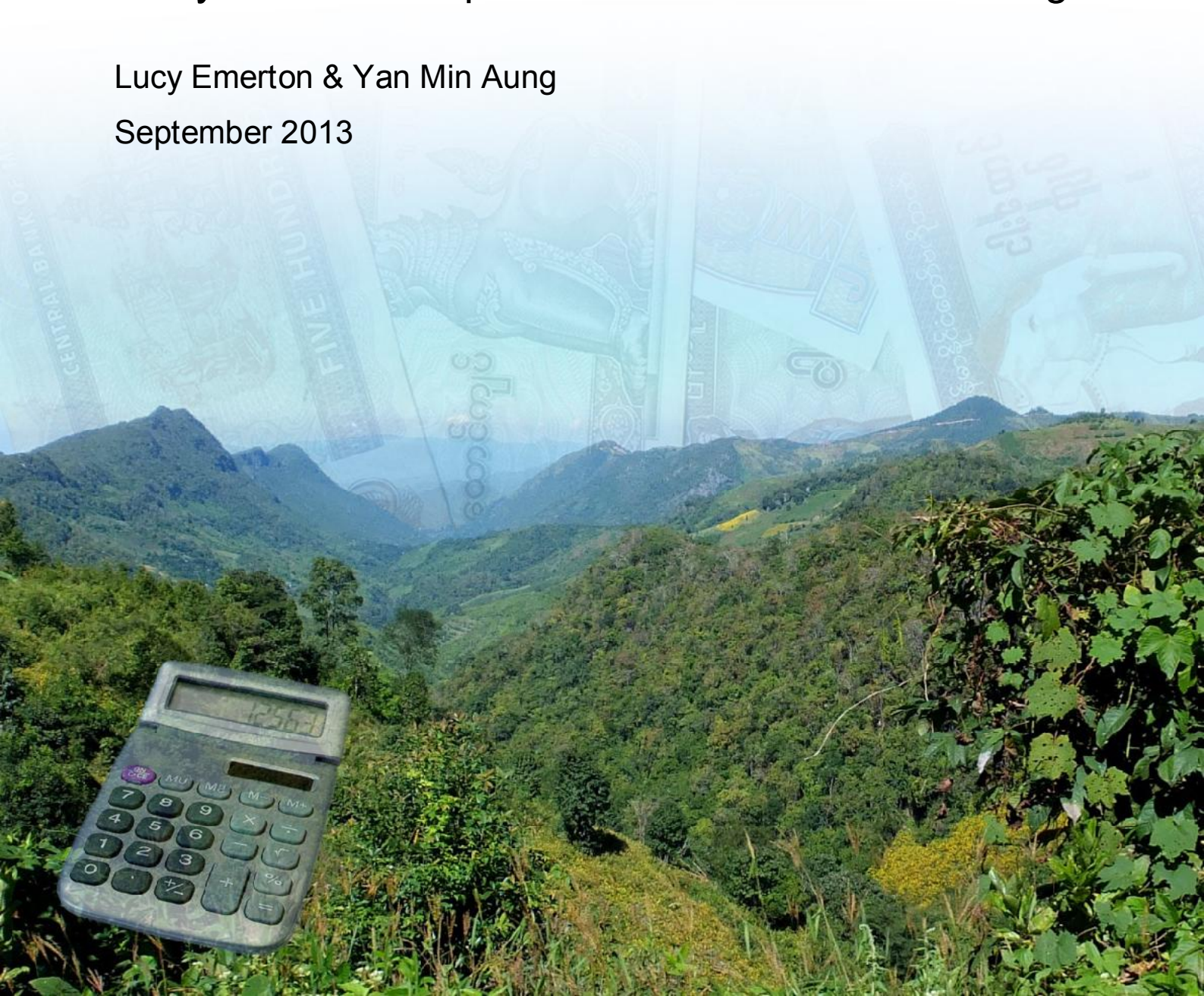
The Economic Value of Forest Ecosystem Services in Myanmar and Options for Sustainable Financing

Lucy Emerton & Yan Min Aung

September 2013



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List of acronyms

EU	European Union
FD	Forest Department
GDP	Gross domestic product
MEA	Millennium Ecosystem Assessment
MHT	Ministry of Hotels and Tourism
MMK	Myanmar Kyat (at the time of the report, US$ 1=MMK 971.00)
MNPED	Ministry of National Planning and Economic Development
MOECAF	Ministry of Environmental Conservation and Forestry
MTE	Myanmar Timber Enterprise
NPV	Net present value
NTFP	Non-timber forest products
PA	Protected area
PES	Payments for ecosystem services
tC	Tonnes of carbon
TEEB	The Economics of Ecosystems and Biodiversity
TEV	Total economic value

Acknowledgements

This document was produced under the project “Strengthening Policy Development to Meet MDGs”. The project is funded by EU and implemented by IMG. The study was carried out in collaboration with the Ministry of Environmental Conservation and Forestry.

The study relied on the support, information and ideas from many individuals, although any errors remain those of the author alone. U Yan Min Aung coordinated the study, and played a lead technical role in helping to collect and analyse the valuation data. U Kyaw Htun assisted greatly in facilitating contacts and meetings with key ministries and individuals. The overall management provided by Ms Lyndal Barry is gratefully acknowledged, as is the excellent logistical assistance of the IMG team in Yangon.

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We are especially appreciative of the assistance provided by U Aung Aung Myint of the Remote Sensing and GIS Section of the Forest Department who acted as the counterpart to the study, and also prepared some of the key maps and statistics upon which the study is based. Many thanks are also given to other MOECAF staff for their kind help and support, including Director General Tin Htun (Planning and Statistics Department), Director General Nyi Nyi Kyaw (Forest Department), Deputy Director General U Win Hlaing (Planning and Statistics), Deputy Director General U Hla Maung Thein (Environmental Conservation Department), Deputy Director General U Zaw Win (Forest Department).

Individuals from many different ministries and agencies assisted by providing information, without which it would not have been possible to carry out the study. While it is impossible to name every individual who inputted into the study with ideas, data and comments, a list of persons consulted is included as an annex to the report. Their generosity in sharing ideas and data is much appreciated. Participants at the roundtable held to present and discuss the study provided extremely useful feedback on the preliminary findings and conclusions, and made numerous suggestions for improvement.

About the valuation study

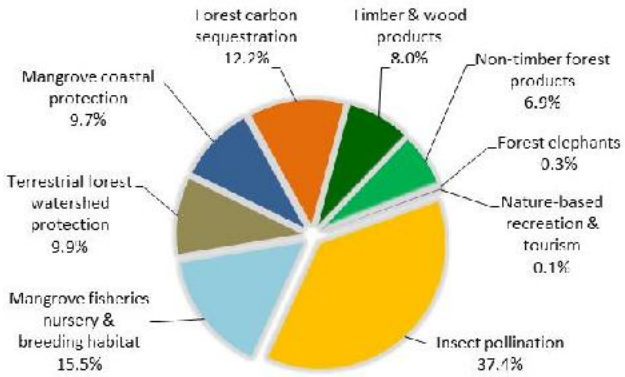
This document reports on a study carried out to assess the value of the forest sector to Myanmar's economy, in order to justify and identify niches for developing forest-based payments for ecosystem services (PES) and other mechanisms that can be used to generate financing for forest conservation.

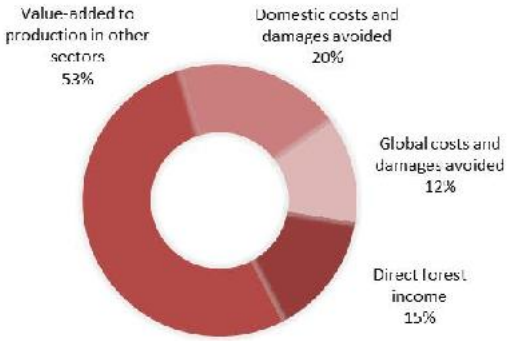
The study focuses on nine categories of forest ecosystem services that are of high importance in economic and human wellbeing terms, and for which sufficient data are available to enable monetary valuation: wood-based biomass and energy, wild foods, animal-based energy, watershed protection, coastal protection, carbon sequestration, maintenance of nursery populations and habitats, pollination and seed dispersal, and nature-based recreation and tourism.

The study first assesses the baseline: it identifies the ecosystem services that are currently being generated by the forest sector, and estimates their economic value. It then models two possible policy and management futures: "Forest Degradation", under which forest lands and resources continue to be degraded and over-exploited; and "Forest Conservation", under which forests are used sustainably and conserved effectively according to the goals and targets laid out in the Forestry Masterplan.

What do forest ecosystem services contribute to the economy?

The current annual value of forest ecosystem services is estimated to be MMK 7 trillion or US$ 7.3 billion. This is far higher than the figures recorded in most development and economic statistics, which only take account of commercial wood and non-wood product removals. Income earned from forest utilisation accounts for less than 15% of the value estimated in this study. By far the largest share – 85%, or around MMK 6 trillion (US$ 6 billion) – comes from forest ecosystem services that maintain the productivity of other sectors, add value to their output, and help them to avoid costs, losses and damages.

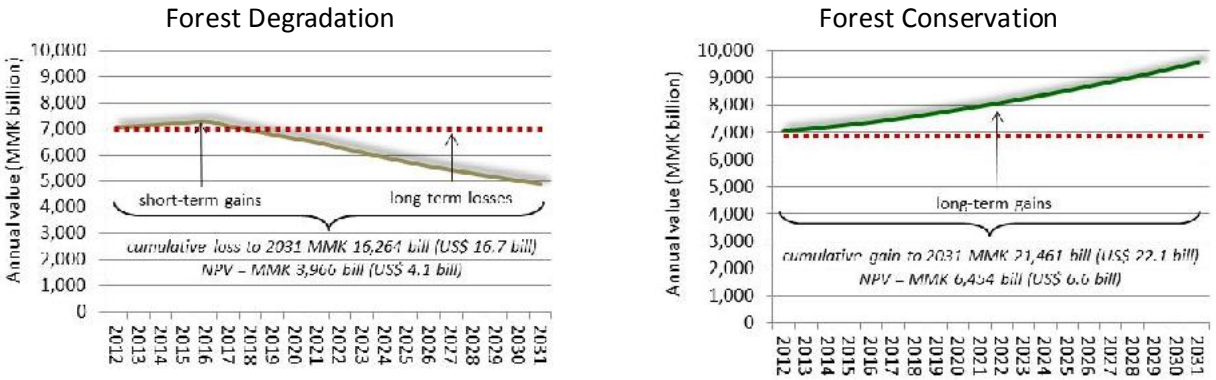




What are the economic impacts of forest ecosystem conservation and loss?

