

Evidence-based Conservation

Lessons from the Lower Mekong

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21 Quantifying threats to forests in the Lower Mekong and assessing responses

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One of the greatest challenges to protecting biodiversity in conservation areas is to reduce environmental and social threats. Typical threats to tropical forest environments include deforestation, unsustainable exploitation of forest resources, pollution and the spread of invasive species (Spangenberg, 2007). Conservation action requires clear perceptions of threats and effective ways of responding to them (Pressey and Bottrill, 2008). The identification and management of threats in conservation projects is, however, still weak (Hughes and Flintan, 2001; Pressey and Bottrill, 2008). There have been calls in the conservation literature to systematically compare threats and conservation actions to advance the understanding of the links between the human and natural world, particularly the protection of biodiversity (Salafsky and Margoluis, 1999; Margules and Pressey, 2000; Pressey and Bottrill, 2008; Sunderland *et al.*, 2008).

Currently, no standardized method exists for the assessment of threats and actions. Salafsky and Margoluis (1999) suggested a framework to clarify the assessment of threats to biodiversity and projects, which is useful for evaluating individual projects, but falls short of comparing between different projects and areas. Expanding this to apply a comparison across sites, Salafsky and Margoluis (1999) called for a standardized catalogue of threats and conservation actions, currently being developed by the Conservation Measures Partnership and IUCN Species Survival Commission (Salafsky *et al.*, 2008). This system is still under development (Balmford *et al.*, 2009), and other research groups are also developing methods (see, for example: Robichaud *et al.*, 2001; Ervin, 2003; Jarvis *et al.*, 2010; Matar and Anthony, 2010). There remains a need to advance conservation planning and implementation through clarifying the links between threats and the concomitant conservation actions to address them and comparing these across multiple sites (Salafsky and Margoluis, 1999; Margules and Pressey, 2000; Pressey and Bottrill, 2008; Sunderland *et al.*, 2008).

In this chapter we systematically explore threats and conservation actions among fifteen sites in three Lower Mekong countries: Cambodia, Laos and

Vietnam. Lacerda *et al.* (2004) and Chanrithy (2010) found that the most severe threats to the protected areas in Cambodia were agriculture encroachment and overexploitation (wildlife poaching, logging and fishing). These were countered by a variety of management interventions, including community livelihood development, species conservation activities and law enforcement (Chanrithy, 2010). Robichaud *et al.* (2001) reported that the greatest threats in Laos were subsistence agriculture and hunting (for subsistence and trade), which were primarily countered through integrated conservation and development approaches.

In this chapter we broaden the scope of previous explorations of threats and conservation actions. The primary aims are to systematically explore threats to biodiversity in the fifteen forest conservation areas and how conservation interventions, operated by government and non-government organizations, are implementing different practices to militate against the threats. We also compare the threats among the three countries and explore whether threats are mainly from internal (threats from people living in settlements within the conservation areas or adjacent buffer zones) or external sources (such as threats posed by national logging companies or international mining concessions). We first discuss several factors that contribute to the threats to forest areas. We then describe the methods used to collect and analyse a set of variables to examine threats and strategies and to compare fifteen forest conservation landscapes of the Lower Mekong.

History and current situation of threats to forests in the Lower Mekong

The Lower Mekong sub-region is one of twenty-five global biodiversity hot spots, of importance for biodiversity conservation (Myers *et al.*, 2000). Protected area coverage has increased over the past two decades in the Lower Mekong, and in 2003, there were over 100 biodiversity conservation areas greater than 10,000 hectares within these three countries (ICEM, 2003c). However, despite this, populations of large mammal species in particular have continued to decline as a result of subsistence hunting and wildlife trade (Traffic, 2008), and previously forested habitats continue to be reduced or degraded (Hirsch, 1999; ICEM, 2003a; Meyfroidt and Lambin, 2008).

The decline in wildlife and habitats are due to several factors stemming from civil conflict, the following periods of reconstruction and development, and an increase in the demand for forest resources. The historical conflicts in the Lower Mekong sub-region had a major influence on biodiversity in protected areas. In Vietnam, during the Vietnam–America war from 1955 to 1975, the management of protected areas received little support, the conflicts degraded forests (such as by the use of the defoliant Agent Orange) and increased the demand for timber (Rambaldi *et al.*, 2001). In Cambodia, during the 1970s and 1980s, civil conflict caused forest degradation and animal species population decline (ICEM, 2003b; Kim *et al.*, 2005). While central Laos was affected by

defoliants and bombing in the Vietnam–America War (Robichaud *et al.*, 2001), the relative geographic and political isolation of the country has, until recently, sheltered the country from external biodiversity pressures (Bugna, 2002b). This has changed during the past twenty years, environmental costs have increased as Laos has opened up to international markets and expanded its economy (Bugna, 2002a; Greenwood, 2008).

