The Values of Land Resources in the Cardamom Mountains of Cambodia

Final Report

Prepared by

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in partnership with the **Ministry of Agriculture, Fisheries and Forests, Cambodia, the Global Mechanism, Conservation International and the Asian Development Bank**

1. Introduction

The management of land resources is the basis of the livelihoods of most of Cambodia's population and is a dominant part of the national economy. Although other sectors are growing rapidly, in 2009 agriculture accounted for nearly 1/3 of Cambodia's GDP and directly employed over 50% of the workforce, whilst nearly 80% of the population still live in rural areas [1]. Other natural resource-based sectors such as forestry and fisheries are also important and the 'multiplier' effects of agriculture and related sectors in areas such as trade and processing increase their significance in the national economy. Despite recent economic progress, Cambodia remains poor, ranking 124th in the world in terms of the UNDP's Human Development Index[2]. The recent global economic downturn and rising food prices have together shown the potential vulnerability of emerging growth sectors to external conditions[3] and the management of land resources remains the foundation of livelihoods and food security for the majority of Cambodia's population.

The contribution of land resources to national development and the potential of these resources, where sustainable land management (SLM) is practiced, for more rapid poverty reduction and sustainable development are too often not recognized. The increasing recognition of the importance of ecosystem goods and services to economic growth and poverty reduction comes at the same time as evidence that human pressure on ecosystems is negatively impacting the provision of these services. Land degradation pressures such as soil erosion and deforestation have emerged as important issues in the development debate in Cambodia, affecting directly the productivity of agriculture as well as impacting on water resource availability, the availability of fish and forest products and other key ecosystems services.

There are also concerns over the integrity of some of the most important ecosystems in the whole Mekong Region, ecosystems that contain biodiversity resources of global significance and provide a wide range of other vital services to people living both in the immediate vicinity and further afield. The study reported in this paper represents the first attempt at a comprehensive valuation of all ecosystems services of a large area in Cambodia, the central Cardamom Mountains, and indeed is one of the first such assessments globally. As is discussed below, such an assessment inevitably has numerous limitations and depends upon the veracity and comprehensiveness of the data available. Although far from perfect, there is an increasingly rich range of such data, including many case studies on the value of individual ecosystems services such as carbon sequestration, non-timber forest products or watershed protection functions. These have been supplemented by field studies to help provide information on a particularly important issue where available data was extremely limited: the role and value of land resources in the livelihoods of local communities living in the study area. There are clear limitations on the results presented here, these are spelt out below, but despite the limitations these results do provide an accurate enough understanding of both the relative values of different ecosystems services and, most importantly for policy development, the overall value of the full range of ecosystems services that an area such as the Central Cardamom Mountains will generate. This understanding is vital if effective approaches to sustainable land management are to be identified.

2. The Study Approach and Method

In recent years an increasing emphasis has been placed on quantifying ecosystems services as a tool for moving towards more sustainable management of land resources and the reversal of land degradation, with a number of studies undertaking the valuation of

1. Guimbert, S. (2009) *Cambodia 1998-2008: an Episode of Rapid Growth* World Bank Policy Research Working Paper 5271, World Bank, Washington D.C.

2. UNDP (2010) *Human Development Report 2010* UNDP, New York.

3. CDRI (2009) *Annual Development Review* Cambodia Development Research Institute, Phnom Penh.

ecosystem services, ranging from those focused at the global level to others where the primary concern is understanding ecosystems services at the micro level, looking at one particular habitat or community.[4] The Global Mechanism of the UNCCD has, in collaboration with SEI and other partners, launched a global initiative on the analysis of the values of land resources and the costs of land degradation. A comprehensive methodological approach for assessing the value of SLM and the cost of land degradation has been developed. The emphasis is on generating evidence to support SLM policies and investments, based on demonstrating their existing and potential contribution to national development and poverty reduction.

There are six stages in the methodology developed under this initiative, with the intention that they can be adapted to different spatial scales for individual studies. These six stages are:

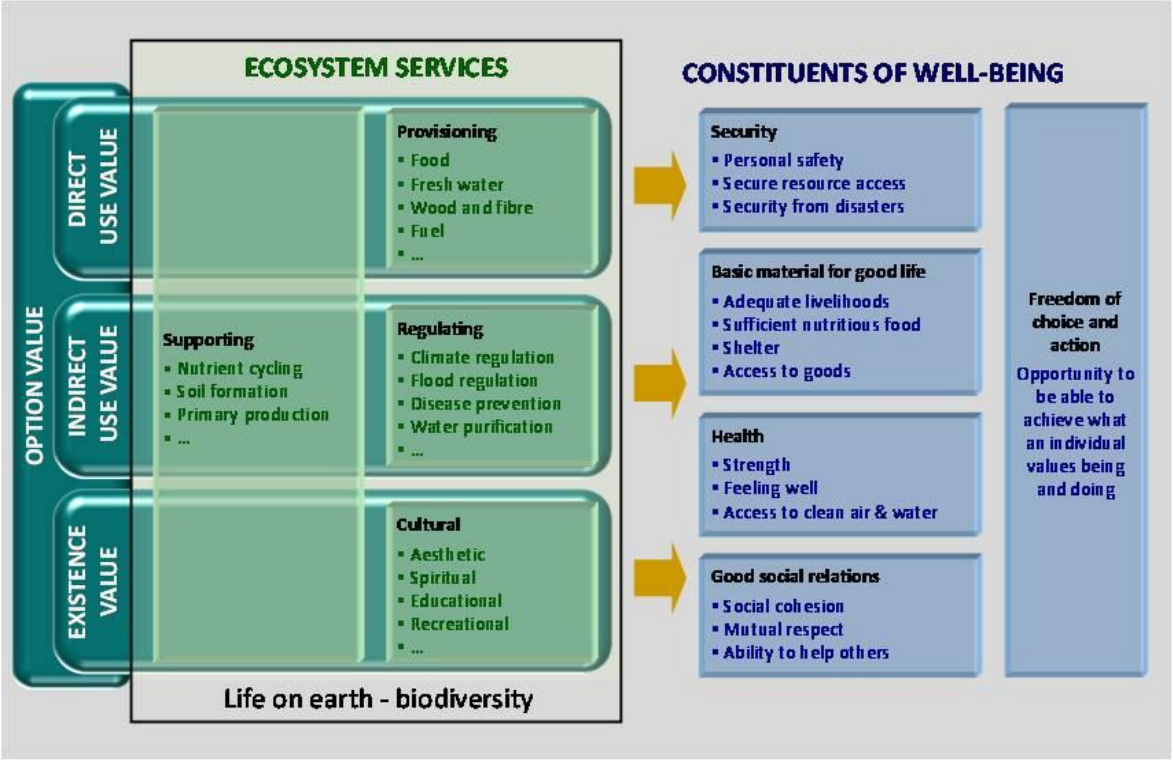
1. **Inception**: the identification of the scope, location, spatial scale and strategic focus of the study, based on stakeholder consultation, and the preparation of background materials on the socio-economic and environmental context of the assessment.
2. The assessment of the quantity, spatial distribution and ecological characteristics of **land cover** types, categorized into agro-ecological zones and analyzed through the use of a Geographical Information System (GIS).
3. The analysis of **ecosystems services** stocks and flows, based on the 4-fold MA categorization, for each land cover category.
4. The role of the assessed ecosystems services in the l**ivelihoods** of communities living in each land cover area and in overall **economic development** in the study zone.
5. The identification of **land degradation** patterns and pressures on the sustainable management of land resources, including their spatial distribution and the assessment of the factors causing the degradation.
6. The assessment of **SLM options** that have the potential to reduce or remove degradation pressures, including the analysis of their economic viability and the identification of the locations for which they are suitable.

