



edited by
Louis Lebel
Anond Snidvongs
Chen-Tung Arthur Chen
Rajesh Daniel

Critical States

Environmental Challenges to
Development in
Monsoon Southeast Asia

SIRD

A Common Need for Action

**Louis Lebel, Chen-Tung Arthur Chen,
Anond Snidvongs and Rajesh Daniel**

INTRODUCTION

Rapid, but very uneven, economic and institutional development in Southeast Asia has left the region precariously poised at what this book describes as the “environmental change–development nexus”. The process of globalization has been central to this regional transformation. Extraordinary levels of growth have improved well-being and economic opportunities for many. At the same time, ignoring the implications of growth locally, regionally and globally is increasingly not an option on environmental, health and economic grounds. Development which has drawn on the natural resource base of the region is now to be constrained by the consequences of that exploitation (Savage 2006). Diverse social groups remain vulnerable to particular environmental changes and events despite national economic activity statistics that grow in multiples (Lebel et al. 2002).

The future of the environmental change–development nexus remains highly uncertain. There are several reasons. First, globalization as an economic and social process is uneven, dynamic and greatly affected by geopolitical events outside the region. Second, global environmental changes, arising from the aggregation and accumulation of a large number of individual actions and decisions can have feedbacks on regional-level processes. Third, social and ecological changes within the region are substantially non-linear, and have a high potential to interact with each other, with consequences that experiences of people in different places may diverge and include significant surprises.

Over the past decade a significant effort has gone into better scientific understanding of the implications for, and consequences of, global environmental change for development in Southeast Asia (Lebel et al. 2002;

Tyson et al. 2002). Much of this research has been coordinated by the global environmental change program known as "The Global SysTem for Analysis, Research and Training" (START), in particular, the Southeast Asian Regional Committee for START (SARCS) (Lebel et al. 2002; Lebel and Steffen 1999; Tyson et al. 2002; Wang et al. 2005, 2007) (See Appendix).

The purpose of this final chapter is to synthesize and integrate the analysis presented in the earlier chapters of this book that has reviewed and extended this body of work. We adopt two complementary perspectives. First, we synthesize current understanding of environmental changes within the region, and how they interact with, and their overall significance for, the global environment. Second, we integrate the various insights about changing vulnerabilities to those environmental changes arising from development within the region, and globally. Bringing these two strands together, the chapter then ends with a brief exploration of how societies in Southeast Asia should incorporate considerations of global environmental change in their environment and development policies over the next few decades.

ENVIRONMENTAL CHANGES

Land

Land cover of Southeast Asia has changed substantially over the past couple of decades (Samek et al. this volume). Agricultural and urban land areas have expanded. Between 1970 and 2002 half of the total expansion of agriculture occurred in just two countries: Indonesian and Thailand (Samek et al., this volume).

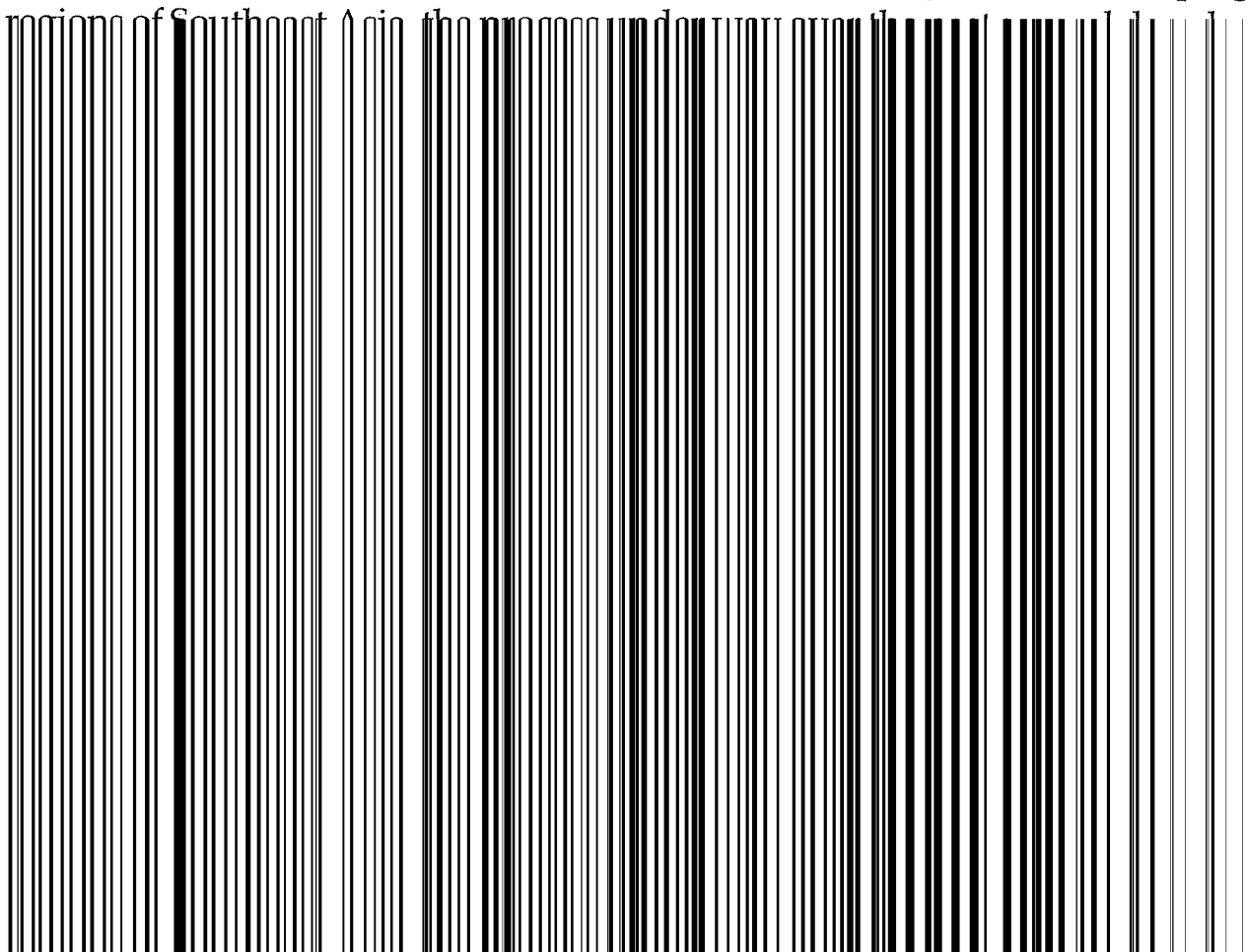
Most closed forests in Southeast Asia have been converted, degraded or fragmented (Muridyarso et al., this volume). But forest cover and quality is not declining in all places. Throughout the region there are pockets of previously degraded lands that are being better managed, replanted, and recovering some of their original levels of biodiversity and increasing flows of goods and services that can sustain livelihoods.