However destructive wartime was to forests of the Lower Mekong, it was the following periods of reconstruction and development that had more impact on forests (Phat *et al.*, 1998; De Koninck, 1999). Demand for raw materials, crops and energy have influenced government strategies to expand the economy of the region, through building of roads and hydropower dams, and agriculture and mining developments (Lacerda *et al.*, 2004; IUCN, 2007). Large areas in the Lower Mekong countries were converted from forest to areas for sedentary agriculture during the 1980s and 1990s (Lamb and Gilmour, 2003), and agricultural expansion continues to be a significant factor in deforestation (De Koninck, 1999). Energy requirements were traditionally met through gathering of fuel wood, itself a threat, but hydropower is now the most abundant and increasing energy source in the region, often developed in the vicinity of protected forests (Alyward and Tognetti, 2003). The construction of roads associated with major infrastructure developments opens up the forest areas, exposing them to intensified threats of logging, hunting, land-grabbing and further agriculture encroachment (Lacerda *et al.*, 2004; IUCN, 2007; Traffic, 2008).

Recent research suggests that the current main threats to biodiversity in the Lower Mekong countries are: over-exploitation of resources, particularly from hunting, logging and collection of NTFPs; deforestation from agriculture and infrastructure development, including the establishment of dams, mines and roads; and degrading processes of fire, over-grazing of livestock and invasive plant and animal species (Robichaud *et al.*, 2001; Lamb and Gilmour, 2003; Lacerda *et al.*, 2004; Polet and Ling, 2004; World Bank, 2005; IUCN, 2007; Traffic, 2008; Robichaud *et al.*, 2009; Chanrithy, 2010). The over-exploitation of resources is often driven by the high demand for timber and wildlife in the region, and globally (Lacerda *et al.*, 2004; IUCN, 2007; Nijman, 2010). Illegal logging and wildlife trade are highly profitable, largely unsustainable and entwined in an informal and corrupt political economy, allegedly dominated by highly ranked government officials (Global Witness, 2004; Ingles and Hicks, 2004; Sunderlin, 2006; Global Witness, 2007; EIA and Telapak, 2008; To and Sikor, 2008; Traffic, 2008). The demand for products is driven partly by the increased spending power of South-East Asian citizens as a result of recent economic development in the region, especially in China (EIA and Telapak, 2008; Traffic, 2008).

At the local level, the activities of human populations living adjacent to forest areas and local changes in land-use patterns threaten forest areas (De Koninck, 1999; Carew-Reid, 2003; World Bank, 2005). Residents who live within and around forest areas in the three countries, including indigenous minority groups

and national majority groups, rely to a large extent on forest resources, including for food, fuel, construction materials, medicines and cash income (Foppes and Ketphanh, 2000; Robichaud *et al.*, 2001; Alyward and Tognetti, 2003; ICEM 2003c; Ingles and Hicks, 2004; Sunderlin and Ba, 2005; Bourdier, 2008). Unfortunately for biodiversity conservation, many local activities, particularly hunting, logging, NTFP collection, livestock grazing and fire, not only are damaging to forests but are continuing at an unsustainable rate (Lamb and Gilmour, 2003; Ingles and Hicks, 2004). Nevertheless, traditional agricultural practices and forest product collection activities of minority groups are less damaging than activities carried out by national commercial interests and migrants to forest areas seeking land-based economic activities (De Koninck, 1999; Robichaud *et al.*, 2001, 2009).

Threats to forests have been further exacerbated by the weakness of the rules and regulations at local or national levels, corruption of government officials and weak law enforcement at protected areas. These issues arise because of a lack of financial and human resources and technical capacity, often mentioned as issues in the forest sectors of the three countries, and especially in the regulation of wildlife and illegal timber trade (Fujita, 2004; Lacerda *et al.*, 2004; Sunderlin, 2006; EIA and Telapak, 2008; To and Sikor, 2008; Traffic, 2008). Due to the lack of transparent and effective governance and management, the control of forest resources by the managers of conservation areas is a continuing challenge. These weaknesses affect both the effectiveness of biodiversity conservation and the livelihoods of local residents who depend on forest resources (Davis, 2005; Sunderlin, 2006).

These multiple threats to biodiversity are managed through different modes, via different organizations and at multiple scales. One mode of management is to target the direct instrumental causes of threats (Hirsch, 1999), through enforcement or provision of incentives to those responsible for the environmentally damaging activities. Another mode is to target the less direct structural drivers, such as improvement of land-tenure and poverty alleviation (Hirsch, 1999). Non-government organizations and donors play an important role in pressuring governments to improve their management practices to conserve biodiversity and improve local livelihoods (Global Witness, 2004; Davis, 2005; To and Sikor, 2008).