Concurrently the methodology is being piloted in a number of countries, in response to demands expressed by UNCCD member countries, with the specific character of the activities in each country reflecting the priorities set by the national authorities. The study in the Cardamom Mountains is part of this wider initiative, but is also a response to demand from partners in Cambodia for this analysis as part of the wider process of development of sustainable land management plans and strategies for the country. The approach and method set out here follows and adapts these six stages to reflect the scale and focus of the study in Cambodia.

One of the key issues in the preparation of a national plan for land resources and the development of sustainable land management strategies is to understand the full value of land resources. This should include all aspects of their values and their contribution to both national economic development and the livelihoods of local communities, and especially the poor who depend on land resources as the underpinning of their livelihoods. These total economic values (TEV) are most easily understood as a series of ecosystems services that are available for different types of human activities, with the ecosystems services framework presented by the Millennium Ecosystem Assessment (MA) as illustrated in Figure 1.

4. See for example: European Communities, 2008; Braat, ten Brink, et al., 2008; Barbier, 2007; CBD, 2007; OECD, 2006; Berry, Olson & Campbell, 2003; Costanza, et al., 1997.

Figure 1: Integrating Total Economic Value into the Millennium Ecosystem Assessment Framework[5]



This framework provides a basis for more informed decision-making on the trade-offs between different aspects of the values of land resources and the economic returns on investments in sustainable land management. A recent study in Lao PDR[6] gives a clear categorization of the constituent components of the TEV in an area such as that studied here:

> "(TEV) is defined as the sum total of all use values (UV) and non-use values (NUV)….UV can further be classified into three types: direct use values (DUV), indirect use values (IUV) and option values (OV)….NUV are made up of existence values (EV) and bequest values (BV)" (ibid, page 9).

Undertaking this type of analysis consequently requires the careful analysis of the full range of values of different ecosystems services and such information is as yet not available for all of Cambodia. A study on the values of land resources in the Cardamom Mountains has been undertaken by a partnership of the Stockholm Environment Institute (SEI), Conservation International (CI), the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the Global Mechanism of the UNCCD (GM). The main findings and policy implications of this assessment are presented here. The approach adopted for this study has been to, firstly, assess the distribution and inherent quality of land resources, secondly, analyze the role of these resources in the livelihoods of local communities and in terms of wider ecosystems services functions, thirdly, to assess the principle degradation pressures on

5. adapted from Emerton, L. (2006) *Counting coastal ecosystems as an economic part of development infrastructure*, Ecosystems and Livelihoods Group Asia, World Conservation Union (IUCN), Colombo

6. Rosales, R.M. *et al* (2005) *Balancing the Returns to Catchment Management: the Economic Value of Conserving Natural Forests in Sekong, Lao PDR* IUCN Water, Nature and Economics Technical Paper no. 5, IUCN Gland

these resources and, finally, to identify sustainable land management policies and options that would contribute to the maintenance of the integrity of the ecosystems and land resource values of the Cardamom Mountains and comparable areas elsewhere in Cambodia.

3. The Study Area: the Central Cardamom Mountains

The Cardamom Mountains represent an area of unique significance in Cambodia and the wider Mekong Region in terms of the value of their land resources. Few other areas have retained the level of integrity of the ecosystems values still found in the Cardamoms and these ecosystems services underpin the livelihoods of people living there and provide value to people and economic activities in a much wider area. According to recent studies, the Central Cardamoms Protected Forest (CCPF) is the single most biologically diverse and least altered natural region in mainland South-east Asia[7]. Contained within the CCPF is a high level of biological diversity, with the presence of globally threatened species, and high levels of endemism. The area may contain as many as 46 globally threatened fauna species, and an unknown quantity of globally threatened or endemic plants. The area supports around half of the country's bird, reptile and amphibian species, and most of its medium to large mammals[8].

These land resources are under severe and multiple pressures, however, and there are serious concerns that the existing ecosystems service values that they generate will degrade unless an effective, comprehensive and coherent approach to the management and maintenance of the land resource base is developed and implemented. Defining such a comprehensive sustainable land management approach needs in turn to be based on an appreciation of the existing benefits that these land resources provide and the inherent values that they represent. These issues were examined in detail through an assessment of the ecosystems service and livelihood support values of land resources in the central Cardamom Mountains, defined as the Central Cardamom Protected Forest (CCPF) and a surrounding buffer zone of 20 kilometres surrounding the CCPF (see Figure 2).

A recent report by the ADB[9] describes the Cardamom Mountains as *"part of the most significant Indochina habitat for the tiger (Panthera tigris) and Asian elephant (Elephas maximus) and most significant global habitat for the Siamese crocodile (Crocodylus siamensis). It is one of the very few sites in Asia with white-winged ducks, black-necked storks, and Asian Arowanas (dragon fish). It includes hilly evergreen forest, unique upland and lowland freshwater swamp forest, with some semi-evergreen and dry forest"* (page 7). One of the most important works on this area in recent years[10] captures the challenges facing this important area, describing both the significance of the ecosystems services it generates and the multiple pressures it faces. The overall tenet of the report is important, that change is both inevitable and desirable when seen from a national development perspective, but that change needs to be managed upon sustainable pathways that do not jeopardize the fundamental integrity of the ecosystems of this unique area. The key to achieving this, the report argues, is to understand and base decisions on the full values of the ecosystems services that the Cardamom Mountains generates. The study presented here is intended as a contribution to achieving this objective.