The study finds that although there may be short-term gains from converting, degrading and over-exploiting forest lands and resources, these cannot be maintained over the longer-term. Ecosystem values will decrease over time, as the ability of forests to provide key goods and services is progressively eroded. It is estimated that the "Forest Degradation" scenario could incur losses to 2031 of more than MMK 16 trillion (US$ 17 billion) to Myanmar's economy over the current situation.

In contrast, forest conservation is projected to result in a steady increase in economic values, as the quality of forest ecosystem services continues to improve. Although values will be sustained, the rate of growth will slow over time as ecosystem and biodiversity status is restored and forest conservation effectiveness targets are reached. It is estimated that the "Forest Conservation" scenario will add values to 2031 of more than MMK 21 trillion (US$ 22 billion) to Myanmar's economy over the current situation.



The study shows that, while there are considerable economic benefits to be gained from investing in forest conservation and sustainable use, forest ecosystem degradation and loss stands to incur substantial costs and losses to Myanmar's economy. Over the next twenty years, the net gain or value-added to the economy from choosing to invest in forest conservation rather than to allow forests to continue to be degraded are estimated to be around MMK 37 trillion (US$ 39 billion) – which translates to a Net Present Value of some MMK 9 trillion (US$ 10 billion).

What is the rationale for capturing ecosystem values as conservation funding?

It is clear that public investment in forest conservation yields high development returns. Every MMK 1 invested by the government in forests helps to leverage more than MMK 40 worth of benefits to Myanmar's economy and population each year. Water, tourism, energy, industry, agriculture, fisheries and infrastructure sectors all stand to gain from the continued provision of forest ecosystem services, and run the risk of incurring substantial costs if they are degraded and lost. Forest ecosystem services also underpin key cross-cutting national development goals such as diversifying rural livelihoods, reducing poverty, enhancing food security, improving access to basic services, strengthening resilience and disaster risk reduction and adapting to climate change.

While a large number of groups and sectors in Myanmar gain in economic terms from forest ecosystem services, they receive these benefits at low or zero cost. MOECAF is essentially subsidising the supply of valuable inputs and services to the broader economy through its budgetary spending. Yet it is not certain that current financing levels are sufficient to ensure that forest ecosystem services will be sustained into the future. There remains a critical shortage of funding for essential management activities, and managers face pressing budget constraints which constrain their ability to conserve forests effectively.

The study concludes that the forest sector is not being managed to its full economic potential: there remain untapped opportunities to increase the level of revenues generate from forest ecosystem services. The sectors and industries that benefit from forests should (where they are economically able to do so) contribute towards the costs of ecosystem services provision, and pay for their use – just as they do for the other inputs, facilities and services that they consume or use to generate production. In turn, any revenues generated should be reinvested in forest conservation, so as to ensure the continued supply of the valuable ecosystem services that the forest sector supplies to the economy.

Which forest financing mechanisms have potential for development?

The study suggests that there are many opportunities to better capture forest values as conservation funding flows. In particular, the principles of "user pays", "cost-recovery", "cost-sharing" and "market development" could be extended to ecosystem services.

Five conservation financing mechanisms that are already widely used in other parts of the world are recommended as having potential for development in Myanmar: introducing payments for forest ecosystem services; accessing forest carbon finance, including REDD+; developing forest biodiversity offset funding; mainstreaming forest conservation into the budgets of other sectors; and establishing a forest conservation fund to attract, earmark, retain and reinvest income and funding.

BACKGROUND: about the study 1

The project

This study on the economic value of forest ecosystem services was undertaken as part of the support being provided to the Government of the Union of Myanmar under the EU-funded programme ""Strengthening Policy Development to Meet MDGs".

The programme has three components: environmental and land governance; national planning and strengthening the statistics system to promote stable reform; and targeted assistance in the areas of trade and migration. The economic valuation study is being carried out under the first component of the programme: environmental and land governance.

The initial phase of this component focuses on capacity building activities for officials from different ministries and departments, to improve their capacity to enforce environmental legislation and coordinate environmental policy implementation, within the Ministry of Environmental Conservation and Forestry (MOECAF) and other ministries. A second phase will focus on supporting the process of policy development necessary to establish the regulations and by-laws to underpin the new environment law and other relevant environmental aspects.

Context and objectives

According to the broader aims of the programme, the **context** of the valuation study is to contribute towards collaboratively collecting evidence and experience for sound decision-making in policy and regulation formulation, so as to enable MOECAF and other relevant line ministries to fulfil their existing and emerging functions successfully.

The agreed **overall objective** of the study is also set by the environmental and land governance component of the programme. It is to generate information on the economic value of key natural ecosystems and associated constraints and opportunities for sustainable economic growth, to be used as a foundation for evidence-based policy making and advocacy for safeguarding environmental services, as well as providing MOECAF with a sound justification and basis for engagement with other ministries in mainstreaming environmental issues into sectoral policies and planning.

The specific objective of the study were determined in consultation with MOECAF, intending to ensure that its scope and focus would reflect current government concerns and interests, and that the ultimate findings would be relevant and useful with respect to ongoing public policy and planning goals.

The **specific objective** is to assess the value of the forest sector to national and local economies in order to justify and identify niches for developing forest-based payments for ecosystem services (PES) and other mechanisms that can be used to generate financing for forest conservation.

The valuation study was carried between June and September 2013. It is based on a desk review of published and unpublished documents and data, analysis of government statistics, expert interviews and stakeholder consultations. The assignment included three missions to Myanmar.

Content of the report

The report contains five chapters in addition to this background section:

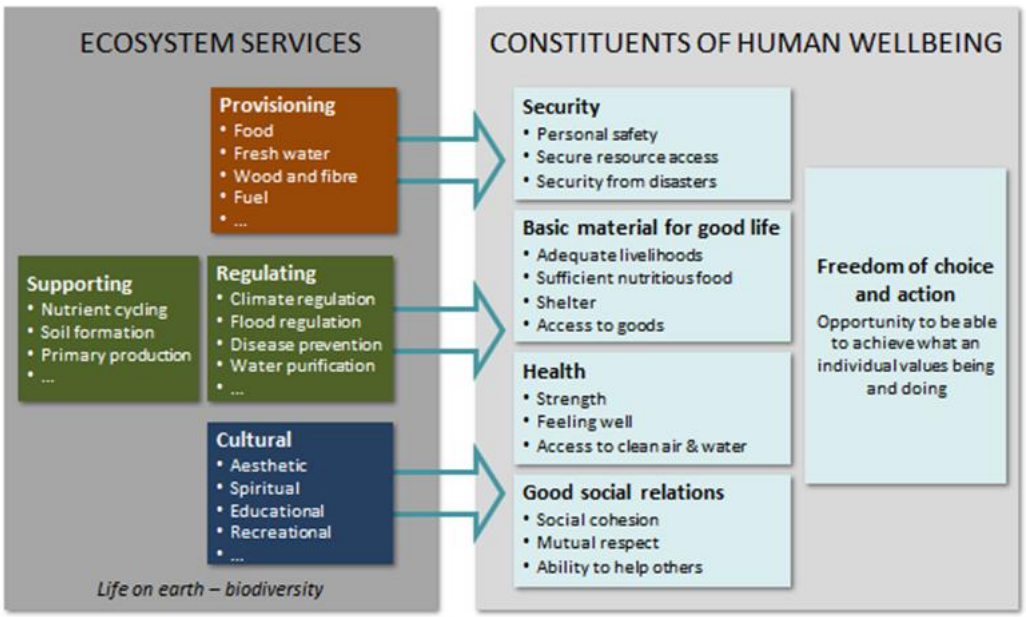
- Chapter 2 describes the overarching **conceptual frameworks** that are used to categorise ecosystem services, classify economic values, and trace through the economic linkages and opportunities associated with ecosystem values;
- Chapter 3 provides an overview of the **study methodology**, including the steps followed, the valuation techniques and data sources used and the assumptions used to model future economic scenarios;
- Chapter 4 documents the **current value** of forest ecosystem services;
- Chapter 5 summarises the **economic costs and benefits of different future forest sector scenarios**; and
- Chapter 6 looks at needs and niches to better capture, compensate and reward forest ecosystem values, and identifies possible opportunities to develop **sustainable financing mechanisms** for forest conservation.

The study draws on and combines three commonly-used approaches for assessing the links between ecosystem services and the economy. This brings the approach in line with what is widely considered to be current best international practice, relates it to models which have already gained currency and acceptance among economic and conservation decision-makers and researchers, and ensures its consistency with initiatives which are being carried out in other parts of the world.

Categorising ecosystem services and economic values

The study characterises forest ecosystem services in Myanmar according to the four basic categories suggested by the **Millennium Ecosystem Assessment** (MEA) – provisioning, regulating, supporting and cultural services (Figure 1). As described in the MEA (MEA 2005), ecosystem services do not just generate products and raw materials, but also provide the primary productivity and vital life support services that are critical to human wellbeing and to the functioning of the economy. It is now commonplace for conservation planners and policy-makers to conceptualise ecosystem services in these terms.

Figure 1: ecosystem services and human wellbeing



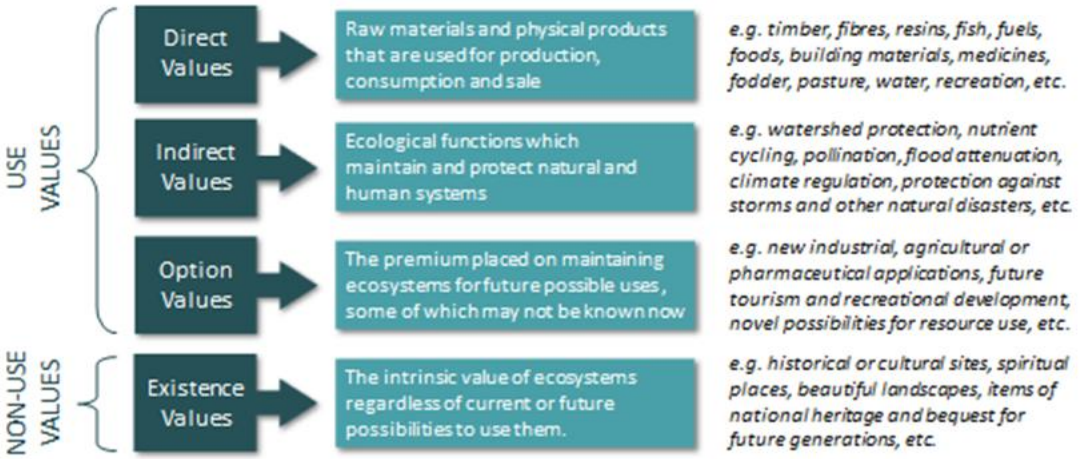
From Millennium Ecosystem Assessment 2005

The concept of **Total Economic Value** (TEV) is used to articulate the value of Myanmar's forest ecosystem services in economic terms. Over the last two decades, TEV has become the most widely-applied framework for identifying and categorising ecosystem values (Emerton and Bos 2004). The major innovation of TEV is that it extends beyond the marketed and priced commodities to which economists have conventionally limited their analysis, and considers the full gamut of economically important goods and services associated with ecosystems (Figure 2).

