”

Just as the Russian leadership, long the leading skeptics within the G-8 on the urgency of acting to address climate change, has done an about face, evidence proliferates that rapid and potentially disruptive change may be underway and showing up over much of our planet. Millions in Pakistan remain homeless from the most devastating floods in that nation’s history. NOAA reported that Arctic sea ice covered an average of 2.3 million square miles during August – 22% below the 1979-2000 average and the second lowest August sea ice extent on record. Large-scale coral bleaching and death, attributed to warming seas and higher CO2 levels in the seas, are on par this year with the devastating results of 1998. Our late and dearly missed Board member, Stephen Schneider, in an article co-authored in the November-December 2008 Boston Review with Stanford colleague Michael Mastrandrea, argued climate adaptation is a crucial component of a climate response strategy.

This should be accompanied by mitigation strategies that will produce near- and medium-term perceptible results in limiting radiative forcing and holding climate change to a rate within which humanity and ecosystems have a reasonable chance of adapting. The Black Carbon Reduction Program advanced by the Climate Institute, following on a seminal paper by its Chief Scientist for Climate Change Programs, Michael MacCracken, seeks to do this as does the Fast Track Climate Mitigation effort advanced by Durwood Zaelke, President of Institute for Governance and Sustainable Development.

Numerous adaptation strategies are available to respond to climate change. This special issue of Climate Alert highlights a few including micro-irrigation, described by Eric Lowe; floating gardens in Bangladesh, planting of plants and shrubs as in India to slow down floods and even construction of artificial islands in the Pacific, all discussed by Saheli Nath; and much more environmentally benign and affordable strategies for air conditioning addressed by Claire FitzGerald. Some other strategies simultaneously achieve enhanced ecosystem resilience while realizing large-scale net emission reductions as described in Bradford Crist’s article on enhancing coastal wetlands. An ingenious proposal by Harvard physicist Russell Seitz has emerged that might achieve large-scale reduction of evaporation of water supplies in reservoirs and ponds while pointing the way to what may be the most environmentally benign form of geo-engineering besides painting roofs white or creating roof gardens. In an article slated for publication in Climatic Change, Seitz proposes use of micro-bubbles both to reduce evaporation and to change albedo of water bodies. The only limit to climate adaptation, assuming climate change can be held within manageable ranges, is the human imagination. A central thrust of the Tickell Interactive Climate Awareness and Response Network being built by the Climate Institute in Mexico is the mobilization of millions of minds to become climate problem solvers. Working with Prof. Daniel Wildcat of Haskell Indian Nations University, a member of the Climate Institute Board and Convener of the American Indian Climate Change Working Group, the Institute is seeking to link the Tickell Network with the tribal college network and Bureau of Indian Education teaching faculty. In his book Red Alert: Saving the Planet with Indigenous Knowledge, Dan Wildcat shows how this coping capability of indigenous peoples can be instructive to the world at large. I am personally spending much of my time in New Hampshire near my alma mater, Dartmouth College, seeking to build for the Climate Institute a Center for Environmental Leadership Training. This Center would focus especially on bringing together young people ages 15-29 and the teachers who inspire them and empower them to be climate problem solvers. Although the initial focus will be climate leaders from indigenous communities, Mexico, and New England, the Center seeks to develop strategies that will empower young leaders worldwide – in Kuala Lumpur, Manila, the Maldives and Buenos Aires as well – to lead in climate solutions in a way think thanks and climate negotiators are unable to do. Climate change can produce enormous international and intergenerational inequities; this effort seeks to empower its potential victims to be at the forefront in climate response.

Commentary by John C. Topping, Jr.
On July 19, the nation, and indeed the world, lost one of its clearest thinkers and communicators on the environmental dilemma in which we are now mired. For four decades, Dr. Stephen Schneider has been a leader in seeking to better understand and communicate how human activities have changed, are changing, and will in the future change the climate; what this will mean for the environment and society; and what the options are and need to be to be able to adapt and respond. In each of these areas, Steve has engaged with enthusiasm, dedication, and a pursuit of the truth that has gained him respect and friendship from scientific colleagues, those being impacted by climate change, and those with the power to make a difference.

While Steve's education was in plasma physics, he early on decided to apply his analytic talents to the challenge of understanding and dealing with climate change. Four decades ago, his early work examined the warming influences of the rising CO₂ concentration versus the cooling influences of the sulfate aerosols that also result from the combustion of fossil fuels. The insights he gained from this comparison led Steve into modeling of the climate system. While some tried to jump quickly to trying to represent in the models as many processes as one could conceive, Steve's special talent (and urging) was to focus intensely on the most important factors first, adding features and feedbacks one at a time in order to systematically build understanding. In this way, and with his early background in physics, Steve developed a deep understanding of how the climate system worked and would be expected to respond to human influences, from greenhouse warming to the smoke from a major nuclear exchange.

But understanding just the physics was not enough. Steve's explorations also made clear that changes in biology and chemistry had the potential to influence the climate, just as changes in the climate can affect the environment and society, and interactive couplings can lead to feedbacks and further changes. Fundamentally, the Earth system is interconnected through many diverse processes, some direct and some indirect. While complex, however, research has provided many insights and improved understanding of the relative strengths, timing, and range of influence of the various processes. Explaining by metaphor, as was Steve's wont, the Earth system is a bit like the various relationships we have, from family to friends to colleagues, each nudging you in a particular way, sometimes in combination, and you are integrating their interactions. Uncertainties, yes, but even in a crowd your path generally continues to move in about the same direction in response to the primary interactions, although, like the climate, you are susceptible to a fall or erratic change if pushed too hard.

