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Introduction

Southeast Asia has been widely viewed as the region most likely to be crushed by global climate change. By one index of exposure to weather risk over the first two decades of this century, Myanmar ranked second, the Philippines fourth, Thailand ninth, Vietnam thirteenth, and Cambodia fourteenth (Eckstein et al. 2021) . These vulnerabilities arise from both the high temperatures already experienced within the region and the huge coastal exposure to flooding and storm surges, with most primary cities hugging the coasts of seas or major rivers.

The projections of increased risk are alarming. Yu et al. (2025) project "an increase of 0.8–1.1°C, 1.1–1.4°C, and 1.5–1.9°C in daily maximum temperatures across nine SEA countries during 2040–2059." Rising temperatures are expected to produce more frequent El Niño events by 2040 (Ying et al. 2022), making accommodation to drought and flooding even more difficult. Under the scenario of a 2°C temperature increase over preindustriallevels, Southeast Asia's sea level would rise by more than 0.2 meters by 2040 (Dong et al. 2024, 3) – more than the average sea rise around the world.[1] Tierolf et al. (2021, 5) project an increase of 191 percent in flood damage from the 2015 base year to 2040 for Laos. For Cambodia, the projection is 153 percent, for Myanmar 73 percent, for Vietnam 52 percent, and 16 percent for Thailand. The region is highly vulnerable with respect to five sectors that are the main focus of this book: agriculture and fisheries, conservation, energy, migration, and health. Agro-exports – especially rice, palm oil, cassava, coffee, rubber, and seafood – are threatened by heat, drought, flooding, pests, and salinity. Its rivers, the life blood of fishing communities and the major source of protein for many people, are threatened by dams, some of which are out of the region's control because of China's control of the upper reaches of the Mekong.

[1] For Southeast Asia, sea level rises will be greater than the global average because of thermal expansion and land subsidence (Jevrejeva et al. 2016).

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The conservation of vulnerable ecosystems is challenged directly by heat, drought, and flooding. For example, valuable hardwoods,[2] providing shade and wood for furniture and other purposes, are highly susceptible to temperature-induced stress, as well as to fire risk (Gaisberger et al. 2022). Sea-level rise and storms jeopardize mangroves (Gilman et al. 2008). Storm surges bring in salt water that kills freshwater fish and renders land too saline for rice. The indirect consequences driven by human reactions present another set of ecosystem threats. For example, building dikes to protect people from floods may interfere with water access. Spraying insect breeding grounds may kill useful biota along with the desired species.

The boom in energy demand has pushed many Southeast Asian countries to the brink of large-scale electricity system failures. Ecosystems are ravaged by the direct impacts of climate change, but also by new energy infrastructure occupying previously pristine land and pushing displaced people into ecosystems without the carrying capacity for increased population.

The migrations compelled by failed farms, uninhabitable living conditions, or displacement for new energy infrastructure, raise threats to the well-being of the migrants and the people with whom they come into contact. Migrants, in turn, often change the ecosystems where they live and work, transmit diseases into new areas, and require new energy infrastructure as they encroach into frontiers.

The health of Southeast Asians is threatened by pests that proliferate because of climate change, and serious infectious diseases are all the more tenacious as viruses, bacteria, and disease carriers evolve. Higher temperatures worsen cardiovascular and pulmonary diseases. Migrants forced out by no longer productive or habitable home areas risk exposure to new diseases and hostility of the people in the areas where they migrate. Rapid urbanization and the resulting shantytown congestion exacerbate these health threats.

We shall see that reactions to these threats are greatly complicated by the fact that typically different institutions are prominent in each sector, grappling with fairly distinctive challenges. Even so, the adaptations undertaken in one sector often have significant impacts on other sectors, sometimes quite adverse ones.

And yet … A host of efforts have been undertaken in Southeast Asia to stave off the adverse impacts of climate change. This book provides a broad treatment of how Southeast Asians adapt to climate change challenges to overall prosperity and particularly poverty alleviation. While the bulk of assessments of climate change impacts on Southeast Asia, as elsewhere, are understandably pessimistic, this distracts attention from some *largely* successful Southeast Asian adaptations. In assessing the adaptations for their benefits – and limitations – it is possible to

[2] Such as *Afzelia xylocarpa*, *Dalbergia latiolia*, *Pterocarpus macrocarpus*, and *Gluta usitata*.

