Troubled Waters

Climate Change, Hydropolitics, and Transboundary Resources

David Michel
Amit Pandya
Editors

STIMSON
PRAGMATIC STEPS FOR GLOBAL SECURITY

ISBN: 978-0-9821935-2-5
Cover photos: Les Penuries D'eau Pourraient Tripler Avec le Rechauffement, India © 2006 STRDEL/AFP/Getty Images; 2007-BG-Noorani-0505, Bangladesh, River Bleeds Black Series © 2007 Shehzad Noorani
Cover design by Free Range Studios
Book design/layout by Nita Congress

The Henry L. Stimson Center
1111 19th Street, NW, 12th Floor
Washington, DC 20036
Telephone: 202.223.5956
Fax: 202.238.9604
www.stimson.org

Climate Insecurity in Southeast Asia: Designing Policies to Reduce Vulnerabilities

Khairulmaini Osman Salleh

The interaction of climate change and poverty will have profound effects on human security and societal well-being. In underdeveloped and developing nations, poor and marginalized communities often depend directly on the environment for their livelihoods, mostly through subsistence agriculture. Climate-sensitive industries, such as agriculture, energy, and tourism, also drive much of these countries' economic growth. When human welfare is threatened, climate itself will likely become a security issue and lead to population stresses, conflicts, and perhaps even war. Such calamities are certain to perpetuate poverty. But even without them, environmental insecurity, or the inability of the environment to sustain ecological and human value systems, could become the defining factor of human security in the next century.

Sir John Houghton, former co-chair of the Intergovernmental Panel on Climate Change's (IPCC's) scientific assessment working group, has described the impacts of global warming as a "weapon of mass destruction," which, like terrorism, knows no boundaries.[1] It can strike anywhere, in any form: a heat wave or drought in one place, a flood or storm surge in another. The UN Millennium Project has also emphasized the emerging importance of environmental security/insecurity issues, arguing that climate change and environmental degradation threaten to unravel progress toward achieving the Millennium Development Goals and undermine the very basis of sustainable economic growth.[2] Similarly, Sir Nicholas Stern, head of the UK Government Economic Service and a former chief economist of the World Bank, suggested in his landmark report on the economics of climate change that global warming threatens to create the greatest and widest-ranging market failure ever seen.[3] In the United States, the linkages between climate change and security were recognized in the very name of the Lieberman-Warner Climate Security Act of 2008.

Currently, Southeast Asia is still considered relatively "safe" from the impact of climate change, but this may be only because limited climate data hinder the ability to relate weather and oceanic events to global warming. Tropical storms and monsoons are a normal part of the region's climate system. However, recent changes in the hydrometeorological

processes of major river basins and the degradation and inundation of the region's coastal regions imply that Southeast Asia will not be "safe" for long. Indonesia, Malaysia, the Philippines, Thailand, and Vietnam are all experiencing changing patterns of floods, coastal storm surges, and erosion. As a developing region, Southeast Asia's GDP is very dependent on the condition of her environment. Regional climate changes could seriously affect agriculture, urban commerce, and the booming tourism industry, among other sectors.

In Southeast Asia, climate change will especially affect the low-income populations of urban, highland, and coastal-island regions. It will also have serious repercussions for modern production systems that are climate driven and environment dependent, such as agriculture, energy, fishing, and certain service industries such as tourism. The objective of this paper is to discuss these vulnerabilities in the context of the potential effects of global warming on regional environmental systems; examine why these systems are vulnerable; and explore the adaptation, mitigation, and policy implications.

Theoretical Framework

Vulnerability to climate hazards refers to susceptibility to being harmed by these threats. Social scientists and climate scientists have different interpretations of the term "vulnerability." Social scientists view the term as representing the set of sociocultural, economic, political, and demographic factors that determine a system's ability to cope with stress or change—sometimes also referred to as "inherent vulnerability." Climate scientists view it as the likelihood that weather- and climate-related hazards will affect society and systems—in terms of external stresses such as the frequency and duration of rainfall, temperature, wind speed, or water level. Vulnerability in climate change studies should integrate these two definitions. Using the climate scientists' viewpoint, the potential impact of a decrease or increase in seasonal rainfall on basin agriculture can be examined. However, this study would be incomplete without a social scientist's knowledge of the inherent state of a system before it encounters a hazard event, such as the local water retention systems in the basin.