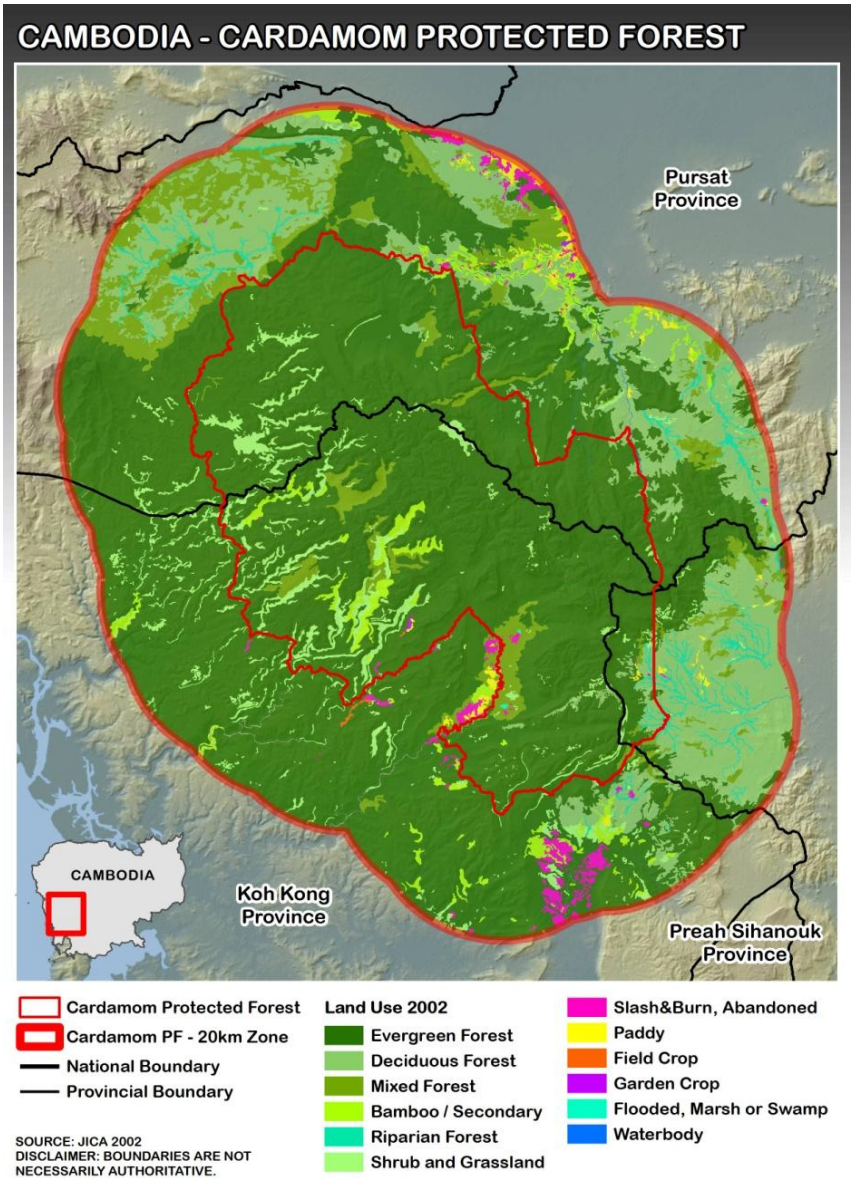
7. Daltry, J.C. and Momberg, F. (eds.) (2000) Cardamom Mountains. Biodiversity Survey 2000. Fauna and Flora International, Cambridge.

8. Daltry, J.C. and Momberg, F. (eds.) (2000) *ibid*, Colson (2002)

9. ADB (2007) *Cardamoms Biodiversity Conservation Corridor, Cambodia* ADB, Manila.

10. Killeen, T. (2009) *The Cardamoms Conundrum: Reconciling Conservation and Development in the Kingdom of Cambodia* Forestry Administration, Ministry of Forest & Fisheries, Royal Government of Cambodia.

Figure 2: The Study Area in the Central Cardamom Mountains



The study zone includes 1,110,085 hectares, most of which is covered by forest. There are approximately 19,000[11] people (just over 4,000 households) living in villages in this zone, including both long-settled traditional communities whose livelihood patterns are based on an intimate relationship with the local resource base, and recently-arrived migrants from other parts of Cambodia who have very different livelihood systems and patterns of use of land resources. Most of these people are poor: the field research and CI's income monitoring in four villages showed an average annual cash or equivalent income (not including most subsistence use of NTFPs) of between 1.6 million Reil ($400) and 2.5 million Reil ($630) per family, significantly below the national poverty line and much less than $1/person/day.

4. Land Resources, Ecosystems Services and Local Livelihoods

The field research undertaken as part of this project[12] showed that the **livelihoods** of the communities living in and around the study area are completely dependent upon access to land resources. Almost all families combine farming, some livestock rearing (with fodder collected from or grazing in the forests) and the collection of fuel, foods and other forest products as their main sources of livelihoods. The exceptions are a small number of traders and shopkeepers who service the rest of the population and a few people employed by the government or other outside agencies as rangers or similar positions. These patterns of livelihoods-land resource relationships are typical of rural areas of Cambodia and other countries across the developing world:

> *"Poor people in rural areas typically depend heavily on ecosystems for their livelihoods. A recent summary of 54 studies from 17 countries found that collecting fuelwood, wild foods and other forest products contributes one fifth of the income of rural poor families (Vedeld et al, 2004) in cash and consumption"*[13].

In Cambodia, a recent study of rural livelihoods in Mondulkiri Province[14] found that rural livelihoods in the villages studied largely consisted of rice cultivation, the collection of forest products and fishing, with access to forest products important in both food security terms and as a source of cash income. A comprehensive analysis of livelihood patterns in communities surrounding the Phnom Samkos Wildlife Sanctuary in the Cardamom Mountains[15] identified a diverse range of products collected from forest areas by local people, including fuelwood, wild foods, herbs, bamboo, rattan and other plant and animal products and showed that almost all families engage in these activities as a core part of their livelihood strategies. A study of livelihoods amongst communities living close to Ream National Park, not far to the south of the study area, found that access to resources from the national park provided more than two-thirds of the average family income: $233 annually

11. The 2008 census gave the population of villages in the study area in Thmar Bong and Veal Veng Districts as being 18,052 but the population of this area is growing rapidly, including through in-migration so the figure has been adjusted upwards.

12. See Annex 1 for a full write-up of the field research methodology and results.

13. Steele, P., Oviedo, G. & McCauley, D. (2007) *Poverty, Health and Ecosystems: Experiences from Asia* IUCN, Gland, page 5. The quote also cites Vedeld *et al* (2004) *Counting on the Environment, Forest Incomes and the Rural Poor* Environmental Economics Series, Paper no. 98, World Bank, Washington D.C.

14. WWF (2008) *Livelihood Sustainability Analysis in Mondulkiri Province* WWF, Phnom Penh.

15. Fox, M., (2007) *Socio-Economic Studies of the Phnom Samkos Wildlife Sanctuary 2004-2006* Flora & Fauna International, Phnom Penh.

from a total income of $316[16], with similar results also found in other communities throughout the Mekong Region.

Agriculture is a major component of most families' livelihoods, including both cultivation on fixed plots and, in some cases, shifting cultivation. Most people grow rice where and when it is possible, but a wide range of other crops are also grown, including (in order of importance) peanut, corn, cassava, taro, sugar cane and vegetable such as cucumber, small species of gourds, cabbage, pumpkin, chili and bindweed. Tree crops like mango, jackfruit, banana, papaya and rambutan are also cultivated by most families. Rice and some other grain crops are sold in part but most other crops are used for home consumption. Livestock, especially buffalo and poultry, are widely kept, with the buffalo also acting as an important source of cash income when needed.

Access to forests is an important part of local livelihood patterns: most people in the villages studied depend on the gathering of foods and other products (often referred to as **non-timber forest products or NTFPs**) from forests and on other ecosystems services such as water supply and soil fertility maintenance that forests provide. The NTFP values of areas such as the Cardamom Mountains are often neglected in the valuing of these ecosystems but can be of tremendous importance. NTFPs are both harvested for, predominantly, subsistence consumption by local communities and, in some cases, are traded commercially. The evidence available suggests that this commercial exploitation of NTFPs in the Cardamom Mountains is higher than is generally appreciated and there are concerns over the sustainability of this trade. In contrast, systems of NTFP extraction by local communities are ages-old practices and reflect an intimate knowledge of the uses and limits to use of these products by local people. This picture in the Cardamom Mountains is again supported by numerous case studies from elsewhere in Cambodia, the rest of the Mekong Region and elsewhere in Asia and the rest of the developing world[17].