Trends in land-use and land-cover change have and are expected to continue to be dynamic, responding to regional and global pressures, but also national policy shifts and more local land-use decision-making. The integration of China into the global economy has a strong regional component, for example, with demand for rubber leading to huge expansion of plantations in Yunnan province of China (Xu 2006) then Lao PDR (Samek et al., this volume). Increasing global demand for biomass fuels is another likely driver of future land-use changes in the region. Finally, provision of food will continue to drive expansion and intensification of agricultural land uses (Pongmanee, this volume).

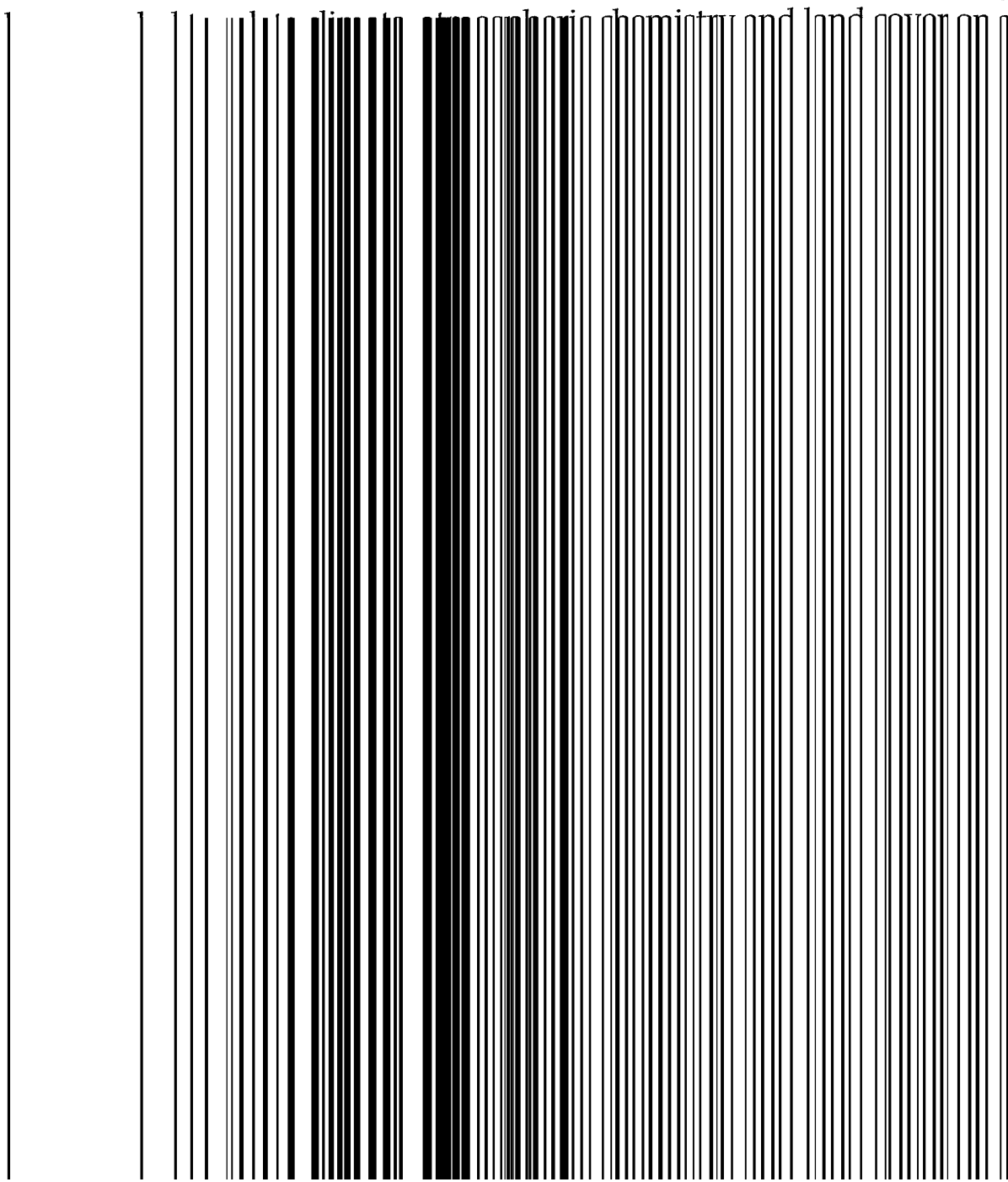
In Southeast Asia the primary threats to terrestrial biodiversity are habitat

destruction from logging, conversion of forests for agriculture and infrastructure, and, for larger mammals and birds, hunting for food and trade. Conservation plans for the protection of remnant tiger populations in Myanmar, for example, hinge on gaining more support from local people (Lynam et al. 2006). Impacts on biodiversity and ecosystem services depend on both spatial factors like the extent of fragmentation and land-use intensity (van Noordwijk and Budidarsono, this volume). Deforestation, by simplifying complex natural ecosystems, often alters the set of ecosystem services provided (Murdiyarso et al., this volume). On the other hand, complex agroforestry systems may maintain many valued hydrological and other ecosystem functions at reasonable levels (Tomich et al. 1998; van Noordwijk et al. 2004).

