Part E

Regions under Stress

Chapter 21

Southeast Asian Fire Regimes and Land Development Policy

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21.1 Introduction

Fires have long been an important tool for land development and management in tropical Southeast Asia. Fire disturbance regimes vary with forest structure, climate, topography and soils. These regimes have influenced, and been influenced by, the land-use systems of diverse cultures over centuries and millennia, producing diverse histories of fire and landscape dynamics. Low and moderate intensity fires are a regular event in the seasonally dry deciduous or savannah forests of Southeast Asia. These forests contain fire-adapted species and are frequently settled and used by swidden – cultivators. In contrast, fires in the moister evergreen forests of the humid tropics are much more irregular and typically associated with unusual events, for example droughts caused by dry phases of the El Niño – Southern Oscillation (ENSO). In the last 50–100 years the rate and extent of change in landscapes and disturbance regimes has increased substantially as societies throughout Southeast Asia have successfully grown in size, expanded and intensified the agricultural and forestry foundations of their economies, and adopted new management strategies to fire.

One of the side-effects of this success has been a more frequent incidence of synchronous fires, especially in very dry years, when deliberately lit and managed fires get out of control to become wildfires. Depending on wind and atmospheric conditions these events can lead to episodes of haze affecting major cities in other regions (Murdiyarso et al. 2004a; Tomich et al. 1998b). The most extreme episodes in Indonesia and Malaysia over the last 20 years have been associated with dry phases of ENSO and resulted in vast parts of Southeast Asia being covered in smoke for weeks at a time. In the northern parts of Thailand, Vietnam, Myanmar and Lao PDR, fires are an annual event associated with a predictable long dry season. There, the intensification of land-use practices and the creation of protected area networks in upland areas may now be reducing the frequency of fires.

At the simplest level fire regimes are affected by ecosystem conditions, land management practices and climate (Fig. 21.1). Agricultural and forest practices are, in turn, influenced by systems of incentives and constraints on land development, the most important of which are systems of local and state property rights to land and land-derived resources, and diverse sets of policies with strong impacts on land development (Fig. 21.1).

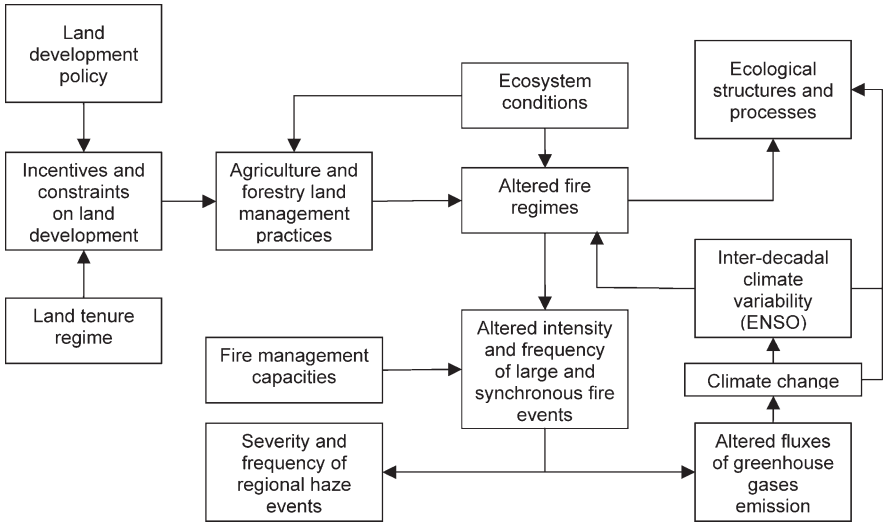

Fig. 21.1. Conceptual framework for how fire regimes are being altered in Southeast Asia

In this chapter we address two overarching questions about land development policies and vegetation fires in Southeast Asia, namely:

1. How have land development policies and changes in land management practices influenced fire disturbance regimes in Southeast Asia? What is the significance of recent changes in fire regimes for local ecosystems and livelihoods, regional air quality and global emissions?
2. How could insights from research about fire ecology, emissions and livelihood impacts be incorporated into development strategies and institutional responses that would reduce the risks of large-scale fire and haze episodes? Are there ways to mitigate undesirable feedbacks on the regional and global atmosphere which would not unfairly disrupt the aspirations of societies in the region to improve their well-being through land development?

The chapter is organized around the broad framework of how human activities are altering fire regimes in the region and the implications this has for ecosystems, livelihoods and feedbacks on the regional and global atmosphere (Fig. 21.1). First, we start with a consideration of what is known about the underlying causes of fires in the region. Second, we consider the immediate ecological and biogeochemical consequences at various scales. And third, we consider how fire has many positive and few negative implications for livelihoods. The chapter ends with a summary of our responses to the two questions.