Looking at the TEV of ecosystems involves considering their complete range of characteristics as integrated systems – resource stocks, flows of services, and the attributes of the ecosystem as a whole, including:

- **Direct values**: the raw materials and physical products that are used directly for production, consumption and sale such as those providing income, energy, shelter, foods, medicines and recreational facilities.
- **Indirect values**: the ecological functions that maintain and protect natural and human systems such as regulation of water quality and flow, flood control, micro-climate stabilisation and carbon sequestration.
- **Option values**: the premium placed on maintaining a pool of species and genetic resources for future possible uses, some of which may not be known now, such as leisure, commercial, industrial, agricultural and pharmaceutical applications and water-based developments.
- **Existence values**: the intrinsic value of ecosystems and their component parts, regardless of their current or future use possibilities, such as cultural, aesthetic, heritage and bequest significance.

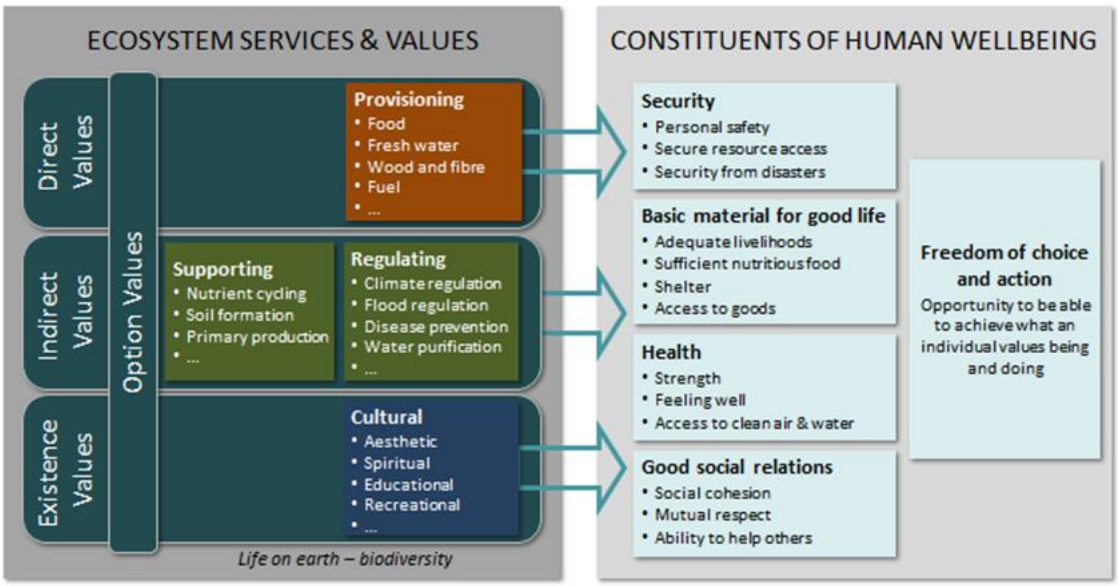
Figure 2: the total economic value of ecosystem services



From Emerton 2012

Each of the categories of TEV correspond to a different component of the MEA framework (Figure 3): direct values to provisioning services, indirect values to supporting and regulating services, existence values to cultural services, and option values potentially cross-cutting all four categories of ecosystem service.

Figure 3: ecosystem services and economic value



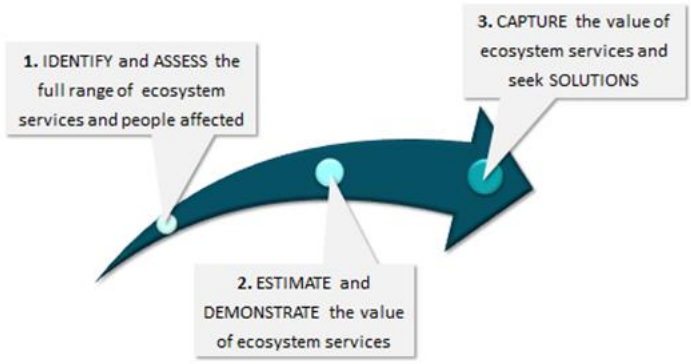
From Emerton 2012

Identifying, estimating and capturing ecosystem values

The study adopts the stepwise scheme proposed by **The Economics of Ecosystems and Biodiversity** (TEEB) to analyse the information generated on the economic value of Myanmar's forest ecosystem services. TEEB is a global programme of work which arose from the 2007 meeting of G8+5 environment ministers in Potsdam, Germany. The meeting agreed to "initiate the process of analysing the global economic benefit of biological diversity, the costs of the loss of biodiversity and the failure to take protective measures versus the costs of effective conservation".

The TEEB initiative presents an approach that can help decision-makers recognise, demonstrate and capture the values of ecosystems and biodiversity. TEEB approaches are currently being applied in many places (including the EU and ASEAN), at regional, national and sectoral levels.

Figure 4: TEEB three-tiered approach to ecosystem valuation



From TEEB 2010

TEEB proposes a three-tiered approach to ecosystem valuation (Figure 4, TEEB 2008, 2010), which is used in the current study:

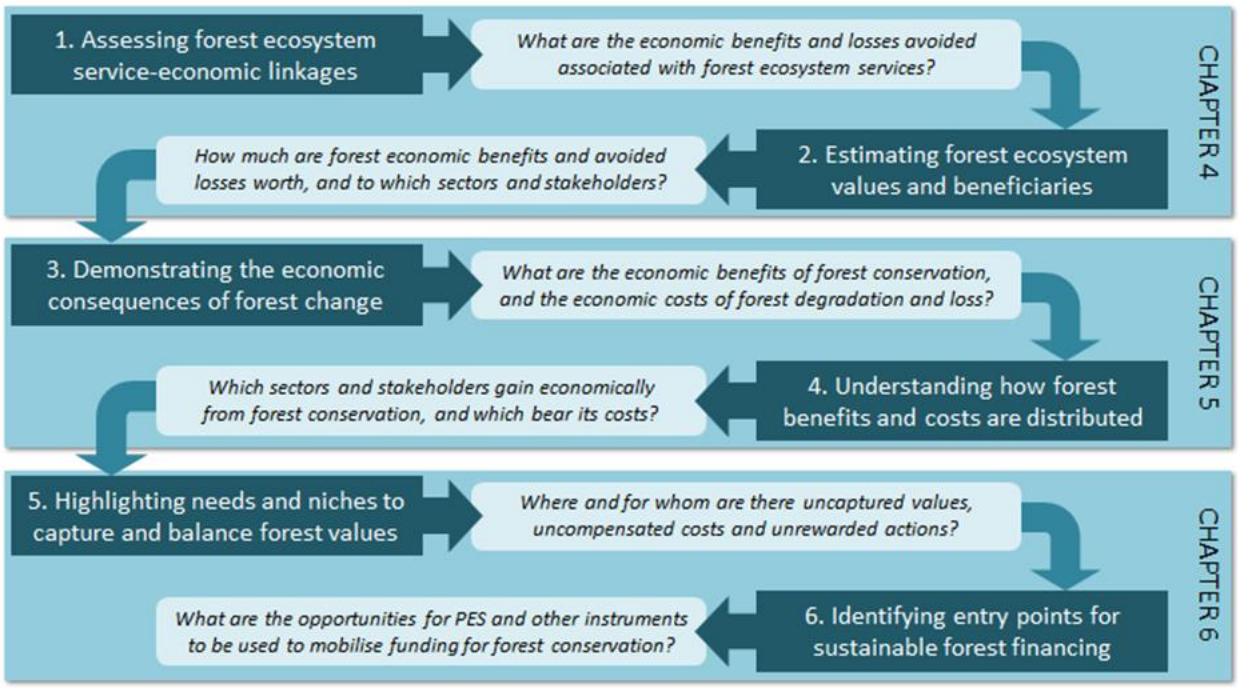
- First of all, it is necessary to **identify and assess** the full range of ecosystem services affected and the implications for different groups in society. This involves including the full range of stakeholders influencing and/or benefiting from the affected ecosystem services and biodiversity;
- Second the value of ecosystem services should be **estimated and demonstrated**, using appropriate methods. This involves analysing the linkages over scale and time that affect when and where the costs and benefits of particular uses of biodiversity and ecosystems are realised, to help frame the distributive impacts of decisions; and
- Last, but not least, comes the step of **capturing the value of ecosystem services and seeking solutions**, in other words to overcome their undervaluation using economically-informed policy instruments.

Steps and key questions

In order to apply the thinking and frameworks outlined in Chapter 1 to Myanmar's forest sector, the study follows six iterative **steps**. Each step is documented in the chapters of this report, and aims to answer a specific question (Figure 5):

1. Assessing forest ecosystem service-economic linkages: what are the ecosystem services that the forest sector generates, and how do these generate economic benefits and help to reduce or avoid economic costs and losses?
2. Estimating forest ecosystem values and beneficiaries: what is the monetary value of forest ecosystem services, and to which sectors and stakeholder groups do these values accrue?
3. Demonstrating the economic consequences of forest change: what are the likely economic benefits of improved and more effective forest conservation and sustainable management, and what are the likely economic costs of forest ecosystem degradation and loss?
4. Understanding how forest benefits and costs are distributed: which stakeholder groups and sectors stand to benefit from improved forest conservation and sustainable management and which will bear the costs of improved forest conservation and sustainable management?
5. Highlighting needs and niches to capture and balance forest values: to what extent, for which sectors and stakeholder groups, and in relation to which forest ecosystem services, do there remain uncaptured ecosystem values, uncompensated management costs and unrewarded conservation actions? and
6. Identifying entry points for sustainable forest financing: what are the gaps, needs and opportunities to mobilise additional financing in support of forest conservation, including through PES?