Land use planning and management are important to both conservation and development. The issue of tropical deforestation is a particularly interesting one to compare the view from both the developed and developing world perspectives (Daniel et al., this volume). For many in the developing



studies revealing large contributions of biomass burning to aerosols (Lebel et al., this volume). In the smaller, nested, domain of Southeast Asia, recurrent major fire-haze episodes associated with dry phases of ENSO have been the primary focus of research (Murdiyarso and Lebel 2007; Murdiyarso et al. 2004). Aerosols typically include salts, organic carbon, black carbon, mineral dust and water from dust, fossil fuel and biomass burning (Bergin et al. 2005; Ramanathan et al. 2007; Seinfeld et al. 2004). Studies of aerosols and trace gases in a remote location on the Tibetan plateau of Southwest China were affected more by emissions from biomass burning in Southeast Asia and South China than urban and industrial emissions from Central and South China (Chan et al. 2006). The aerosols from fires may have impacts on regional climate. Effects on climate are difficult to assess accurately as there are cooling impacts by blocking radiative flux reaching the earth's surface as well as heating impacts from absorbent substances like black carbon. More observations and modeling



Water

Land-use and land-cover change also have complex effects on the rates of horizontal transfer of water and pollutants across the landscape and their delivery to coastal zone and marine systems. A common assertion in Southeast Asia is that deforestation of upland catchments is one of the primary causes of lowland flooding and droughts and high rates of downstream sedimentation.

Small catchment and plot-level studies indicate that land-use and land-cover changes can cause erosion and high sediment yields to water bodies (e.g. Chen et al. 2004). It is unclear whether these findings can be scaled-up to landscape and larger basins as processes at other time scales and time lags become more important (Lu and Higgitt, this volume).

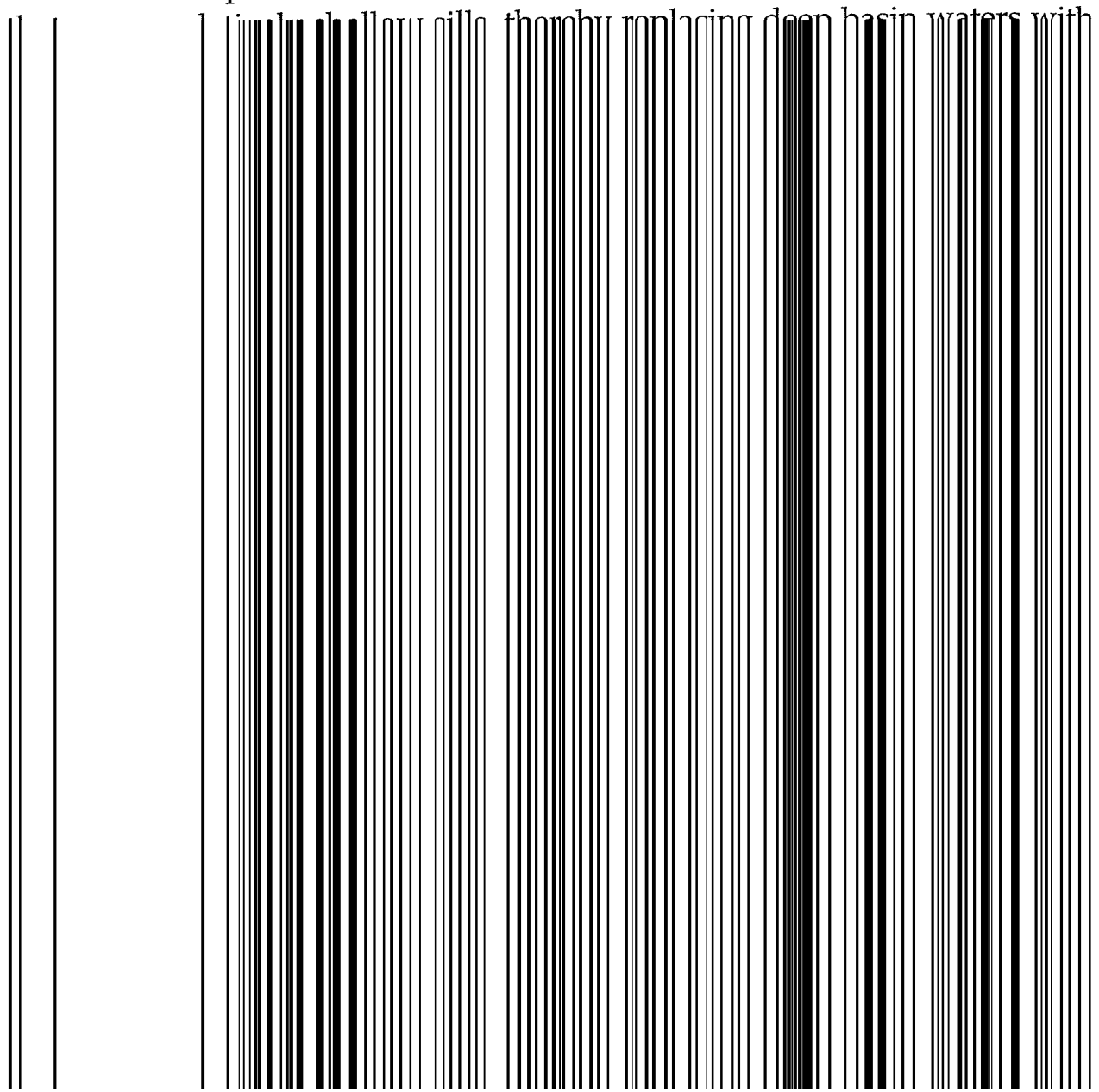
Overall, the land surface changes have altered regional hydrology in insular and mainland Southeast Asia through impacts on interception loss, evapotranspiration and soil infiltration capacities (Wang and Lu, this volume; Kummu et al., this volume). Conversions often increase water yields and peak flows while also reducing low flows, but can be minimized with good logging

volume). Irrigation is already an important factor in some areas, like the central plains of the Chao Phraya in Thailand and the Mekong Delta in Vietnam. Dam, reservoir and embankment construction alters flow regimes (Kummu et al., this volume) with multiple impacts.