21.2 Underlying Causes of Land Fires

21.2.1 Explaining Fire Occurrence

The likelihood of fires has been usefully conceptualized as an interplay between *pre-disposing conditions* and *human causes* (Stolle et al. 2003). A multi-factor analysis of factors associated with the distribution of fires from NOAA-AVHRR satellite imagery for 1992–1993 in Jambi province documented interactions between condition- or context-creating factors like climate, elevation, vegetation cover and suitability of land for rubber with more direct human factors like the presence of transmigration projects and timber concessions (Stolle et al. 2003). What is noteworthy from this study is that few fires were accidental. Land development policies and land-use practices were largely driving vegetation fires.

Repeated burning alters the nutrient balance of soils (Crutzen and Andreae 1990) and fires are frequently used as tools by farmers in nutrient-poor soils to take advantage of short-term nutrient releases from burned vegetation. Major fires as well as even more modest understorey fires in closed canopy forests generally increase the likelihood of subsequent fires both in Southeast Asia and the Amazon (Cochrane et al. 1999).

To this we add that past human practices, for example those which make ground conditions drier, alter fuel loads and fragment vegetation, over-time may themselves feedback to alter the "pre-disposing" conditions.

21.2.2 Land Development Policies

A wide range of land development policies have been important in choices of land use, in use of fire for land management, and in fire management practices. Some of the land policies with the most direct effects include forest timber concessions, re-zoning of land for human settlement and cultivation, subsidies for land improvements for specific crops, and irrigation infrastructure projects to stimulate expansion or intensification of production. In Indonesia, Myanmar and Lao PDR, in particular, but in all countries of the region at some stages, resettlement policies backed by varying degrees of coercion and force have been used against swidden farmers, in part, because of perceptions about the negative impacts of their land management practices using fire.

Several other policy areas are not so easy to label as "land development" per se, but their effects may be even larger than some of those listed above because, by altering economic incentives, these policies have much broader reach than rules and regulations that need to be backed by agency actions. In this set, those policies aimed at stimulating (or not) export-oriented agricultural development appear to be particularly important. These include rural credit schemes, trade tariffs, investments in and special deals for agribusiness, for forestry and for forest product enterprises, and monetary policies that influence foreign exchange rates and domestic interest rates.

Fire is often used in conversion of land from forest to agriculture. In Indonesia, much of this expansion has been driven by export-oriented agricultural development policies in recent decades, especially for pulpwood, palm oil and rice, but also by a need to open new land for growing rural populations. Fires may lead or follow other land-use activities like logging (Eva and Lambin 2000).

The history of major fires in Sumatra and Kalimantan, Indonesia, illustrate the interactions with land development policies well. In 1981 the Government of Indonesia released Decree No. 682/Kpts/Um/8/1981 that designated 20–30 Mha of forestland as Conversion Forests (World Bank 1999). Among others, 5 Mha of forest lands were allocated for timber plantations in Sumatra and Kalimantan. This policy sparked extensive fires mainly in those two islands as fire was used as a tool to clear land before plantation activities were established. In 1982 3.6 Mha were burned. The area of oil palm plantation more than tripled between 1981 and the fires of 1997. More than 2 Mha of new plantation was established in less than a decade.

At least as important as the policies on paper has been the rich history of *de facto* policies of the Suharto era that ensured land conversion permits, lucrative timber concessions, and deals for paper mills and associated tree plantations went to friends and family in the military, business and government (Dauvergne 2001; Pasong and Lebel 2000). Throughout this history, fire was often a tool for intentionally degrading land in insurance scams and a weapon of legitimization for land claims or of resistance by displaced people.

Another controversial policy-driven land development was the conversion of around 1.4 Mha of peat-swamp forests in Central Kalimantan (Murdiyarso et al. 2004b; Tacconi 2003; World Bank 1999). The project, legalized by Presidential Decree No. 82/1995 and known as the Mega Rice Project, planned to create some 500 000 ha of rice fields and other tree crops. The construction of 700 km of primary canals (25 m wide and 6 m deep) and of numerous secondary canals has caused substantial drainage and peatland subsidence (Fig. 21.2). The drained area which was prepared to accommodate some 1.5 million transmigrants became susceptible to fire. Around 200 000 transmigrants who had settled there had to leave the area since it was no longer suitable to support their livelihood. Transmigration schemes which aimed to move people away from the densely populated island of Java often failed to live up to their original goals, but nevertheless, had important impacts on land use in many parts of Indonesia. In the strong 1997–1998 ENSO event, 11.6 Mha were burned.

Furthermore, in line with an attempt to decentralize authority, the government of Indonesia launched a new law in 1999 (Law No. 22/1999). As a result many regional regulations were enacted to boost revenues. Unfortunately, the human resources at regional levels could not meet the challenges when extraction of natural resources created new social and environmental problems.

21.2.3 Land Management Practices

In Fig. 21.1 we highlighted fire management capacities. This should be understood to mean not just technical capacities in terms of number of trucks or planes, but also understanding of farmers and local government agencies about how to handle fire regimes which have changed or with which, as new settlers, they may be unfamiliar (Colfer 2001).

Furthermore, at least six distinct interest groups have a stake in the trajectory of land-use change in Sumatra, but there are crucial differences among them in the weights they place on the various economic and environmental outcomes (Tomich et al. 1998a). These groups include the international community, hunter-gatherers, small-scale farmers, large-scale public and private estates, absentee farmers, and public policymakers.