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identify measures for governments, individuals, civil society, the private sector, and the international community. This has the potential to be relevant for other climate-threatened tropical regions, such as Sub-Saharan Africa, other Pacific islands, South Asia, and Latin America, and even for currently "temperate" regions moving away from these temperate conditions.

The focus on existing adaptations and the remaining challenges obviously does not mean that this book is an overall assessment of the region's politics and socioeconomic conditions, except insofar as specific conditions shape adaptation efforts and their limitations. The book's positive assessments of particular adaptations are not endorsements of governmental stances on overall societal needs, distributional policies in the face of generally high levels of inequality, elite dominance in policymaking, or the treatment of minority or otherwise marginalized groups.

In addressing the challenges, we have to be mindful of what adaptation means, and of the possibility that adaptations may have negative consequences. The Intergovernmental Panel on Climate Change has defined "adaptation" as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (Intergovernmental Panel on Climate Change 2001, 365). This does not dispute the fact that adaptations can have adverse impacts, which are especially troubling when they affect highly vulnerable populations, particularly the poor. Therefore, some critics worry that adaptation would be considered as necessarily good, despite its potential adverse impacts, and therefore they would prefer a focus on "vulnerability reduction" (Ribot 2011, 1160). Certainly, reducing vulnerability is essential, but the IPCC definition of adaptation that includes exploiting beneficial opportunities makes this a robust concept as long as "maladaptation" risk is not ignored (Magnan et al. 2016; Rouzaneh and Savari 2024) .

Adaptations occur at all levels. Efforts by individuals range from selecting new crops or relocating in the search for safer or more productive areas to changing occupations, many entailing considerable risk. Cooperatives and other joint efforts try to reduce the risks through collective action, ranging from negotiating better prices to fending off government restrictions. Businesses adapt to the opportunities to build energy infrastructure or homes for migrants, to develop and market new crops and vaccines, and a host of other new potentials, but they are also forced to innovate as climate change challenges their uses of land, the availability of reliable energy, and conservation imperatives. Governments may be able to take advantage of increased revenues by promoting new export opportunities, selling electricity as the demand for cooling increases, or steering migrants to serve political objectives. Yet, the burdens on responsible governments include sheltering vulnerable people most exposed to climate change, addressing rising health risks, accommodating

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greater energy demand, protecting ecosystems, and coping with the potential for disruption from migration, whether state-managed or spontaneous. Civil society groups develop strategies to press for social protection; some press for ecosystem protection from climate change per se and from ecological harm caused by the coping efforts of others.

Thus far, numerous adaptations have staved off some of the nightmare scenarios. For crops and fisheries, rice supply has not collapsed despite heat, drought, salinity, and flooding. Palm oil exports have not dried up despite destructive insects, bacteria, and viruses. The discovery that some products will thrive in greater heat, drought, or even salinity has yielded, with governmental and international support, enormous export opportunities. Land too saline for crops may be repurposed to aquaculture, for which the salinity threat to freshwater aquaculture has been countered by introducing aquaculture species that thrive in brackish or salt water. Vaccines have made inroads against diseases of fish and shellfish in aquaculture. Expansion of more hardy crops such as Thailand's cassava have rescued very poor land, and new cultivation techniques have forestalled greater soil depletion. Crop insurance, utilizing weather-indexed payments to avoid the pitfalls of standard damage-based insurance, has been introduced, though with limited success, in Myanmar, the Philippines, Thailand, and Vietnam. As more weather stations are built, it is likely to be more widely embraced.

For conservation, most Southeast Asian countries have been successful in reducing the erosion of mangroves. Although deforestation is still a problem, and accelerated in Cambodia and Indonesia from 2010 to 2020, most Southeast Asian countries have reduced rates of deforestation, and Vietnam has been enjoying reforestation.[3] The risk of deforestation to expand oil palm cultivation has been reduced by the embrace of certification standards, the Indonesian Sustainable Palm Oil standard and the Malaysian Sustainable Palm Oil standard, by the large-scale palm oil operations, even if many do not meet the most stringent Roundtable on Sustainable Palm Oil.