The field studies showed that the local communities gather the vast majority of these materials from forests within five kilometers of their villages, and that these materials are essential for the functioning of their livelihoods. We can consequently identify what we call a "**livelihoods support zone**" surrounding each village in this area, with the forest and land resources of these zones underpinning the livelihoods of the people living in the study area. The diversity of products gathered from the forests is tremendous and includes both plants and animals that meet most household needs for food, fuel, medicines, building materials and many other purposes. It is estimated that around 1,300 plant species and a wide range of animal species are gathered for food, medicines and other purposes from forests in Cambodia[18], including ones such as resin collection and rattan that are significant sources of cash income for poor households in remote areas that have few alternative means of gaining cash.

Access to these resources are essential for even basic survival: the survey in the four villages showed that in 2009 between 68% and 88% of the villagers were not able to grow enough rice for their basic needs, with more than half of these having at least a three month deficit. The gap is filled either by forest foods or by buying rice with money earned, mainly, by selling forest products. Almost all non-rice foods are gathered in the forests or grown in

16. ICEM (2003) *Field Studies in Cambodia, Lao PDR, Thailand and Vietnam: Economic Benefits of Protected Areas* ICEM, Australia.

17. See, for example, Steele, P. *et al* (2007) *ibid*, ICEM (2003) *ibid*, Campbell, J. (2008) *Systematic Approaches to Livelihoods Enhancement and Diversification* IUCN, Gland, CDRI (2005) Non-timber forest products: their value to rural livelihoods *Cambodia Development Review* vol. 9, issue 4, Emerton, L., Faccer, K. & Huberman, D. (2009) *Markets and Incentives in Livelihoods and Landscapes Strategies*, IUCN, Gland, Agarwal, A. & Gibson, C. (1999) *Enchantment and Disenchantment: the Role of Community in Natural Resource Management* **World Development** vol. 27(4), 629-649.

18. Ministry of Environment (2005) *State of Environment Report 2004* MoE, Phnom Penh.

home gardens or from livestock. The value of NTFPs for local livelihoods is estimated to be around $350 per household per year, or at least half of the average household cash income, a figure based on similar research throughout Cambodia: for example, a study of over 500 households in 16 villages in four different provinces found the values of NTFPs collected varied, on average, between $280 and $345 per household per year[19]. This would mean an ecosystems service value from NTFP to local villagers in study area of approximately $1,400,000 per annum.

The overall theoretical potential value of NTFPs is far greater, as most of these resources are only exploited to a very limited extent: a figure of $400/ha/year has been calculated elsewhere in Cambodia[20]. If this value is applied to the study area for good quality forests and $200/ha/year for other forests then the total NTFP potential value is over $400 million per year; reflecting the large areas of high quality forests in the study area. Of course, the low population density and inaccessibility of many of these NTFPS mean that they are unlikely ever to be gathered but this is not the point: NTFPs are an important aspect of the provisional services that forests generate and their inclusion in the overall valuation of these resources is essential.

The intimate interactions between local people and the land resource base is consequently the basis of livelihoods in the study area and amongst similar communities, but these relationships are changing. In particular, traditional patterns of 'slash and burn' agriculture are breaking down and settled agriculture in permanent fields is becoming more prevalent. This in part reflects the movement in of migrants from other parts of Cambodia, who tend to farm settled fields exclusively, but the indigenous communities also practice swidden agriculture far less than they used to: something reflected in the large areas of land categorized as "slash and burn abandoned" in Figure 2. These areas are able to recover, given sufficient time, but remain in a degraded state for some time. This is just one of the aspects of pressures on land resources discussed in more detail in the next section.

5. Land Resource Pressures

There are a wide range of **pressures** on these traditional and sustainable systems of land resource management and concerns over the extent and severity of land resource degradation here as throughout the country. A recent government report[21] identified soil erosion and deforestation as being widespread and of particular concern in Cambodia, jeopardizing both agricultural productivity and the integrity of a number of ecosystems. The same report identifies a range of causes of land degradation, a number of which characterize the study area in the Cardamom Mountains. These include recent influxes of external migrants to the area, increasing resource pressures and leading to new forms of land resource exploitation and encroachment. One pernicious but widespread pressure is illegal forms of forest exploitation such as illegal logging or the wildlife trade. Although the exact extent of these activities is unknown, evidence from local residents and forest and wildlife protection agencies in the area suggest they are extensive and are threatening the ecological integrity of some vulnerable ecosystems.

These pressures can lead to rapid degradation of land resources even in an area of such ecological richness as the Cardamom Mountains. Indeed the combination of high rainfall,

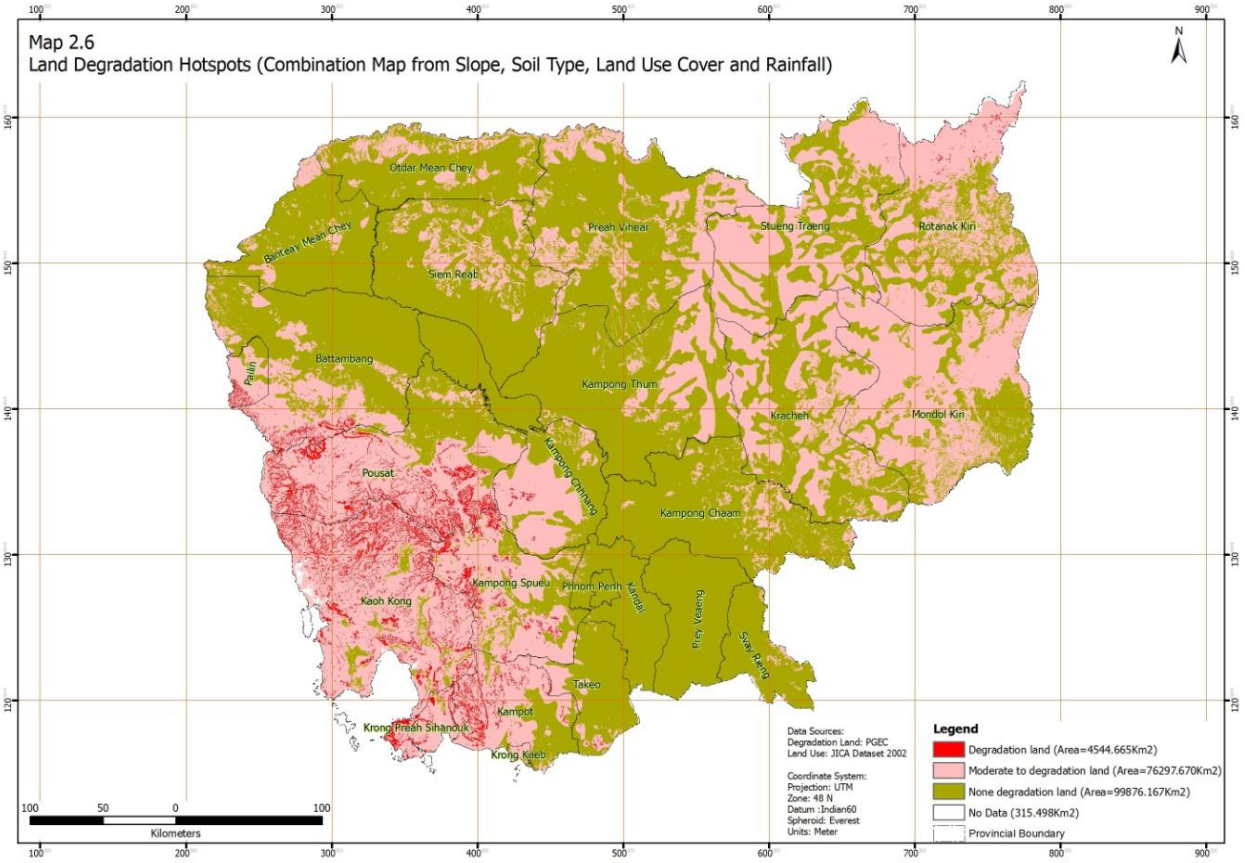
19. CDRI (2005) Non-timber forest products: their value to rural livelihoods *Cambodia Development Review* vol. 9, issue 4, pages 1-5.