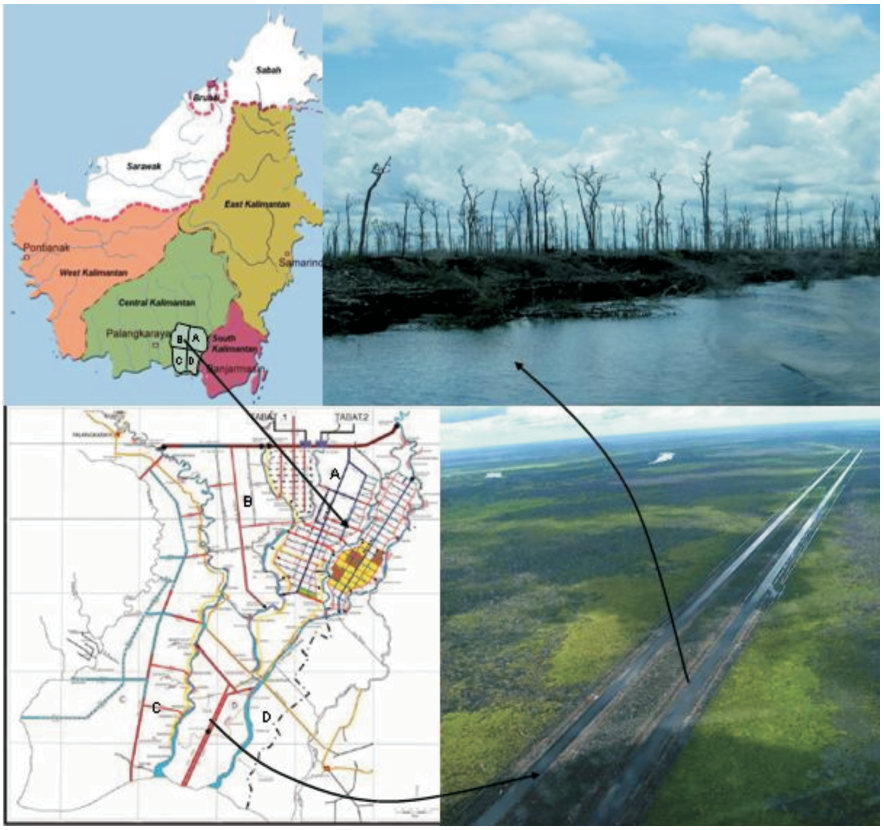

Fig. 21.2.
Mega Rice Project in Central Kalimantan, Indonesia (photos: Wetland International-Indonesia Program 2002)

Small-Holder Farmers

Fire is often used as an effective tool for land clearing (Tomich et al. 1998a). Land management practices and the use of fires, however, fall into different categories depending on the intension of land-users. Wibowo et al. (1997) categorized four different types of Indonesian farmers practising shifting cultivation: (1) traditional communities with strong local institutions restricting the actions of individual farmers; (2) communities that are more integrated in the market economy, often combined with a loosening of traditional restrictions; (3) spontaneous settlers/migrants who may have skills but who are usually landless; and (4) government-sponsored transmigrants, who are granted land with titles. Except for the first category, these groups of farmers practice non-sustainable agriculture and bring no significant conservation skills to the management of their agricultural lands. Most of them viewed that burning is the cheapest and quickest way for land clearing.

Fires are used to provide space since they offer cheap and effective means to remove the debris before new plantations are established. Furthermore, fires also provide ash which contains readily available nutrients and controls pests and diseases. This may not be the case for large-scale plantations, especially as to the long-term economic advantages (Simorangkir In press.). In eastern Malaysia exclusion of fire and minimum soil disturbance during plantation forest establishment could double production of wood and strongly reduce environmental impacts (Nykvist et al. 1994). However, this has not automatically led to a reduced use of fire in the region. Slash-and-burn fires are still a common tool for halting or re-directing succession.

The practice is slightly different compared with that used in the peatlands. There, the fires burn much more belowground biomass and, as the combustion is usually incomplete, they tend to produce a lot more haze over longer periods (Murdiyarso et al. 2004b). Fuller and Fulk estimated that during the 1997/1998 fires, 1.45 Mha of peatlands were burned involving 300 000 ha in Sumatra and 750 000 ha in Kalimantan. The most recent assessment shows that the total area of peatland burned was 2.12 Mha (Tacconi 2003). This is about 10% of Indonesia's total peatland area or 20% of the total area burned in the 1997/1998 fires.

Clearly, policy interventions are needed but, given the variety of fires, they cannot be generalized since each type requires a specific intervention. This confirms the earlier finding that quick fixes by banning fires will not be successful unless they properly address the underlying causes and provide alternatives (Tomich et al. 1998c).