Conservation is also strengthened by the use of payments for environmental services, which has reduced even rightful resource depletion while also inducing restoration for natural endowments as diverse as forests and coral reefs. The use of incentives and co-management has strengthened initiatives by reducing the animosity that more heavy-handed approaches often provoke. Even better, co-benefits arise when economic activities are promoted that improve ecosystems without the need for subsidies. Environmental impact assessments for major physical infrastructure have improved, even though further progress needs to be made.

[3] Figures from 1990 to 2020 are available in FAO (2020).

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For energy, blackouts would be even more serious were it not for the adoption of renewable energy sources with special attention to reduce the environmental and socioeconomic harms of hydroelectric dams through their siting and design. Growing adoption of renewable sources, and the movements to wean energy generation away from coal, are making progress, albeit far from optimal, in reducing pollution. The vulnerability of localities to power outages is being addressed by electric grid expansion, crossing national boundaries.

For coping with high rates of migration, bold initiatives have established satellite cities and new cities to relieve the pressure on existing cities. The excessive flooding that periodically plagues low-lying areas like the Mekong Delta has been addressed by dramatic land recontouring to create higher ground. The short-sighted approach of simply expelling new urbanizers occupying shantytowns is giving way to the more sustainable approach of vertical housing.

For health, the incidence of mortality from infectious diseases has declined, at least for now. The shift to less polluting hydrocarbons is underway, along with the promotion of electric vehicles to reduce pollution from gasoline and diesel. Nutrition has been strengthened by fortifying food with vitamins and minerals in Papua New Guinea, the Philippines, and Vietnam. Some success in vaccines against dengue has been achieved, and the establishment of domestic vaccine facilities is promising both for more effective vaccines and to reduce import dependence. Efforts are mounting to reduce air pollution by diverting agricultural waste to profitable uses such as biofuels and cellulosic materials, rather than burning.

However, many of the negative consequences are harder to see, often because they impact low-income families, whose travails are not captured by the broad trends that grab most of the attention. For those who cannot afford the adaptation costs, they often lose their land and migrate to cities where they are the underclass living in shantytowns. Land-use changes, such as the expansion of oil palm plantations, have not only reduced ecosystem services but have also furthered the formal or de facto appropriation of land from people with customary user rights. The inroads in addressing energy shortages frequently come at the expense of people displaced by energy infrastructure. The proliferation of major viral diseases, such as malaria and dengue, disproportionately afflict the poor. as they are more exposed to outdoor pests such as mosquitoes, while bacterial diseases such as tuberculosis are more prevalent in the congested shantytowns.

1.1 Interconnections of Vulnerabilities

Because it is tropical, Southeast Asia is heavily exposed to the full range of global warming consequences. Three main causal patterns arise. One pattern begins with

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the *exposure of agriculture and fisheries* to the entire complex of heat, drought, flooding, and storm surges. These bring on salinity (through sea-level rise and the storm surges), shore erosion, subsidence, and pests including insects, viruses, fungi, and worms. The combination of the deterioration of the world's oceans and overfishing in the open seas has led to a boom in aquaculture, currently a major source of revenue particularly for the Philippines, Thailand, and Vietnam. Yet, the impressive expansion of irrigation ponds to address drought runs the risk of providing a breeding ground for disease-bearing mosquitoes and other threats to human health. In addition, the proliferation of aquaculture has been achieved in part through mangrove removal, increasing the risk of storm surges that bring flooding and salinity to coastal areas. The export booms that have enriched many groups within the region are vulnerable to all of these adverse conditions.

The decline of agriculture and fisheries (both wild-caught and aquaculture-raised) compels the abandonment of sites and the migration of the farmers or fishers. Migrants, whether moving on their own or through state resettlement programs, are often economically unsuccessful, and the relocation may expose them to conflict with host communities or exposure to diseases against which they have limited immunity. State resettlement programs are frequently coercive, increasing hostility toward the government. Land uses more suitable to climate-induced changes may also lead to displacement, as reduced economic opportunities for small-scale farmers lead to land consolidation through large-scale plantations for commercial crops such as palm oil or rubber.