This integrated perspective is used in the IPCC *Third Assessment Report* and in the *Fourth Assessment Report*, which describes vulnerability as "the degree to which a system is susceptible to, and unable to cope with [inherent vulnerability], adverse effects of climate change, including climate variability and extremes [external stresses].[4] *Vulnerability* is a function of the character, magnitude and rate of climate change and the variation to which a system is exposed, its sensitivity and its adaptive capacity." A vulnerable system needs to increase its resilience by either reducing the effect of the external stresses or adapting to these threats. To reduce the effects of external stresses is costly and usually involves mitigating measures. In Southeast Asia, the immediate need is to increase resilience through adaptation. It is important to understand the regional environmental stresses, the vulnerable

systems, and possible adaptation and mitigation measures. An understanding of the relationships of these three components will influence what kinds of policies are needed to address the climate change threat in the region.

Regional Environmental Stresses

Southeast Asia consists of the 10 member countries of the Association of Southeast Asian Nations (ASEAN): Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. These countries lie on the waters of the Pacific Ocean, Indian Ocean, Andaman Sea, and South China Sea. The region stretches more than 3,300 kilometers from north to south, and 5,600 kilometers from west to east. Cambodia, Laos, Myanmar, Thailand, and Vietnam are located in the Indochina subregion (commonly referred to as Mainland Southeast Asia), while Brunei Darussalam, Indonesia, Malaysia, the Philippines, and Singapore are located in a subregion commonly referred to as the Malay Archipelago, also known as Maritime Southeast Asia. Of the 10 member countries, only Laos is landlocked; the others have direct access to the sea.

The climate of the Southeast Asia region is dictated by the behavioral patterns of the monsoons, the El Niño event of the South Pacific Ocean, the low oceanic pressure cells (LOPCs) of the western Pacific Ocean–South China Sea region and the Bay of Bengal–Indian Ocean region, and, to a certain extent, by the Indian Dipole Oscillation (IOD) of the Indian Ocean. Monsoons are an annually recurring weather phenomenon, triggered by the Earth's tilt in relation to the sun. They develop as a result of changing patterns of atmospheric pressure caused by the varied heating and cooling rates of continental landmasses and oceans. The summer monsoon, which blows southwesterly across the Indian Ocean, is extremely wet. The winter monsoon blows northeasterly and is generally dry.

El Niño is an oscillation of the ocean-atmosphere system in the tropical Pacific. In normal, non-El Niño conditions, the trade winds blow west across the tropical Pacific. These winds pile up warm surface water, so that the sea surface temperature is much higher in the Southeast Asia region and northern Australia than in western parts of South America. Rainfall is found in rising air over the warmest water. During El Niño, the trade winds relax in the central and western Pacific, with a backward sloshing effect of sea surface temperatures. Rainfall follows the warm water eastward, with associated flooding in Peru and drought in Indonesia and Australia. This century has witnessed an increasing frequency and intensity of El Niño events in 1982, 1987, 1991, 1994, and 1997, with the last being the worst. Experts anticipate that a much more intense El Niño will occur in the not-so-distant future. Dry weather associated with El Niño events not only brings about drought in many parts of Southeast Asia, but also contributes to the combustion of extensive peat lands and the intensification of atmospheric haze pollution. To a lesser extent, Southeast Asia is also influenced by La Niña events, which are characterized by stronger than normal (easterly)

trade winds over the Pacific Ocean, and result in higher rainfall in the Southeast Asia region. Important La Niña events occurred in 1988, 1996, 1998, 1999, and 2000.

LOPCs are low-pressure systems, or tropical depressions, that develop in the western Pacific Ocean–South China Sea region and in the Indian Ocean–Bay of Bengal region. These low-pressure systems usually start off as low-pressure depressions, intensify into tropical storms, and become full-blown typhoons in the western Pacific Ocean–South China Sea region and cyclones in the Indian Ocean–Bay of Bengal region. LOPCs are becoming more frequent, as evidenced by recent storms that affected Myanmar, the Philippines, and Vietnam.