21.2.3.1 *Logging*

Logging and tree plantation forestry have had a major impact on fire disturbance regimes. On the one hand logging has made much of the landscape susceptible to fire during periods of drought, and on the other, management for timber has often involved fire suppression policies. A history of unsustainable logging practises has been reinforced by state corruption that together have exacerbated fire management challenges (Dauvergne 2001).

Logging in closed canopy tropical forest creates canopy gaps and a pulse of leaf litter. The resulting drier conditions are likely to increases the risk of fires (Nepstad et al. 1999). Moreover, after fires occur in a concession the normal restriction on the 20-year cutting cycle is lifted for salvage harvesting, thus creating a perverse incentive for poor fire management (van Nieuwstadt et al. 2001). Logging in the logged-over forests appears to increase the risk of disastrous fires (Siegert et al. 2001).

21.2.3.2 *Forest Management*

Forestry departments in Southeast Asia have adopted models of "land management" based on moist, temperate forest ecologies. The key attitude is that fires are natural disasters and management is about fire suppression to protect property, especially valuable timber, from being burned. Although this may make sense in some forest ecosystems near urban areas, ecologically, and eventually economically, it doesn't make sense in many others. In seasonally dry tropical forests, fire suppression leads to higher fuel loads, more intense fires and the possibility of devastating fires, which take a long time for forest ecosystems to recover from because of massive mortality, destruction of seed banks, and alteration of soil structure (Stott 1988, 1996).

21.2.3.3 *Shifting Cultivation*

Fire is also an integral part of shifting cultivation practices that are diverse and in many ways qualitatively distinct from using fire to clear forests (Dove and Kammen 1997; Fox et al. 2000; Schmidt-Vogt 1998). Some practices, for instance, appear to be particularly effective in maintaining intermediate-level forest cover at landscape scales, with a very diverse spatial mosaic of landscape patches in different stages of succession. Whether or not swidden systems are viewed as destructive to forest biodiversity depends very much on what components are emphasized and to which land-uses such practices are compared (Forsyth 1998, 2003; Schmidt-Vogt 1998). The mosaic landscapes do not support many of the larger mammals needing intact tracts of forest, but on the other hand much other vegetation and small animals may persist in these landscapes and many other watershed functions may be maintained (Forsyth 1996; Thomas 2002). In comparison to plantations or conventional tillage agriculture such systems of course preserve a lot more of the original biodiversity (Schmidt-Vogt 1998; Thomas 2002).

This is brought home by comparing such practices to for example the impacts of conventional lowland agriculture which leads to largely irreversible conversion of land cover. In longer rotational systems there can be very intentional pre-burn preparation of land including lopping and stacking of branches and so on.

Intentional fires to prepare land for upland cultivation of rice and a diversity of other products is common in Lao PDR, in northern Vietnam, and in some scattered locations of northern Thailand, Borneo Indonesia, northern Myanmar and Yunnan province of China.

Lao PDR has pursued a policy of resettling ethnic minorities that utilize shifting cultivation practices from the uplands to the lowlands with the rationale that such practices cause deforestation and erosion. By 1997 the government had established 62 "sedentarisation" sites targeting some 320 000 people. In practice local officials have varied widely in their implementation efforts, and villagers may move to the lowlands for economic reasons rather than as a result of government intervention. Either way, the Akha in Muang Sing who moved to lower slopes were often not able to secure better livelihoods, received little or no government assistance, and instead became a cheap and exploited labor force for lowland Tai (Cohen 2000). In some locations the Akha remain under pressure to continue opium cultivation.

Government policies to limit or end shifting cultivation are found throughout montane mainland Southeast Asia. In combination with macro-economic changes accompanying improved road infrastructure and emerging markets for cash crops apart from opium, this has undoubtedly lead to major shifts in human use of fire in the uplands. After several decades of expansion of areas under shifting cultivation as a result of migration and population growth, there has been a large decline in areas with such practices over the past two decades. As far as we know, however, there has been no detailed study of fire regime changes and their ecological consequences. For example, is the occurrence of fires less frequent now, but when they occur are they more intense? Has the proportion of all fires that are accidental or lightning-lit increased?

21.2.4 Property Rights and Conflicts

The likelihood of destructive fires, both intentional and accidental, appears to be often related to investments in fire protection and management by communities, which in turn is affected by land tenure security and conflicts over land access rights. Insecure tenure and poor relations reduce the incentives for careful fire management. In serious conflicts fire may be used as a weapon, both by smallholders and larger commercial enterprises (Colfer 2001). Thus, in the 1997–1998 fires, estimates suggest that as many as 14% of the fires were related to social conflicts between plantation developers and local communities (Ganz 2003).

In most remote areas it is not the existence of formal state-recognized property rights that matters so much as whether the rights, customary or formal, are recognized by the various local actors. Upland swidden farmers throughout Southeast Asia typically have lacked formal title to the land they cultivate, but nevertheless have continued with well-defined land-use systems in which controlled fires are a crucial tool for food production.