20. Emerton, L. et al (2009) *Markets and Incentives in Livelihoods and Landscape Strategies* IUCN, Geneva, citing a detailed study of Tapean Forest in Ratanakiri Province.

21. Ho Puthea (2008) *Situation Analysis on Sustainable Land Management in Cambodia* Ministry of Agriculture, Foresty & Fisheries, Phnom Penh.

often steep slope and dominant soil types makes this zone the area of Cambodia that is most vulnerable to erosion and degradation (see Figure 3). Such degradation will occur rapidly if there is a significant decline in the integrity of the land cover, leading to tremendous loss of value not just in this zone itself but also resulting in severe damage to land quality and water availability in surrounding downstream areas, including the high population density areas south of the Tonle Sap as well as areas with high poverty incidence and limited development opportunities to the north, west and south of the study zone.

Figure 3: Land Degradation Hotspots in Cambodia



6. Valuing Land Resources in the Central Cardamom Mountains

In addition to the vital livelihood support functions of land resources in the Cardamom Mountains, which benefits communities living in and around the CCPF, the land resources of the study area provide a range of other ecosystems services values that benefit much wider communities in the surrounding districts downstream of the mountains, in the rest of Cambodia and at the global level. The total cumulative value of these ecosystems services is assessed in this section, as far as is possible with the data available. There are some limitations on the information that could be used for this, with certain functions not measurable with the data available, but some estimate of the values of most of the key ecosystem services provided by the land resources of the study area possible. These estimates are outlined in this section.

The most familiar value of forests such as those of the CCPF and surrounding areas is the value of the **timber** they contain. The tropical forest of areas such as the Cardamom Mountains contains large quantities of extremely high value hardwood trees and the unsustainable extraction of these timber trees has been a major factor behind the widespread destruction of such forest areas. The timber values can be calculated in two ways: as a total stock value, the value of all the timber in the forest at one time or as a continual value based on the sustainable harvesting of the timber on an annual basis. It should be noted that 'sustainable' in this context means sustainable in terms of the long-term capability of the forest to produce timber and the overall integrity of the ecosystem. It does *not* mean no alteration at all to the characteristics of the ecosystem and any form of timber extraction can have an impact on biodiversity and other potential values such as tourism. Both overall timber value and sustainable harvesting estimates are largely hypothetical in this case as logging is not permitted in most of the study area, but their inherent value needs to be included in the overall valuation of land resources. Recent studies in the Mekong Region have placed total stock values as high as $20,000/ha if forests are clear-felled, but timber values are much lower under sustainable harvesting: between $200 and $450/ha/year depending on forest type and quality. These would give an aggregate annual income, if the entire area was sustainably harvested, of nearly $440 million a year, but it must be noted that even 'sustainable harvesting' systems can entail considerable disruption to ecosystems integrity and would require major investments in access roads and processing facilities.

Agricultural lands constitute a relatively small proportion of the study area, which is sparsely populated and predominantly covered in forests. The GIS analysis identified 5,972 ha of paddy fields and 711 ha of other farmed lands such as home and village vegetable gardens. Rice (upland and lowland) is the dominant crop but some families plant crops such as cassava and peanuts as a second, dry season crop. Although relatively small in area, however, these agricultural lands are of great significance in livelihoods terms and generate a high economic value per hectare when compared to many other types of land cover. Yields and incomes are relatively low by national standards but are comparable to those found by other studies in the Cardamom Mountains and in similar areas elsewhere in Cambodia[22]. Average rice harvests in the villages studied varied between 617 kg and 917 kg and averaged 758 kg per household per year, frequently below that needed for their subsistence needs. In valuation terms, this is best valued in relation to the border export price for South-East Asia (which the latest figures available from the FAO show to be around $460/ton at the time the study was undertaken). This would give an average economic value for the rice produced in the area of $349 per year, to a total for all households in the study area of just under $1,400,000 per year. An alternative means of calculating this value is as a proportion of total household income, the fieldwork showed that around 66% of total

22. Fox, M. (2007) *Socio-Economic Studies of Phnom Samkos Wildlife Sanctuary* Flora & Fauna International & Ministry of Environment, Cambodia; WWF (2008) *Livelihood Sustainability Analysis in Mondulkiri Province* WWF, Phnom Penh.

measured income comes from agricultural lands, comparable to the 70% found in the FFI study in Phnom Samkos Wildlife Sanctuary. The economic value of this method of calculation comes to an average of $363 per household per year, which would give a total value to the study area of just over $1,450,000 per year: close enough to the earlier calculation method to be a good verification of this value. There is insufficient information available to give an accurate valuation of the crops produced from the other agricultural lands, which are extremely diverse in type and are mostly consumed in the home rather than sold on markets. The very small area under these crops mean that, whilst they are an important part of local livelihoods and food security systems, they will make relatively little difference to the overall valuation of the study area's land resources. In consequence, and including a notional sum for the economic valuation of other crop lands, the total valuation of the provisioning services from the 6,682 ha of agricultural lands in the study area is estimated to be $1,500,000 per year.