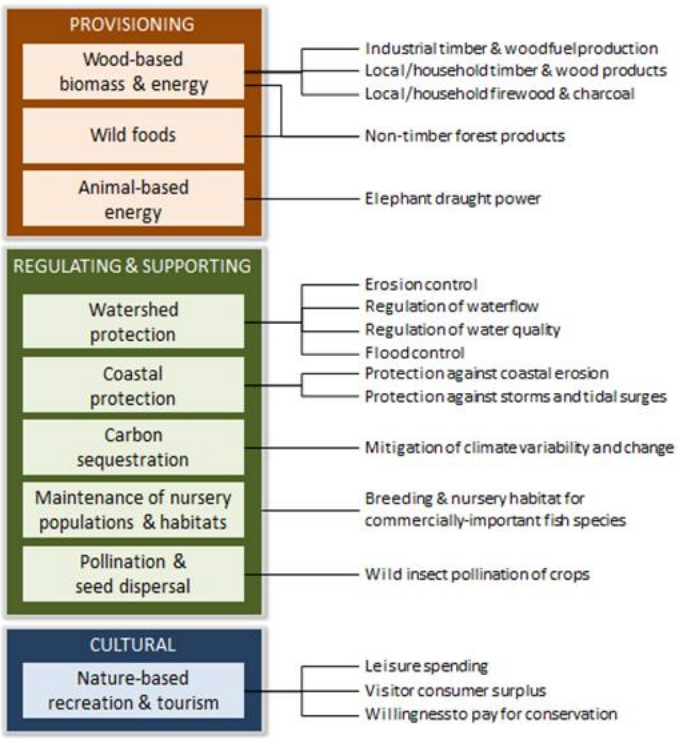
Figure 5: steps in the valuation study



Forest ecosystem services included in the study

No systematic assessment of forest ecosystem services has yet been carried out in Myanmar, and up-to-date information is extremely scarce. Because of the difficulties in accessing reliable socio-economic and biophysical data, it is not possible to value each and every ecosystem service associated with the forest sector. The study therefore focuses on nine categories of forest ecosystem services that are of the greatest importance in economic and human wellbeing terms, and for which sufficient data are available to enable monetary valuation: wood-based biomass and energy, wild foods, animal-based energy, watershed protection, coastal protection, carbon sequestration, maintenance of nursery populations and habitats, pollination and seed dispersal, and nature-based recreation and tourism (Figure 6).

Figure 6: forest ecosystem services considered in the valuation study



Valuation techniques and data sources

The question of how to place a monetary value on ecosystem services has long posed something of a challenge to economists. The easiest and most straightforward way to value goods and services, and the method used conventionally, is to look at their market price: what they cost to buy or are worth to sell. In the current study, it has been possible to use market price techniques to value selected forest provisioning services: timber, woodfuel and NTFP harvesting, and the leisure spending associated with nature-based tourism and recreation. The main data sources are national and local-level statistics provided by the Forestry Department and MOECAF, and those documented in FAO 2010, Khin Htun 2009, MOECAF 2011a and MNPED 2012.

Many forest ecosystem services however have no market price (or are subject to market prices which are highly distorted). This is the case for most of the regulating, supporting and cultural services generated by Myanmar's forests, and some of the provisioning services. For this reason, other valuation techniques must be found. Over recent decades a suite of methods have been developed with which to calculate ecosystem values that cannot be estimated accurately via the use of market prices. These are used in the current study (Table 1), and include (from Emerton and Bos 2004):

- **Production function approaches:** relate changes in the output of a marketed good or service to a measurable change in the quality of quantity of ecosystem goods and services by establishing a biophysical or dose-response relationship between ecosystem quality, the provision of particular services, and related production. In the current study, the value of mangroves for the maintenance of nursery populations and habitats of commercially important fish species and the value of wild insects for crop pollination are estimated using effect on production methods;
- **Surrogate market approaches:** look at the ways in which the value of ecosystem goods and services are reflected indirectly in people's expenditures, or in the prices of other market goods and services. In the current study, the value of certain non-traded, locally-harvested NTFP are estimated using surrogate market methods;
- **Cost-based approaches:** assess the market trade-offs or costs avoided of maintaining ecosystems for their goods and services. They assess the expenditures that are saved by not having to invest in physical infrastructure and measures to replace, mitigate or remediate ecosystem service loss, or the physical damages that are avoided. In the current study, the value of elephant draught energy, watershed protection, coastal protection and carbon sequestration are estimated using cost-based methods; and
- **Stated preference approaches:** rather than looking at the way in which people reveal their preferences for ecosystem goods and services through market production and consumption, these valuation techniques ask consumers to state their preference directly. In the current study, the visitor consumer surplus and willingness to pay for conservation associated with nature-based tourism are estimated using stated preference methods.

Table 1: valuation methods used in the study

Ecosystem service	Component	Valuation method	Indicator of value
Wood-based biomass & energy	Industrial timber & woodfuel production	Market prices	Value of roundlogs harvested from Permanent Forest Estate
	Local/household timber & wood	Market prices	Value of wood collected for house construction, fuel and other purposes
	Local/household firewood & charcoal		
Wild foods	Local/household non-timber forest products	Market prices, surrogate prices	Value of harvested fruits, vegetables, nuts, berries, mushrooms, fibres, resins, etc.
Animal-based energy	Elephant draught power	Replacement costs	Cost savings on alternative forms of timber transport
Watershed protection	Erosion control, regulation of waterflow, regulation of water quality, flood control	Mitigative & avertive expenditures, damage costs avoided	Cost savings on mitigation, remediation & physical protection
Coastal protection	Protection against coastal erosion		Cost savings from damages to houses, crops, infrastructure and other assets; and physical protection structures
	Protection against storms & tidal surges		
Carbon sequestration	Mitigation of climate variability & change	Damage costs avoided	Avoided damage costs from carbon stored in terrestrial and mangrove forests
Maintenance of nursery populations & habitats	Breeding and nursery habitat for commercially-important fish species	Effects on production	Value-added to inshore and offshore production of fish, crustacean and other marine products
Pollination & seed dispersal	Wild insect pollination of crops		Value added to cereals, oil crops, pulses, fruits, vegetables, roots and tubers, stimulant crops, sugar crops, treenuts, fodder crops that are dependent on insect pollination
Nature-based recreation & tourism	Leisure spending	Market prices	Income generated by protected area tourism
	Visitor consumer surplus	Stated willingness to pay	Value for international tourists visiting protected areas
	Willingness to pay for conservation		

This is the first time that an attempt has been made to value Myanmar's forest ecosystem services. Aside from records on commercial wood and fisheries production, there are no pre-existing estimates of the economic value of biodiversity and ecosystem services. There is also a critical lack of ecological, biological, hydrological and other information pertaining to the forest sector and its ecosystem services. Of necessity, "benefit-transfer" techniques have therefore been used to value many of the supporting, regulating and cultural services associated with forests. This refers to cases where ecosystem service values are transferred from studies which have been carried out in other countries.

There are many hazards in using such an approach, which are mainly to do with the credibility of applying data about one site to another context which might have very different biological, ecological and socio-economic characteristics. For this reason, where benefit transfer techniques have been used, a conservative approach has been taken, and efforts have been made to ensure that transferred values are as appropriate as possible to the situation of Myanmar.

All data sources are clearly referenced. Transferred values have been adjusted to bring them to 2012 Myanmar price levels, applying a consumer price index (CPI) deflator to account for domestic inflation, and using appropriate Gross Domestic Product Purchasing Power Parity (GDP PPP) conversion rates to equalise differences between Myanmar and other countries. The resulting unit values have then been applied to country-specific data for Myanmar on the relevant area of land, quantity of production or affected population/sectors. The primary source of benefit-transfer data is valuation studies that have been carried out in neighbouring or nearby South and Southeast Asian countries which share similar economic, institutional and ecological conditions to Myanmar. It is only for the consumer surplus and willingness to pay for conservation associated with nature-based tourism that estimates from other parts of the world (in this case Central, Southern and Eastern Europe) have been used, where international nature tourists have a similar profile to those visiting protected areas in Myanmar.

Scenarios and assumptions of forest ecosystem change

Coming up with a snapshot figure of the economic value of forest ecosystem services in Myanmar has little meaning. It is not a case of trying to show that "forest ecosystem services are is worth *x* amount", but rather "course of action or situation *a* would add this much additional value (or incur this much additional cost) as compared to course of action or situation *b*". It is the change in the value of ecosystem services that arises from a change in forest management regime or shift in land and resource use that is of interest.

To do this, the study first assesses the **baseline**: it identifies the ecosystem services that are currently being generated by the forest sector, and estimates their economic value. It then models two possible policy and management futures for the forest sector (and, by implication for the status of biodiversity and ecosystem services): **"Forest degradation"**, under which forest lands and resources continue to be degraded and over-exploited; and **"Forest conservation"**, under which forests are used sustainably and conserved effectively according to the goals and targets laid out in current government policies and plans.

The difference between the two scenarios represents the economic value-added and cost-avoided of maintaining forest ecosystem services. The scenarios presents (very simplified and generalised) models of how the use of land and resources, and the type and quality of ecosystem services generated, might change in the future. A period of twenty years (2011/12-2030/31) is chosen for the scenario analysis as it reflects the schedule of the National Comprehensive Development Plan and other sectoral policies, strategies and plans, including the Forestry Masterplan.

The valuation study is thus, in effect, attempting to **estimate the value-added and cost-avoided to the Myanmar economy to 2031 of implementing the Forestry Masterplan and associated government strategies and plans**. Baseline figures are taken from existing government records and statistics, while actual past trends and stated future government targets provide the basis for making projections (Table 2). The scenarios, and the assumptions they are based on, were built up and validated during a workshop held with technical staff from MOECAF and other forest-dependent sectors in September2013.