Among Steve's other special talents was the ability to communicate clearly with colleagues, decision makers, and the public. He was a prolific writer of journal articles, books, and assessment chapters, as well as being an enthusiastic speaker, to the Congress, to the public, and in private conversations. Steve's involvement with the Intergovernmental Panel on Climate Change was longstanding and extensive, ranging from writing chapters to communicating with national delegates about what was known and uncertain.

We at the Climate Institute have benefited greatly from Steve's encouragement and advice. Steve was an early participant in the Climate Institute's activities, speaking at our conferences in Washington, DC in the 1980s and early 1990s when the issue was just emerging as one facing policymakers. He served on our Board of Directors from 1988 until the date of his death. Many of us were fortunate to see the human side of Steve as a proud father as his two lovely children, Becca and Adam, revealed in the sites of Egypt as 40 of the merry Climate Institute crew cruised the Nile for a week following the December 1989 Cairo World Climate Conference; some of us more recently had a chance to talk with him about the brave struggle he waged for nearly a decade with lymphoma. Even in the most trying of times he displayed a delicious sense of humor.

Steve devoted his life to seeking to build the base of scientific information and to help society understand the consequences of its actions and the path it is on so that less risky choices can be made. The risks of climate change have been well recognized for more than four decades, but yet Steve was on another mission (this one to Scandinavia) to educate and encourage action. A fitting tribute to his record of devoting his last measure to this issue would be for the US and the community of nations to heed his message and to take an appropriate response—there is still hope if we act together and quickly. Steve helped lay the seeds for a very tangible step in this direction, the Sir Crispin Tickell Climate Interactive Network being built by the Climate Institute in Mexico. In the 1970s as Crispin was on leave from the British diplomatic service to study at Harvard while writing Climatic Change and World Affairs Steve provided crucial scientific counsel for this seminal work. A decade later he was instrumental in recruiting Sir Crispin to the Climate Institute family. In some modest way we hope to recognize Steve as this Interactive Network unfolds in Mexico and elsewhere. At this point, however, we most of all send our heartfelt condolences to his brave wife and fellow scientific trailblazer, Terry Root, and to Becca and Adam.
The United Nations Development Program (UNDP) defines adaptation as “changing existing policies and practices and adopting new policies and practices so as to secure Millennium Development Goals in the face of climate change and its associated impacts.” The ‘economics of adaptation to climate change’ is a multi-dimensional issue that involves the study of the relative costs and benefits of adapting to a changing climate, an appreciation of the specific financial limitations encountered by different countries and communities in undertaking adaptation, and an analysis of how these monetary barriers can be overcome. From an economic viewpoint, adaptation is most efficient when the cumulative benefits from the adaptive activity exceed the total costs of implementation. But even when the projected benefits surpass the estimated costs, less developed countries (LDCs) and Small Island Developing States (SIDS) are confronted with pecuniary difficulties in allocating sufficient funds for adaptation, and in ensuring that aid reaches the most vulnerable part of society, namely the poor people in risk-prone zones. In such instances, improvised low-cost pro-poor approaches have to be adopted, as in the case of the ‘floating gardens’ in Bangladesh and the mangroves in Vietnam, or the international community has to act collectively to provide a sustainable solution, as demonstrated by several European countries who are evaluating the feasibility of a plan to construct an artificial island for the Pacific SIDS.

**The Economic Constraint to Adaptation**

Many countries most severely affected by climate change have limited monetary, technical, and research and development capabilities. For these nations, the cost of undertaking adaptive techniques may be greater than the national budget allocated for adaptation to climate change. The ‘adaptation funding chasm’ refers to the difference between the total aggregate money required for implementing proposed adaptive programs and the amount of money that is available under current conditions (Müller, 2008). Moreover, sources of international funding like the Global Environment Facility (GEF), Least Developed Countries Fund (LDCF), Special Climate Change Fund and Adaptation Fund do not stipulate the amounts that developed countries need to contribute, and tend to underestimate the costs of adaptation (Wong, 2010). Thus, at present, conventional funding is not adequate for the scale of actions required, and the developing countries may be lacking “relevant ‘absorptive capacity’, i.e. the capacity to carry out the adaptation measures needed, even if the funding were available (Müller, 2008, P.5).” In the global context of uncertain funding, it will be wise to explore low-cost sustainable resilience-building strategies open to the risk-prone poor communities. Such policies, which are enacted in the interest of the poverty-stricken, are termed as ‘pro-poor adaptation,’ and are vital in reaching marginalized citizens.

**How to Finance Pro-poor Adaptation**

Due to the insufficient ability of people below the poverty line to construct autonomous coping mechanisms, the financial pressure of pro-poor adaptation has to be shared among the concerned community, respective national governments, businesses in the private sector, non-governmental organizations, international institutions, and developed countries historically responsible for greenhouse emissions. Apart from the players who are responsible for addressing the fiscal aspect, adaptation also “involves the interests of numerous actors: agriculture, urban planning, water supply, tourism and recreation, human health, etc. Albeit, all these sectors are potentially impacted—decisions, whether to adapt or not, are taken at different levels, ranging from individual farmers to national planning services (Anantram, 2005).”