Methods

A quantitative analysis of a set of variables was used to compare and explore the relationship between threats, influences and management in the fifteen selected forest conservation landscapes.

The analyses were performed on a subset of the variables; only those that are related to threats were included. While many threats have an impact on protected forest areas in the Lower Mekong, workshop participants identified ten threats as the most important threats to most forest areas. The ten direct threats selected for analysis were: hunting, logging, invasive species, fire, pollution, dams,

mining, infrastructure development, agriculture encroachment and land grabbing. The magnitude of their potential to affect species and habitats was measured on a scale of 0 (little, if any, future threat) to 4 (likely to severely damage populations of species and habitats in the near future). Two classifiers were included to indicate the source of the actors involved in hunting and logging – whether from local people, people from outside the conservation area, or both. Variables covering sites' physical environment, demographics, economy, livelihoods and project activities were used in the analysis to explore the factors related to these threats. In a similar way to threats, the workshop participants identified the actions they undertake to address the identified threats. These were: research, education and training, local economic support, health support and infrastructure development, tourism, land-use planning, institutional development, law enforcement, conservation payments and any other conservation activities (which includes such things as habitat restoration, wildlife rehabilitation, boundary demarcation and monitoring of biodiversity). Analysis of the variables was conducted step-wise, analysing individual variables first, then bivariate correlations and finally principal components analysis (PCA).

Alongside the quantitative analysis, we illustrate the threats to forest conservation areas by reporting qualitative results from individual sites. Qualitative information, collected for all fifteen sites, mainly relied on secondary information from a review of the peer-reviewed literature, “grey” literature and project documentation, but was supported by over a hundred semi-structured interviews and discussions with key informants during visits to the project offices and field sites. Informants included project managers, project staff, forest guards, local people (including village chiefs, farmers and traders), government officials and staff from other NGOs in the area. When possible, direct observations were made of the local land use, forest quality and obvious threats to the area.

Results

Human and environment context

In order to understand the similarities and differences in threats in each country and site, which we discuss below, it is important to understand the broad human and environmental context. The major differences between sites in each country are the size of conserved area, forest quality, buffer-to-core ratio and population density. The Vietnamese sites are characterized by small core zones, with comparatively low forest quality, and large buffer zones, with comparatively higher population density. The Cambodian sites have larger core zones, with higher forest quality, and relatively smaller buffers, with very low population densities. Laos is in between these two extremes, with medium forest quality (but an outlier, the BCI site, has very poor forest quality), large core zones, medium buffer zones and low population density. While these

Table 21.1 Site characteristics by country, with standard error

Country	Area of core zone (10 ³ ha)	Area of buffer zone (10 ³ ha)	Buffer to core ratio ^a	Buffer zone population density (people per km ²)	Forest quality index ^b
Vietnam	48 ± 13	96 ± 43	1.7 ± 0.5	161 ± 46	-0.09 ± 0.10
Cambodia	295 ± 40	152 ± 46	0.5 ± 0.2	18 ± 9	0.20 ± 0.06
Laos	191 ± 73	137 ± 45	1.2 ± 0.4	30 ± 16	-0.02 ± 0.05 ^c

Notes:

a Above “1” – larger buffer zone than core zone; below “1” – larger core zone than buffer zone.

b Created by PCA of variables: forest integrity, forest fragmentation, proportion of high quality forest and buffer-to-core forest transition.

c The BCI site was removed from this calculation, as it was an outlier with a value of -0.66.

characteristics are not in themselves explanatory, they help contextualize the threats in each area.

Threats to forest conservation areas

The primary threats to biodiversity in all fifteen sites are hunting and logging. In some sites, such as Mondulkiri Protected Forest and Van Ban Nature Reserve, local residents traditionally hunt for food, but in other sites, such as in Seima Biodiversity Conservation Area and Cat Tien National Park, local residents and outsiders (such as people from other provinces) also hunt for the purposes of wildlife trade. Hunters target a variety of animals, including pigs, deer, pangolins and tigers. The source of hunting varies among the sites: hunting is predominantly conducted by local hunters in seven sites, by outsiders in three sites, and by both local people and outsiders in five sites.

Illegal logging is a threat to all sites, but is considered a severe threat (score of 3 or more) in three sites. Interview results suggest that the reason for logging is the flourishing trade in high-quality timber, often by organized groups who selectively cut trees and transport the logs out of the forest via isolated tracks. As with hunting, the source of logging varies among sites: it is predominantly conducted by local loggers in seven sites, by outsiders in three sites and by both local people and outsiders in five sites. For illustration, in Phnom Samkos Wildlife Sanctuary (PSWS) in Cambodia, logging is a severe threat (score of 3), conducted by teams of local people and outsiders. The roots of one species of tree, *mreah prov* (*Cinnamomum parthenoxylon*), are processed in kilns in the forest to extract oil used to make the psychoactive drug MDMA (3,4-methylenedioxymethamphetamine), otherwise known as ecstasy. In Nakai Nam Theun in Laos, logging of rosewood (*Dalbergia* sp.), a valuable timber species for making high-quality furniture, has increased in recent years.