Seas

The Pacific and the Indian oceans are joined up by means of the intricacies of the Southeast Asian seas which themselves are interconnected with narrow and sometimes extremely shallow straits. The seas include broad continental shelves and some of the deepest sea floors found in the world's oceans. With largely monsoonal circulation in concert with the El Niño-Southern Oscillation (ENSO) in these seas, the "Ekman pumping" process transports nutrients to these shelves to support high productivity and fish catches. Apart from this, the large "Indonesian Through-Flow" transports roughly $10 \times 10^6 \text{ m}^3 \text{ s}^{-1}$ of relatively fresh Pacific waters to the relatively salty Indian Ocean (Gordon and Yanagi, this volume).

Several deep basins in the Southeast Asian seas are filled with overflow



coastal protection and other measures for mitigation of coastal degradation (Saito, this volume).

There is no question that coral reefs, mangroves, wetlands and seagrass ecosystems serve as natural defenses against typhoons, storm surges and wave actions while at the same time nurturing marine life and fostering high biodiversity. In Southeast Asia, insofar as mangroves line approximately 50 percent of the coastline, they make up the dominant form of coastal ecosystem and in fact, about one-third of the world's mangroves are found here. But between 1980 and 2000, mangroves in Southeast Asia were destroyed at an alarming, unabated rate of 1.8 percent per year (FAO 2003). Aggravating the situation even further, global warming coupled with the associated rise in sea-levels are expected to pose even greater threats to the mangrove ecosystem (Ong, this volume).

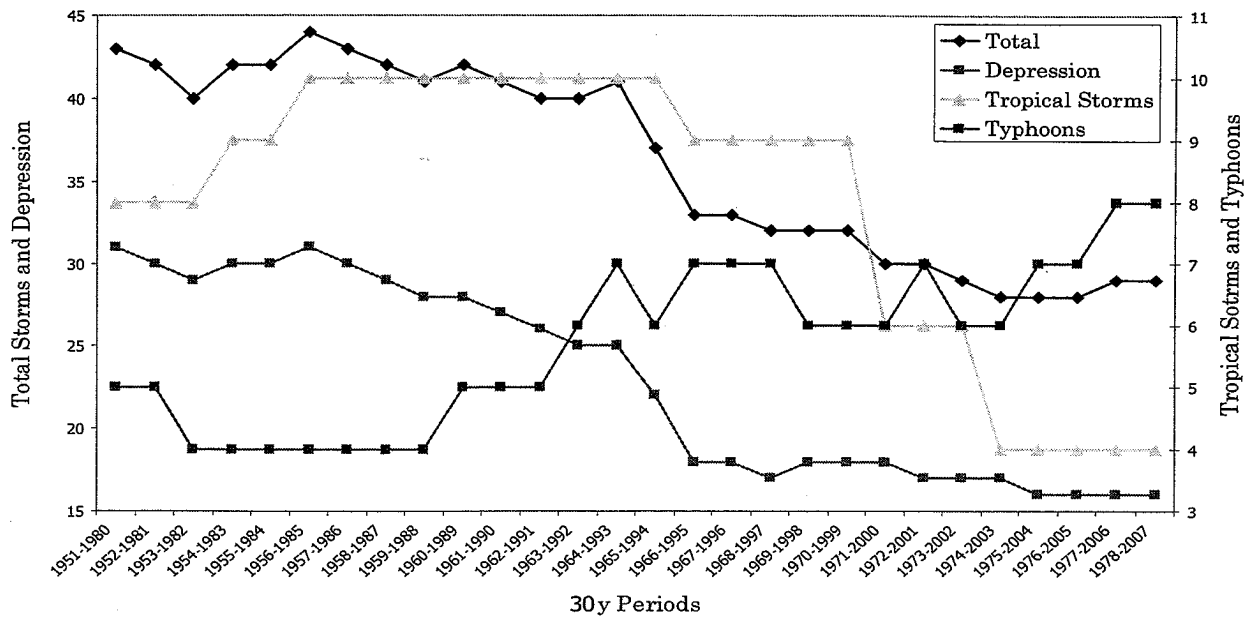
Although seagrass ecosystems are resilient to environmental changes, countless factors, like the acidification of seawater from the invasion of anthropogenic CO₂, increased water temperatures and rising sea-levels, plus

phase (Juneng and Tangang 2005; Singharatana et al. 2005). Other climatological factors known to have influences on rainfall amount and timing in Southeast Asia include the Indian Ocean Dipole and Madden-Julian Oscillation (Callaghan and Bonell 2005; He et al. 2006).

The Asian monsoon is the largest pattern of atmospheric circulation. Past and future changes in the monsoon are among the most significant questions for the sustainability of the Earth's system (Hsu and Hung, this volume) and of critical significance to livelihoods and enterprises in Southeast Asia.

Several changes have been observed. Apart from rising average temperatures, one of the most significant has been the shrinking in the diurnal temperature range (Hsu and Hung, this volume). In the future, climate warming is expected everywhere, but more over land than seas.

Observed trends in average and extreme precipitation are complex. In northeastern Taiwan and the Indochina peninsula increasing trends are observed, whereas most other parts of Southeast Asia show decreasing trends (Hsu and Hung, this volume). Not much is known about longer-term trends in

Figure 8.1 Trends in low latitude tropical storms in Southeast Asia

cyclones and storms, or unusual seasons are an important source of crop failures.

While industrial and economic development has reduced direct dependencies on agriculture for many households, rural livelihoods remain central to the majority of households and national economies (Pongmanee, this volume). Poverty in rural areas, caused, for example, by factors limiting opportunities to develop skills, invest or innovate, remains a major source of

under current climate to 30–40 percent in 2050. Adaptation strategies needed to address such critical vulnerabilities might include crop diversification, diversified water storage and early warning systems (*ibid.*).

