Chapter 1

Dwindling habitats

If the human impact on the natural environment continues unabated at its present rate, or indeed increases in severity, then by the turn of the next century, the resulting changes in land use will have exerted a profound and irreversible effect on tropical biodiversity (Sala *et al*. 2000). Habitat loss will probably have far greater effects on terrestrial ecosystems in the tropics than other drivers such as climate change, elevated carbon dioxide (CO_2) levels and invasive species (Sala *et al*. 2000). Rain forest loss, its degradation and fragmentation, has been a widely publicised example of habitat loss in the tropics. Anthropogenic activities such as logging are degrading and destroying tropical rain forests at a rate that lacks historical precedence (Jang *et al*. 1996; Whitmore 1997; Laurance 1999). In the decade from 1979 to 1989, the annual global area of tropical forest lost increased by more than 90% (Myers 1991). Given that the vast majority of the Earth's terrestrial biodiversity is harboured in these threatened and little studied biomes (Wilson 1988; Myers *et al*. 2000; Sodhi & Liow 2000), they represent obvious foci for conservation. In this chapter, we discuss the loss of native habitats (primary forests) of Southeast Asia.

Unprecedented losses

Almost the whole of Southeast Asia was covered by forest 8 000 years ago (Billington *et al*. 1996). Today, this region has the highest rate of rain forest loss, with deforestation rates more than double those of other tropical areas (Hannah *et al*. 1995; Laurance 1999; Achard *et al*. 2002), and only a few areas (e.g. Borneo and Sulawesi) retain large tracts of intact primary forests (Laurance 1999). Using the United Nations Food and Agriculture Organization's (FAO) data on forest cover change from 1980 to 1990 (FAO 1993), Laurance (1999) estimated that 15.4 million ha of tropical forest is destroyed every year, with an additional 5.6 million ha being degraded through such activities as selective logging. Overall, an average of 1.2% of existing tropical forests are degraded

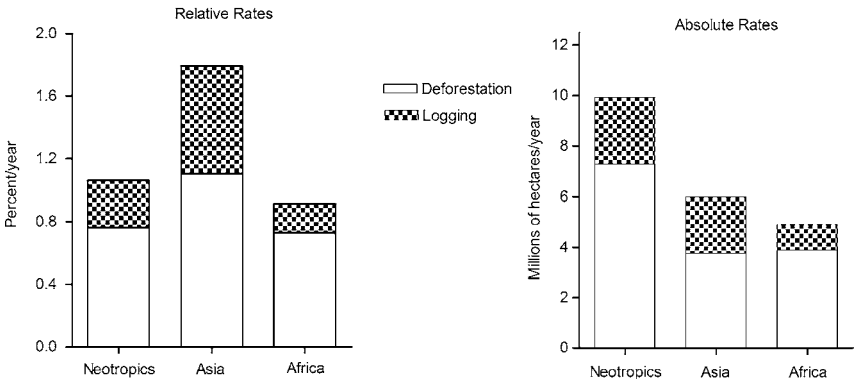

Figure 1.1 Relative and absolute rates of forest conversion in the major tropical regions throughout the 1980s. (Modified from Laurance 1999. With permission from Elsevier.)

or destroyed every year (Whitmore 1997; Laurance 1999). In terms of absolute loss of area, forest conversion is the highest in Neotropics (10 million ha/year) followed by Asia (6 million ha/year) and Africa (5 million ha/year). However, if we consider forest conversion relative to the existing forest cover in the region, Asia clearly tops the list (Laurance 1999) (Fig. 1.1), with 1.5 million ha of forest removed each year from the four main Indonesian islands of Sumatra, Kalimantan (Indonesian Borneo), Sulawesi and Irian Jaya (Indonesian New Guinea) alone (DeFries *et al.* 2002). Even the so-called 'protected forests' of Kalimantan declined by more than 56% (or 2.9 million ha) between 1985 and 2001 (Curran *et al.* 2004).

There is a controversy as to whether the FAO values are accurate, as they may fail to include catastrophic events such as the vast 1997–8 forest fires in Indonesia, and perhaps erroneously include plantations as forest cover (Matthews 2001; Achard *et al.* 2002). Deploying remotely sensed satellite imagery, Achard *et al.* (2002) reported that tropical forest loss may be much lower (5.8 million ha/year) than FAO estimates. Yet even Achard *et al.*'s estimates have been questioned. It has been argued that their lower estimates of forest loss may be due to lack of representativeness owing to their relatively small sample sizes (Fearnside & Laurance 2003). Nevertheless, despite the different methodology used, Achard *et al.* (2002) also found, as reported earlier by Laurance (1999), that rates of deforestation and forest degradation are among the highest in Southeast Asia (Fig. 1.2).