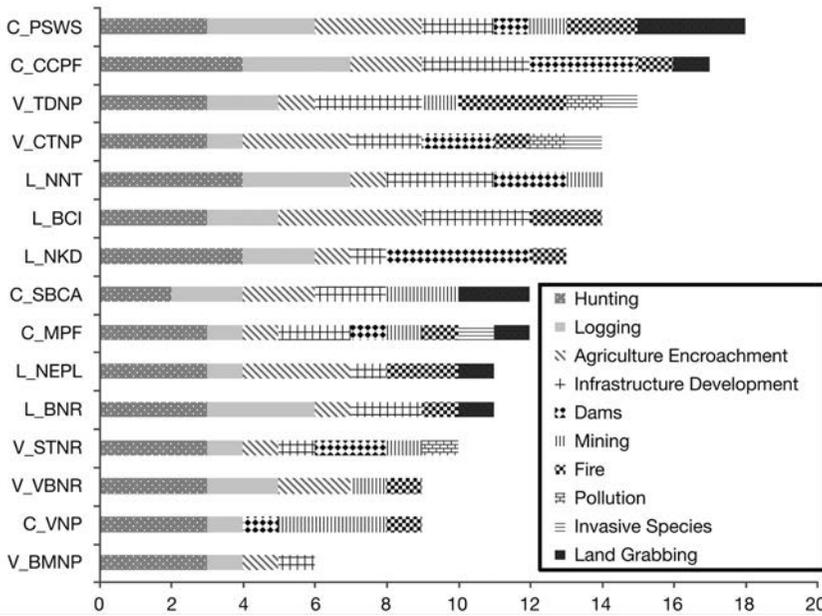


Figure 21.1 Sum of ten threats by site

Notes: Each threat is scored on a scale of 0 (no threat) to 4 (likely to be highly damaging to forests and wildlife populations in the near future).

Infrastructure development in this analysis includes building of roads and buildings, but not mines or dams. Acronyms: BCI – Biodiversity Corridors Initiative (specifically refers to the corridor between Dong Hoa Sao and Xe Pian National Protected Areas); BMNP – Bach Ma National Park; BNR – Bokeo Nature Reserve; C (prefix) – Cambodia; CCPF – Central Cardamom Protected Forest; CTNP – Cat Tien National Park; L (prefix) – Laos; MPF – Mondulkiri Protected Forest; NEPL – Nam Et-Phou Louey National Protected Area; NKD – Nam Kading National Protected Area; NNT – Nakai-Nam Theun National Protected Area; PSWS – Phnom Samkos Wildlife Sanctuary; SBCA – Seima Biodiversity Conservation Area; STNR – Song Thanh Nature Reserve; TDNP – Tam Dao National Park; V (prefix) – Vietnam; VBNR – Van Ban Nature Reserve; VNP – Virachey National Park.

Agricultural encroachment and infrastructure development also threaten most sites. In PSWS, the current land use by local people is centred on agriculture. Rapid in-migration has increased the threats to the forest as more land is cleared for settlement and cultivation. In the BCI site, deforestation in the corridor is caused partly by agriculture encroachment and the establishment of rubber plantations. In Van Ban Nature Reserve, cash incomes are derived mainly from forest resources, particularly the cultivation of cardamom, which requires clearing the undergrowth of the forest for shade.

Infrastructure development, including construction of roads and buildings (but not including mines and dams, which are reported separately below), is the greatest threat to some of the conservation areas. For example, in PSWS, the

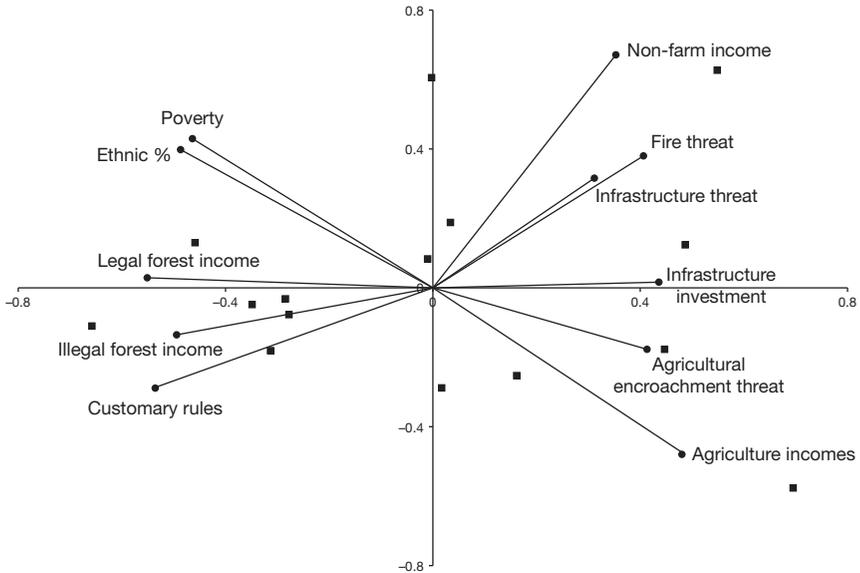


Figure 21.2 Principal components analysis of socio-economic factors and threats of fire, infrastructure and agriculture encroachment