**Community-level Adaptation in Very Poor Regions of Bangladesh**

The decision to adapt can be a spontaneous response from the local people. An example of innovative non-traditional community-based adaptation is the ‘floating gardens’ (locally called Baira) in the haors (back-swamp or wetland ecosystem) of Bangladesh. Flexible platforms made of hyacinth float on the flood waters, and are topped with a layer of soil, on which farmers grow crops like cauliflower, tomatoes and turmeric (Figure 1).

These gardens are inexpensive and easy to make, as they only require locally available materials. More importantly, the crops move with the flow of the tide and therefore are never washed away; this ensures some form...
Climate change can educate facilities and increasing job public health amenities, increasing can be integrated through improving adaptation and economic development sequences. To some extent, pro-adaptation or long ries the danger of leading to mal on achieving immediate benefits car- with time (Figure 2).

The benefits of this particular project lives of an estimated 7,750 families. Furthermore, the submerged, coastal mangrove forests act as buffer against the huge sea waves created by recurrent typhoons, protecting the lives of an estimated 7,750 families. The benefits of this particular project are apparent, but such deliberate region-specific pro-poor adaptive activity should be financed only after careful appraisal of the cost-effectiveness of proposed plans.

NGO-sponsored Pro-poor Adaptation in Vietnam

The decision to adapt can be also be a deliberate plan financed by a non-governmental organization and backed by the national government. An excellent example is the biodiversity-based mangrove rehabilitation program in Vietnam that has demonstrated the cost-effectiveness of nature-oriented soft defenses, and is deemed suitable for global applications. The Vietnam Red Cross mangrove project, which cost US $1.1 million, has saved US $7.3 million/year in dike maintenance and has brought additional benefits to local families in the form of fisheries (Reid, 2008). Furthermore, the submerged, coastal mangrove forests act as buffer against the huge sea waves created by recurrent typhoons, protecting the lives of an estimated 7,750 families. The benefits of this particular project are apparent, but such deliberate region-specific pro-poor adaptive activity should be financed only after careful appraisal of the cost-effectiveness of proposed plans.

Determining Cost-effectiveness of Pro-poor Adaptive Activity

While some adaptation projects may yield immediate benefits, for others the largest benefits will occur in the long-run, and initial high costs will decline with time (Figure 2). Too much focus on achieving immediate benefits carries the danger of leading to mal-adaptation or long-term negative consequences. To some extent, pro-poor adaptation and economic development can be integrated through improving public health amenities, increasing educational facilities and increasing job opportunities to create a strong financial safety net. Developing extensive irrigation channels will protect poor farmers by reducing vulnerability of agriculture to droughts. In this respect, the private sector can assume a more inclusive role by building hospitals, opening schools and generating employment. The role of the private sec- tor is exemplified by microfinance institutions operating in Bangladesh, Brazil, Haiti, India and Indonesia, which are endeavoring to help in disas- ter risk reduction through poverty alleviation, income generation and development programs.

When the Problem of Survival Precedes Cost-effectiveness

While it is important to understand the cost-benefit aspects of pro-poor adaptation, there are several developing countries for which adaptation is no longer an option: it is a necessity for survival. Ambassador Moses, the Chair of Pacific SIDS, Permanent Representative of Nauru to the United Nations, once commented: "Climate change can devastate a country just as thoroughly as an invading army." This is especially true for nation-states that sorely lack the financial capacity required to fend off the ‘invading army.’ As a conse- quence of rise in sea-level, the Pacific SIDS are in the danger of becoming completely submerged. With their existence on the line, a very expensive alternative available to these states is artificial island creation by land recla- mation. But the design of environmentally viable artificial islands is cost-prohibitive and demands advanced technology that can only be procured through technology transfers from de- veloped nations. In this case, the states of Fiji, Micronesia, Marshall Islands, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu, which comprise the Pa- cific SIDS and have relatively small GDPs, can consider artificial islands as a feasible choice only if they receive comprehensive monetary and technical assistance from the international com- munity.

Pro-poor Adaptation: Financing the Future

Financing future pro-poor adaptive activities depends on the initiatives taken at different levels of decision-making. "It is not for lack of options that adaptation lags. It is lack of deter- mination, lack of cooperation and lack of means that impede adaptation (Leary, 2008)." These impediments to pro-poor adaptation can be overcome through community level innovations like the ‘floating gardens’ in Bangladesh, well-planned NGO efforts sup- ported by national governments as in the mangrove project in Vietnam, or through international-level coordi- nated action, such as the proposal to develop artificial islands to help the Pacific SIDS. Indeed, as the age-old saying goes, "The best way to predict the future...is to create it."
REDD and Blue: a Win-Win with Coastal Wetlands  

The world is losing its coastal ecosystems four times faster than its rainforests. In the last 15 years alone, coastal development and timber harvesting have reduced the global land area of sea-grass meadows and mangrove forests by more than 50 percent and salt marshlands by 25 percent. Simultaneously, the effects of global climate change—sea level rise, coastal storm surges, increased flooding, soil erosion, wind damage, and salt water intrusion into freshwater aquifers—threaten roughly one half of the world’s population who calls the coast home. Fortunately, coastal ecosystems can be preserved, which will mitigate carbon emissions and help local communities adapt to climate change.