A comparative study on the risk of rain-fed rice farming communities in the Lower Mekong countries to future climate regimes indicate that risk management strategies depend strongly on the level of socioeconomic development and current status of government intervention in the communities and to a lesser extent to physical impacts. For examples, “soft” measures such as financial and marketing strategies would be much more effective for rain-fed farming communities in Thailand and Vietnam than in Lao PDR, while technologically-based strategies would be equally effective in all the three Lower Mekong countries (Chinvanno et al. 2008).

Upland farming communities that depend on rain-fed land-use systems are probably more vulnerable to climate change than those with access to irrigation (Puhlin et al., this volume). Economic and political marginalization exacerbates vulnerabilities arising from climate variability. Bottom-up

Urban-industrial transformation, atmosphere and health

Urbanization is invariably blamed for a variety of environmental ills, both within cities and beyond them. Most cities have struggled to cope with the emissions from expanding vehicle use in densely settled and commercial centers (Lebel et al, this volume). But as Kioe-sheng and Lebel (this volume) argue, the problem in Southeast Asia lies more with the incompleteness of urbanization than urbanization itself, which has many desirable economic and social benefits. Incompleteness is apparent both in provision of key infrastructure and in institutional development. It has arisen, in part, because of failures to keep up with the speed of the urban-industrial transformation that has been central to economic development (*ibid.*).

The contribution of urbanization to changes in emission and air quality in Southeast Asia are significant: key emission sources exist in urban areas, and others outside them are strongly driven by activities in urban areas (Lebel et al., this volume). There are significant opportunities to reduce climate forcing greenhouse gases, aerosols with multiple impacts, and particulates with

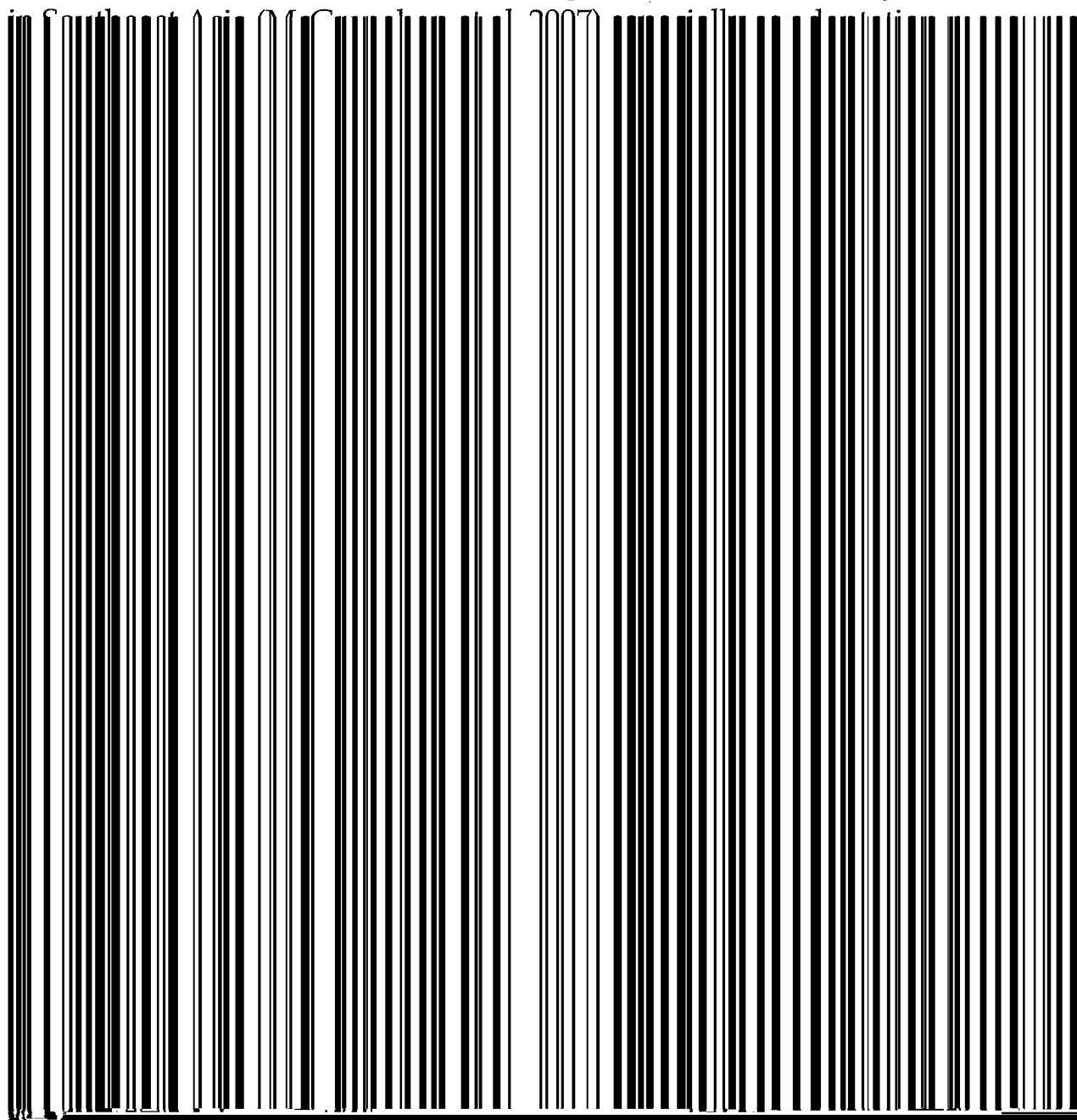
local health, and regional and global emissions (Forsyth 1999; Rock and Angel 2005). With respect to energy, much will depend on the extent and speed to which the knowledge economy takes shape and penetrates the various countries and sectors in Southeast Asia: such a transformation is not guaranteed (Islam et al., this volume).

Altered flood regimes and human settlements

In Southeast Asia the monsoonal climate adds additional challenges to flood management (Lebel et al., this volume). On the one hand, wet season rains associated with cyclones, major depressions and thunderstorms pose different and overlapping risks to urban communities. On the other hand, the retention and storage of water for dry season irrigation and recharge of groundwater is also important for those parts of the region with a prolonged dry season.