Note: “Customary rules” indicates the presence of customary rules of local residents; “Ethnic %” is the percentage of surrounding population consisting of national minorities. Data points represent the sites. Variance explained: x-axis = 47%; y-axis = 17%.

migration of people from other provinces has increased the amount of land cleared for infrastructure development and agriculture. In the BCI site, infrastructure development has recently been a key factor in changing the land-use patterns of the area. The site is also part of the Greater Mekong Subregion east–west economic corridor, which includes a road that bisects the corridor.

A detailed analysis of three key threats – agricultural encroachment, infrastructure development, and fire (which, if uncontrolled, affects the degradation of forests and potentially changes the assemblage of species) – showed relationships among the socio-economic condition and forest reliance of local people. There is a greater magnitude of these threats in areas where the livelihoods of local people are based on non-farm and agricultural activities, rather than forest products, and in areas with more infrastructure investment by government and industry. Fewer threats occur in areas where there is a higher level of poverty, more minority groups, more customary rules and where local people gain much of their incomes from forest resources.

Dams and mining are two other forms of infrastructure development that threaten the conservation areas. Hydropower dams are currently established in four sites, but future dams were identified as threats in eight of the fifteen sites. Development of all of the major hydropower dams is decided by national government, in close consultation with the hydropower industry. For example,

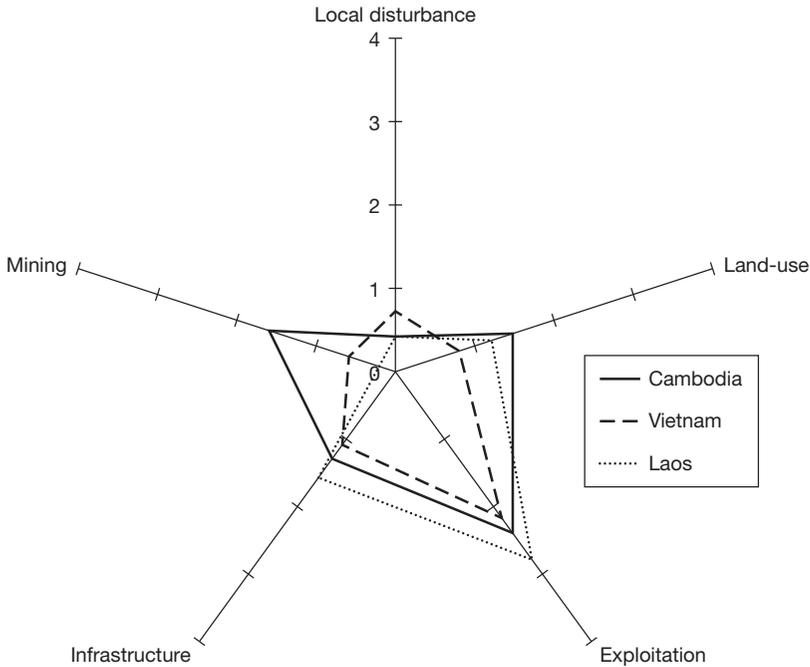


Figure 21.3 Typology of threats by country, based on similar causes

Notes: Measurement was scored on a scale of 0 (no threat) to 4 (likely to be highly damaging to forests and wildlife populations in the near future). Categories are an average of the following threats: local disturbance = fire, pollution and invasive species; land use = agriculture encroachment and land grabbing; exploitation = logging and hunting; infrastructure = dams and infrastructure development; mining.

a Chinese investment company is establishing a hydropower dam that borders PSWS and the adjacent Central Cardamom Protected Forest, which requires connecting roads and transmission lines.

Mining is a threat in eight sites and is most evident in Cambodia. While much of the mining activity is characterized by illegal artisanal mining, the approval of larger mining activity is influenced by pressure from large companies or governments, with little consultation with local people or between different ministries. In Van Ban Nature Reserve, a gold mine has been established on the edge of the nature reserve by a government-approved company; it pollutes the waterways and land near the core zone. A mine is also being established in part of the core of PSWS, authorized by the Ministry of Industry, Mines and Energy. Areas such as Song Thanh Nature Reserve, however, are threatened by mining at a more local level, where small-scale mining operations, mainly gold panning, are conducted by local people or outsiders.