The main culprit in this devastating forest loss in Southeast Asia is expansion for agriculture, with more than 1 million ha of forest converted annually by this human activity (Achard *et al.* 2002). A particularly worrying trend is that

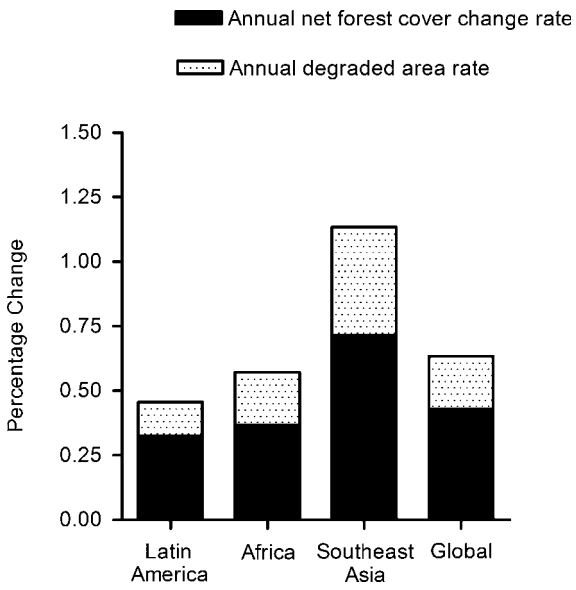

Figure 1.2 Mean annual estimates of deforestation in the humid tropics during 1990–7. (Data from Achard *et al.* 2002.)

although native forest loss seems to be decelerating with time in tropical Latin America, it continues to accelerate in tropical Asia (Matthews 2001) (Fig. 1.3).

Globally, 0.8% of native tropical forests (primary and secondary forest, excluding plantations) are likely to be lost each year (Matthews 2001). Let us now consider what is happening in different Southeast Asian countries. In 1880, almost all Southeast Asian countries had more than 70% of the original forest cover intact (Flint 1994) (Fig. 1.4).

The island nation of Singapore was an exception, with only 30% of its forest intact at that time, because as early as the late nineteenth century, it supported a relatively high population density (2 persons/ha) and was a well developed international trading centre of the British Empire (Saw 1970). However, even Singapore was almost totally covered by rain forest in 1819, yet now less than 1% remains (Turner *et al.* 1994). Although Singapore represents an apex of forest loss and urbanisation in the region, other countries are moving in the same direction. Between 1961 and 1991, forest cover declined from 53% to 27% in Thailand (Ruangpanit 1995) (Fig. 1.5), and in the Philippines, forest cover has been reduced by 55% since 1948 (Kummer & Turner 1994).

Perhaps most dramatically, it has been estimated that by 2010, human actions will cause the near complete destruction of native lowland forests

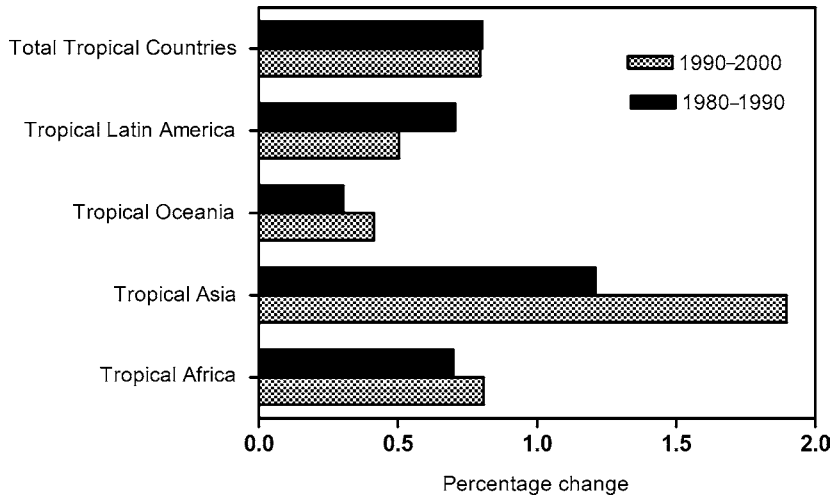

Figure 1.3 Worsening deforestation rates in all tropical regions except Latin America. (Data from Matthews 2001.)