Table 2: baseline and scenarios data sources and assumptions of change

Variable	Baseline	Change assumptions and sources	
		Conservation	Degradation
Land cover			
Protected Areas	National Biodiversity Strategy and Action Plan (MOECAF 2011b)	Target to 2031 cited in National Biodiversity Strategy and Action Plan (MOECAF 2011b)	No change from baseline
Terrestrial forest (by forest type and functional/ management categories)	From Global Forest Resource Assessment (FAO 2010)	2010 baseline figures and 2031 targets cited in Forestry Masterplan (MOECAF 2011a) and District Forest Management Plans	Continuation of actual annual rates of change 1990-2010 as cited in Global Forest Resource Assessment (FAO 2010),
Forest in reservoir watersheds	From FD data	Assumed to grow steadily in line with expansion of water supply and hydropower production	
Mangroves		For Y1-5 from actual annual rates of change 1990-2010 as cited in Global Forest Resource Assessment (FAO 2010), then decreasing rate of loss.	
Terrestrial forest			
Forest-dependent rural population	From FD data	For Y1-5 grows in line with half of national population growth rates, then growth rate declines due to resettlement of in-forest populations and urban shift of forest-adjacent populations	Grows in line with half of national population growth rates,
Industrial timber production	Total volume from FD data (MOECAF 2011a), proportion distributed to different uses from Myanmar Industrial Sector Development 30-year Plan (cited in Khin Htun 2009)	From MTE targets expressed in Myanmar Industrial Sector Development 30-year Plan (cited in Khin Htun 2009), modified according to current MTE plans and targets	Initially increases Y1-10 then decreases steadily due to deforestation and exhaustion of stocks
Industrial fuelwood & charcoal production	From Myanmar Data 2011 (MNPED 2012)	Small but steady increase as industrial and urban demand grows	
Local woodfuel per capita consumption	From FAO Myanmar Forestry Outlook (Khin Htun 2009)	Increases in line with half of rural population growth rate, due to shift to other domestic fuel sources	
Local NTFP value per household	Value-transfer (see Chapter 1 for sources)	No change in real price	No change Y1-5 then decreases steadily due to increasing scarcity and declining quality of products
NTFP export value	From FAO Myanmar Forestry Outlook (Khin Htun 2009)	Small but steady increase reflecting improved product quality and ability to access higher-value markets. Note: export ban on roundlogs is assumed from 2014, reflecting current policy	
Roundlog prices	Domestic from MTE data; export from FD data		
Fuelwood market price	From Myanmar Data 2011 (MNPED 2012)	No change in real price	
Charcoal market price	From Myanmar Data 2011 (MNPED 2012)		
Terrestrial forest per hectare carbon value	Value-transfer (see Chapter 1 for sources)	Small but steady increase as carbon markets develop and Myanmar is better able to capture premium prices	
Terrestrial forest per hectare watershed protection value	Value-transfer (see Chapter 1 for sources)	Small but steady increase as downstream water-dependent industries expand and forest quality improves	No change Y1-5 then decreases steadily due to deterioration of forest cover and quality

Variable	Baseline	Change assumptions and sources	
		Conservation	Degradation
Mangroves			
Fish catch	From Department of Fisheries data	No change: MSY is already being fully-tapped according to National Sustainable Development Strategy (MOF 2009)	Initially increases Y1-5 then decreases due to over-exploitation of stocks
Fish market price	From Myanmar Data 2011 (MNPED 2012)	No change in real price, although nominal prices rise in line with inflation	No change in real price
Mangrove contribution to offshore catch - fish	Value-transfer (see Chapter 1 for sources)		No change Y1-5 then decreases steadily due to deterioration of mangrove cover and quality
Mangrove contribution to offshore prawn catch	Value-transfer (see Chapter 1 for sources)		
Mangrove contribution to inshore fish catch	Value-transfer (see Chapter 1 for sources)		
Mangrove contribution to inshore prawn catch	Value-transfer (see Chapter 1 for sources)		
Mangrove local NWFP value per hectare	Value-transfer (see Chapter 1 for sources)		
Carbon price per tonne	From State of the Voluntary Carbon Markets 2012 (Peters-Stanley and Hamilton 2012)	Small but steady increase as carbon markets develop and Myanmar is better able to capture premium prices	No change Y1-5 then decreases steadily due to reduced quality and difficulties in marketing
Mangrove per hectare carbon sequestration	From Huxham 2013	No change	No change Y1-5 then decreases steadily due to deterioration of mangrove cover and quality
Mangrove per hectare coastal protection value	Value-transfer (see Chapter 1 for sources)	Small but steady increase due to expanded settlements and infrastructure depending on protection services, and increased disaster incidence and impact due to climate change	
Tourism & recreation			
Total visitors to Myanmar	From Ministry of Hotels and Tourism data (MHT 2012)	Increases in line with Tourism Masterplan Targets (ADB 2013a,b,c)	Increases in line with Tourism Masterplan Targets (ADB 2013a,b,c)
Average length of stay in Myanmar	From Ministry of Hotels and Tourism Statistics (MHT 2012) and Tourism Masterplan (ADB 2013a)	No change	No change
Visitor leisure spending	From Tourism Masterplan (ADB 2013a)	Increases in line with Tourism Masterplan Targets (ADB 2013b)	Increases in line with Tourism Masterplan Targets (ADB 2013a,b,c)
Visitors to Protected Areas	From MOECAF data	Increase as facilities improve and tourist demand grows	Initial increase Y1-5 then decreases as visitor experience and demand declines
Average length of stay in Protected Areas	Estimated at 1.25 days		
Nature tourists consumer surplus and willingness to pay for conservation	Value-transfer (see Chapter 1 for sources)		
Crops and pollination			
Crop value (production and prices)	Myanmar Data 2011 (MNPED 2012)	Small but steady increase, reflecting rise in productivity and value-added from agriculture	No change Y1-5 then steady decline reflecting declining insect populations
Logging elephants			
Number of logging elephants	MTE data, MNDPED 2012	Changes in line with change in roundlog extraction	No change Y1-5 then steady decline reflecting shift to mechanised transport
Real value of logging elephant		No change	No change

Data constraints and limits to valuation

This is an extremely ambitious study, given that it is based only on pre-existing information (no primary data has been collected), and has been carried out over a relatively short time period. It must be noted that in many cases the data that were available to the study contained gaps, were of doubtful quality and accuracy, or showed significant inconsistencies (and even contradictions) between different sources.

As well as the limitations to the study that arise from poor data quality and coverage, it should be emphasised that extrapolating current ecosystem values into the future is also both imprecise and risky, and involves many unknowns. As interesting (and hopefully useful) as the aggregate numbers presented in this report are, the reader must also always bear in mind that such figures will inevitably mask some important elements of ecosystem service values, and over-simplify the complex dynamics and relationships at play when looking at the impacts of ecosystem change on ecosystem service provision and economic values.

Of particular concern is the lack of information about the sustainability of current ecosystem use, and about what future levels might be supportable in different sites and for different ecosystems. Another important issue is that the calculations in this report do not account for non-linearities and threshold effects in ecosystem functioning. Other parameters, such as the degree of human dependence on ecosystem services, the real value of these services over time, and changes in population, demography, income levels and societal preferences all affect ecosystem values, and also cannot be predicted with any certainty. This is especially the case given the rapid livelihood, economic, social and institutional changes that are currently taking place in Myanmar.

The study represents a first attempt to value and model Myanmar's forest ecosystem services. The figures presented in this report should be understood within these limitations – they are partial, indicative estimates, generated for communication, awareness and policy/management support purposes. They should be seen as a broad indication of what *might* occur under different forest management futures, rather than a definitive statement of what *will* happen. It is to be hoped that as better and more accurate information becomes available, value estimates can be updated and improved.

Wood-based biomass and energy

Just under half of Myanmar's land area or 317,730 km^2, is classified as forest (Figure 7), of which around two thirds comprise Permanent Forest Estate (MOECAF 2011a). In 2010, forest was dominated by mixed deciduous forest (38% of the total), hill and temperate evergreen forest (27%) and tropical evergreen forest (17%). Around 40% is categorised as closed forest, and just under 60% as open forest (40%). Up-to-date figures do not exist on forest cover, but it should be noted that the area of land that is actually covered by trees is considerably less than this.

Timber harvesting has long been an important source of income, government revenues and foreign exchange earnings in Myanmar. A total production volume of 538,340 tonnes of teak and 2,725,700 tonnes of other hardwoods was recorded in 2009/10 (MOECAF 2011a).

Timber is destined for a variety of markets. Private enterprises purchase roundlogs from Myanmar Timber Enterprise (MTE); after processing, veneer and high-quality sawlogs are exported in log form, and low-quality logs are transferred to sawmills and wood-processing factories (Khin Htun 2009). In 2011, around a fifth of log production was destined for sawmills, 3% for local sales, 4% for wood-based industries and just under 45% for export (MNPED 2012). In 2012/13 exports of roundlogs, sawn wood, finished products and other wood items were worth more than US$ 700 million or almost MMK 690 billion (FD records).

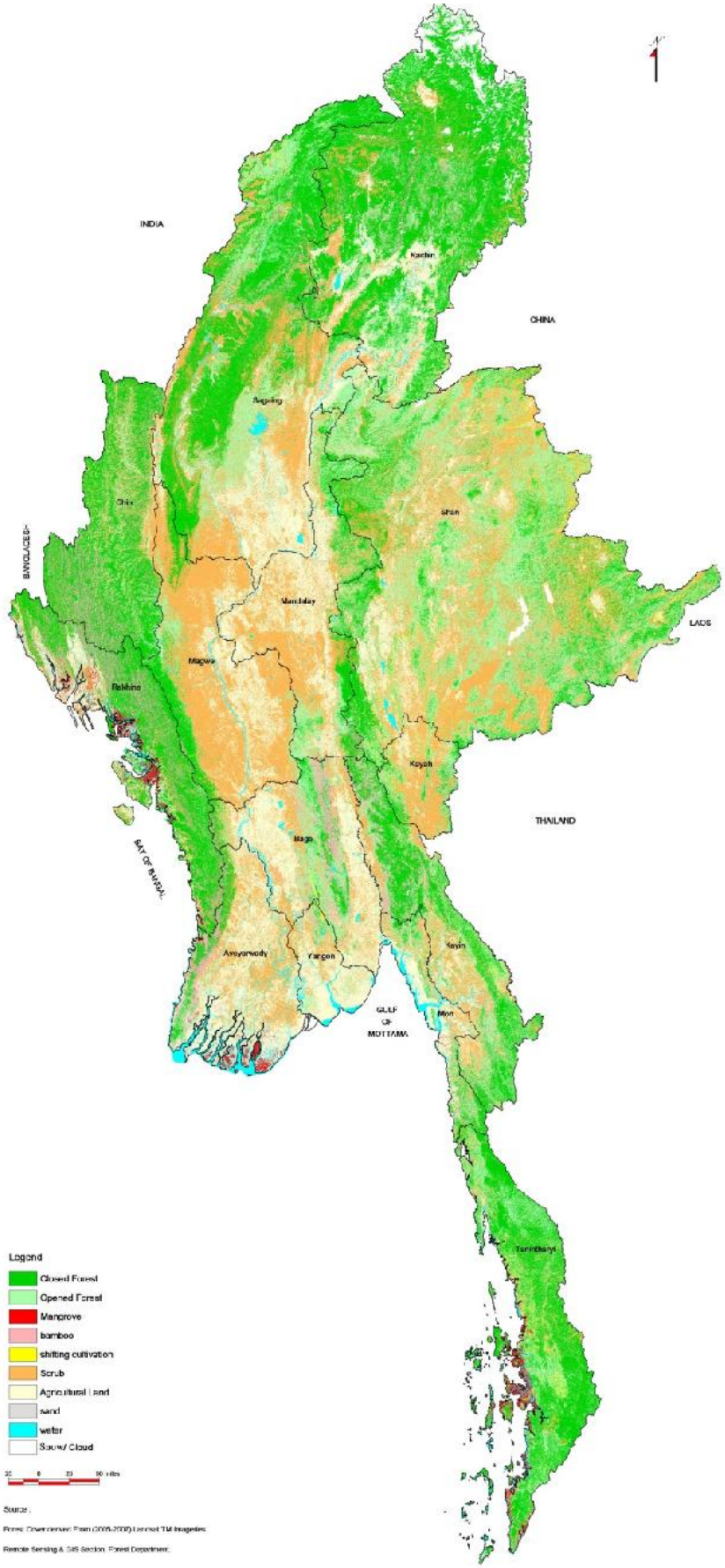
There is also known to be a substantial informal cross-border timber trade, especially to supply markets in China (Forest Trends 2011, 2012; Kahrl *et al* 2005). For example, it was estimated that at least 1 million m^3 of unlicensed timber was exported across the China border in 2003 (Forest Trends 2011). This figure is approximately equal to recorded licensed timber exports for that year.