Although coastal ecosystems are not accounted for in most carbon cycle models, they offer a vital, natural process for carbon capture and sequestration. Vegetated coastal habitats are highly autotrophic, which means they fix CO2 to produce sugar through photosynthesis. Covering less than 1% of the ocean’s total surface area, coastal wetlands naturally “sink” over 50 percent of the ocean’s organic carbon. The sink capacities of salt marshes, mangroves, and sea-grasses exceed the Amazon Rainforest by factors of 10, 6, and 2 respectively. According to the UN Environmental Programme, preventing degradation and recovering coastal ecosystems would offset 3 to 7 percent of current fossil fuel emissions in just twenty years, or more than 10 percent of reductions needed to keep concentrations of CO2 below 450 ppm in the atmosphere. Preservation and restoration of coastal ecosystems is a key component for carbon mitigation.

Even if these “blue carbon sinks” can help to slow global warming in the long-term, climate change will continue in the short-term due to existing greenhouse gases in the atmosphere. Fortunately, coastal ecosystems can help vulnerable countries, such as small island developing states (SIDS), adapt to the impacts of climate change. Mangroves can accommodate up to one centimeter per year of sea level rise via sediment entrapment and accumulation of organic matter. Mangroves, marshes, and reefs provide shorelines with a first line of defense against storms and extreme weather events. In spite of the devastating effects of the 2004 tsunami, the wave attenuation by kelp, mangroves, and marshes saved land that would have otherwise been destroyed. Sea-grasses and mangroves also help to recharge groundwater aquifers, increase the resilience of coastal areas through alluvial plain accumulation, and create a freshwater buffer to prevent saltwater intrusion into local water tables. Coastal ecosystems offer a variety of important adaptation mechanisms.

In addition to direct adaptation to climate impacts, the world’s coastal ecosystems provide a host of other adaptive benefits. Economists value the world’s coastal ecosystems at $25 trillion dollars per year because of their contributions to economic activity, natural shoreline protection, and water quality maintenance. Over 2 billion people rely on mangrove and coastal fisheries for food security and tourism-based revenue. Coastal aquaculture, specifically, supports over 43 million jobs, and fish provide half of the dietary protein for people in island states. Despite the environmental and economic magnitude, our coastal habitats remain submerged underwater and out of sight, receiving minimal attention from policy makers compared to terrestrial ecosystems.

In order to advance coastal ecosystems on the climate change agenda, policy makers could amend the Reduced Emissions from Deforestation and Degradation (REDD) program to include all coastal ecosystems, not just mangrove trees and terrestrial forests. This would engage coastal ecosystems in carbon offset trading schemes, and ideally it would set up a fund for the SIDS and other oceanic countries to receive aid from the developed world to adapt to climate change. Under the Clean Development Mechanism (CDM) of the Kyoto Protocol, Annex I countries can meet a portion of their target commitments by investing in emission reduction projects in developing countries. The 2001 Marrakesh Accords established REDD, which allowed forest preservation to qualify as CDM projects. Coastal wetlands are not included in REDD, despite discussion of expanding the proposal at the COP-15 last year.

An improved REDD proposal could 1) expand the list of acceptable vegetation for CDM projects to include all mangrove forests, sea-grass meadows, and salt marshlands; and 2) to include funding for developing countries to directly reduce deforestation and coastal degradation. Already there is an overlap between types of ecosystems—mangrove forests grow out of saltwater environments—which would favor an expanded REDD program for coastal ecosystem restoration. Other strategies that could be explored include: international regulation against over-development in threatened coastal areas, global funding for local wetland restoration, and ecological mangrove restoration (EMR). Any policy that seeks to replant vegetation should pay close attention to local species ecology, hydrologic factors, and proper site selection. If executed properly, a “REDD and blue” program would be a win-win for coastal ecosystems, both sinking carbon and helping communities adapt to climate change. Indeed, action is needed now to slow the loss of vital coastal ecosystems.
Beyond Air Conditioning

Claire FitzGerald

The global average of first seven months of 2010 has been warmer than any other year on record. To avoid the direct effects of the heat, the fortunate people will stay inside and turn up the air conditioning. Yet this attempt to be cool is unsustainable. Dependence on air conditioning has increased energy demand and carbon dioxide emissions, furthering the greenhouse gas effect and global warming. Higher temperatures lead to greater air conditioning use, creating a positive feedback loop.

Widespread air conditioning is a relatively recent phenomenon. From 1978 to 2001, the number of American households with conventional air conditioning systems rose from 23 to 55 percent. Today air conditioners consume 5 percent of overall energy in the United States, a noteworthy portion of overall building consumption, which accounts for 40% of all energy use and 40% of CO₂ emissions.

While air conditioning popularity has skyrocketed, technological upgrades have significantly lagged behind. Today’s air conditioners are slightly more efficient than those of previous generations: Energy Star’s appliances advertise 14% less energy use compared to conventional systems. While this is indeed an improvement, more efficient technologies are emerging with significant potential, including radiant cooling and heating systems, which have gained recent popularity in Europe, and advanced systems that utilize alternative coolants.