The Indian Dipole Oscillation occurs interannually in the tropical parts of the Indian Ocean. During a positive IOD event, the sea-surface temperature drops in the southeastern part of the Indian Ocean—the northern coast of Australia, the eastern coast of Japan, and throughout Indonesia—while it rises in the western equatorial Indian Ocean, off the eastern coast of Africa. A positive IOD brings heavy rain to East Africa and droughts to Indonesia and parts of Australia. There is an analogous negative IOD, which is, in effect, the reversal of the positive IOD. Studying and monitoring the IOD will not only increase weather- and climate-forecasting capabilities in the Indian Ocean, but also contribute to general understanding of ocean-atmosphere dynamics, which has the potential to provide new insight into the puzzle presented by current global climate variability.

These atmospheric and oceanic systems control river basin hydrological processes, such as floods and droughts, and thus they also govern the evolution of major human settlements and the development and sustenance of the region's economic activities. These basins include the Mekong, the Menam Chao Phraya, and the Irrawaddy in Mainland Southeast Asia, and a number of much smaller basins in Borneo, such as the Rejang and Kinabatangan Rivers. Changes in the behavioral patterns of ocean-atmosphere weather systems will bring about changes in the time of onset and increase the intensity, frequency, magnitude, and duration of low-pressure storms, floods, and droughts. The impacts of these climatic shifts risk fostering new threats, such as the emergence of diseases in new regions (such as highlands), accelerated erosion, rapid slope failures and landslides, and other forms of climate-induced hazards.

In Southeast Asia, the greatest threat of changing basin hydrology is to agriculture, with the associated decline of food security and rise of poverty. Southeast Asia is very much an agrarian region, with a mix of small-scale cultivation and major plantations. Agriculture employs a huge population of manual and low-income labor. Similarly, the threats posed by floods; atmospheric haze; slope failure; droughts; and outbreaks of dengue, malaria, and the Japanese encephalitis virus are directly or indirectly related to climate and climate-induced hazards. They have the potential to threaten people's well-being, health, and livelihoods.

Already, the IPCC has found that temperatures in Southeast Asia rose at a rate of 0.1°C to 0.3°C per decade over the second half of the 20th century (1951–2000). The region saw extreme weather events associated with El Niño grow more frequent and intense in the past 20 years. Similarly, the strength, frequency, and damage caused by tropical cyclones has increased since 1970. Over the course of the 21st century, the IPCC projects average temperatures will warm another 2.5°C, rainfall increase 7 percent on average across the region, and sea levels rise by at least 40 centimeters even under the most conservative scenario. The IPCC also expects that extreme events such as floods, droughts, and heat waves will strike Southeast Asia more often; tropical cyclones will increase in intensity by 10 to 20 percent.[5] With this in mind, the 2008 inaugural meeting of the ASEAN environmental ministers called for a reassessment of each country's development policy so as to begin incorporating climate change considerations in order to be better prepared for any form of climate change-related threats in the future.[6]

Mapping Vulnerabilities

Defining Poverty

As in most developing regions, many of Southeast Asia's rural economic practices and modern economic production systems are governed by the condition of the environment and behavior of the seasons. Increasing climate extremes and variability will severely affect the region's natural environment. Indonesia, Malaysia, the Philippines, and Vietnam, which have very long coastlines and many islands, are threatened by sea-level rise. Southeast Asia's biodiversity-rich forests, water resources, and marine ecosystems, including its very rich coral reefs, are threatened by increasing land and sea temperatures. Damage to any or all of these could have serious ramifications for agriculture, fishing, tourism, energy, rural-urban commerce, and international trade.