The most common option for dislocated rural people is to move to cities. This poses additional vulnerabilities of conflict and health risks in the overcrowded shantytowns that are often in coastal areas unprotected from flooding and other life-threatening impacts. Government officials may simply expel recent urbanizers, who are generally among the most vulnerable. More constructively, they may engage in dramatic efforts to create new cities, with all the challenges that entails, or recontour the countryside to try to keep flood-threatened rural people from moving to the cities. Heat and drought also increase fire risk. The greater fear of fire puts even greater pressure on governments to ban shifting cultivation, with the effect of reducing the viability of traditional farming practices, reducing the incomes of the most marginal people, and often compelling dislocation.

The second causal pattern begins with the vulnerability of the *energy supply*. Higher temperatures increase the need for cooling, which in turn increases the need for electricity even beyond the demand stemming from the rapid economic growth of several of the region's countries. Yet, the generation of electricity is challenged by the droughts that limit hydropower, and higher temperatures reduce the efficiency of solar arrays, as does the dust exacerbated by drought. Meeting energy shortfalls has forced the continued reliance on fossil fuels, particularly coal, despite

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the severe health risks that are quite apart from the region's contribution to global warming. The expansion of electricity generation through renewable resources – especially hydroelectric dams but also solar arrays and windfarms – requires displacement of residents who are typically of low income. Stronger storms threaten energy infrastructure, requiring even more generating and transmission capacity to offset the loss of existing capacity.

The third causal pattern centers on the *living conditions* directly impacted by heat, pests, fires, subsidence, and flooding. Disease is an obvious risk, including infections, cardiovascular diseases, and pulmonary diseases. Floods and fires pose threats to physical security; pests thriving in climate-altered conditions also pose health risks in particular areas. These conditions, apart from the economic failures, may compel relocation.

The disproportionately greater adverse impacts on more vulnerable people from all three patterns need to be given heavy weight in assessing the success and limitations of the initiatives. Higher-income people have more options to minimize the potential harms; low-income rural people risk losing their farms or aquaculture ponds, and are usually relegated to the most precarious urban sites if not simply expelled.

1.2 The Adaptations

Individuals, collectives, businesses, government, and civil society all engage in adaptations to climate change threats and opportunities. Technological advances, developed both within and beyond the Southeast Asian region, have overcome some of the seemingly insurmountable challenges of farming and aquaculture through new varieties and cultivation techniques. For example, to combat the threat of flooding to rice crops, rice varieties crossbred to incorporate a gene that had existed in a low-yield rice variety have become high-yield varieties, cleverly dubbed as "scuba rice" (Ismail et al. 2012, 46–47). These varieties are now used in Cambodia, Indonesia, Laos, Myanmar, the Philippines, Thailand, and Vietnam. In Vietnam, the government has engaged another approach to combat the ravages of flooding: a huge series of dikes in the Mekong Delta, to place homes on higher ground.

To attack the wide spectrum of agricultural pests that multiply in greater heat or higher humidity, a broad range of biopesticides have been developed that do less damage to the ecosystem and human health. New vaccines are being used to protect aquaculture from the viruses that plague fish and shrimp ponds.

To reduce the air pollution that poses such a heavy burden on human health, the substitution of more damaging fuels for power generation and transportation is underway, including concerted efforts with international support to wean the two

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major coal producing countries, Indonesia and Vietnam, away from coal burning. Converting agricultural waste into biofuels is an exciting alternative to burning that waste.

These examples are but a taste of the myriad adaptations. Some of these adaptations are in the hands of government at various levels, whether by introducing regulation, financing research and development, assisting in establishing supply chains, assigning extension agents, administering medical treatments, requiring environmental impact assessments, undertaking major physical infrastructure, approving or rejecting energy infrastructure proposals, undertaking resettlement programs for "environmental refugees," and agreeing to international collaborations. The private sector develops and produces new varieties of crops and aquaculture species. It builds new cities to house the new urbanizers; it builds solar arrays, windfarms, and hydroelectric dams. It operates the large-scale crop and aquaculture operations, but also develops, manufactures, and markets biopesticides and aquaculture vaccines. It develops vaccines and treatments for evolving infectious diseases, while operating some clinics and hospitals.

Regarding the roles of government and the private sector, the book tries to take an even-handed approach to the actors involved in responses to climate change. Government obviously plays a central role in regulating, investing, and in many instances overseeing relocations. Government officials' motives prove to be mixed; often, they feature a strong commitment to protect vulnerable people, but in other cases the well-being of vulnerable families has been sacrificed for political motives or to reduce government's accountability risk.