Rapid urbanization that has resulted in expansion into flood-prone areas is making some urban communities increasingly vulnerable and poses a major challenge to flood management (ibid.). Urbanization contributes to the alteration of physical flood regimes through changes in land surfaces and the introduction of drainage systems altering patterns of storm run-off

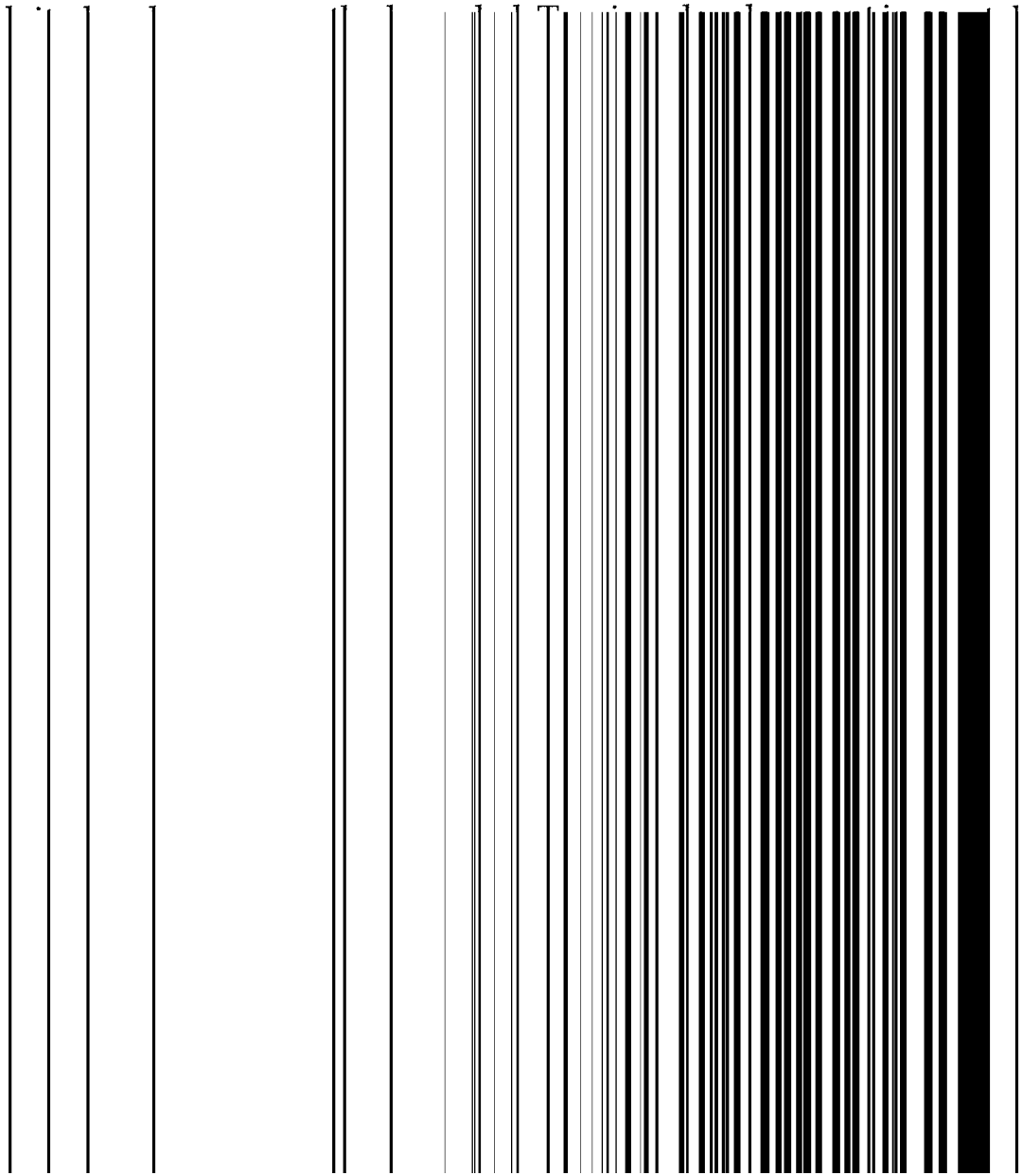
risks and altering vulnerabilities (Lebel et al., this volume). The hydrology of the Chao Phraya River has been drastically altered during the last five decades with embankments, dams, irrigation and drainage canals (Haruyama 1993). Wetlands became irrigated fields and are now suburbs (Molle 2004). Roads and other structures block drainage of local rainfall, increasing the risks of deeper and longer flooding in flood-prone areas further inland in Suphanburi and Angthong provinces (Haruyama 1993). Within the city floodwaters tend to collect in low-lying eastern parts of the city for prolonged periods (Dutta and Tingsanchali 2003). Land subsidence as a result of extensive groundwater extraction compounds these problems. The local and regional factors driving flood regime and vulnerability changes are larger than those expected from sea-level rise caused by climate change but often not as well recognized (Babel et al. 2006; Rodolfo and Siringan 2006). Adding the two effects together underlines the seriousness of the challenges for several of the key coastal cities



many of these conflicts over land resources are ongoing and governments are increasingly being forced to consider alternative models for integrating conservation and development objectives.

There is now growing evidence across Southeast Asia that local involvement in natural resource management can be effective, especially if co-management with accountable authorities can be negotiated, and there is a real interest and incentive for conservation. In some cases of course, the conflict is a more fundamental one of objectives: farming versus forestry or wildlife conservation. In these instances a fair negotiated solution may require compensation, and often needs a landscape or regional approach, that recognizes the need for farmers to grow food or have suitable alternative livelihoods.