The magnitude and type of threats are also country-specific. Figure 21.4 represents a typology of all ten threats based on related causal factors. Cambodia and Laos sites face more threats from infrastructure development than does

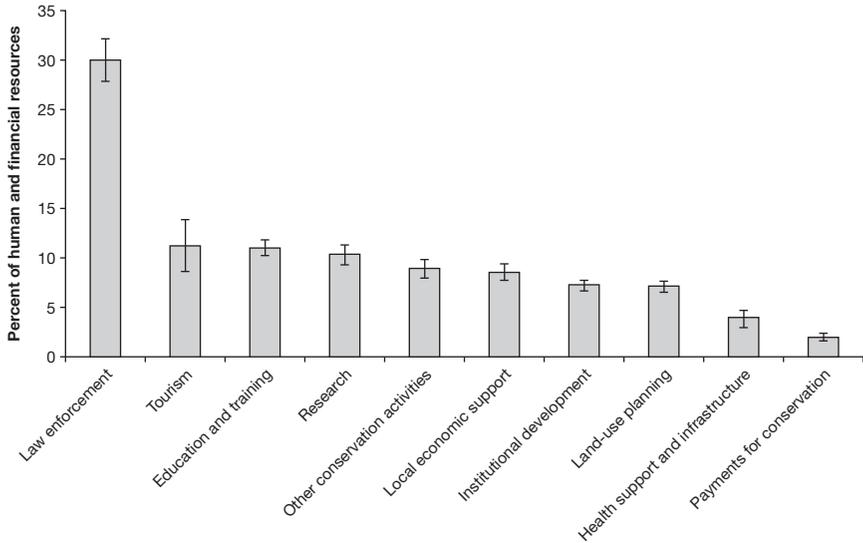


Figure 21.4 Conservation management interventions in 2007 across the fifteen forest conservation areas, grouped into ten main categories

Note: Bars represent mean percentage of expenditure of resources across the fifteen sites (\pm standard error).

Vietnam. Nevertheless, Vietnam is threatened more by local disturbance from chemical pollution, fire and invasive species. Land-use threats (agriculture encroachment and land-grabbing – where local people and/or temporary migrants clear forest to sell to wealthier people from other provinces, which is very difficult for local authorities to control) are highest in Cambodia, less high in Laos and lowest in Vietnam.

The management responses to threats

Across all sites, the largest investment by management interventions to reduce threats was in law enforcement (30 per cent) followed by education and training and research (Figure 21.5). Other threat reduction activities include local economic support, health support and infrastructure development, land-use planning and institutional development (of regulations, policies and laws). Tourism, while second only to law enforcement, is not a threat reduction activity in itself, but it is a significant part of the investment of conservation organizations.

While these ten categories of management intervention can be delineated, in practice management efforts usually involve working on several activities at once to reduce multiple threats. For example, most law enforcement is conducted by government officials, but in ten areas local people are also employed to undertake village-led patrols and inform the authorities about illegal activities

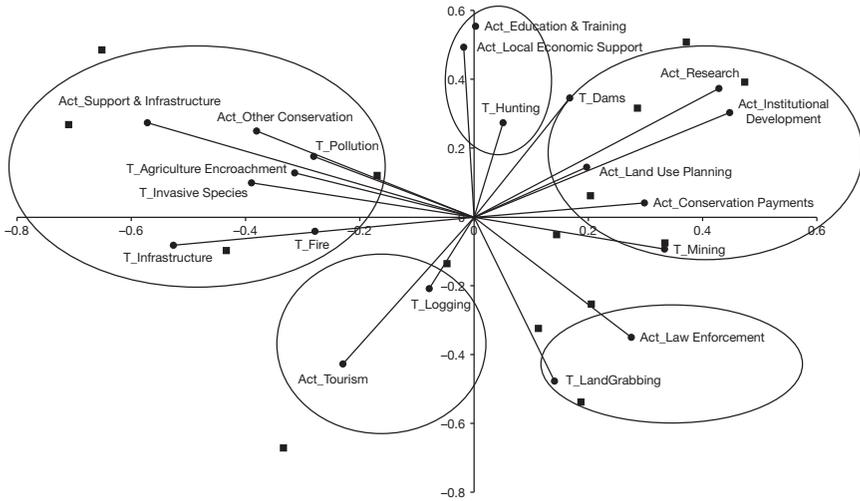


Figure 21.5 Principal component analysis of the relationships between conservation intervention activities (Act) and threats (T)

Notes: Data points represent the sites; groups of threats and activities are bound by ovals. Variance explained: x-axis = 19%; y-axis = 16%.