The region needs to assess its present vulnerability and resilience to climate change threats and carry out adaptation and mitigation programs. Particular attention should be given to the fact that while major economic systems may have the capacity to adapt, the traditional, low-income economic systems predominant in many parts of the region may not. To understand the linkages between climate change and poverty, however, one must define "poverty" in a broader context. The first and most important step in studying poverty is determination of the poverty line. Poverty lines are used in estimating the incidence of poverty and in examining the nature and severity of poverty, and they can vary according to geographical region (e.g., rural versus urban) or household size and composition. Though there are major debates over what indicators should constitute the poverty line, there is agreement that the threshold value should be able to provide for a comfortable and decent living of household members without any breakdown of social structures. This threshold value also describes the level of vulnerability inherent in the household unit and its ability

to adapt to conditions that could undermine its stability and sustenance. Thus, poverty-reduction programs in this region have two main objectives: to reduce vulnerability, and to increase the adaptive capacities of individual households to achieve and sustain a certain quality of life.

The latest available national estimates of poverty based on national studies show that 36 percent of the population of Cambodia lives below its national poverty line, 17 percent of Indonesia, 32 percent of Laos, 5 percent of Malaysia, 27 percent of Myanmar, 30 percent of the Philippines, 12 percent of Thailand, and 27 percent of Vietnam.[7] Adapting to climate change will cost individual households as they attempt to sustain their comfort, health, and livelihoods; the costs will increase as climate change worsens. However, climate change is not currently one of the elements used in computing poverty lines. Even for developed economies such as the European Union and the United States, whose poverty line index is much higher, the population's adaptive capacities to climate change are not unlimited. Hurricane Katrina, which hit the Gulf Coast of the United States in August 2005, brought about destruction in the billions of dollars, population displacements, and more than 1,000 deaths, resulting in increased poverty and changing social structures. In all countries, there is a substantial percentage of the population whose household income might be higher than the poverty line but that is dangerously vulnerable to climate-related hazards. Although the incidence and nature of poverty in Southeast Asia vary among countries, the present poverty lines do not adequately incorporate the climate change threat.

In Southeast Asia, the vulnerability of people living below or near the poverty line is a function of many factors. These include demographic structure of the household, economic livelihood activities, physical characteristics of the household unit, immediate living environment, exposure to climate induced hazards, inherent coping mechanisms, and the existence of infrastructure and support systems. In addition, limited knowledge and awareness of climate change threats could hinder immediate responses to hazards, which could be costly or fatal.

The Geography of Vulnerability

Low-income populations in Southeast Asia can be grouped into three geographic regions, based on how climate change can affect economic systems and practices dependent on human-environment relationships. These are urban regions, where the urban poor derive their income from informal activities; highland regions, where traditional agriculture and harvesting of forest products are a major source of livelihoods; and coastal and island regions, where the low-income populations generally work in traditional fishing and agriculture. It is important to remember that many of these low-income people are not

significantly below the poverty line. The majority exists on or near the threshold, and may thus not be considered "vulnerable" under standard indicators.

In urban Bangkok, for example, many farmers sell their farm products on boats along the Menam Chao Phraya. Any significant change to the river system's flow would severely affect these informal traders. The highland regions of the Irrawaddy, Menam Chao Phraya, and Mekong Basins, as well as the much smaller river systems of Insular Southeast Asia, are home to thousands of small-scale, rural farms which produce upland *padi* rice, corn, and millet. These regions also have rich forests that play a part in the livelihoods of the local people. Climate change, through its effects on water availability and seasonality, could affect rural agriculture productivity and forest biodiversity. The main rural livelihood activities of the coastal regions of Indonesia, Malaysia, Myanmar, the Philippines, Thailand, and Vietnam are still agriculture and fishing. In many of these areas, irrigation water pumped from underground sources is critical to sustaining agricultural activities. Regional precipitation shifts, temperature increases, evaporation processes, and the impact of El Niño events would severely limit groundwater recharge. The economic performance of the fishing communities of the northeastern region of peninsular Malaysia, the eastern region of Vietnam, southern Thailand, and many parts of the Philippines is largely dictated by weather conditions in the South China Seas, such as LOPCs, El Niño, and the northeastern monsoon.