In conflicts between large firms and small-holders, on the other hand, as has been the case frequently in Indonesia, clear systems of property rights appear to help reduce conflicts (Tomich et al. 1998b). Procedures also matter. Communities complain about unheard claims, unfair judicial systems, and non-transparent decision-making processes (Suyanto 2005). When push comes to shove, customary or "*adat*" rights are often not fully recognized by legal systems in the region. In the Philippines, fires in reforestation projects were also caused by conflicts between management (typically Department of Environment and Natural Resources, DENR) and field labourers (typically from local communities). It was not uncommon for newly planted trees to be burned because of some grievance, real or imagined (R. Lasco pers. comm. 2005).

21.3 Landscape, Regional and Global Interactions

21.3.1 Ecosystem Dynamics

Land fire regimes across Southeast Asia vary among locations because of differences in climate, types of vegetation and intensity and form of human activities. Some woody savannas burn very frequently, whereas other moist tropical communities are very rarely burned (van der Werf et al. 2003).

Knowledge about the ecological consequences of fires on tropical forests in Southeast Asia is modest, with most research coming from work on moist but ENSO-impacted forests in Indonesia. For many key processes influenced by humans activities the most detailed understanding so far is based on studies done in Central and South America (Cochrane et al. 1999; Nepstad et al. 2001), and more recently in northern Australia (Edwards et al. 2001; Horstman and Wightman 2001; Yibarbuk et al. 2001). This matters greatly for generalizations because the ecological impacts vary widely across different ecosystems (Eva and Lambin 2000) which is probably reflected by the cultural variation in land-use practices (see Sect. 21.2.1).

Nutrient losses due to volatilization during the burning of residual biomass are generally higher than the losses by leaching (Bruijnzeel 1998). This is not only for nitrogen, which comprises more than 90% of the lost biomass (Note: the sentence reads like if 90% of the biomass burned (presumably by weight) is nitrogen; I as-

sume this is incorrect as N is a much smaller fraction of the biomass; please rewrite accordingly), but often also for mineral nutrients. These high atmospheric losses have been used to suggest the reduction of burning in land-clearing but very little reduction has been implemented. Burning also increases losses by leaching when compared to non-burning practices (Malmer et al. 1994).

As the carbon content of biomass fuels, apart from charcoal, varies over only a narrow range (37–54%) emission factors are largely determined by the combustion process. However, many other chemical species are emitted as trace gases and aerosols and these can vary substantially across both types of vegetation and fires (Andreae and Merlet 2001).

Southeast Asia is home to about 60% of the world's tropical peatlands. The impacts of fire and ecological change in this landscape are probably the area of greatest concern from the perspective of both regional haze episodes and global greenhouse gas emissions. The impacts of fires in Kalimantan were described in detail earlier in this chapter. Changing fire regimes in peat wetlands are an issue not only for Indonesia. Similar problems have arisen in the Melaleuca peat forests of U Minh in the Mekong delta of Vietnam, an area targeted for conservation but where new and enlarged canals have altered the water regime exacerbating the seasonal drying and facilitating the human access that increase the risks of ignition at critical times (Sanders 2002). Likewise, in peninsular southern Thailand road construction, as well as infrastructure for shrimp farms and agriculture, has contributed to some major peat forest fires by altering water regimes. Such fires produce relatively large amounts of smoke and greenhouse gas emissions per unit area.

Ecological interactions with fire are likely, but not well understood in Southeast Asia. Pest outbreaks by causing crown loss and tree dieback may increase susceptibility to fires. There are likely to be important interactions between fire, pest regimes, harvesting and other land management practices (Gower 2003). Post-fire undergrowth and seedbanks are sensitive to additional disturbances. Thus, the damage caused by conventional machinery used in "*salvage*" logging after fires reduces the forest's potential for recovery (van Nieuwstadt et al. 2001).

21.3.2 Regional Haze Episodes

Regional haze episodes are primarily a consequence of synchrony of fire events, strong winds and atmospheric inversions that expose large, sometimes distant, populations to hazardous levels of smoke and haze (Murdiyarso et al. 2004a). Trans-boundary haze episodes pose significant economic and public health burdens. For this reason they attract the attention of the international media and policy makers alike, at least until the next monsoonal rains clear the skies.

In the 1997–1998 fire events in Indonesia there were some indications that permits for clearing land had been held onto in the hope of drier, and thus easier to use, fire conditions eventuating and that these permits were then "used" simultaneously by many farmers when the dry ENSO phase unfolded.

Long-term fire histories in regions of Argentina and the US in which the climate is affected by the El Niño-Southern Oscillation have indicated that major fire years are those after a switch from wetter conditions that built up fuel loads to drier conditions that then rapidly dried out the forests (Kitzberger et al. 2001). In Southeast Asia human activities appear to be a more critical part of the causal fire cluster and to modify the pre-disposing conditions.

21.3.3 Greenhouse Gas and Other Emissions

The 1997–1998 fire events in Indonesia were well studied and provide some of the better estimates of carbon fluxes (Table 21.1).