To understand the benefits of alternative technologies, one must first understand the basics of an air conditioner. An air conditioner works by compressing a refrigerant, causing it to heat into a high-pressure gas. The gas runs through coil, dissipating its heat as it condenses into a liquid. The liquid passes through an expansion valve and evaporates to a low-pressure gas, which passes through another set of coils. The gas absorbs the heat, allowing the air inside a building to cool.

Conventional air conditioning is inefficient because it ignores a basic principle: thermal energy can be transported more efficiently with water than with air. Hydronic radiant cooling systems heed this principle. Water flows through tubes or pipes attached to the panels, slabs, walls, ceilings, or beams of a building’s surface. As these surfaces cool to a lower temperature than other surfaces in the room, heat flows to them from warmer surfaces, including people, equipment, and lights. The cooled surface absorbs the heat by the circulating water.

Radiant cooling systems function best in buildings with lower cooling loads located in drier climates like the American West and Southwest. Roof spray systems can be coupled to them to create even more efficient systems. In ideal conditions, the amount of energy saved by a radiant cooling system compared to conventional (not Energy Star) air conditioning can be as high as 42 percent. In humid regions radiant cooling systems are supplemented by air-conditioning systems to dry the air and avoid condensation. Still, radiant cooling’s energy savings are 17 percent overall compared to conventional air conditioning systems.

While radiant cooling may be the most available alternative to air conditioners today, other technologies in development may soon push the bounds of energy efficiency. In July Secretary of Energy Steven Chu announced $92 million in awards for energy research projects. Of this, one-third was allotted to Building Energy Efficiency Through Innovative Thermodevices (BEETIT). Funded projects include the Absorption-Osmosis Cooling Cycle, a new air conditioning system that uses water as a refrigerant and salt as a heat absorber, with reverse osmosis to separate water from the salt solution.

Solid State Cooling, which uses a magnetic refrigeration cooling system, is also being funded. Many proposed projects have the potential to increase the energy efficiency of air conditioning by up to 50 percent, as well as eliminate the use of refrigerants with high global warming potentials.

The United States has been using the same conventional air conditioning technologies for over 50 years. For a large-scale transition to alternative cooling, education, incentives, and higher standards are needed. With informed building professionals and distributed financial incentives and/or subsidies to cover upfront costs, and performance-based compensation programs based on savings, architects and engineers will be more likely to include alternative cooling in their designs. Higher building standards that reflect government and public commitment to energy efficiency must also be imposed to lay a foundation for change.

Without a transformation of habits and technology, warmer temperatures will lead to increased air conditioning use and burden wallets, utilities, and the environment. The sooner alternative technologies are implemented, the farther down the road the world will be towards a sustainable future.
At the 16th Summit of the South Asian Association for Regional Cooperation (SAARC) held in Thimphu, Bhutan on 28-29 April 2010, India’s Prime Minister Dr. Manmohan Singh announced the creation of a climate adaptation fund for South Asia. Indian political leaders have recognized it as a necessary step to move ‘Towards a Green and Happy South Asia’ - the theme for this year’s Summit. The SAARC member nations jointly adopted the Thimphu Statement on Climate Change, which among other measures, promised to plant ten million trees over the next five years. It also commissioned a SAARC Inter-governmental Monsoon Initiative to study evolving monsoonal trends, and a SAARC Inter-governmental Climate Related Disasters Initiative on integrating Climate Change Adaptation with Disaster Risk Reduction. These actions indicate a renewed sense of urgency to cope with the changing climate and the increasing frequency of extreme weather disturbances associated with an erratic monsoon in this region.

How Climate Change Affects Monsoon Patterns

The Indian summer monsoon (ISM) is often dubbed as a 'mysterious phenomenon' due to its complex and irregular nature. The collaborative research work, Tipping Elements in the Earth’s Climate System, published by the Proceedings of the National Academy of Sciences has classified the transformation of the ISM as one of the intermediate ‘Tipping Points’ of our climate system, which can lead to radical and irremediable changes in the global environment. Scientists observed that the monsoon rains in Central India from 1981 to 2000 were more severe and frequent than the monsoons during 1950s and 1960s. In November 2008, these findings were summarized in a Regional Assessment Report by the United Nations Environment Programme (UNEP) for Project Atmospheric Brown Clouds. It deduced that:

1) The rainfall over India and Southeast Asia has decreased by 5 to 7 per cent since 1950 due to weakening of the ISM. This weakening implies that the total amount of rainfall during the monsoon season has gradually declined over the past several decades, and there has been a reduction in the number of long rain spell events (days of continuous rain).

2) The weakening has been accompanied by erratic behavior of the ISM. Despite decrease in aggregate rainfall, extreme rain events and days of very heavy rainfall have significantly increased in certain pockets of India and China, while days of moderate rainfall have become rarer. The dry spells or ‘breaks in monsoon’ between extreme rain events are now longer, which adversely affects farming activities.

Recently, researchers at the University of Liverpool confirmed that climate change will significantly alter India’s annual monsoon season resulting in intense droughts and severe flooding in various regions. The heightened unpredictability of the ISM is a result of a combination of factors including specific land-use patterns, increasing temperature, retreating Himalayan glaciers, warming of the Indian Ocean and rising sea levels.