There are general and specific characteristics that describe the vulnerability of the low-income economic systems of the urban, highland, and coastal-island regions. The main general vulnerability indicator is income, defined as a family's total remuneration and translated into monthly or yearly earnings, since, in general, the source of income is not fixed or consistent. For low-income economic systems, daily income is much more important, as the household's everyday activities are governed by it, with limited savings potential. Whatever limited savings are available are used for social obligations, such as providing for children's education and religious duties, and increasing economic opportunities, such as investing in better machinery and technology. The more specific indicators of vulnerability are associated with local environmental stresses, the sociodemographic profile of the communities at risk, their external and living environment, and cultural practices. Adding to vulnerability are the communities' levels of awareness: whether they perceive environmental stress as part of the normal cycle of the human-environment relationship or as something that is part of a broader climate change scenario that will influence their future relationships with the environment.

People and communities do develop coping strategies to deal with climate variability. These include building social networks as forms of insurance, traditional forecasting, and ingenious means of protecting assets, such as the use of floating seed beds during floods. However, the poor's coping strategies are naturally restricted by lack of assets and other stresses on their livelihoods.

Adaptation to Climate Change and Policy Implications

Determining Adaptive Capacity

Adaptation can be described as the ability or capacity of a system to modify or change its characteristics or behavior so as to better cope with existing or anticipated external stresses. To a large extent, the adaptation process is determined by the nature of the hazard to which a system must adapt and the type of system under threat. A particular hazard could devastate one system while having no impact on others. Similarly, different systems could exhibit different levels of vulnerability and resilience to particular hazards. For example, the presence of early warning systems that detect risks and communicate and mobilize action will enable people and communities to adapt to increasingly frequent climate hazards.

If we were performing a national assessment for a particular country, we might begin by assessing that country's general vulnerability and adaptive capacity in order to identify needs and options for increasing the country's ability to cope with a wide range of hazards. We would then identify the principal existing hazards that already have significant negative impacts on a regular basis and potential future hazards that represent the most likely threats to human welfare and economic development. Existing hazards are easily identified from the recent historical record, while potential future hazards might be identified through modeling studies, historical or paleoclimatic analogy, analysis of existing trends, and a consideration of physical principles.

Once hazards are identified, assessments of specific vulnerability and adaptive capacity can be carried out for each hazard in turn. The identification of priority hazards, and of vulnerability to them, is essentially an exercise in the assessment of outcome risk. Within the context of the framework outlined above, we may view the outcome risk associated with a particular type of hazard over a given time period as a function of event risk and the social/inherent vulnerability of the exposed systems and populations. The way in which event risk is defined will depend on the nature of the hazard. Event risk might refer to the probability of occurrence of a single, unique, or long-return-period event, or to the actual or projected frequency of occurrence of a recurring hazard. We might be interested only in the occurrence of events whose severity exceeds a given physically defined threshold, or we might wish to define event risk in terms of the frequency of occurrence of a particular type of hazard combined with some measure of intensity, perhaps based on mean or peak severity.

The Nexus of Poverty and Adaptation

The climate is becoming more variable and creating additional risks, and the poor are becoming more vulnerable. As climate extremes are "covariant risks" (i.e., simultaneously affecting a wide range of people), current safety nets are likely to be overwhelmed. This includes both formal systems, such as social assistance, and informal systems, such as

social networks. Comprehensive national plans on adaptation to climate change impacts are still in preparatory and planning stages in all countries of Southeast Asia. Many Southeast Asian countries are just beginning to take action to adapt, beginning with an analysis of their vulnerability and implementing some limited policies.

There are a number of climate-related adaptation strategies already practiced in the region, and there is talk of mainstreaming climate change concerns into existing practices. Indonesia and the Philippines, for example, have expressed a strong interest in linking adaptation with disaster risk management and planning. In Indonesia, the disaster risk-response infrastructure is in place, thus presenting an opportunity to link with climate risk management. National governments in the region have been implementing and accumulating substantial relevant experience in programs that address poverty, disasters, weather monitoring and forecasting, and environmental issues.

There are also focused national measures that address climate risk management and impacts on specific sectors. In the farming sector of the Lower Mekong countries, these involve financial support to farmers; support for transition to other crops and more diversified farming systems; support for marketing of village products; R&D into new seed varieties; development of rural infrastructure; and providing information for farm management, including seasonal forecasts. These sector-specific measures have been implemented in Laos, Thailand, and Vietnam, with low to moderate effectiveness.