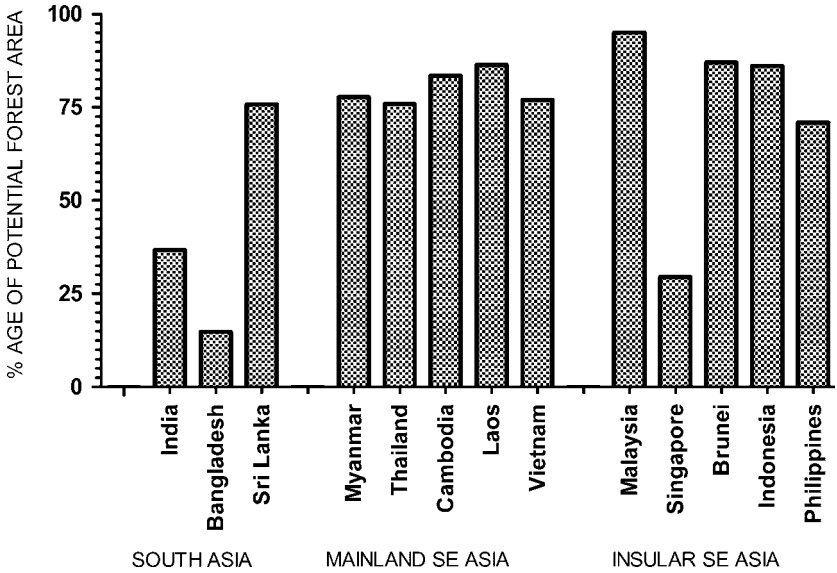

Figure 1.4 Percentage of potential forest area within each South and Southeast Asian nation that was still occupied in 1880 by forest. (Modified from Flint 1994. With permission from Elsevier.)

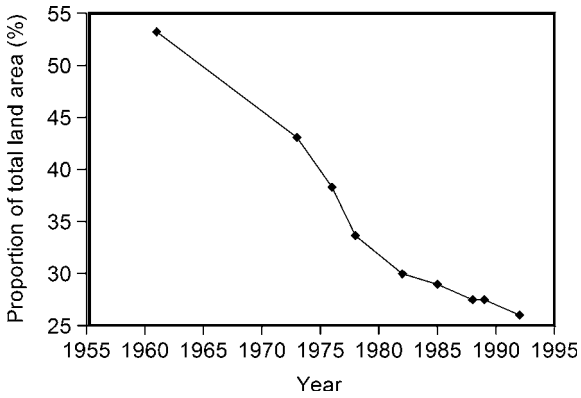

Figure 1.5 Periodic change in forest area in Thailand from 1961 to 1991. (Data from Ruangpanit 1995.)

(<1000 m elevation) from the hyper-biodiverse regions of Sumatra and Kalimantan (Jepson *et al.* 2001). Such a massive loss of habitat will almost certainly have profound knock-on effects for the region's spectacular megafauna, such as the Sumatran rhinoceros (*Dicerorhinus sumatrensis*), Sumatran tiger (*Panthera tigris sumatrae*) and Asian elephant (*Elephas maximus*).

Vietnam is the only country in the region with a net annual increase in forest cover. Establishment of plantations helps offset annual losses of natural forest cover in Vietnam of the order of 30 000 per ha year^{-1} (http://www.fao.org/DOCREP/004/Y1997E/y1997e0t.htm#bm29). According to the World Resource Institute (WRI) estimates (WRI 2003), annual deforestation rates vary between 0 (Singapore) and 2.9% (Thailand) (see Table 1.1), and the various countries in Southeast Asia currently retain between 0.3% (Singapore) and 65.5% (Cambodia) of their original forests. Although the lowest estimates of remaining forest cover were identical for both WRI and FAO, the latter organisation reported the highest forest cover to be remaining in the tiny nation of Brunei (83.3%; Table 1.1), located in northern Borneo. Differences in definitions and methods appear to have led to the differences between the two data sets.