Biomass energy contributes more than 60% of total energy consumption in Myanmar, and is used by more than 70% of the population; wood is the largest source of biomass energy, most of which is sourced from natural forests (ADB 2012a). In 2012/13, just over 50 million m^3 of firewood and 391,000 m^3 of charcoal were produced from state forests (MNPED 2012).

The gross value of wood for biomass and energy has been calculated based on recorded volumes and prices, based on the value of unprocessed roundlogs. It excludes large-scale unlicensed timber removals and exports, although includes forest utilisation by rural households which is carried out without permits. The industrial production volume is estimated from the domestic and export consumption figures for teak and other hardwoods for 2009/10 (MOECAF 2011a), converted to a roundlog equivalent volume of 311,274 m^3 of teak and 1.84 million m^3 of hardwoods. Distribution to different types of traders, users and processors is then estimated (from figures given in Khin Htun 2009), and consumption is valued according to the prevailing price of different grades of roundlogs (from MTE records). Fuelwood and charcoal production volumes are taken from FD records, and valued according to prevailing market prices (from MNPED 2012). Government revenues are taken from FD records.

These calculations give a baseline value of MMK 565,178 million (US$ 582 million) for industrial wood production.

Figure 7: forest cover 2010



From Forest Department, MOECAF

Non-timber forest products

A wide variety of non-timber forest products (NTFP) are harvested at a commercial-scale, including bamboo, rattan, barks, resins, oils, honey, beeswax, guano, orchids, edible birds' nests and lac. NTFP extraction and trade is mainly undertaken by the private sector under the control of the Forest Department, primarily to supply the domestic market (MOECAF 2011a). In addition to woodfuel obtained from industrial harvests, rural households collect firewood directly from private and community forests and wooded lands, and mangroves are also heavily utilised as a source of fuel (Khin Htun 2009). NTFP also provide an extremely important source of subsistence and income for rural communities, supplying wild foods, construction materials, natural medicines and other products (Springate-Baginski and Thaun 2011).

In addition to the NTFPs that are extracted under permit, sold by the Forest Department and collected by local households, there is a large illegal wildlife trade supplying regional markets (MOF 2009). The commonest traded species include all eight species of wild cats found in Myanmar Shepherd and Nijman 2008b), as well as elephant, bear, otter, pangolin, deer, wild cattle, various birds, turtles, snakes and monitor lizards; orchids and numerous medicinal plants (Clarke undated). Many of these products pass on to China; a recent survey of border markets found numerous live animals and wildlife products, including some 9,000 pieces of ivory and 16 whole tusks for sale (Shepherd and Nijman 2008a).

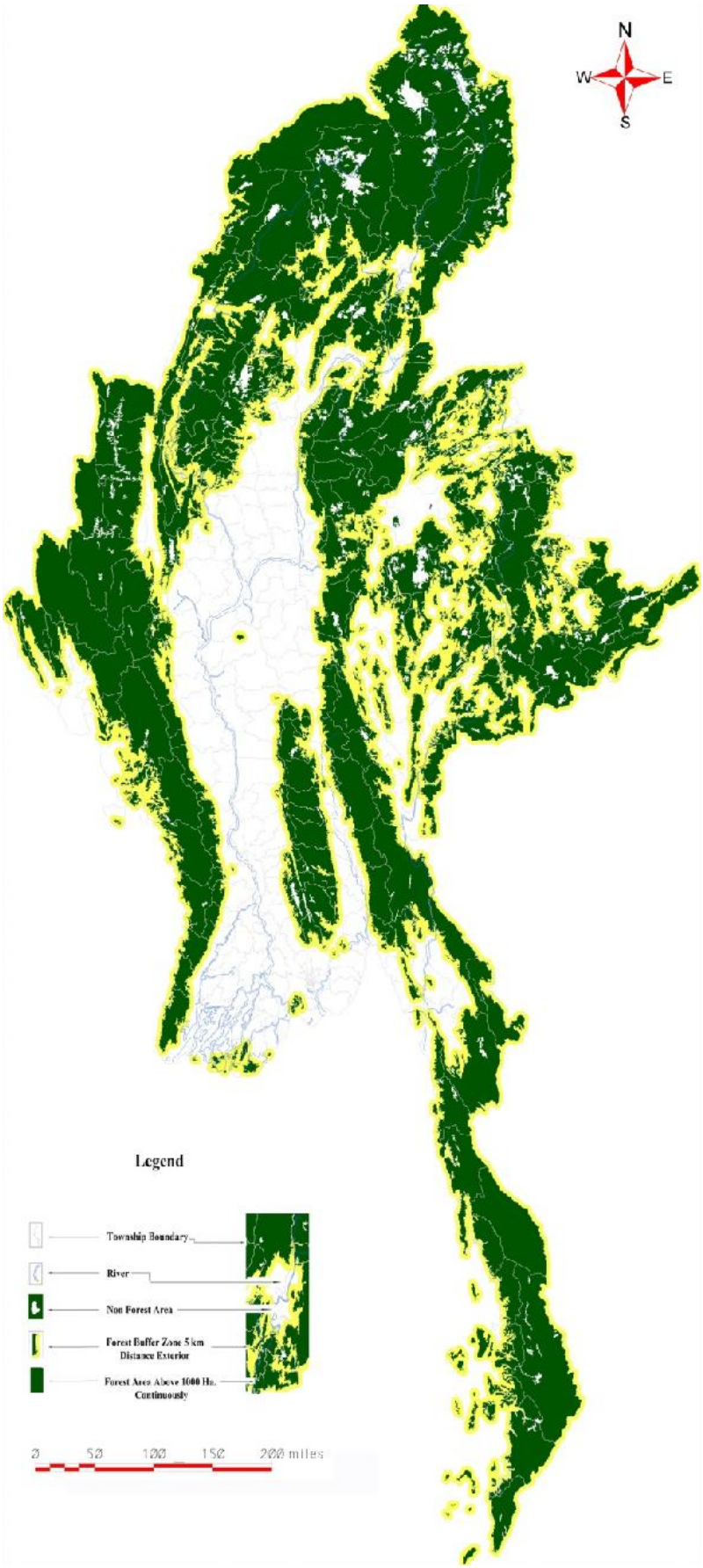
Estimates of the gross consumption value of NTFP includes only exports, government revenues and collection by rural households. No figures are available on the price or value of commercial NTFP extraction for the domestic market. The illegal wildlife trade is also excluded from calculations. Export earnings are estimated from average annual figures for the last decade – approximately US$ 6 million a year (Khin Htun 2009). Government revenues come from Forest Department records.

The gross value of NTFP harvests from terrestrial forests by local households uses benefit-transfer techniques, and applies an average per household figure taken from recent studies carried out in similar forest areas of Cambodia, Lao PDR and Thailand (Boscolo 2004, Grieg_Gran *et al* 2008, Hansen and Top 2006, Heov *et al* 2006, Emerton *et al* 2002b and Delang 2005). The resulting average of MMK 166,000 per household per year at 2012 Myanmar prices is consistent with recent estimates made for Forest User Group members in Mandalay of 131,250 MMK/household/year (Springate-Baginski and Thaun 2011). Rural fuelwood harvests use an average consumption figures of 4.5 m^3 per household per year (Khin Htun 2009). Average These values are applied to the estimated forest-dwelling and forest-adjacent rural population in Myanmar. The number of forest-dwelling households is taken from Forest Department records. Estimates of the forest-adjacent population have been made by calculating the area contained within a 5 km buffer of forests above 1,000 ha in size (Figure 8), and applying the average rural population density taken from the Townships within which these areas are located. This suggests a 2012 figure of some 520,000 rural forest-dwelling and forest-adjacent households.

The gross value of local-level collection of non-timber, non-fish mangrove products also uses benefit-transfer techniques. An average per hectare value is taken from recent studies carried out in Cambodia, Indonesia, Thailand and Viet Nam (Bann 1997b, Emerton *et al* 2002a, Ruitenbeek 1992, Seenprachawong 2002 and Tri 2000). The resulting average of MMK 44,000 per hectare per year is applied to the estimated area of mangroves in Ayeyarwady, Rakhine and Thanintharyi States. Approximate mangrove areas in each State come from visual estimates based on maps provided in the 2010 World Atlas of Mangroves (Spalding *et al* 2010).

These calculations give a baseline value of MMK 472,715 million (US$ 487 million) for NTFP harvesting from terrestrial forests and MMK 19,237 million (US$ 20 million) for mangrove forests.

Figure 8: forest-adjacent area



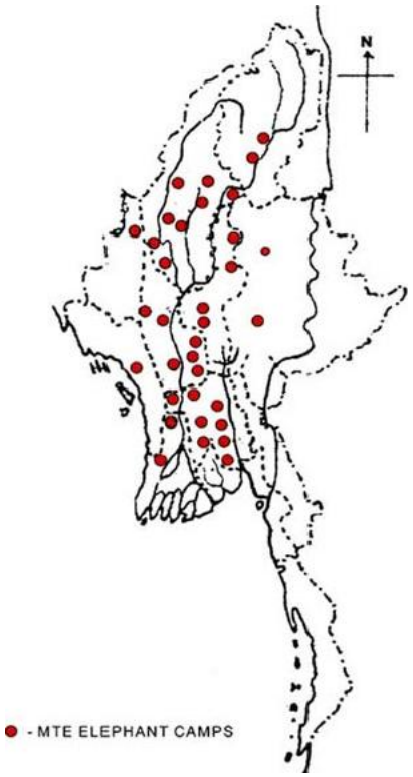
From Forest Department, MOECAF

Elephant draught power

Elephants provide an important source of draught power for harvesting operations, moving the felled logs from the cutting area to roads or rivers for onward transport out of the logging site. MTE currently operates just under 1,500 working elephants, and there are something over 800 privately-owned elephants (MNPED 2012). MTE keeps records via a studbook which is also used to record every elephant's reproductive and medical history. Privately-owned elephants must be registered with, and licensed by, the Forest Department.