It is necessary to widen the practice and understanding of climate risk management to include livelihoods. Generally, there are two types of local adaptations to climate change in the region: those initiated and driven by the provincial, municipal, or commune/village-level governments, and those implemented by NGO—often international—intermediaries. In a number of Southeast Asian countries, local officials have a low level of knowledge and awareness of climate change impacts, mitigation, and adaptation measures, insufficient to prompt them to formulate proactive and anticipatory action agendas. However, many local governments have long been responding to extreme events, such as flooding, storm surges, and typhoons, in their own areas. These concerns fall under the conventional mandate of local governments for disaster preparedness, relief, and rehabilitation.

It has often been observed that in the strategic management of extreme events, local governments exhibit a strong propensity—with support from national governments—to employ purely technical fixes by constructing physical structures such as seawalls, breakwaters, and flood control systems. Yet many local governments have also employed "soft technologies" for disaster preparedness. According to a study of four provinces in the Philippines (Batangas, Cebu, Davao, and Pangasinan), local government actions in disaster preparedness included the creation, enhancement, or strict implementation of coastal laws and land regulations, general coastal management, and disaster programs.[8] Vietnam has

similarly moved to create proactive adaptation programs to build on ground-level disaster risk management measures that have been largely emergency response–oriented. In 2004, the provincial government of Thu Thien-Hue forged a three-year project partnership with the Canadian Centre for International Studies and Cooperation, an NGO funded by the Canadian International Development Agency. The joint program focused on strengthening capacity to plan and implement community-based anticipatory adaptation strategies through disaster preparedness and integration of risk reduction and mitigation with local development planning. The project covered four communes and a total of eight villages.

International and domestic NGOs, in partnerships with local people, have also been the drivers of planned adaptation measures focused on vulnerability reduction and strengthening the adaptive capacities of households and village communities. Examples include community-based disaster preparedness projects in the Philippines to reduce vulnerability and implement disaster management strategies; the International Federation of Red Cross project in urban Jakarta setting up community-based action teams to strengthen disaster response capacity; water supply provisioning in six villages in the Kravanh district of Pursat in Cambodia; and livelihood projects conducted by Oxfam GB in four provinces of Vietnam for poor farmers and laborers, delivering humanitarian assistance and disaster preparedness, and empowering people by facilitating their inclusion in the policy process. Also in Vietnam, international and domestic NGOs have started a forum to discuss ways of integrating the climate change agenda into their ongoing programs as they build adaptation capacity for vulnerable people and places. While their current local programs are not explicitly called climate change adaptations, they nevertheless are oriented toward generic vulnerability reduction and enhancement of household adaptive capacities through empowerment and welfare projects.

Vulnerability to climate variability has significant implications for the achievement of the Millennium Development Goals. Development must be based on understanding existing and future vulnerabilities to climate risk if it is to be resilient enough to cope with climate change. In some cases, climate change adds urgency to current activities to improve policies and institutional mechanisms that affect the poor. In other instances, there may be a case for changes in planning or institutional reform to take account of climate risks, or for building additional capacity into infrastructure investment. Whatever the response, managing climate risks should be an integral part of development planning. Policymakers must recognize the impact of climate variability on the poor, which includes improving the understanding of their vulnerability to all external shocks and trends, as well as of their native coping capacities and strategies.

Multilevel Adaptation Policy

Adaptation to climate change needs to be mainstreamed into development policy and practice at national, international, and regional levels. Particular attention needs to be paid to

supporting community-based approaches to adaptation. It is essential to build on the considerable body of knowledge already possessed by low-income people. For instance, rural farmers of the upland regions of Mainland Southeast Asia can learn from the practices of the farmers in the Yamuna River area of Rajasthan, India. There, poor communities have revived traditional rainwater harvesting methods in the form of *johads*—small semicircular dams—which have helped recharge groundwater and virtually drought-proofed their villages.