The lowland rain forests of Southeast Asia are particularly imperiled due to their high accessibility to humans, and are increasingly being converted to logging concessions, agricultural land and urban areas (Kummer & Turner 1994). In addition to this wide-spread forest type, other rain forest types are by no means being spared. For example, montane/submontane rain (cloud) forests (usually >1000 m elevation) provide timber, fuel-wood, soil and watershed protection. There is about 50 million ha of montane forest worldwide, and it is currently being cleared at an average rate of twice the global deforestation rate

Table 1.1. *Summary information on forestry and biodiversity in Southeast Asia, showing land area, original and current forest area, and change in forest area*

Country	Land area (ha)	Original forest area (ha) (% land area)	Current natural forest area (000 ha) (% original forest area)		Mean annual % change in forest area 1990–2000	
			WCMC	FAO	'Natural forest' – WRI	'Total forest' – FAO
Myanmar	65755	65755 (100)	33519 (51.0)	33598 (51.1)	– 1.5	– 1.4
Laos	23080	23057 (99.9)	4495 (19.5)	12507 (54.2)	– 0.5	– 0.4
Vietnam	32550	32452 (99.7)	5015 (15.5)	8108 (25.0)	– 0.3	0.5
Thailand	51089	51089 (100)	17107 (33.5)	9842 (19.3)	– 2.9	– 0.7
Cambodia	17652	17652 (100)	11562 (65.5)	9245 (52.4)	– 0.6	– 0.6
Malaysia	32855	32691 (99.5)	13452 (41.1)	17543 (53.7)	– 1.4	– 1.2
Singapore	54	54 (100)	0.2 (0.3)	0.2 (0.3)	0	0
Indonesia	181157	181157 (100)	91134 (50.3)	95116 (52.5)	– 1.5	– 1.2
Brunei	527	527 (100)	267 (50.7)	439 (83.3)	– 0.3	– 0.2
Philippines	29817	28416 (95.3)	2405 (8.5)	5036 (17.7)	– 2.1	– 1.4
Total	434536	432850 (99.6)	178956 (41.3)	191434.2 (44.2)	– 1.4	– 1.0

Data taken from FAO, United Nations Environment Programme, World Conservation Monitoring Centre (WCMC) and World Resources Institute (WRI). (Reprinted from Sodhi *et al.* 2004b. With permission from Elsevier.)

(Long 1994; IUCN 2000). Because of their unique environmental conditions (e.g. low humidity, cooler temperatures), montane forests support a high degree of endemism. For example, the proportion of endemic moths is reported to be at least twice as high in montane forests than in their lowland counterparts in Sarawak (Lanjak-Entimau) (Chey 2000). Montane forests also have a low recovery potential following disturbance (Ohsawa 1995). Yet despite their fragility and high endemism, human activities continue to threaten these vulnerable forests (Ohsawa 1995; IUCN 2000).

Some 85% of global forest loss occurs in the tropical rain forests (Whitmore 1997). However, Southeast Asia also contains seasonal deciduous forests. These generally lie below 1000 m elevation in certain countries such as Thailand (Ruangpanit 1995), and constitute only 7% of the existing forests in Asia. Due to their close proximity to humans, seasonal forests also suffer from a similar predicament as lowland rain forests in Southeast Asia. In fact, seasonal forests are often pooled for convenience with rain forests, and are thus included in some of the regional deforestation calculations (Achard *et al.* 2002). It is estimated that the seasonal forests, on their own, are being lost at the rate of 1.4% per year (Whitmore 1997).

Table 1.2. *Estimates of mangrove area and area loss for selected countries in Southeast Asia*

Country	Mangrove area (km^2)	Approximate % lost	Period covered
Brunei	171	29	Original extent to 1986
Cambodia	851	—	—
Indonesia	42 550	55	Original extent to 1980s
Malaysia	6424	74	Original extent to 1992–3
Myanmar	3786	75	Original extent to 1992–3
Philippines	1607	67	1918 to 1987–88
Singapore	6	—	—
Thailand	2641	84	Original extent to 1993
Vietnam	2525	37	Original extent to 1993

Adeel & Pomeroy (2002). Copyright Springer-Verlag.

Mangrove forests represent another unique tropical ecosystem. Mangroves are juxtaposed between land and sea and are found within 25° north and south of the equator, and Southeast Asia supports 40% of the world's total mangrove cover (Sasekumar *et al.* 1994). In addition to over-harvesting, mangroves face threats from other factors such as pollution, silting, coastal development, aquaculture development, and boating and shipping (Adeel & Pomeroy 2002). Traditionally, mangroves have been undervalued and largely considered to be useless swamps or wasteland (Liow 2000; Adeel & Pomeroy 2002). However, as with other forest types, mangroves have both biodiversity and utilitarian values. The presence of mangroves may enhance fish, shrimp and prawn catch (Baran & Hambrey 1998). It is estimated that fisheries related annual income from 1 ha of mangrove can range from US$66 to almost US$3000 (Baran & Hambrey 1998). Although this estimate may be inflated as it does not include fisheries yield exclusively reliant on mangroves, it does show that livelihoods do depend on this habitat type. Because of their other benefits (e.g. ecosystem services needed for the maintenance of offshore fisheries), conversion of mangroves for aquaculture actually generate around 70% less revenue from the overall system than if they had been left in a pristine state (Balmford *et al.* 2002). Despite their environmental and economic benefits, mangroves are currently being lost at a rate of 2–8% per year, with between 29 and 84% loss of the original mangrove cover in Southeast Asian countries (Adeel & Pomeroy 2002) (Table 1.2).