Recognizing the Need for Adaptation

For a long time, India has been especially susceptible to the adverse effects of climate change. On 5th August 2007, the New York Times article ‘South Asia Grapples with Results of Flooding’ observed: “Nothing tests the mettle of government in this part of the world than a fierce monsoon, as unusually heavy rains across South Asia showed this week, leaving a trail of death and ruin and raising the risk of disease. Freak rains, which scientists describe as a hallmark of climate change, seemed to be responsible...In India... the death toll since the start of the monsoon in June stood at 1,225.”

This marked just the beginning. In 2008, flooding from monsoon rains caused unprecedented damage by destroying property and displacing over 2 million people. In summer 2009, drought conditions hit 246 Indian districts, resulting in water conflicts and large-scale internal migrations. It is now estimated that four out of every ten people in India suffer from water scarcity. India is still predominantly rural with 71 percent of its 1.1 billion people engaged in primary activities. As only one-third of the arable land is under irrigation, subsistence agriculture is largely dependent on monsoon rains. Even a nominal change in the intensity of the monsoon can have a huge impact on the country’s economy and lifestyle. Small, marginal and landless farmers inhabiting river floodplains are most vulnerable to the changing pattern of rainfall.

India’s future undeniably holds more extreme weather. It is essential to increase the resilience of local communities by adapting to changing conditions in water availability and demand. The Third Assessment Report of the Inter-governmental Panel on Climate Change fittingly concluded: “adaptation can reduce sensitivity to climate change, and mitigation can decrease exposure.” Thus, there is an imminent need to develop coping mechanisms to survive climatic variability and change.
Traditional Adaptation Strategies: Community Action in Tonk District

In Human Security, Vulnerability and Sustainable Adaptation, authors Karen O’Brien and Robin Leichenko highlighted the traditional adaptation practices used by vulnerable communities in the drought-prone Dotana and Sāfipur villages of Tonk District, Rajasthan. Most of the farmers in these communities are very poor, and rely on subsistence agriculture and cattle rearing for livelihood. As a response to an acute water shortage, they decided to grow drought-resistant crops like chick peas, cumin, mustard and vegetables. To raise their income, these farmers are now cultivating higher value medicinal crops for commercial sale. This is very important because poverty and economic insecurity impede people’s ability to deal with disasters.

As established in a case study by Chatterjee et al. (IDS Bulletin 36, 2005), the farmers have also resorted to improved water conservation and harvesting techniques through bunding of fields, constructing anicuts, and deepening wells and ponds. Contour bunding refers to small raised earthen embankments that act as barriers to water flow, retain water to build soil moisture storage, and prevent erosion by reducing the velocity of running water. Anicuts are water-harvesting structures made of dry stone, typically suited for arid and semi-arid regions like Rajasthan. They are built across streams to store water and to submerge upstream locations during sporadic periods of rainfall. The villagers use this accumulated water for domestic consumption and for recharging nearby wells. Such grassroots-level initiatives are indispensable to improving adaptive capacity of vulnerable communities.

Adaptation through Soft Engineering Defenses

Hard flood control measures like dams and levees have a distressing history in India. Instead of preventing floods, ill-conceived structural measures have actually aggravated flooding, as is evident from the Srisailam Dam overflow in Andhra Pradesh (2009), the Kosi embankment breach affecting Bihar (2008) and the Ukai Dam disaster in Gujarat (2006) that claimed hundreds of lives, and cost millions of dollars in infrastructure and property damage. Therefore, soft flood control techniques like mudflats, forest buffer zones or salt marshes are a highly recommended alternative for India. The soft path assumes that we must learn to live with floods. Instead of preventing floods, soft measures focus on reducing the speed, intensity, impact and duration of the deluge. Trial tests in Abergavenny, Scotland have shown that riparian woodlands are a sustainable method of flood alleviation. Riparian plants, which include trees and shrubs along the banks of water bodies like rivers, streams or lakes, serve to slow down the momentum of flood flows. Studies in the River Devon Demonstration Site in Clackmannanshire have further reinforced the benefits of natural flood control through soft defenses. India can also learn from Canada, which has one of the best models of artificial flood diversion: the Red River Floodway around Winnipeg. Since its construction in 1968, the floodway has been used more than twenty-five times and has prevented over ten billion dollars worth of damages. These low-cost and eco-friendly options will allow risk-prone populations in India to better manage frequent floods.

Adaptation through Empowerment: The Road Ahead

Adaptation is not a pre-determined set of products; it is an ongoing and evolving process. India must move from a mere acceptance and understanding of climate change to resilience and risk-management. Empowering citizens and encouraging them to take the lead in influencing development programs is a vital component of adaptation. A good working example of this is Coastal Area Disaster Mitigation Efforts (CADME) which operates in 150 districts along the east coast of India, educating villagers on disaster preparedness and awareness about early warning systems.