Elephant management is organised around logging and resting camps (Figure 9). Elephants work during the rainy and cool seasons but are in rest camps during the hottest time of the year (Leimgruber *et al* 2011). Stringent regulations govern the care and use of elephants, including veterinary attention, staffing, rest periods and maximum allowable loads and working hours under different conditions and at different ages (Tun Aung and Thoung Nyunt 2002).

Figure 9: MTE elephant camps



From Tun Aung and Thoung Nyunt 2002

Although the capture of wild elephants is regulated by the law, it is necessary to supplement captive populations with wild-caught animals. A recent population modelling exercise demonstrates that captive elephant populations are not self-sustaining because mortality is too high and birth rate too low, and estimates that between 50-100 elephants are captured from the wild each year to be used for logging purposes (Leimgruber *et al* 2008).

The gross value of elephant draught power has been calculated using replacement cost techniques. Based on discussions with MTE, it was established that a skidder is the closest replacement for elephant draught power. The cost of purchasing and running a skidder was calculated based on market prices and MTE records, and brought to an average annualised value. To this sum was added the costs of constructing rough tracks at each logging site to enable access by the skidder. The average annual cost of a working

elephant is deducted in order to come up with costs saved by using elephant draught power. Logging elephant costs comprise expenditures on birthing, training, staff, food, medicines, veterinary care and equipment. In order to calculate the cost of a working elephant it is also necessary to take into account the fact that at any given time the herd also consists of "non-productive" or "partially-productive" animals. The calculation therefore incorporates the costs associated with dependent infants (age 0-4 years), carriers (age 5-17 years), adult working elephants (age 18-55 years) and retired elephants (age 56 years and over). Dependency ratios were calculated based on MTE data: at any one time an adult working elephant is "supporting" an average of 0.2 infants, 0.5 carriers and 0.25 retirees.

These calculations give a baseline value of MMK 19,977 million (US$ 21 million) for elephant draught power.

Terrestrial forest watershed protection

Myanmar's forests play an important role in watershed protection, including regulating waterflow and water quality, as well as minimising erosion, siltation and sedimentation. This helps to save costs and avoid damages for downstream water users. Some urban water supply schemes are already facing turbidity problems, as a result of river sedimentation arising from the depletion of forest in watershed areas (Bo Ni 2012, WEPA 2013). Water quality issues are a particular concern given that most supply schemes distribute untreated water.

Forest watershed protection is also key to the hydropower sector. Current installed capacity is around 2,500 MW (WEF 2013), generating around 8.6 billion kWh and distributing around 6 billion kWh (MNPED 2012) – about three quarters of total electricity generation capacity in the country. The Ministry of Electric Power estimates the country's hydropower potential to be more than 100,000 MW, and has identified almost a hundred potential sites for development, with an estimated capacity of just under 50,000 MW (ADB 2012a). Almost all of these planned or existing schemes lie within, or immediately downstream of, forested areas (Figure 10).

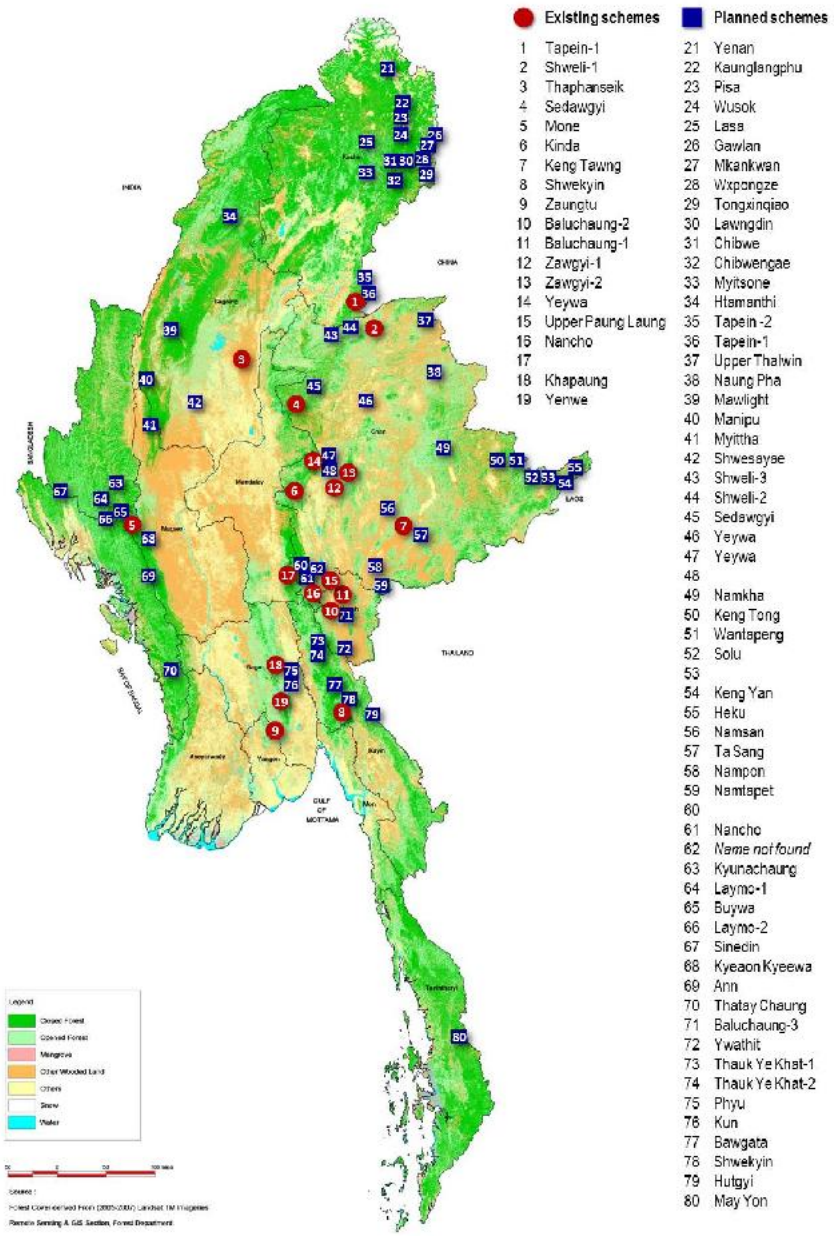
Waterflow regulation is already a critical factor in hydropower generation: energy capacity is significantly reduced or even eliminated altogether during the dry season, due to inadequate flow (ADB 2012a). Most hydropower schemes in Myanmar operate for 4,000 hours or less of the potential 8.760 hours of generating time a year and have severely reduced (or even zero) capacity between December and March (Dapice 2012a,b). Natural forest plays a key role in maintaining dry season base flows, and minimising the period over which facilities are unable to operate. The effects of deforestation in upper catchments is also starting to be manifested as increased rates of sediment and silt transport to downstream hydropower schemes, resulting in machinery breakdown and damage, load loss and outages (ADB 2012a, Bo Ni 2012, WEF 2013).

Forests also play a role in flood attenuation. As a country which is prone to heavy rainfall, Myanmar already suffers regular flood events during the mid-monsoon period (June to August) in areas traversed by rivers or large streams (UNEP 2009). Each year, an estimated two million hectares of land are severely flooded and another 3.25 million hectares are moderately flooded (Nyo 2012). Government records indicate that almost two hundred and fifty significant flooding events have occurred since 1990, incurring damage costs of MMK 1.6 billion (US$ 1.8 million) (MNPED 2012). Deforestation and land degradation on the steep slopes and mountainous areas of upper catchments is cited as a key risk in terms of worsening the incidence and impact of flooding (Nyo 2012) .

The gross value of terrestrial forest watershed protection is calculated using benefit-transfer techniques, using a per hectare figure calculated from recent studies carried out in similar forest areas of Cambodia, Lao PDR, Philippines, Thailand and Viet Nam (ADB 2010, Aymui and Chanhda 2009, Bann 1997a, Hansen and Top 2006, MARD 2008, Nabangchang 2010, Paris and Ruzicka 1991, Rosales *et al* 2005). The resulting average of MMK 210,000 per hectare per year for waterflow regulation and flood control and MMK 193,000 for regulation of siltation, sedimentation and water quality is applied to the almost 13,650 km^2 of forest designated for soil and water protection (from FAO 2010) and the approximately 3,700 km^2 of forest in dam and reservoir catchments (from FD records).

<u>These calculations give a baseline value of MMK 700,085 million (US$ 721 million) for the watershed protection services provide by terrestrial forests.</u>

Figure 10: existing and planned hydropower schemes



Based on ADB and MOECAF maps

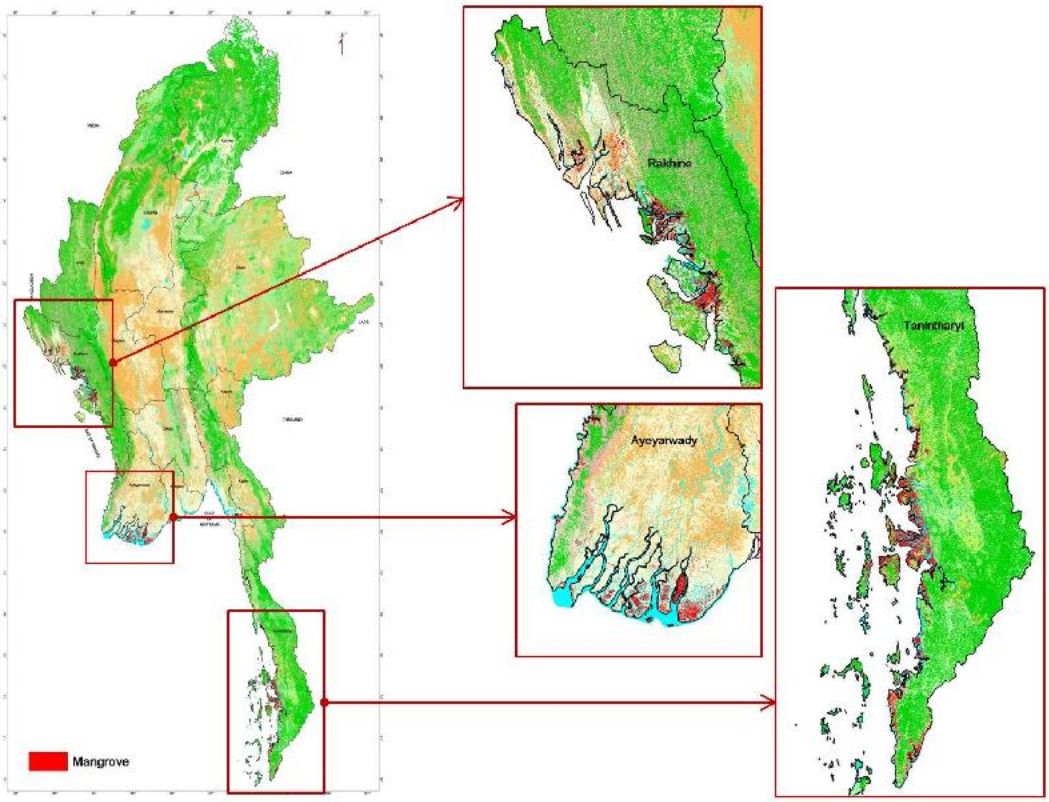
Mangrove coastal protection

Mangroves cover an estimated area of 467,330 hectares (MOECAF 2011a). They are concentrated in three main sites (Figure 11): the Ayeyarwady Delta, the northern state of Rakhine facing the Bay of Bengal, and southern Thanintharyi Division facing the Andaman Sea (FAO 2005, FAO 2003, Pe undated).