The analysis also strikes a balance in the treatment of the potential and problems of the private sector, often the target of imbalanced criticism. To be sure, businesses sometimes act in ways that undermine the well-being of many people, often the most vulnerable. Private capital has been implicated in land grabs, the overuse of fossil fuels, deforestation, exclusionary urban development, and efforts to corrupt state officials. Yet, private entities sometimes assist low-income farmers to improve their productivity, sometimes provide affordable housing, and often take on scary economic risks to meet energy demands. Some collaborations with government leverage private-sector capital and technical expertise in renewable energy, electric vehicles, new crop or aquaculture varieties, and more sustainable cities.

A key premise is that governments typically have considerable influence over how private interests can be directed to the well-being of the population; many positive private-sector activities have been essential to constructive adaptations, especially when government and civil society establish proper safeguards. For example, under governmental oversight, the large-scale plantations in Indonesia and Malaysia have arrangements with small holders to share technology and marketing channels, though not all requirements are being met.

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In one important respect, some Southeast Asian governments have ceded some authority to the private sector. With the capital to undertake major infrastructure for energy, urban structures, and transportation, to recontour land for new cultivation, or to establish the logistics for new industries, the private sector is in a strong position to claim a greater role in planning and control. This is epitomized by the Indonesian "private cities," over which private developers are accorded considerably more authority than government officials are usually willing to cede. Governmental tendencies to overregulate, delay, or fall prey to corruption are sometimes checked by private-sector initiatives that demonstrate the ability to adapt with greater speed and efficiency.

And then there is the public, organized in complicated ways, through civil society organizations pushing for conservation, Indigenous clans sometimes embedded in broader confederations, self-help communities in shantytowns, and families trying to adapt on their own. It is important to acknowledge the agency of families coping with the risks and taking advantage of the opportunities that climate change poses. The most inspiring example is the brilliant summary by Professor A. Terry Rambo (2017, 3) of the transformation in Thailand's Northeast region (Isan or Isaan), formerly the country's poorest region:

> Isan villagers have never been the "simple peasants" conceived of in the elite imagination. Today their life as farmers is even more removed from that persistent historical stereotype, due to a process of very rapid change, one that has broadened their economic base and provided greater profits and increase social mobility ... It also involves changes in all aspects of rural life, including technology, economics, social relations, and cultural values.

While it is heartening to discover positive adaptations, the uncertainties, resource constraints, and tradeoffs in trying to address climate change risks and opportunities pose the risk that adaptations may backfire; maladaptations are a rather common occurrence. They may be due to inadequate resources, misunderstanding of the nature of the challenges, shortsightedness, dominance of narrow interests, or even the result of efforts to address challenges facing one sector at the cost of greater problems in another sector.

1.3 Poverty

An important normative commitment of this book is to identify how to harness the adaptations to reduce poverty. This is connected to both the ability to take advantage of adaptation options, and to minimize the negative impacts of climate change. Some low-income Southeast Asians have been able to increase their wealth substantially through adapting away from rice cultivation to other ground or tree crops or even aquaculture; others have lost their land because available

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adaptations were out of reach or impossible in the face of climate change. Some have found greater incomes and skill capabilities in migrating to cities; others have been stranded in shantytowns exposed to greater risks of communicable diseases.

To be sure, in terms of absolute income, official statistics indicate considerable progress in poverty reduction in some Southeast Asian countries over the past quarter century. According to a widely accepted poverty measure of the proportion of people living on less than US$3.00 a day with the proper cost-of-living adjustments,[4] the poverty headcount in Indonesia went from nearly 85 percent to 20 percent; in the Philippines from 39 percent to 18 percent; in Thailand from 23.5 percent to less than 1 percent.