Singapore epitomises mangrove destruction and conversion in Southeast Asia, supporting 6334 ha (63% of original mangrove forest cover) in 1953, but only 6.5% by 1993 (Hilton & Manning 1995), and a further projected reduction to 4% by 2030 (Fig. 1.6). The primary driver of this massive loss

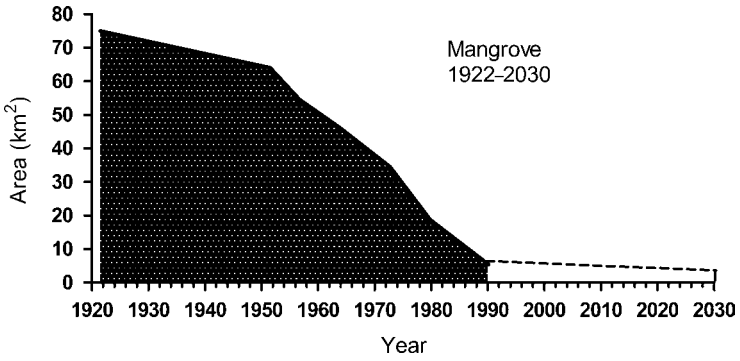

Figure 1.6 Change in area of mangrove forest in Singapore, with estimates for the year 2030. (Reprinted from Hilton & Manning 1995. With permission from Cambridge University Press.)

of mangrove forests in Singapore has been coastal developments associated with urban expansion and industrialisation (Hilton & Manning 1995). The mangrove loss in Singapore has certainly resulted in biotic losses. For example, at least four mangrove plant species (e.g. *Barringtonia conoidea*) have been extirpated from the island (Liow 2000).

The pathology of habitat loss

Direct causes of deforestation (and loss of other habitats) are many, including slash and burn clearing, selective logging, cattle ranching, plantations, agriculture, fuel-wood collection and transmigration. These drivers can act singly or in concert. In Asia, the main proximate drivers of deforestation are agriculture, followed by wood extraction and infrastructure expansion (Geist & Lambin 2002). The precise underpinnings of these causes of deforestation are complex, however. For instance, some governments have little choice but to sell forests as logging concessions to alleviate foreign debt (Bawa & Dayanandan 1997). Below we discuss in some detail the various drivers of habitat loss in the Southeast Asian region.

Human population pressure

Resource consumption by humans shows no sign of abating. Rapid economic development, population expansion and poverty are key drivers of land conversion (Giri *et al.* 2003). In the century from 1880 to 1980, the human population of Southeast Asia has increased from 0.1 to 0.8 person/ha

(Flint 1994). Within the next 100 years, it is likely that as many as 11 billion people will inhabit the planet, a number that will be difficult to sustain (Palmer *et al.* 2004). Urbanisation will greatly expand in the future, with expectations that more than half of the world's total human population will be living in cities by 2030 (Palmer *et al.* 2004). Expanding human population and specifically its actions (e.g. land conversion), exerts pressure on the native biodiversity (Cardillo *et al.* 2004).

It would be immeasurably informative, from both a scientific and management perspective, if we could hypothetically excise a representative Southeast Asian country, allow it to fulfil its economic potential, and document the consequent losses of natural habitats and biodiversity, all within a greatly accelerated time frame. It is perhaps both depressing and fortunate that Singapore is exactly such an ecological worst case scenario for Southeast Asia. Singapore has experienced an exponential population growth from around 150 subsistence-economy villagers around 1819 to 4 million people in 2001 (Corlett 1992; WorldBank 2003). In particular, Singapore has transformed itself from a third world country of squatters and slums to a first world metropolis of economic prosperity within the past few decades, and has thus been widely regarded by the regional developing countries as the ideal economic model. However, the success of Singapore came with a hefty price, one that was unfortunately paid for most heavily by its biodiversity (see Chapter 3 for a detailed analysis). The island has suffered massive deforestation, initially from the cultivation of short-term cash crops (e.g. gambier: *Uncaria gambir*, rubber: *Hevea brasiliensis*), and subsequently from urbanisation and industrialisation (Corlett 1992). Similar environmental scenarios are already unfolding in other Southeast Asian countries (Jepson *et al.* 2001). As the human population of Southeast Asia continues to grow, enormous pressures will be placed upon its natural resources (WorldBank 2003). The current trend in Southeast Asia suggests that forest loss is likely to increase in step with both human population density and economic expansion (Fig. 1.7). The point to note, however, is that population pressure represents only one of the factors in habitat loss, even with the relatively low populated areas of Southeast Asia, there is a widespread loss of natural forests (Whitmore 1997).