Biodiversity conservation objectives have proven equally hard to pursue in coastal and marine environments. Involvement of local resource users is often important to successful management, but is easily undermined by powerful, mobile, interests: appropriately labeled as the "roving bandits problem" (Berkes et al. 2006). Most commercially important fishery resources

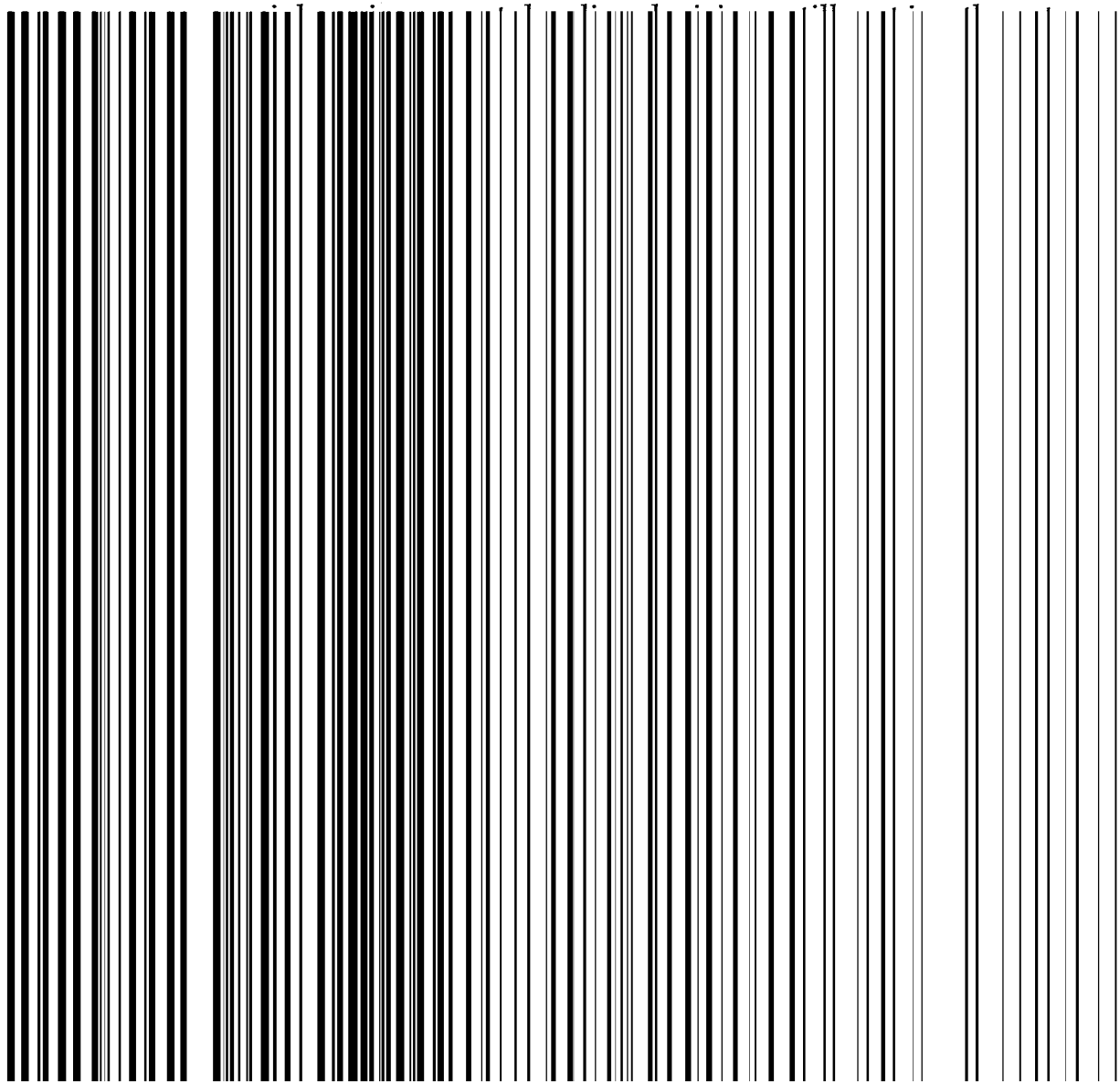


NEED FOR ACTION

Timely responses

The governments and societies of Southeast Asia can no longer ignore global environmental changes as something remote and of little consequence to the pursuit of economic development. A narrow pursuit of economic growth has damaged the social and ecological foundations for long-term sustainable development. Current development pathways need to be adjusted to reduce the risks and burdens of vulnerable groups to environmental changes. They need to be adjusted to strengthen the resilience of society and the ecosystems upon which well-being depends.