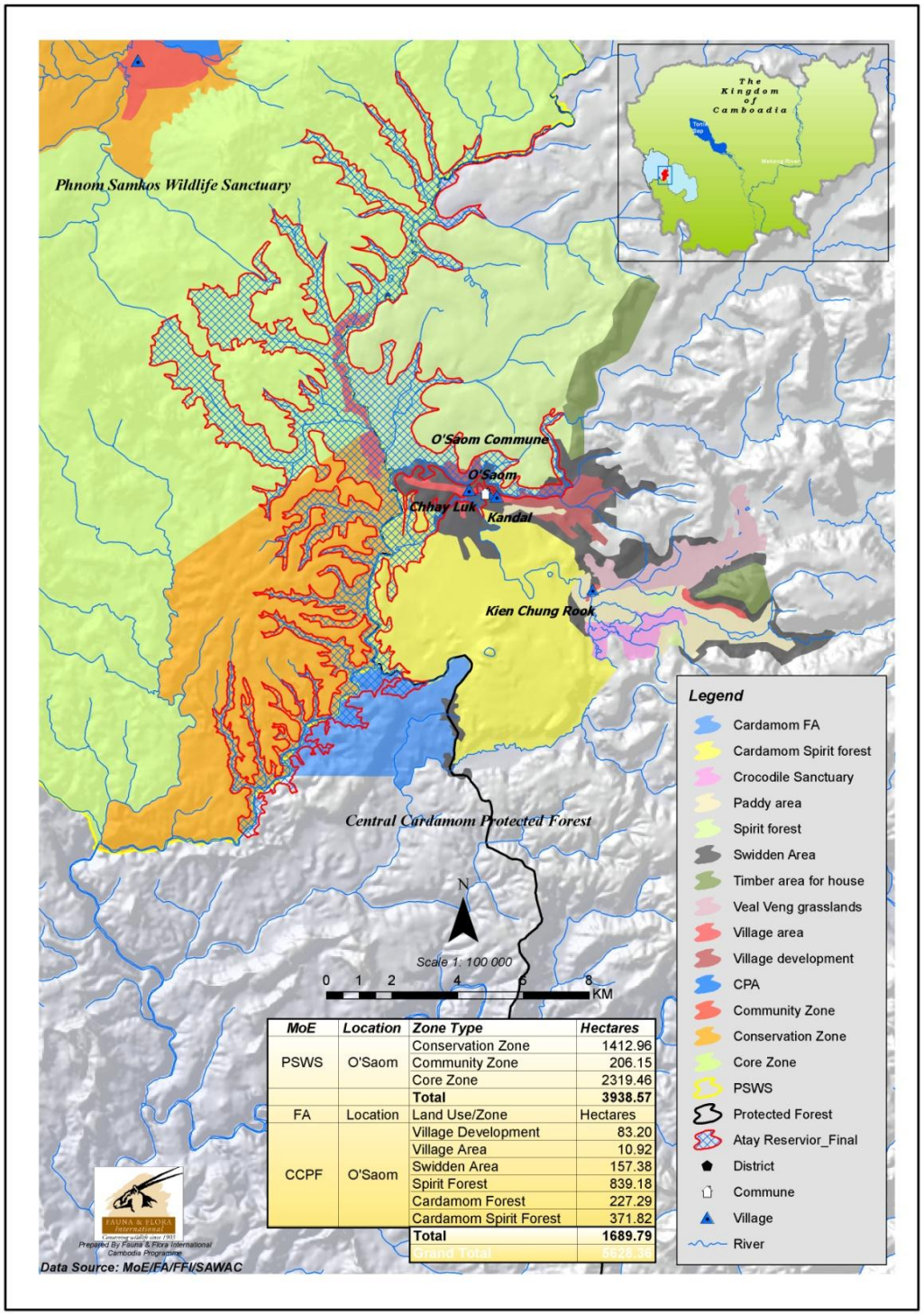
Watershed functions are a key ecosystem service in the central areas of the Cardamom Mountains. There are plans for the construction of three hydropower schemes[23] in locations adjacent to the study area; hydropower schemes that will make a vital contribution to meeting the growing demand for electricity that Cambodia faces as economic development accelerates. The economic rates of return and development benefits from hydropower are very high and beneficial to the nation as a whole, but there are concerns over the potential effects of hydropower development in areas such as the Cardamom Mountains. These concerns reflect experiences in the wider Mekong Region and elsewhere around the world where poorly-planned hydropower development has had negative impacts on both people and the environment in the vicinity of the dam and reservoir construction. Such concerns can to a great extent be ameliorated where the construction and operation of the dams is done with due attention to the protection and sustainable management of the lands in the upstream watershed areas that services the dams. In this case, a substantial part of the CCPF and the adjacent lands will form the watershed for the planned hydropower schemes.

For example, Figure 4 shows the planned inundation area for the Steung Atay dam reservoir. As can be seen, some lands in the conservation area and some forests will be inundated and lost by the dam's development, but a much larger area upstream will be potentially affected depending on how the site is developed. Figure 3 has demonstrated that this is an area highly vulnerable to erosion, but the retention of good quality forest cover goes a long way to reducing these erosion risks. This is essential for the effective operation of the hydropower scheme and it is in the interest of the dam operators and the country as a whole to ensure that the forest cover is retained, water flows are regulated and soil erosion and reservoir sedimentation are kept to as low a level as possible. This in turn is contingent upon the way in which the lands in the watershed areas servicing the dams are managed.

These dams will consequently depend upon water provided through watershed areas in the CCPF and surrounding lands, whilst the lifetime and operational efficiency of the hydropower schemes is severely affected by the rate of sedimentation which in turn is contingent upon the levels of erosion in the watershed areas. The protection of these watershed functions is of great economic significance: high levels of sedimentation can greatly reduce the functional life of a hydropower scheme (international experience shows that this can be by as much as 50%, with effective dam life falling from 60 to 30 years where severe sedimentation takes place). In addition, high sediment loads greatly reduce turbine efficiency and poor water regulation can result in periods of low operational effectiveness due to water shortages in the reservoir. This is particularly an issue where there is high seasonality in rainfall combined with other demands on the waters such as irrigation in downstream areas.

23. Cheay Areng, with an installed capacity of 108MW, Lower Steung Russei Chrun, installed capacity 340MW and ATAY, installed capacity 120MW, all of which are approved and either in planning or construction phase.

Figure 4: Steung Atay Hydropower Scheme Planned Site & Reservoir Area



MoE	Location	Zone Type	Hectares
PSWS	O'Saom	Conservation Zone	1412.96
		Community Zone	206.15
		Core Zone	2319.46
		Total	**3938.57**
FA	Location	Land Use/Zone	Hectares
CCPF	O'Saom	Village Development	83.20
		Village Area	10.92
		Swidden Area	157.38
		Spirit Forest	839.18
		Cardamom Forest	227.29
		Cardamom Spirit Forest	371.82
		Total	**1689.79**

In addition, the Cardamom Mountains is the upper watershed serving the needs of extensive downstream agricultural areas and other ecosystems. The productivity and seasonal viability of agriculture can be greatly affected where upper watershed conditions change, with resultant increases in sedimentation and changes to water flows. A recent long-term pilot study of these watershed functions in relation to hydropower in Vietnam has estimated

these ecosystems service values[24], values which are similar to those found in other studies internationally. The estimated annual benefits to the hydropower schemes from erosion protection were $55/ha/year and from water conservation were $15/ha/year: conservative figures when compared to many studies in other parts of the world[25]. The similarity of ecological and other conditions means that, in the absence of detailed local studies, these values can be applied to the Cardamom Mountains, in relation to all watershed functions. This gives a figure of over $75 million a year for the value of the watershed functions of the study area in the Central Cardamom Mountains. The maintenance of these watershed functions through sustainable land management in the Cardamom Mountains is of central importance for national development, as it is the key to sustainable hydropower development and is also important for agriculture and other downstream water uses.

The Cardamom Mountains, and especially the CCPF, are of global **biodiversity** significance and represent one of the most outstanding areas of biodiversity value in the whole Mekong Region. This has been recognized at the national level and is the main factor behind the designation of the CCPF and other protected areas in the Cardamom Mountains. Extensive studies by CI and others have both catalogued these values and demonstrated the extent to which they are under threat. Killeen (2009) has identified 66 mammal species, 174 bird species, 74 species of reptile, 32 amphibian species and 44 fish species as resident in the Central Cardamoms area. Of these, 17 species of mammal, 12 of bird and 4 reptile species are listed as rare and endangered in Cambodia and overall 37 species (including 20 of the mammal species) are identified as globally threatened species. The invertebrate and plant biodiversity is similarly both diverse and, in some cases, under threat. Valuing such biodiversity is difficult, but the TEEB has provided a framework for analysis and comparable data from many other sites around the world with values ranging as high as thousands of dollars per hectare per year (though most are less, in the hundreds of dollars). In the case of Cambodia, the Bann (1997) study[26] gave a valuation of $511/ha/year for biodiversity values of high quality forests.