(which is part of the “conservation payments” strategy). Law enforcement is also supported by the development of institutions at local and national levels. Regulations made at the level of individual villages or entire conservation areas are used as tools to reduce over-exploitation from hunting, logging and NTFP extraction. In areas such as the BCI site and Van Ban Nature Reserve, the management boards set up the regulations by involving local people in the planning processes and in the management of the forest areas. Conservation area managers also conduct land-use planning for villages in or bordering conservation areas, by mapping and zoning forest areas for local people’s use, with the intention of reducing agricultural expansion into forests.

Training of local people and government officials in environmental education is conducted at all fifteen sites, often through multiple development projects, and represents a substantial portion of investment in conservation interventions (an average of over 10 per cent – Figure 21.5). Training and awareness activities for national-level actors, such as staff of government departments and industries, are used to build their technical capacity and understanding of conservation. The aims of environmental education at the local level generally are to improve local people’s awareness and understanding of conservation and the benefits of environmental services, and to improve technical capacity for environmental management. Thus environmental education at the local level is used mainly to reduce the threats from local resource extraction, such as NTFP exploitation, hunting and, to a smaller extent, logging. Furthermore, several conservation organizations use the national media, including newspapers, radio

and television, to improve the awareness of conservation in the wider community, as an attempt to reduce the demand for forest resources and hence drivers of some threats.

Local economic support is centred around natural resource use, by intensifying agriculture, providing training for agricultural techniques and developing the markets for non-timber forest products (such as honey and resin) by setting up community associations. For example, the BCI spends a large amount of effort (approximately 38 per cent) in development-related activities, which has a primary focus on natural resource management through training, agriculture and NTFP development, and improvement of infrastructure for schools, clinics and roads.

Many conservation area managers conduct institutional building, which involves the reform of existing regulations, decrees and laws or the development of new ones, at both local and national levels. Developing institutions and implementing management plans can help to reduce threats of land-grabbing, invasive species and pollution. Conservation organizations attempt to reduce the impact of large-scale infrastructure, including mines, hydropower dams and roads, by lobbying government and industry. In Phnom Samkos Wildlife Sanctuary, for example, multi-sectoral collaborations, in which the management board collaborates with multiple government authorities and international conservation organizations, have been conducted to develop regulations and enhance the efficiency of the judicial system to target the most serious threats. In Van Ban Nature Reserve, however, a series of locality-specific regulations have been set up to control degrading activities and unsustainable exploitation of wildlife and timber. Villagers developed these regulations over several years with the assistance of the nature reserve managers.

Linking threats with management

Quantitative analysis using PCA shows that many of the activities are correlated with the magnitude of threats (Figure 21.5), although the total variance explained by this graph is relatively low, at only 35 per cent. One of the clearer patterns is on the x-axis. There is a positive relationship among the activities “support and infrastructure development” and “other conservation activities” (which includes practices such as forest rehabilitation and management, support for sustainable resource use, biodiversity monitoring and boundary demarcation) with the threats of pollution, agricultural encroachment, invasive species, fire and infrastructure. Another positive relationship is among the activities of “conservation payments”, “institutional development”, “research” and “land-use planning”, which appear to be in areas least threatened by infrastructure, agricultural encroachment and degradation from invasive species and pollution. A second clear pattern is on the y-axis, where the activities of “education and training” and “local economic activities” are positively correlated with hunting, but negatively correlated with land-grabbing. Interventions that use law enforcement as a major activity are in sites where land-grabbing is a major threat.

Discussion

Threats to forest areas of the Lower Mekong are complex and interlinked, and the causes come from both local and external sources. Some specific threats are caused by local-level use of land and forest resources, such as hunting and agricultural encroachment. In many of the conservation areas, local people have a long history of hunting, NTFP collection and swidden agriculture (ICEM, 2003c; Robichaud *et al.*, 2009). Nevertheless, although wild harvested meat is eaten within the three countries, many of the drivers of hunting come from international drivers, including the demand for medicines and wildlife meat from China and, more recently, Vietnam (Traffic 2008). Agricultural encroachment is a threat driven by local subsistence needs (Robichaud *et al.*, 2009) and the national demand for agricultural commodities (De Koninck, 1999; Malhotra, 1999; ICEM, 2003c). Furthermore, new migrants to the forest areas are increasing the pressures of greater agricultural areas in the conservation areas.

External actors (people outside the conservation areas, such as those living in other provinces or working in industries) also influence the threats to forest areas, especially with respect to national socio-economic development interests. Government and industry have an interest in infrastructure development (including hydropower dams and mines) and forest products, especially timber, to support the national economy (IUCN, 2007; EIA and Telapak, 2008). Selective logging is often conducted by local and external actors, but is driven by the international trade in timber (EIA and Telapak, 2008). The development of dams and mines in conservation areas perhaps arises from the government's willingness to benefit from mineral exploration and hydropower, which means allowing industries to explore areas away from population centres where forest lands are yet to be exploited. Land-grabbing is also a major threat to some sites, especially in Cambodia, but this is driven by the demand from wealthy individuals from outside the conservation areas, who buy the land for agriculture or housing (Boreak, 2000).