Default estimates of carbon released from deforestation could be based upon the decomposition of biomass over the lifetime of the wood products, but fire is the most effective and direct means to convert carbon stored in the biomass into the gaseous phase. Fire could also release the enormous below ground biomass stored in the peatlands. Page et al. (2002) made a detailed study of a 2.5 million hectare area in Central Kalimantan from which they estimated 0.81 to 2.57 Gt of carbon were released to the atmosphere in 1997 as a result of peat and vegetation fires in Indonesia. This represents 13–40% of total emissions in that year from fossil fuel burning. The contribution from peat fires was very significant.

The stability of wetlands overlying peat deposits is very important for the global carbon balance as they contain huge deposits. In 1990 Sumatran peatlands covered an area of 7.2 Mha, but this had reduced to 6.5 Mha in 2002. The estimated carbon released during that period was 3.47 Gt (Murdiyarso et al. 2004b). This is one of the more problematic aspects of land development and how it affects fires. Changes in these wetland peat landscapes which result in carbon emissions may be much harder to reverse. Due to the uniqueness of the ecosystems, car-

Table 21.1. Estimates of the carbon fluxes attributable to land fires in various locations during the 1997–98 dry phase of ENSO in Indonesia. Numbers in brackets indicate emissions just from fires in peatlands (Murdiyarso and Adiningsih in press)

El Nino year	Area burned (Mha)	Estimated C-released (Gt)
1982	3.6	0.45
1987	0.1	0.01
1991	0.5	0.06
1997	11.6 (2.1)	1.45 (0.47)

bon sequestration elsewhere may not compensate the loss in their biological diversity.

Van der Werf et al. (2003) analysed a 4-year infrared satellite dataset from the TRMM (Tropical Rainfall Measuring Mission) and combined this with a large-scale biogeochemical model to estimate global carbon fluxes from fires in the tropics and sub-tropics. The model made estimates of emissions from combustion losses and decomposition due to fire-induced mortality. They estimated that overall the annual direct and indirect carbon losses from fires amounted to about 9% of net primary carbon production in the tropics and sub-tropics.

21.3.4 Interactions with Climate Variability and Change

How precipitation regimes across Southeast Asia will be affected by climate change is still highly uncertain at the spatial resolutions relevant for land management and vegetation community dynamics. Nevertheless, historical observations, experimental studies manipulating soil moisture and modeling, all suggest that climate changes could have major impacts on terrestrial ecosystems (Weltzin et al. 2003). Short-term changes in soil moisture can impact risks of ignition, and longer-term changes in rainfall may influence vegetation structure and litter densities that in turn influence fire regimes. Interactions between precipitation and temperature changes are likely.

Regional land-surface interactions that dominate weather patterns in the Amazon seem less likely to be important in most parts of Southeast Asia because of the predominance of ocean influences on climate in SEA.

21.4 Human Well-Being

21.4.1 Economic and Health Impacts

The regional economic impacts of fires have rarely been assessed, but the 1997–1998 event was so large and clear that several estimates were soon made (Bapenas 1999; Glover and Jessup 1998). These highlighted the importance of losses to the transport and tourism sectors within and outside Indonesia. The most worrisome impact in the public mind, however, was on health which can help explain the declines in tourist visits. The health impacts on inhabitants near fires were likely to have been much higher than on distant populations but longer-term health effects of recurrent episodes of haze and smoke are not well understood and most of the emphasis has been on the discrete transboundary episodes.

For example, in Singapore effective computerized patient information systems and air quality monitoring networks allowed researchers to analyze the association between air quality measurements and diagnoses for haze-related outpatient visits to hospital (Emmanuel 2000). They found that an increase in levels of fine particulate matter, PM_{10} from 50 $\mu g\,m^{-3}$ to 150 $\mu g\,m^{-3}$ was associated with increases of 12–26% in upper respiratory tract illness, asthma and rhinitis. No significant increases of admissions or mortality were noted. Emmanuel concluded that the health effects on Singapore of the 1997 smoke haze were generally mild. A thorough assessment in Malaysia, reporting at the same time as the Singapore study, acknowledged the significant economic costs of the transboundary haze, but concluded that the most serious sources of air pollution for human health were domestic, especially motor vehicles and oil and gas works (Awang et al. 2003).

21.4.2 Livelihoods

Fires have both positive and negative impacts on the livelihoods of people in affected and nearby areas. Most fires in Southeast Asia, as we have seen, are not accidental, but deliberately lit to achieve land conversion and management goals.

The drivers for land-use change, however, are often in part embedded in national development policies that are reinforced by preferential allocation of land for different activities. It is through these mechanisms that large negative impacts on the livelihoods of the poor are to be found, and fire is mostly a side-effect of these rather than a cause. In many remote areas, it cannot be ignored that fire is a tool for land improvements that help stake a land claim. In addition, it is not insignificant the involuntary risks that neighbouring and sometimes distant populations are placed under by smoke from vegetation fires, but neither are they unprecedented disasters – many of the citizens with the largest complaints are in cities filled with exhaust fumes of cars and the investments and consumption patterns of these citizens are driving some of the land-conversions in those distant places.