There are many examples of local-level adaptations in Southeast Asia that people already use to cope with climate events. In upland Pantanbangan, in the Philippines, floods from prolonged rains prompted farmers to dig canals and install drainage systems, diversify crops, and plant rain-tolerant species. In the El Niño–prone uplands of Sulawesi, Indonesia, farmers proceed with standard crop management both in nondrought and drought seasons, but they reduce their household expenditure on food, clothing, and housing during drought periods. In lowland Java, farmers' adaptation to El Niño impacts takes the form of reducing the area planted. In lowland, rain-fed rice farms in Kandal Province, Cambodia, farmers adapt to rainfall uncertainty by dividing their rice plots—utilizing conventional wet-paddy rice techniques (resistant to heavy precipitation) on one half, and applying the system of rice intensification (a drought-resistant cultivation technique) on the other. In the floodplains and wetlands of the Lower Songkram River Basin, Thailand, farmers minimize the uncertainties and risks of floods and drought through livelihood diversification that includes farming, fishing, raising eucalyptus and rubber trees, and nonfarm occupations.

At the country level, climatic change is just one aspect of the external events and changes to which economies and societies must adapt. Southeast Asian governments can, however, attempt to increase the resilience of their growth strategies to the impacts of increasing climate variability. Although there is still little experience of best practices of adaptation to climate change on which to rely, experience of more general adaptive economic policies offers some pointers. It is important to maintain the principles of good economic policy that assist adjustment to exogenous factors, such as climate shocks, by encouraging a policy environment conducive to changing market trends. Governments should allow prices to reflect the changing availability of resources and avoid economic instruments, such as guaranteed prices or quotas, that may distort rational decision making at a time when change is needed. Other possibilities exist as well. Policymakers should avoid mechanistic responses that impose direct or indirect subsidies to protect the status quo and that result in increasingly large and unsustainable fiscal burdens. Policy decisions should include contingencies for climatic variability within budget planning processes. Policy should encourage individuals to move away from geographical areas or sectors most affected by climate change. Authorities should remove restrictions that confine the poor to increasingly unsustainable livelihoods or marginal areas. And governments should support technological development and the provision of information in sectors that will allow individuals and markets to adapt

to or mitigate the impact of climate change. These could include new varieties of crops or adoption of more water-conserving technologies by industry.

Governments also have a role in disseminating weather information and climate forecasts, and predicting impacts on natural resources, water resources, and the instance of disease outbreaks. Many Southeast Asian countries have a good core of professional planners and managers who operate in key development sectors, but they are usually unaware of the potential impacts of climate change on their sector. These professionals need to incorporate climate risk assessment into their development activities. Vulnerability to climate change can be reduced or increased by the choice of development path. For example, national investment in large-scale agricultural programs may be misplaced if more droughts or flash floods are expected. Small-scale, drought-resistant agriculture might be more sustainable in the long term. Each country needs its own plans and institutions to ensure adaptation is both mainstreamed into development activities (such as integrated water resources management) and considered at a strategic planning level (for example, planning for increased malaria incidence in the health sector). Incorporating climate change risks into national development activities at both project and strategic levels will require greater institutional capacity in most Southeast Asian countries.

Conclusion

The potential threat of climate change–induced hazards on economic development and progress in Southeast Asia should not be taken lightly. The most recent IPCC analysis reports a comparatively smaller increase in temperature for the Southeast Asia region in the last 50 years or so relative to the warming in higher latitudes. Yet there is general agreement among scientists that the changing behavioral patterns of LOPCs, El Niño, and other weather events are triggering hydrometeorological and geomorphological events such as floods, droughts, haze pollution, and slope failures.[9] To date, the impact of these changes can still be absorbed by the strong foundations of Southeast Asia's environmental management programs and backed by its stringent economic policies, including effective poverty eradication programs. However, this scenario can change if the gradual increase in global warming is left unchecked and leads to threshold breaches where habitats and ecosystems cannot recover their equilibrium.

Southeast Asian countries must strengthen their environmental management programs by integrating climate change concerns. They need to address the issues of vulnerability and the adaptive capacities of their economic systems, with particular attention to the poor and those near the poverty line. To do this, Southeast Asian countries need to reassess their existing poverty line values to take into account the challenge of climate change threat. However, this needs to be done within the context of streamlining the climate change threat into existing environmental management strategies and national economic development programs.