The World Development Report 2010, Development in a Changing Climate, stresses the importance of information management through intra-community communication channels and advocates social policies aimed at gender inclusion. In Asian households, women traditionally play a central role in agricultural activities, in teaching children and looking after family welfare, and in influencing spending or saving habits. The Oxfam International found that the carbon footprint of women is significantly smaller than men’s, and that women lead many of the pioneering responses to environmental challenges. So engaging and empowering women can be very beneficial in policy planning, and can raise environmental performance. The voices of children and young adolescents are also imperative in a holistic approach to adaptation. Estimates by the International Food Policy Research Institute reveal that by the year 2050, twenty-five million Indian children would be among the worst hit by the impact of climate change. India needs to strengthen its Child Led Disaster Risk Reduction Program through more child-centered policies in order to minimize risk in local communities. The call for adaptation to changing climate and precipitation patterns is an opportunity to achieve growth, to ensure human security and to promote human development. India must make the best use of this chance.
Climate Alert

Micro Irrigation

Eric Lowe

Of the many anthropogenic climate change impacts, the advent of drought and global water shortages due to changes in weather, precipitation, evapotranspiration and other climatic patterns will prove most worrisome. Agriculture, itself highly dependent on water, will be hard hit if water resources become scarcer. Globally, almost 70% of fresh water is consumed by irrigation for crop growing. Some countries, such as Egypt (nearly 100%), Pakistan (85%) and other arid-land nations must irrigate almost all of their crop-land, making their agricultural industries highly dependent on nearby water source access. As climate change is expected to divert or eliminate many water sources, agriculture itself will become much more difficult for many vulnerable countries.

Reduced access to fresh water due to climate change will pose a significant threat to food security and population centers in many areas of the world. Cost-effective adaptation measures exist that will allow for survival in a world with a changed climate and limited freshwater access.

One such measure is the implementation of drip- or micro-irrigation techniques in farming practices. Drip irrigation is a highly efficient method of watering crops, one which applies a constant, slow, and localized flow of water to the root zones of plants, rather than sprinkling water above the leaves of plants. An example of this might be found in a home garden where a hose with small holes, coiled around the base of plants, slowly seeps water into the soil around the root zone.

Improved water delivery efficiency is the primary motivator for the implementation of micro-irrigation techniques, meaning more plant growth for less water. Since soil is less likely to be oversaturated and water is directed at the root system, ab- 

soption levels are higher. According to a study conducted by the Florida State Horticultural Society, the efficiency of overhead sprinkler water delivery systems (by far the most common) was only 8-9%, while the efficiency of a drip- or micro-irrigation system was between 51-57%, meaning more water is absorbed. In horticulture, water efficiency refers to the “leaching fraction,” or how much water escapes below the plant’s root zone and seeps out to surrounding areas. According to the University of Rhode Island, a drip irrigation system will see upwards of 90% of its water reach the roots of plants (remember that absorption rates are higher too), whereas sprinkler-based systems only see 65% contact the roots. Not only does more water reach the root zone of crops irrigated with drip-based methods, where it is absorbed by the plant, but less water escapes below the root zone to be leached into surrounding water tables and ecosystems.

Therefore, even a two-fold decrease (a conservative estimate) in water usage will preserve tens of millions of gallons of drinkable water every year in the U.S. alone.

A secondary benefit to micro-irrigation is a decreased use of pesticides, fungicides and fertilizers during irrigation, or so-called “fertigation.” Micro-irrigation is more efficient: the continuous flow of water (containing fertilizer) allows the plant better absorption, and the constantly exposed root zone requires less fertilizer. According to the USDA, less than 0.1 percent of the system flow rate need contain agrochemical products to maintain current absorption levels. In 2020, the global demand for fertilizers is expected to exceed 220 million metric tons, a dramatic growth in consumption over the roughly 141 million metric tons used annually from 1960-2000. Fertilizers and other agrochemicals have adverse environmental and social consequences, as the majority of these chemicals are not absorbed by crops but instead seep into water tables and local ecosystems. According to U.S. data, there has been a 33 fold increase, domestically, in the use of agrochemicals since 1945, while the toxicity of many of these chemicals has increased upwards of 10 fold in the same time period. 18% of all pesticides and nearly 90% of all fungicides are categorized as carcinogenic. It is estimated that the pollution from agrochemical runoff causes $100 billion in public health and environmental damage every year. These costs could be significantly addressed with the implementation of micro-irrigation.

Another benefit of drip irrigation systems is increased resistance to fungal disease, since these systems do not water leaves themselves which are most vulnerable. Water-based diseases are less likely to be transmitted because the water flow is constant, preventing disease in stagnant water of irrigation lines. Oversaturation promotes weed growth, so drip-irrigation systems help to alleviate this problem as well.

Greater water exposure to root system, combined with higher levels of oxygen content in soil (due to less overwatering) and less oversaturation of the root zone can dramatically improve crop yields. More efficient use of water and fertilizer makes the production of these improved crop yields less capital intensive, thereby multiplying the cost-effectiveness of drip irrigation. Especially because less physical labor is needed to operate a drip irrigation system.

There are, however, potential complications. Specifically, drip-irrigation systems used in developing countries lack many of the technological capacities of their more expensive counterparts, such as back-flow restrictors or filters. Without advanced filtration systems, micro-sediment, algae and mineral precipitates accumulate over time, clogging emitters along the drip line. The system needs to be flushed with sufficient water pressure so as to wash out any sediment buildup. If the water pump fails, lack of a back-flow restrictor may cause water to flow back into the system, flooding it. Moreover, frost or freezing cold temperatures can disrupt the system, requiring additional equipment and labor to fix.