Road-building in remote areas is a controversial topic throughout the tropics. Obviously, improved infrastructure is important to market-integrated development and provision of basic services. Improved access can also accelerate land-conversion in un-intended places as well as the risks of accidental fires (Nepstad et al. 2001).

The importance of macro-economic conditions is underlined by the interactions between the 1997–1998 ENSO dry event and the Asian financial crisis which simultaneously impacted on livelihoods in the region. Sunderlin et al. (2001) found that dependence on forest resources increased markedly during the 1997–1999 economic and political crisis in Indonesia as unemployed city workers returned to their home villages.

One of the difficult ideas for policy and rural development advisors from developed countries is to understand that the conventional separation of agriculture and forestry activities so firmly embedded in their natural

resource management bureaucracies is not the way many smallholder livelihoods have been organized in the tropical landscapes of Southeast Asia. Forestry, including collection, active management and cultivation of useful plants within "forests", and farming activities that often include tree-crops, is much more integrated than the rural extension and new state-centric models of property rights can handle. On the other hand, people in the region are remarkably adaptable and willing to try new technologies given appropriate incentives. This often undermines the guiding, somewhat nostalgic, assumptions of non-government actors about aspirations for cash-crops of many smallholders. Much of the debate about alternative fire and related land management practices begins with assumptions about "*appropriateness*" of different livelihood and lifestyle activities, a debate which unfortunately is not always well-informed about or with representation of the interests of the "*farmers*" concerned. The appropriate use of fire in the tropics is ultimately a political issue to which research-based knowledge, about impacts and likely sustainability, can make a contribution, but not pre-determine deliberation around trade-offs.

21.5 Informed Decision-Making and Better Governance

21.5.1 Role of Expertise

Research-based knowledge has been summarized several times as inputs into policy. Nevertheless, there appears to still be a large gap between the information which is needed to strengthen and re-design institutions at various scales to address changes in fire regimes and, in particular, large fire and haze episodes and the contributions which various expert communities have been able to deliver. In part this reflects the tendency for both science and policy to de-politicize issues by emphasizing the technical aspects of fire fighting and prevention or the alternative land preparation techniques, rather than by addressing directly the underlying causes which lie primarily in land development policies and investments. It also is an acknowledgment of some of the inherent complexities in an issue where the drivers, consequences and institutional responses are each significantly multi-scale (Fig. 21.3).

Multilateral and bilateral technical assistance by organizations and governments, such as the Asian Development Bank, the European Union, FAO, UNEP, The World Bank, Germany, Canada, Japan, USA, UK, and Australia has prepared global, regional, and national fire assessments. Capacities of national and local governments have been built up to suppress and mitigate fires. International and national NGOs, such as IUCN and WWF, have also been devoting increased attention to fires and highlighting the underlaying causes and impacts. Some 40 fire projects and missions costing well over US$30 million have worked in Indonesia over the last 20 years (Dennis 1999). Despite the money and effort spent on them, fires continue to burn every year. Thus it may appear to some that efforts to address the "fire problem" have not been effective (Tacconi et al. 2003).

Several other policy initiatives are possible and have in part been taken up. These include development of drought and fire information systems, medium-term forecasting of ENSO drought conditions, and reviews of

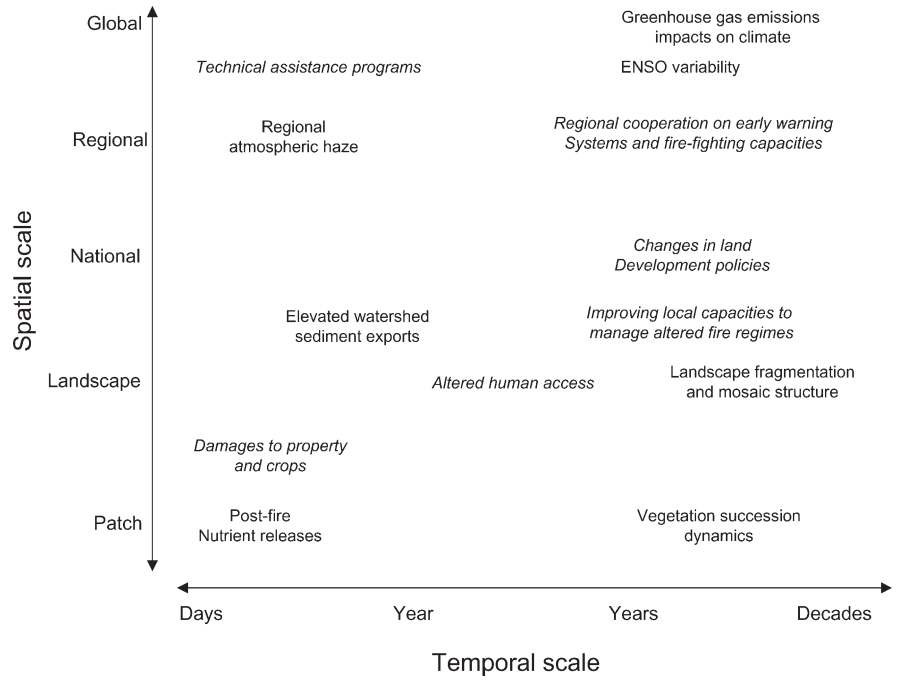

Fig. 21.3.
Multi-scale view of the large-scale fire and haze events in Southeast Asia as an environmental and social "problem"

land-use zoning and clearing regulations (Applegate et al. 2001; Murdiyarso et al. 2004a). Proposed zero-burning options do not appear likely to be adopted widely (Murdiyarso et al. 2004a). There are also opportunities to improve the utilization of waste wood after logging by the removal of policies distorting prices (Murdiyarso et al. 2004a).