Yet official statistics mask some of the realities of poverty, given more attention in subsequent chapters. Consider Malaysia, the wealthiest of the large Southeast Asian countries. Its government, under criticism that its fixed poverty line was unrealistic, adjusted its national poverty rate from 0.4 percent in 2016 to 5.6 percent in 2019, but maintains that "hardcore poverty," defined as the income level that does not permit adequate food purchase, has disappeared.[5] Yet, Malaysia's own Health Ministry reported in 2023 that in 2022 the overall rate of child stunting in the Bornean state of Sabah was 25.3 percent, and 19.4 percent in Sarawak. Wasting was 7.7 percent in Sabah and 9.8 percent in Sarawak. The 2022 survey did not distinguish among Indigenous and non-Indigenous children, but the 2019 survey reported that among Indigenous people in Sarawak the rate of child stunting was an astonishing 41.5 percent (Government of Malaysia Ministry of Health 2019, 207).

The biggest poverty challenge is in rural areas. Musngi and Purba (2022) note that "[i]n the ASEAN region, rural areas experience poverty twice as much as urban areas." For example, in the Philippines, the 2023 rural poverty rate was 22.1 percent, compared to the urban rate of 10.3 percent (Republic of the Philippines Statistics Authority 2025). As of 2024, the incomes of more than 11.8 percent of rural Indonesian families were below the official poverty line, compared to 7.1 percent of urban families (Republic of Indonesia Badan Pusat Statistik 2025). The prevalence of rural poverty justifies the prominence given to agriculture and fisheries in this book.

More generally, the book embraces the criterion that no initiative that significantly harms the most vulnerable people is a success. Resources must be both sufficient and directed toward these vulnerable people. The resource

[4] The figures reported in the World Bank Databank are in 2021 Purchasing Power Parity.

[5] The Statistical Department Malaysia (2025) clarifies: "A household is considered to be in hardcore poverty if their gross monthly household income is below the Food Poverty Line Income (Food PLI). This indicates that the household does not earn sufficient income to meet basic calorie requirements. It should be noted that hardcore poverty is a subset of absolute poverty."

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commitments for adaptation need to be high enough to permit the poor to undertake sound adaptations and to shield them from any potential adverse effects of adaptations, whether losing out to wealthier farmers who can afford better crop varieties, being displaced by new energy infrastructure, or other negative impacts on the poor arising from adaptations. We find that some governments, often joined by other institutions, have dedicated substantial resources to promote awareness and competence to adopt sustainable practices, as well as some material resources to undertake these practices. However, the most common obstacle to implementing clever initiatives has not been the essence of the initiative, but rather the financial capacity of people with lower incomes to take advantage of the opportunities. This is what makes Thailand's Isaan region so encouraging, but the following chapters report on government initiatives that have not provided sufficient opportunities for the poor.

Securing and allocating these resources, combined with the needs for regulations, collaborations, and communications, put great burdens onto governments to navigate the tradeoffs among the challenges. Protecting agriculture and fisheries can be in direct conflict with conservation and health. Conservation efforts limit the opportunities for energy infrastructure as well as migration destinations. Meeting the growing needs for electricity can jeopardize agriculture as well as conservation and health, while increasing dangerous internal migration. Protecting health may require limiting where people can be resettled and where energy infrastructure can be built. Responsible resettlement may have to encroach on productive agricultural land.

Although some synergies do exist in addressing some challenges together (for example, producing biofuels from agricultural waste instead of burning it contributes to conservation, health, and energy), tradeoffs cannot be fully avoided. Therefore, the decision-making challenge is to minimize the damage that defending against one climate-change risk might impose on another sector. More about these painful trade-offs is covered in subsequent chapters.

1.4 Preview

This book casts a broad net across Southeast Asia, although the very small states of Singapore and Brunei get less attention, and little information is available about adaptation in Papua New Guinea and Timor-Leste. Successful initiatives can be found at local or higher subnational levels as well as at national levels, although the challenges of scaling up to maximize the approach's impact can be very challenging. The attention given to experiences of particular countries in each chapter varies considerably, along with the degree of the challenges and the degree of adaptation to meet these challenges. Thus, for example, Thailand is covered

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prominently in the adoption of new rice varieties and largely export crops such as rubber and cassava; Indonesia and Malaysia in the expansion of oil palm plantations; the Philippines in urban self-help co-management; Indonesia and Vietnam in the development of new and satellite cities; Laos and Cambodia in the opportunities and challenges of hydropower.

Because each nation's situation is highly distinctive, comparing the same indicator (e.g., deforestation rates, fish survival rates, mangrove conservation levels) across different countries is of limited value. Examining changes over time for each country is a more powerful approach: adopting sounder policies and programs, reversal of destructive resource practices, improvement of the plight of vulnerable resource users, higher yields of more appropriate crops, and other very encouraging developments. Nevertheless, some comparisons across countries are useful to determine why a relatively successful initiative in one country falters in another.