Based on inflation and increased biodiversity pressures, as well as on international comparisons, this figure has been updated to an estimate of $650/ha/year for the richest forests and $550 for the remaining forest areas of the central Cardamom Mountains, again figures that are conservative when compared to many international studies but which are considered appropriate for Cambodia. Appropriate values have also been estimated for the other land cover types. The result is an estimated biodiversity value of $1.36 billion per year for the study area: a major source of ecosystems services values that does not appear in traditional accounting methods for the valuation of land resources.

This biodiversity, and the beauty of the landscape, makes the central Cardamom Mountains an area of great **tourism** potential. As yet, the lack of facilities and poor transport links mean that tourism is only small scale and is confined to a limited part of the region close to the main access points. A study by CI[27] has highlighted the much greater tourism potential of the central Cardamom Mountains, including the listing of a number of specific attractions such as waterfalls that would complement the overall attractiveness of the region. The extent and value of this potential tourism is a matter of speculation and to a great extent will depend on the level of investments made in transport, accommodation and other facilities in the area. This study does not assign specific economic values to the tourism potential and

24. MARD (2008) *Values of Forest on Water Conservation and Erosion Control Danhim Watershed, Lam Dong Province* MARD, Hanoi

25. Studies compiled in the data base prepared by the Economics of Ecosystems and Biodiversity (TEEB) programme cited values as high as $500-$600/ha in many places and a study by Bann in Cambodia in 1997 quoted a watershed service value of $76/ha in 1997 values.

26. Bann, C. (1997) *An Economic Analysis of Tropical Forest Land Use Options* IDRC, Canada

27. Bauld, S. & Sovan, S. (2004) *A Rapid Ecotourism Assessment of Thmar Bang District* CI, Phnom Penh

there is no other data on this available, but the overall growth of tourism in Cambodia plus the general growth of ecotourism as a high value niche market suggests that tourism could become a significant source of income and alternative livelihood opportunities in the study area. The landscape characteristics and long settlement and livelihood characteristics of the communities living in the area also give rise to values that are difficult to quantify but nevertheless of great significance: the cultural values of different localities for local communities. In particular, local communities have traditionally identified certain forest areas as 'spirit forests' which are an integral part of their cultural and cosmological identity. These cultural values need to be considered whenever consideration is given to changes to existing patterns of land use and land resource exploitation.

Carbon sequestration is one of the most important ecosystems services provided by functioning forest ecosystems but had traditionally not been taken into account in the valuation of these resources. The forests of the Cardamom Mountains, and especially the CCPF, are extremely high in vegetation volume per hectare and it is ecosystems of this type that are the most effective in absorbing carbon. Terrestrial ecosystems globally absorb around 25% of all carbon emissions and the speed and severity of climate change would be much greater without these vital sequestration functions: "*forest ecosystems contain twice as much carbon as the total amount contained in the atmosphere, so can be significant sources of carbon dioxide when they burn or decay. Tropical forests, in particular, hold a large share of the world's terrestrial carbon, with a range of 120 to 400 tons per hectare*"[28]. Similarly, a recent assessment in Indonesia[29] used a value of 185 tonnes of carbon per hectare. Effective forest management has the potential to play a key role in the battle to reduce climate change: "*the potential of forests to help mitigate climate change is now widely recognized. Stopping global deforestation and degradation would decrease global CO_2 emissions by about 17%, and enhancing forests would store even more carbon*"[30].

The calculation of the value of this carbon sequestration function obviously applies to the whole area, with different values assigned to different categories of forest and land cover. The analysis has been based on a number of different sources including studies currently being conducted in Cambodia on REDD potentials and values as well as a detailed recent study in Vietnam and other international sources. To date, there has been very little direct income to Cambodia from REDD schemes and it is not suggested here that the values calculated for carbon sequestration can be easily turned into monetary income. That is not the point; rather the figures have been calculated to demonstrate the high inherent value of the land resources of the study area and the potential development benefits that will come from adopting a land management approach that integrates carbon values as a core dimension of their objectives. As Nasi *et al* (2011)[31] demonstrate for Latin America, this in turn relates as much to the governance conditions characterizing forests as to the technical parameters of any SLM approach: a key consideration in the Cardamom Mountains area. The calculation of a value for the carbon sequestration functions of the land resources in the study area is consequently essential if the overall value of the ecosystem services functions of this area is to be appreciated. The result of this valuation (Table 1) is estimated to be $3,669 million, one of the highest value ecosystems services that the Central Cardamom provides and represents a resource of global significance.

Table 1: Land Cover, Key Ecosystems Functions and Values in the Central Cardamoms

28. Peskett, L. *et al* (2008) *Making REDD Work for the Poor* ODI/IUCN, London, page 7.

29. Verchot, L. *et al* (2010) *Reducing Forest Emissions in Indonesia* Centre for International Forestry Research, Indonesia.

30. RECOFTC (2011) RECOFTC website, climate change mitigation section

31. Nasi, R. *et al* (2011) *Sustainable Forest Management and Carbon in Latin America* Forests, volume 2

(all monetary values in US$)

Land Cover Type	Total Area (ha)	Provisioning Services: Timber & Crop Values ($/year)	NTFP Values ($/year)	Watershed Protection Values* ($/year)	Biodiversity Values ($/year)	Carbon Sequestration Values ($ total)
Evergreen Forest	750,278	337,625,100	300,111,200	52,519,460	487,680,700	2,625,973,000
Deciduous Forest	174,968	61,238,800	69,987,200	12,247,760	113,729,200	612,388,000
Mixed Forest	81,946	32,778,400	32,778,400	5,736,220	53,264,900	286,811,000
Other Forest	41,224	8,294,400	8,294,400	2,885,680	22,673,200	94,815,200
Shrub & Grassland	42,472			1,486,520	4,247,200	38,224,800
Abandoned Slash & Burn	11,213			392,455	1,121,300	10,091,700
Paddy Fields	5,972	1.400,000			597,200	4,180,400
Other Croplands	711	100,000			71,100	497,700
Wetlands & Water Bodies	253				164,450	177,100
Others	1,051					
Total	1,110,085	441,436,700	411,171,200	75,268,095	1,360,897,250	3,668,978,500

*Full watershed service values are used for forested areas, a 50% of the full figure used for other non-agricultural land cover types as there is some loss of functionality with reduced land cover density.

There is consequently a diversity of ecosystem services values in the land resources of the Cardamom Mountains and it has been possible to calculate an economic value for most of these functions, as shown in Table 1. The values contained in Table 1 appear staggering, running into billions of US$ per annum. The study area in the central Cardamom Mountains is a large and resource-rich area, however, and the figures presented here are not out of line for those found in other valuation studies. For example, the total valuation in Table 1 for evergreen forests is just over $5,000/ha/year, a figure comparable to that presented for Cambodia in the recently-published summary of the TEEB programme[32] and significantly below that estimated for similar forest types in countries such as Malaysia and Brazil. The figures in Table 1 represent the dominant ecosystems service values from this area and take into account a diverse range of services including ones that have direct and immediate economic significance such as the water regulation and spoil conservation functions and ecosystem services such as potential timber values that are more hypothetical and are unlikely to be realized.