State capacities are in general limited, given the size of the areas of forest and cultivated lands under their jurisdictions. However, for communities to play an important role in fire management they must have control over forest resources (Ganz and Moore 2002). Where ownership is weak there is no incentive for communities to help. Incentives, however, can also act perversely: in parts of Indonesia communities are paid to fight fires, creating an incentive to light them (Karki 2002). On the other hand, without control of and rights to forest resources, pushes for "community-based" fire management may be seen by governments as a way to obtain "cheap labor" to protect their "forestry" resources. The private sector, in general, has not had responsibilities for fire management of forests commensurate with the benefits it has extracted.

In wetlands, greater attention to the impacts of infrastructure projects on hydrology could remove some of the underlying fire problems. In the provinces of Jambi, South Sumatra and Central Kalimantan, Wetlands International promotes canal blocking in the peatlands to prevent further peat dome subsidence, to improve hydrology and to avoid fires (Murdiyarso et al. 2004b). Controlling the water table is a key issue of peatland management in which local communities are heavily involved. Alternative livelihoods are also promoted by re-introducing local timber species with a high economic value and traditional fishery practices (*tabat*) wherever the water table is elevated.

21.5.2 Regional Cooperation

The Association of Southeast Asian Nations (ASEAN) has been at the forefront of mostly rhetorical attempts to promote regional cooperation on trans-boundary pollution issues, including those arising from vegetation fires. In 1999, after several years of discussions a Regional Haze Action Plan was developed by a Haze Technical Task Force with support from the Asian Development Bank. The widely accepted ASEAN response was expected to be revisited annually (Qadri 2001). The emphasis in implementation, as for example laid out in the Operationalized Regional Action Plan, remains firmly on fire suppression and mitigation. The underlying causes of fires are not addressed (Murdiyarso et al. 2004a).

The legally binding Agreement on Transboundary Haze Pollution (ATHP) adopted in 2002 entered into force in November 2003 following ratification by six member countries. However tension and pessimism with regards to the ATHP remain since Indonesia, the most likely source of such pollution, has not ratified the agreement. Indonesia faces tough institutional challenges in trying to bring together central and increasingly autonomous provincial governments for the implementation of international agreements of this type.

The ASEAN Peatland Management Initiative (APMI) with technical support from the Malaysia-based Global Environmental Centre (GEC) is a promising venture as it has been based on the concept of broad consultation with diverse stakeholders.

Improved fire-fighting capacities and preventative measures, especially with respect to "scaling-down-activities" in seasons with high risks of unintentional fire-spread, are both needed. Research has provided many new insights into the proximate causes of fires, their spread and the climactic and local conditions under which people prefer to light them. All this is useful background understanding to assist institutional and educational interventions. So far, however, this cumulative understanding has not had anywhere near enough impact. In the last few years, the transfers of responsibilities by central governments to local communities and local governments have risen but they have usually not being accompanied by the resources required to build the capacity to understand and manage new fire regime. While the barriers are not insurmountable the challenges are large and will require investments. These should be the focus of regional cooperation and broader technical assistance.

21.6 Summary and Conclusions

Forest and land fires in Southeast Asia are not the apocalyptic ecological and social disasters that are sometimes portrayed by the international media and some experts. However, fire regimes for most landscapes in the region have undoubtedly been altered by human activities, sometimes in ways detrimental to the ecosystems upon which livelihoods partly depend. In the past two decades the changes in Indonesia, in particular, have been rapid and associated with conversion of forest lands to agricultural crops and pulpwood plantations. In this latter context fire remains an important land-conversion and management tool for both larger corporations and small holders.

The challenge is largely one of governance. Alternative visions, objectives and paradigms for the development of the rural hinterlands of Southeast Asia persist (Lebel et al. 2004). Each adopts a narrow set of assumptions about the appropriateness of different ways to manage the complex agricultural and forested landscapes of the region, but without adequate regard for how the knowledge and interests of various stakeholders are to be considered nor how those vested with authorities are to be held accountable (Pasong and Lebel 2000).

At the same time other forces are making the institutional challenges even more difficult. Macro-economic and political changes are placing more of the critical drivers beyond the control of governments and societies in the developing countries within the region. The fire regimes in the tropics of Southeast Asia have been altered by human actions for millennia and undoubtedly will continue to be, but in the future these will increasingly be confounded by the short-term and cumulative impacts of the consumption behavior of distant actors on crop choices, land-use, atmospheric composition and climate change.

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