Burgeoning human population means more mouths to feed. Agriculture is the main factor in land conversion in the tropics, with an estimated contribution to annual tropical forest losses of as high as 90% (Hardter *et al.* 1997; Achard *et al.* 2002). In Asia, 100 million ha of land was converted for cropland between 1880 and 1980. Over these 100 years, the area of land converted for agriculture increased by four-fold in Southeast Asia (Flint

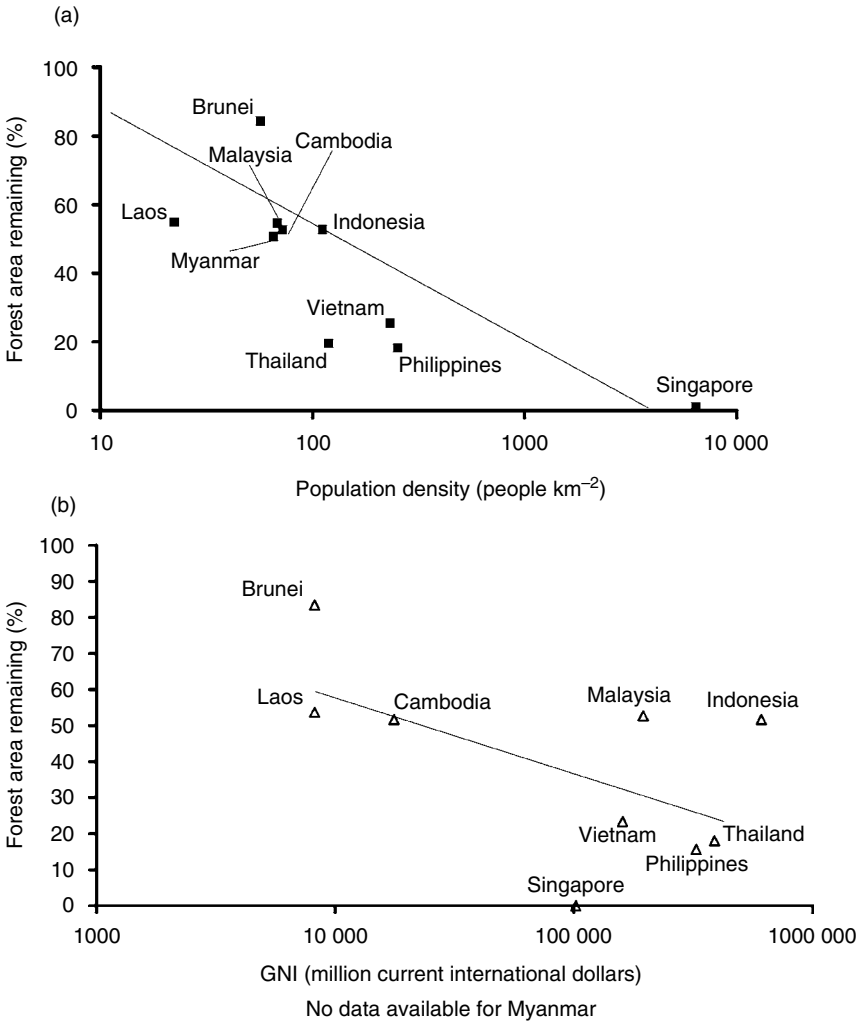

Figure 1.7 Socioeconomic correlates of forest loss. The proportion of forest area remaining in Southeast Asian countries correlated with (a) Population density ($r = -0.78$, $p = 0.008$) and (b) Gross National Income (GNI) at current international dollars ($r = -0.57$, $p = 0.111$) in 2000. GNI of Brunei was taken in 1998. (Reprinted from Sodhi *et al*. 2004b. With permission from Elsevier.)