Despite potential challenges, drip-irrigation is highly cost-effective, and capital requirements for installing a new system are, while high compared to traditional irrigation techniques, still quite modest (estimated below $300 per standard garden). Benefits for water consumption, agrochemical usage levels and resultant crop yields are undeniable. In sum, micro-irrigation offers a small-scale, efficient adaptation measure to limited freshwater availability.
Tickell Network Expanding Rapidly in Mexico

A year and a half after Climate Institute’s the first greenhouse monitoring measurements atop Sierra Negra, 4550 meters above sea level, in Mexico, the Interactive Climate Awareness Network is rapidly growing across the country. On July 22 Morelos Governor Marco Antonio Adame Castillo and Federal Environment Secretary Juan Rafael Elvira Quezada inaugurated the Tickell Network Interactive Climate Outreach Centre Parque Ecológico San Miguel Acapantzingo in Cuernavaca. This climate theatre joins two others—one in Flor del Bosque Park in the State of Puebla and a second at Mexico City Museum of Natural History and the Environment. Work is underway in the City of Veracruz on a fourth climate theatre. On the August 4th Global Forum he hosted in Toluca, capital of the State of Mexico, at which Al Gore, Mario Molina, Margie Simon de Ortiz and Luis Manuel Guerra spoke, Governor Enrique Pena Nieto announced that his state has asked the Climate Institute to build four climate theatres within his state. Plans are underway to extend the Tickell Network to a number of other states — to both Acapulco and Chilpancingo in the State of Guerrero, Chetumal and Cancun in the State of Quintana Roo, Morelia in the State of Michoacan, Oaxaca in the State of Oaxaca, and Tijuana in the State of Baja California Norte. Luis Roberto Acosta, Director of the Climate Institute’s Mexico and Latin America Program and its entire Global Climate Observation Program, has spearheaded the remarkably rapid growth of the Sir Crispin Tickell Climate Awareness and Response Network. Barbara Hernandez, President of Fundacion Pedro y Elena Hernandez, and an active member of the Climate Institute Board, has played a vital role in the growth of this network linking the world’s highest climate observatory and a series of Climate Outreach Centers, a climate education equivalent of an astronomy planetarium.

Daniel Wildcat book shows how climate savvy of indigenous peoples can guide smart adaptation strategies

Professor Daniel Wildcat, Dean at Haskell Indian Nations University in Lawrence, Kansas and Convenor of the American Indian Alaska Native Climate Change Working Group, in his book Red Alert: Saving the Planet with Indigenous Knowledge: Fulcrum 2010, shows that Native Americans and other indigenous peoples have a wealth of experience in coping with climate and environmental stress.

Prof. Wildcat, a Board member of the Climate Institute, describes how this know how can be vital to humanity in designing anticipatory adaptation strategies. The Working Group that he has sparked has inspired a number of tribal college students to meld indigenous knowledge of coping strategies with mastery of geographic information systems and other tools. Prof. Wildcat also shows how adaptations to the cold have profoundly shaped indigenous cultures in the Arctic, including even language.

Former Climate Institute intern assumes post-doctoral research position at University of Illinois

Michael Ring, who served as an intern at the Institute a decade ago just before completing his senior year at Massachusetts Institute of Technology (MIT), earned his Ph. D in atmospheric sciences in 2008 at MIT and then joined the University of Illinois where he is working closely with internationally renowned research scientist, Michael Schlesinger. Institute President John Topping remarked "Mike Ring is a true polymath. During his internship with us in the summer of 2000 he not only created the climate science and extreme weather sections of climate.org but showed himself an expert on political trivia and sports. Perhaps this shouldn’t have been surprising as he was Editor of the school paper, The Tech, at MIT. Only recently, however, in scanning his page on the University of Illinois site did I discover that he is a Life Master in bridge.”

John-Michael Cross named Director of Research at the Climate Institute

A graduate of Johns Hopkins University with a Masters Degree from the Climate and Society program at Columbia University, Mr. Cross has worked for the past 18 months at the Climate Institute focused largely on the Global Sustainable Energy Islands Initiative and the Black Carbon Reduction Program. With his new responsibilities he is slated to assume the lead in the Institute’s efforts to highlight win-win opportunities in reduction of emissions of black carbon and short-lived greenhouse gases. This includes an analysis of opportunities within wealthier nations to reduce diesel related emissions of black carbon.
The Climate Institute is a non-profit, 501 (c)(3) charitable, educational organization. It receives financial support from government agencies, foundations, corporations and associations, environmental and research organizations, and individuals.

Founded in 1986, the Climate Institute was the first non-profit organization established primarily to address climate change issues. Working with an extensive network of experts, the Institute has served as a bridge between the scientific community and policy-makers and has become a respected facilitator of dialogue to move the world toward more effective cooperation on climate change responses.

The Climate Institute’s mission is to ...

CATALYZE innovative and practical policy solutions toward climate stabilization and educate the general public of the gravity of climate change impacts.

ENHANCE the resilience of humanity and natural systems to respond to global climate change impacts especially among vulnerable groups (e.g. Native American tribes and Small Islands).

WORK internationally as a bridge between policy-makers, scientists and environmental institutions.

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Editor’s note: For all citations and references, see the electronic version of this newsletter at www.climate.org