Chapter 2 provides the political economy analysis needed to understand how adaptations are chosen, who has the resources and the motivations to adapt in particular ways, and who benefits and loses. The summary of broad economic trends clarifies the generally impressive but uneven economic growth patterns, the emergence of both extreme wealth of "big business" and especially the overseas Chinese, and the emergence of middle-income sectors. Yet, continued poverty, complicated by the lack of citizenship, land rights, or other livelihood obstacles faced by millions, poses essential questions of how to support the most vulnerable families. This involves making adaptation benefits available to them, especially those in peripheral rural areas and the poor compelled to migrate to shantytowns.

The chapter offers a taxonomy of maladaptation pitfalls and causes, including the painful maladaptations that occur when efforts to address one climate-change risk undermine efforts to address other climate-change risks, worsened by intra-governmental conflict when policymakers proceed with poor problem definitions. Other limitations arise, especially in the poor areas, if an adaptation saddled with insufficient resources has adverse side-effects that are too costly to rectify. Maladaptations may also occur if policymakers evade accountability, if government capability is weak, or if those with the capability to shape adaptations do so at the expense of the vulnerable.

The region's status in the global system is introduced for its relevance to the abundance of foreign assistance, investment, and technical expertise applicable to adaptations, and the essential but problematic dependence on exports to countries of varying concern regarding ecosystem impacts of climate adaptations. The relative peace in the region and its trade and investment opportunities have made Southeast Asia the object of competition among the major industrial countries, including China, Japan, the United States, and the European Union nations.

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Chapter 3 addresses the precarity of farming and fisheries – due to heat, drought, flooding, salinity, and pests – and the challenge of meeting sustainability certification standards required by major importing countries. Remarkable technical advances have occurred to address these challenges. New crop varieties are more resistant to a host of threats, aquaculture is better adapted to cope with saltier water, and better management techniques address the problems of water, pests, and waste. The shift to climate-adapted export-oriented crops, ranging from palm oil and rubber to cassava and new rice varieties, has been a boon to Southeast Asian exports and to the prosperity of some rural people controlling small landholdings, yet the rise of huge plantations, particularly for palm oil, has marginalized many of the rural poor or placed them in greater dependency.

Beyond the direct agronomic advances, Southeast Asian agriculture and fisheries have been subjected to government policies of mixed success in stimulating productivity and protecting vulnerable smallholders. These range from subsidies and extension services to land banks and crop insurance. The success of these policies hinges largely on the level of resource commitment and the fairness of how these resources are applied.

Chapter 4 addresses conservation concerns, covering both the threats and the means to address them. Increasing drought, salinity, forest decline, and flooding threaten many terrestrial and aquatic species, exacerbated by development-driven encroachments into fragile habitats. The greater pressures on ecosystems, and the need for renewable-energy infrastructure, add to the importance of developing better environmental impact assessments. Climate threats also increase the importance of developing certification protocols for sustainable crop and aquaculture cultivation. These must cover not only product safety but also the soundness of the processes through which they are cultivated. Existing certifications are vulnerable to both neglect of conservation risks and import bans by countries demanding sustainable practices.

The conservation impulse, heightened by both climate-induced decline of species and the availability of climate finance, drives governments to declare more areas as protected nature reserves, often limiting the livelihoods of the most vulnerable people, unless they are protected through prearranged revenue sharing and job opportunities. Similarly, to reduce the environmental risks of encroachments that often result in deforestation, disease-vulnerable monoculture, and deprivation of local people, local community control of resource uses ought to be a high priority. This can be pursued through state recognition of traditional rights and practices (such as shifting cultivation), including Indigenous rights, and facilitating the supply chains for small-scale agriculture and fisheries.

The climate-induced proliferation of pests requires pesticides, but the ecosystem and health hazards of chemical pesticides call for further development and

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dissemination of biopesticides. Because of the regional variations of targeted pests, domestic production of biopesticides is quite promising.