Many other valuations have not accounted for all values in this manner and consequently frequently under-represent the multiple benefits that the use of ecosystems services from land resources bring to local communities and national development alike. This approach, to take account of all the dominant ecosystem services values of the land resources of the area, is essential if a clear understanding of the need for and benefits of SLM approaches are to be understood. Assessing the costs and benefits of SLM based on only part of the story has characterized many past approaches and has tended to not reflect fully the benefits that SLM can bring. The consequence of this can be perverse policy signals that incentivize unsustainable land management practices and land conversion that appears to have short-term economic benefits but that in fact reduce the value of the land resources. The full accounting of the ecosystem services values of land resources can counter this by demonstrating that SLM approaches that conserve and protect vital ecosystems functions are not just of moral and aesthetic importance: they are also economically sensible.

32. TEEB (2009) *TEEB for Policy Makers: Summary, Responding to the Value of Nature,* page 22.

7. Moving Towards Sustainable Land Management

Preserving and enhancing these benefits requires more effective sustainable land management strategies that are attuned to the dominant service values. This in turn can require conscious decisions on trade-offs between different potential values. For example, the income from timber logging, even if conducted on a sustainable basis, can compromise biodiversity and other values. Similarly, some of the values are potentials rather than benefits that currently accrue: for example, only a small proportion of the NTFPs available in the Cardamom Mountains are actually harvested by local residents, and those gathered predominantly come from areas relatively adjacent to their homes. Similarly, there is an issue of who should pay for the benefits in a situation where the beneficiaries (such as the operators of hydropower schemes or downstream farmers) are often not directly responsible for the management of the land resources.

There are also complex governance issues related to rights and entitlements to access to land resources and the benefits of any investments in SLM approaches in a situation where, as found in the Cardamom Mountains, livelihood systems and resource utilization are based on traditional systems of customary rights in relation to common property resources rather than on documented land tenure. These issues are made even more complex where, as is again the case in some communities, there has been recent in-migration of people who are not part of the traditional customary rights systems but whose livelihoods now depend on access to the land resources of the area. The importance of effective, legitimate and understood governance arrangements for SLM and access to the benefits of ecosystem services cannot be over-stated: indeed this can be seen as a pre-condition for the introduction of most SLM approaches. This is reflected in the points made below, many of which relate to governance issues for land resources in the study area.

These issues need to be carefully balanced in the development of an integrated sustainable land management strategy for an area such as the Cardamom Mountains. Further consultation and analysis is needed to develop such a strategy but some valuable initial recommendations on possible elements of a sustainable land management strategy for the Cardamom Mountains can be identified:

- Local communities have livelihood systems that depend on sustainable access to a variety of resources gathered from local forests and lands in addition to the farmland they cultivate. The study showed that most come from a zone within five kilometres of villages and these zones could be placed under some form of communal management, with safeguards to ensure sustainable management takes place. The multiple benefits and sustainability of community-based land resource and forestry management systems have been demonstrated around the world. They are particularly effective where uncertainties exist over access rights and where resource use is based on customary rights systems rather than land ownership. Such a scheme has great potential for development in the study area and similar areas in other parts of Cambodia. This would, of course, be contingent upon the willingness of the local communities to participate in such schemes but the consultations undertaken during the fieldwork showed an understanding of the value of these resources and enthusiasm to be involved in their management. The definition of a five kilometre zone is, of course, to an extent arbitrary and the actual range of resource collection depends on additional factors such as terrain and access barriers such as steep slopes and rivers. The process of consultation can use methods such as participatory mapping or GIS to define a livelihoods support zone in more detail that reflects more closely local realities of resource use and dependency.

- The hydropower schemes currently being developed in the area will bring great benefits to Cambodia's overall development, and in turn would gain enormous economic benefits from effective watershed conservation to conserve water and reduce sedimentation.

These benefits should be reflected through a payment for ecosystems services (PES) system whereby there is a levy on electricity generated that is used to protect the watershed and benefit local communities. The exact level of such a levy would need to be decided, but it would be an extremely small fraction of the income such schemes would generate: typically less than 1% of revenue. Such a scheme would provide the economic basis for a sustainable approach to hydropower development without compromising the financial viability of the hydropower schemes in question. Although is a relatively new policy instrument and has at times been difficult to implement, experience shows that it can be particularly effective in this sort of context, where the beneficiary (and fee payer) is easy to identify and the benefits they gain are of direct and material economic value. The income from such a PES scheme has the potential to be the financial basis for a number of the other recommendations for developing SLM options outlined here. It means that the development of the area would not be dependent on resources provided from outside, whether from central government or civil society, ensuring the long-term sustainability of these measures.

- The high value biodiversity, watershed maintenance and carbon sequestration ecosystems services are contingent upon the continued maintenance of the integrity of the large forest ecosystems of the area. The Cardamom Mountains already have a series of conservation measures in place, including several designated protected areas and active work by organizations such as Conservation International. These existing conservation measures should be continued and strengthened, for example to prevent encroachment and combat illegal logging and wildlife trading. This can be paid for through the PES levy described above and through further levies on beneficiaries from these ecosystems services such as tourists to the area and downstream water users. It is stressed that this does not mean that effective and planned developments, including the hydropower schemes as well as some level of land conversion for permanent agriculture and other activities, should not take place, but rather the planning of these development should be done in a way that takes into account, and where feasible provide resources to support, the wider values of the area.

- Action is needed to regulate and limit in-migration of 'outsiders' who illegally occupy lands made accessible by improvements to road transport. Such transport improvements are both desirable and inevitable, but can lead to destructive practices such as unauthorized forest clearance and illegal logging unless there is some control over the resultant in-movement of people who do not have the traditional, more harmonious relationship to local ecosystems that long-time residents have. It is recognized that this is a sensitive issue and it is certainly not proposed that the rights to settle of legal migrants should in any way be proscribed. Rather it is a recognition of the need to balance development aspirations with the sustainable management of threatened ecosystems and land resources in this highly sensitive area. As part of this, there is a need to work with existing and new migrants to the area to assist them in developing sustainable systems of land management, including through the community-based resource management and livelihoods support groups discussed above. In particular, it is essential that SLM systems are put in place that do not try to transpose land management systems, such as lowland paddy rice, that are familiar to in-migrants to a setting where fundamental ecological characteristics are different. Rather SLM systems that are appropriate to the region need to be introduced and supported amongst in-migrants.

- The existing trend to move away from 'slash-and-burn' farming where plots are cleared in forests should be encouraged through working with local communities to develop appropriate and sustainable upland farming systems on permanent plots closer to their villages. There are over 11,000 ha of abandoned 'slash-and-burn' fields that will take many years to recover. Growing populations mean that this traditional form of cultivation

is no longer viable and incentives and technical support to move to settled agriculture should be put into place. It is not intended to compromise traditional livelihood systems through this, but rather it reflects existing trends in the evolution of these livelihoods where land management practices that were traditionally practiced on a sustainable basis are no longer able to do so.

The final conclusions from this assessment of the values of the land resources of the Cardamom Mountains are clear: these resources have multiple values, many of which have traditionally not been taken into account in many planning decisions. These resources underpin local livelihoods and are also of national and, for services such as biodiversity and carbon sequestration, global significance. The study indicates that it is possible to develop sustainable land management strategies that reflect the dynamics of change in the area and that can provide a more harmonious relationship between desirable development such as livelihood changes and hydropower investments and the long-term sustainability of the land resource base. There is a need to develop this analysis further through the more detailed assessment of specific sustainable land management options and land degradation pressures, but the valuation presented here provides the basis upon which these assessments can be made.