The results provide some evidence that organizations are acknowledging whether the threats are caused locally or by outsiders. In several sites, many of the threats come from local land use. In these situations, the conservation managers are implementing integrated conservation and development approaches, such as involving residents in forest management and planning, rehabilitation of habitats, education and awareness of the environment and conservation, provision of support for agriculture and development of NTFP markets. Outside the conservation landscapes, organizations are targeting threats from external actors by building the capacity of governments at the national level to develop and implement regulations and policies, cooperate among authorities and improve the judicial processes. This, then, suggests that expanding the scope of interventions to influence factors at multiple levels, including careful coordination with national government and other national conservation actors (Wells, 1998; Barrett *et al.*, 2001) is necessary to improve the institutions and reduce the large-scale drivers of forest threats.

The results of the examination of associations between the activities of conservation interventions and the threats to conservation areas provide a picture of the causal relationships and suggest that specific strategies need to be responsive to specific threats. For instance, “health support and infrastructure” and “other conservation” activities are implemented in an attempt to reduce the pressures arising from high populations, such as infrastructure development, agricultural encroachment, pollution and invasive species. Strategies beyond the site (such as institutional development and increasing environmental awareness at the national level) might aid in reducing threats such as dams, through development and implementation of better environmental policies (Sneddon and Fox, 2008). Other local activities, including education, training and local economic support, might also be targeted at locally caused threats, such as hunting (although the effectiveness of these types of interventions is yet to be tested). Interventions must be implemented carefully, however, because they may have unintended consequences. For instance, if an organization attempts to improve infrastructure in an area to reduce some threats related to over-exploitation, it might also cause an increase in threats of pollution and invasive species.

Differences between the social, environmental and institutional contexts of each country also influence, to some degree, the magnitude of threats to biodiversity. In Cambodia and Laos, the weak land tenure system allows for a higher threat of land grabbing than is found in Vietnam, where land tenure and state control are stronger (Pham *et al.*, 2008). Also, due to the relatively larger areas and untapped resources within the forest areas of Cambodia and Laos, resource exploitation, agriculture encroachment and infrastructure development are occurring at higher rates. These findings support previous studies of threats in these countries, which suggested that agriculture encroachment and resource exploitation were the most severe threats (Lacerda *et al.*, 2004; Robichaud *et al.*, 2009; Chanrithy, 2010). In more developed Vietnam, however, infrastructure development and land grabbing are less threatening, but the population pressures to forest conservation areas are higher, perhaps causing the threats from invasive species and pollution. This suggests that strategies in different countries are required to be pragmatic and adapt to each individual situation, such as recommended by the studies of Cat Tien National Park in Vietnam (Polet and Ling, 2004) and Nakai Nam Theun National Protected Area in Laos (Robichaud *et al.*, 2009).

Conclusions

This chapter has explored the threats to forest areas and the conservation actions by management interventions at the site level in three Lower Mekong countries. The methods used allow the threats and conservation actions to be teased apart to identify local and external threats and actions, and how the threats and actions are linked. This is possible only through an assessment of the magnitude of threats and an understanding of the context of each of the conservation

landscapes. This, then, suggests that further development of the existing frameworks assessing how conservation actions mitigate threats (Salafsky and Margoluis, 1999; Salafsky *et al.*, 2008; Balmford *et al.*, 2009) should include a measure of the magnitude of threats and an appraisal of context.

These results suggest that threats are country-related and context specific, and that external factors are as important as local factors in leading to threats to forest conservation areas. This has implications for the strategies to counter these threats. Integrated conservation and development approaches at the site level might help to reduce local and some external threats if implemented through appropriate engagement with local resource users (Sayer, 2009). A broader suite of strategies by conservation managers, however, such as improving environmental institutions and lobbying industries that are exploiting forest areas, might help to reduce the external drivers and causes of the threats.

The results here lead to three key recommendations. First, reiterating recommendations from other conservation studies (Margules and Pressey, 2000; Geist and Lambin, 2002; Polet and Ling, 2004; Pressey and Bottrill, 2008), the different settings and uniqueness of sites suggest that interventions must be made with a good understanding of the context at the local level prior to intervention and be planned systematically for pragmatic conservation actions. Second, the results showed some differences in the type and magnitude of threats among the three countries studied, which suggests that specific policies at the national level could improve threat reduction. And finally, while no universal approach for reducing all threats exists, due to the pervasiveness of specific threats, including hunting, logging and agricultural encroachment, shared learning across sites could improve the effectiveness of conservation actions and aid in the reduction of threats at a regional level.

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