The adaptive involvement of small-scale landowners can be enhanced through payments for environmental services. Payments can be to engage in conservation behavior, such as planting trees or coral, or to desist from degrading the environment. The effectiveness of ecosystem protection and restoration can be enhanced through co-management arrangements to avoid heavy handed governmental imposition.

The challenge of balancing conservation and human welfare has been addressed quite differently across the region. For example, the efforts to address the pressures toward farm consolidation have varied enormously, from strong support of small farmers in Thailand to land consolidation for plantations in Malaysian Borneo.

Because roughly one hundred million Southeast Asian residents have a basis to claim "customary rights" over land, governments' recognition of these rights is extremely important in limiting or permitting destructive land-use changes. "Customary law communities" in some countries have been making progress in regaining their customary natural-resource rights, but migration, evolving cultivation practices, and state manipulations threaten to undermine the recognition of customary law claims.

Chapter 5 examines the growing challenge to meet the rapidly increasing energy demand, particularly for electricity, in the face of a greater need for cooling and likelihood of drought-induced reductions in hydropower. Continued reliance on coal and other fossil fuels, especially for electricity generation, transportation, industrial production, and home use poses dire health risks of air pollution. Some initiatives, such as the development of less polluting biofuels and the expansion of the electric vehicle fleets, are helpful, but coal burning will continue to be the greatest challenge.

One premise of the chapter is that, because of the limited long-term potential of solar and wind energy, it is imperative to promote responsible hydropower. Development of small- and medium-scale hydropower sources is a promising development, though of limited scope for most Southeast Asian countries. The potential for hydroelectric dams of varying size is extremely high, yet they hold serious, often clearly demonstrated risks that have deterred hydropower development. Success through responsible hydropower will require new approaches to secure adequate climate finance to subsidize otherwise unprofitable responsible facilities.

Southeast Asia lacks commercial nuclear reactors, although one reactor, suspended before it ever generated power, is being renovated. Nuclear power has great promise, with the advent of small modular reactors, especially for deployment in fairly remote areas. However, cost barriers, regulatory hurdles, and public fears must be overcome.

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The ongoing expansion of electricity grids, including multi-country connections, reinforces the robustness of electricity generation and transmission vulnerable to localized drought or more extreme storms.

Chapter 6 addresses the "push factor" of internal migration due to the growing impact of climate change, as crop failures, flooding, and other disruptions force people from their land, despite efforts to make agriculture and physical infrastructure less vulnerable. Ironically, forced displacement, particularly of the poor, results from many of these physical infrastructure projects (dams, solar arrays, or wind farms), whether for mitigation or adaptation. The government faces the dilemma of whether to prohibit migrations to minimize migrant–host community conflict or environmental degradation, to undertake state resettlement programs to increase the certainty of where migrants go and maintain sufficient state management, or to be passive toward internal migration.

The management of accountability risks is an important political economy consideration in the government's choice among these alternatives. The same holds for aid agencies in their decisions whether to collaborate with the government or with non-governmental organizations in managing internal migration.

Because urbanization is the major migratory pattern, the chapter describes the varied efforts to divert migrants from the congested major cities, through satellite cities, new cities, urban rehabilitation, and recontouring flood-prone rural areas in order to reduce the urban flow.

Chapter 7 addresses the heightened health risks that climate change poses through the direct stress of higher temperature, water-borne diseases exacerbated by flooding, the proliferation of disease-bearing insects and other pests, and the worsening health effects of pollution due to fossil fuel burning. Land-use changes may mitigate these risks, yet other land-use changes may worsen them. The crucial link between reducing conventional pollution and addressing global climate change provides possibilities of situating climate-finance projects within highly polluted areas. Challenges to nutrition arise from both the greater difficulties of raising food crops and the shift to drought-tolerant exported cash crops, such as rubber and cassava. The chapter also covers the missteps of substituting food self-sufficiency for food security, and the reforms to avoid this problem.

Chapter 8 concludes by reiterating the difficulty of addressing warming and its consequences for all five sectors, underscoring the needs to confront the tradeoffs, the normative priority of poverty alleviation, and the importance of government structures to do so adequately. It restates the need for bold initiatives in all the sectors, but also the need to identify which initiatives would harm the poor, considering the differential impacts on segments of the poor. The chapter concludes with 12 insights that should guide the approaches to address the risks and opportunities posed by further climate change.

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