14. Anthony Young, *Land Degradation in South Asia: Its Severity, Causes and Effects on the People*, World Soil Resources Reports 78 (Rome: FAO, 1994).
15. Cruz et al., op. cit.
16. See I. Serageldin's personal homepage, www.serageldin.com/water.htm.
17. See T. Deen, "Climate Change Deepening World Water Crisis," March 19, 2008, available at www.globalpolicy.org/socecon/envronmt/climate/2008/0319deepwater.htm; accessed January 21, 2009.
18. R. Iyer, *Towards Water Wisdom: Limits, Justice, Harmony* (New Delhi: Sage Publications, 2007), p. 197.
19. "Editorial: Water May Be Cause of Future Wars," Pakistan *Daily Times*, April 11, 2007.
20. B. Chellaney, "China Aims for Bigger Share of South Asia's Water Lifeline," *Japan Times*, June 26, 2007.
21. K. Schneider and C. T. Pope, "China, Tibet, and the Strategic Power of Water," *Circle of Blue Water News*, May 8, 2008, available at www.circleofblue.org/waternews/world/china-tibet-and-the-strategic-power-of-water/; accessed January 21, 2009.

Climate Insecurity in Southeast Asia: Designing Policies to Reduce Vulnerabilities

1. J. Houghton, "Global Warming is Now a Weapon of Mass Destruction," *The Guardian*, July 28, 2003.
2. UN Millennium Project, *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals* (New York: UNDP, 2005).
3. N. Stern, *The Economics of Climate Change: The Stern Review* (Cambridge, UK: Cambridge University Press, 2007).
4. M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson, "Technical Summary," in Parry et al., eds., op. cit, p. 27.
5. J. H. Christensen, B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R. K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C. G. Menéndez, J. Räisänen, A. Rinke, A. Sarr, and P. Whetton, "Regional Climate Projections," in Solomon et al., eds., op. cit.; Cruz et al., op. cit.
6. "Ministerial Statement of the Inaugural EAS Environment Ministers Meeting: Ha Noi, 9 October 2008," available at www.aseansec.org/22004.htm; accessed January 21, 2009.
7. Association of Southeast Asian Nations Secretariat, *Third ASEAN State of the Environment Report* (Jakarta: ASEAN Secretariat, 2006).
8. B. P. Resurreccion, E. E. Sajor, and E. Fajber, *Climate Adaptation in Asia: Knowledge Gaps and Research Issues in South East Asia* (Kathmandu: Institute for Social and Environmental Transition [ISET]-International/ISET-Nepal, 2008).
9. Cruz et al., op. cit.

Climate Change in the Arab World: Threats and Responses

1. WHO, *Protecting Health from Climate Change: World Health Day 2008* (Geneva: WHO, 2008), p. 19.
2. M. Janardhan, "Climate Change-MIDEAST: Producers and Victims of Fossil Fuels," *IPS*, December 13, 2007.
3. M. Babiker, "Environment and Development in the Arab Countries: Economic Impacts of Climate Change Policies in the GCC Region" (Kuwait: Arab Planning Institute, 2003).
4. J. Tulloch, "Water Conflicts: Fight or Flight?" Allianz Knowledge March 19, 2008, available at http://knowledge.allianz.com/en/globalissues/climate_change/natural_disasters/water_conflicts.html; accessed July 10, 2008.
5. Kundzewicz et al., op. cit.
6. See UNEP, *Sudan: Post-Conflict Environmental Assessment* (Nairobi: UNEP, 2007).
7. The UNFCCC tracks submission of the national communications on its website at http://unfccc.int/national_reports/items/1408.php.
8. B. Al-Yousafy and A. Alkorah, "Environmental and Economic Feasibility of Renewable Energy in the Arab Region," *Dar Alhayat* March 5, 2007.

A Case for Integrating Groundwater and Surface Water Management

1. R. Iyer, *Water: Perspectives, Issues, Concerns* (Delhi: Sage Publications, 2003), p. 206.
2. M. Masahiro, *Managing Water for Peace in the Middle East: Alternative Strategies* (Tokyo: UN University Press, 1995).