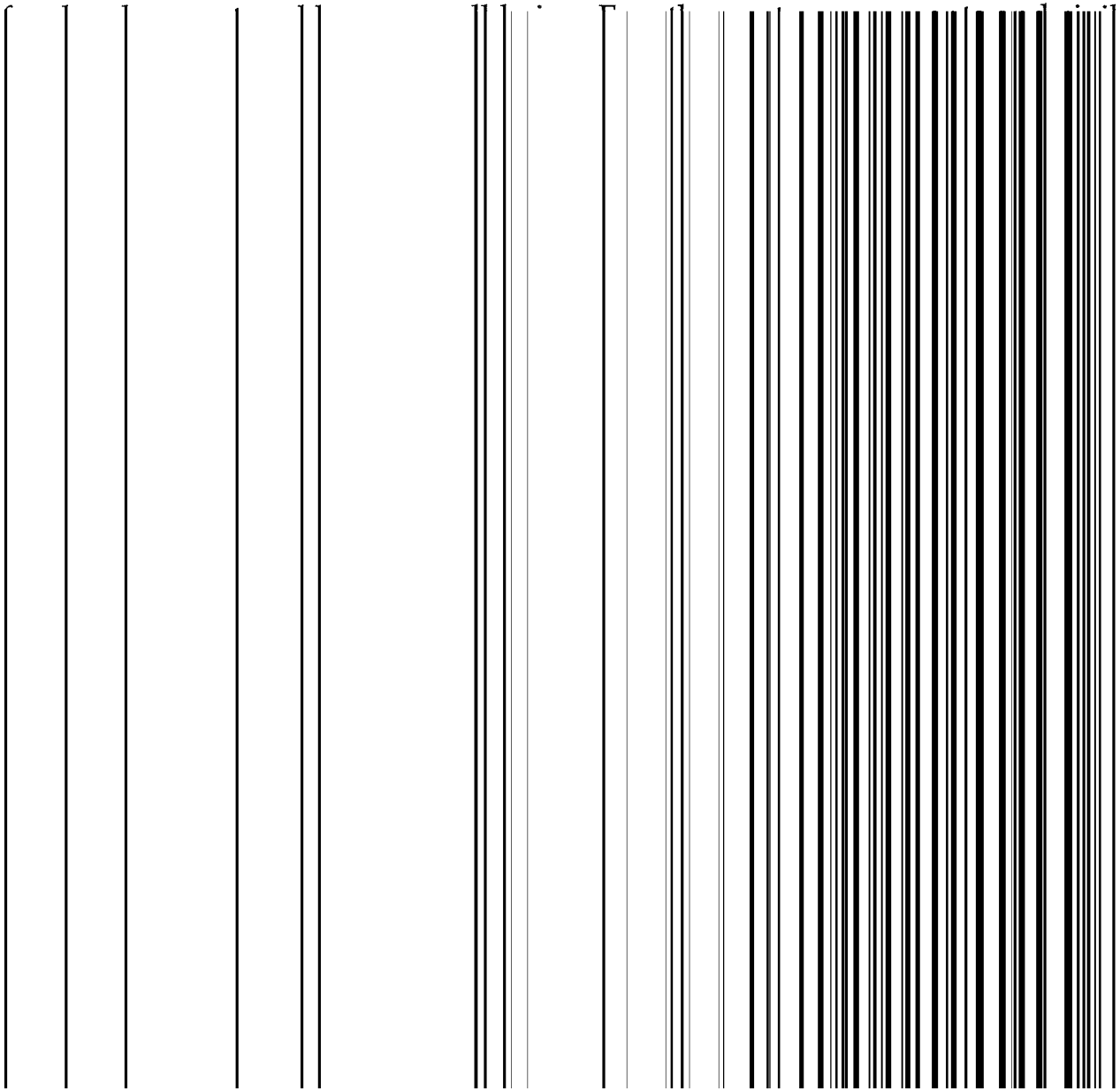
Increasingly, Southeast Asian governments and societies also need to respond to formal and informal pressures from within and beyond the region to reduce contributions to transboundary and global environmental changes. It is often assumed that new environmental laws and agencies will solve all the problems. Environmental agencies are usually expected to do their job through command-and-control mechanisms. But these agencies are relatively new in many governments and often weak (Ooi, this volume). As a



Asian region as a whole to influence future levels of emissions is modest compared to large neighboring states like China and India, both directly, as they are not a major contributor, and indirectly, because they are not politically powerful enough.

Policy innovation

Global environmental changes represent, in some aspects, novel challenges for society in general, and environmental governance, in particular, in Southeast Asia (see Introduction). First, many of the key drivers and sources of change, like the growth in greenhouse gas emissions in the atmosphere, or growth in environmentally-significant consumption, are largely beyond the normal spheres of influence of even the largest national economies of the region. Second, even as a regional bloc and with the combined capacity of state and non-state actors, Southeast Asia’s global leverage is modest, with respect to, for example trade, adaptation funding or energy security. Third, whereas many of the changes can be documented, and possible adaptation strategies explored, there is still nothing like a useful consensus about the level of risks they pose



are not independent of each other (Adger et al., this volume). Adaptation measures taken by one social group can end up shifting burdens and risks on others (Lebel 2007). Migration may trigger vulnerabilities in new locations (Adger et al., this volume). Although the possibility of unwanted side-effects on vulnerabilities is present, so is the opportunity for synergies in actions taken (Adger et al., this volume). Reducing some kinds of risks and building generic adaptive capacities may have broad benefits to livelihoods locally and more distantly; but, identifying this requires a more integrated approach to vulnerability and risks than is conventionally adopted.

Regional cooperation

The countries of Southeast Asia are aware of their individual vulnerability to impacts from economic, cultural, political and ecological events in the rest of the world (Malayang et al., this volume). To reduce their vulnerability, they have begun to look to regional institutions. Typically, they adopt a southern perspective, skeptical of international environmental initiatives (Tay, this volume). Maintaining individual competitiveness on the one hand, while

building up the region's collective institutional strength on the other is a

Domestic imperatives, as a consequence, usually triumph over regional ones. Nevertheless, a regional orientation can emerge when events compel policy leaders to see that their own interests are in fact linked to the region's ability to respond to the changing global situation. The financial crisis of 1997–98 may have awoken this realization among the region's national elites for most of those who didn't soon lose power. Another event was the regional haze associated with fires during an unusually strong dry-phase ENSO event (Murdiyarso et al. 2004) at the same time (Tay, this volume).

Some of the highest priority, high leverage, actions needed are at the multi-country, or regional, level where this is understood for some issues to be Southeast Asian, but in other cases would benefit from larger groupings, especially, given the shared importance of the Asian monsoon (Fu et al. 2006). Framed narrowly as environmental challenges these include freshwater and marine resources, airsheds and watersheds. Framed more broadly and strategically, these include linking road and telecommunication infrastructure, regional trade and investment agreements, transboundary conservation areas,

has created opportunities for better multi-level governance, but at the same time many such reforms are reversed in times of economic or political stress. Deliberative processes, protests and everyday resistance have been crucial counter-forces in the face of elite-driven policy corruption, administrative oversight and poor accountability.

Local, regional and global environmental changes interact with each other through relatively direct physical pathways, and also more indirectly through the shared social drivers and consequences of environmental change. The globalization of socio-ecological systems (Young et al. 2006) has transformed many purely local environmental management challenges into regional and global ones.

At the same time, people most immediately and directly dependent on natural resources are those often most vulnerable to impacts of environmental change. The burdens of coping with increased risks of extreme rainfall events, changed flood regimes and unprecedented droughts often fall on the very groups which now work hardest to grow and catch food to eat and market.

And government measures and policies to address these vulnerabilities

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