The role of mangroves in protecting coastal lands, settlements and infrastructure against the effects of cyclones, typhoons, other storms and tidal surges is well-recognised (Aung *et al* 2004, Springate-Baginski and Thaun 2011). This is a particularly important set of functions: Myanmar ranks first as the 'most at risk' country in Asia and the Pacific, and the coastal strip is vulnerable to a wide range of natural hazards including floods, cyclones, earthquakes, landslides and tsunamis (OCHA 2012, Oo 2011). More than two hundred and seventy cyclonic events are recorded since 1990 (MNPED 2012). The Ministry of Social Welfare, Relief and Resettlement and the Department of Meteorology and Hydrology of the Ministry of Transport list fifteen medium or severe cyclonic events over the last ten years alone. Excluding Cyclone Nargis, these are estimated to have accounted for 11,700 deaths, and damage costs of MMK 6.6 trillion (US$ 6.8 billion). Cyclone Nargis alone resulted in a death toll of almost 140,000 and a bill for damages of around MMK 13 trillion (US$ 13.4 billion) (Department of Meteorology and Hydrology figures). The impacts of cyclones, including Nargis, are believed to have been exacerbated by deforestation and degradation of mangroves, which could have served as more effective buffers against the waves and storm surges (UNEP 2009).

Erosive wave action has been identified as a particular problem in Rakhine State, which is also particularly prone to cyclonic events (FAO 2005). Mangroves also serve to regulate water quality: episodic heavy rainfall events can result in rapid land runoff where mangroves can play an important role in trapping sediments before this runoff water body reaches the open sea (FAO 2005).

Figure 11: main mangrove areas



The gross value of mangrove coastal protection is calculated using benefit-transfer techniques, using a per hectare figure calculated from recent studies carried out in similar coastal mangrove areas of India, Kenya, Philippines, Sri Lanka, Thailand and Viet Nam (Batagoda 2003, Das 2007, IUCN 2006, Samonte-Tan et al 2007, Sathirathai 1998, Sathirathai and Barbier 2001, Ranasinghe and Kallesoe 2006, Seenprachawong 2002, Tri et al 1998, UNEP 2011, White and Cruz-Trinidad 1998). The resulting average of MMK 946,000 per hectare per year for protection against coastal erosion and MMK 621,000 for protection against storms, tidal surges and extreme weather events is applied to the 4,673 km^2 of mangroves recorded for Myanmar (MOECAF 2011a).

These calculations give a baseline value of MMK 687 billion (US$ 707 million) for the coastal protection services provide by mangrove forests.

Forest carbon sequestration

Myanmar's terrestrial and mangrove forests constitute an important carbon sink. No systematic estimate has yet been made of the total stock of forest carbon, although the 2010 Forest Resources Assessment cites a partial figure of 1.65 billion metric for above and below-ground living forest biomass, and 67 million tonnes of carbon in leaf litter (FAO 2010). Carbon emissions are also avoided by maintaining forest cover and quality. Emissions from wood removal, land use change and forest degradation are significant: Myanmar's Initial National Communication to the UN Framework Convention on Climate Change (2012) shows more than 40,000 GgCO2e of GHG emissions from forest land use change and deforestation, and almost 30,000 GgC loss of carbon from wood removal for the year 2000.

The gross value of forest carbon sequestration is calculated using benefit-transfer techniques. For terrestrial forests, figures calculated for the additional carbon sequestered annually by evergreen, semi-evergreen, deciduous and dry forest in Cambodia (Hansen and Top 2006) are applied, giving a 2012 Myanmar value of between MMK 15,000 (US$ 16) and 37,500 (US$ 39) per hectare per year. For mangroves, recent estimates of annual above-ground, below-ground and sediment trapping carbon sequestration for mangroves in Kenya of 6.85 tC/ha/yr for (Huxham *et al* 2013) are used, and an average voluntary market price equivalent of MMK 4,900 (US$ 5) is applied.

These calculations give a baseline value of MMK 863,938 million (US$ 890 million) for terrestrial and mangrove forest carbon sequestration.

Mangrove fisheries nursery & breeding habitat

Fishing is the major livelihood source for Myanmar's coastal communities (Oo 2011), and also generates substantial commercial income and export earnings. Mangroves provide breeding and nursery habitat for commercially-important fish species that are caught in other inshore and offshore areas (Aung *et al* 2004). At least sixty nine species of fish, thirteen species of shrimp, four species of crab and nine species of other shellfish are listed as being found in Myanmar's mangroves (FAO 2003).

In 2012/13, more than 23,000 inshore fishing licenses and 28 offshore licenses were issued to national vessels operating in the three main mangrove areas of the country: Ayeyarwardy, Rakhine and Tanintharyi (from Department of Fisheries Data). Records indicate a total catch of more than 2.2 million tonnes of fish, prawn and other marine species.

The gross value of mangrove-dependent fisheries production is calculated as a proportion of the market value of fisheries along mangrove-protected coastlines in Ayeyarwardy, Rakhine and Tanintharyi fishing

areas. The length of coastline protected by mangroves comes from measurements made from the maps provided in UNEP-WCMC's World Atlas of Mangroves (Spalding *et al* 2010), expressed as a percentage of total coastline length. Dependency ratios are taken from a number of recent studies carried out in ASEAN countries, India and Sri Lanka (Gunawardena and Rowan 2005, Ronnback 1999, Singh *et al* 2004, Untawale 1986). These suggest that mangrove-dependent species contribute an average of 90% of inshore and offshore prawn and crustacean catch, 60% of inshore fish catch and 30% of offshore fish catch. These two percentages (share of catch from mangrove-protected areas, and contribution of mangroves to catch) are applied to come up with the amount of domestically-consumed and exported catch that can be ascribed to mangrove ecosystem services. Prevailing market prices (from MNPED 2012) are then used to calculate the value of mangrove-dependent fisheries. Government revenues from licence fees are taken from Department of Fisheries records.

These calculations give a baseline value of MMK 1,097,574 million (US$ 1,130 million) for mangrove fisheries nursery and breeding habitat services.

Insect pollination and seed dispersal

Animal pollinators contribute significantly to the pollination, pest control, nutrient burial and decomposition processes that support and enable crop production (Losey and Vaughan 2006). These services are provided by many insect species, as well as several species of birds and bats (Bauer and Wing 2010). Out of the 115 crops whose pollen vectors were determined in a recent global study, over 75% depend to some degree upon animal pollination (Gallai and Vaissière 2009).

These services are particularly valuable in a country such as Myanmar, where agriculture is the primary source of income, food and livelihood of the majority of the population. Farming is estimated to provide employment to two thirds of the population, contribute 58% to the county's GDP and almost half of exports (UNDP 2013).

The gross value of wild insect pollination of crops is calculated using a tool developed by FAO and INRA for assessing national vulnerabilities to pollinator declines (Gallai and Vaissière 2009). This provides dependence ratios for major crops, which establish the share of crop value associated with insect pollination services. The tool is applied to national records of production, yields and prices for the 184,495 km^2 of land in Myanmar planted with cereals, oil seeds, pulses, spices and condiments, tobacco and betel, beverages, fruits, vegetables, fibres, other tree crops and medicinal plants (MNPED 2012).

These calculations give a baseline value of MMK 2,649,220 million (US$ 2,728 million) for wild insect crop pollination services.

Nature-based recreation & tourism

By the end of 2009, something between thirty six (MOECAF 2011a) and forty three (MOF 2009) Protected Areas (PAs) were recorded in Myanmar, covering between 40,000 and 50,000 km^2. In 2012, almost 34,000 tourists visited the twelve PAs for which records are kept (from FD records).

Myanmar's tourism sector has been expanding rapidly over recent years. Recorded international arrivals have risen by nearly 50% over the last five years, and estimated leisure spending has increased by a factor of almost three (MHT 2012). Although nature-based recreation currently accounts for a relatively small share of both domestic and international tourist markets, it is seen as having major potential for growth. The Tourism Masterplan for 2013-20 emphasises the promotion of quality ecotourism in and nearby PAs

(ADB 2013a), and highlights nature-based segments of the market as key components in a future diversified set of tourism products (ADB 2012c). Twenty one natural sites have been identified by MOECAF as nature tourism destinations: Alaungdaw Kathap National Park, Chatthin Wildlife Sanctuary, Hkakaborazi National Park, Hlawga Park, Hponkanrazi Wildlife Sanctuary, Hukaung Valley Wildlife Sanctuary, Indawgy Wetland Wildlife Sanctuary, Inlay Lake Wildlife Sanctuary, Kwaikhityoe Wildlife Sanctuary, Lampi Marine National Park, Lawkananda Park Sanctuary, Meinmahla Kyun Wildlife Sanctuary, Moeyongyi Wetland Bird Sanctuary, Myinghaywan Elephant Camp, Natmatung National Park, Panlaung-Pyadalin Cave Wildlife Sanctuary, Phokyar Elephant Camp., Popa Mountain Park, Shwesattaw Wildlife Sanctuary, Thamihla Kyun Wildlife Sanctuary and Wethikan Bird Sanctuary.

Calculations of the gross value of nature-based tourism includes the leisure spending that is injected into the economy from visitors to PAs as well as their consumer surplus and willingness to pay for conservation. The total number of PA visitors is taken from FD records, and an average stay of 1.25 days is assumed. Average daily leisure spending in-country is calculated at US$ 135 according to figures prepared as part of the Tourism Masterplan (ADB 2013b). Three quarters of this figure is assumed to be direct spending on goods and services, and one quarter is assumed to comprise government taxes, levies and other charges (based on WTTC 2013). Benefit-transfer techniques from studies dealing with similar visitor and PA profiles in Central, Eastern and Southern Euroope are used to estimate a per-trip visitor consumer surplus of MMK 56,000 (Ceroni 2007) and willingness to pay for conservation of MMK 33,000 (Dumitras 2008, 2011; Getzner 2009).

These calculations give a baseline value of MMK 8,578 million (US$ 9 million) for nature-based recreation and tourism.

The baseline economic value of forest ecosystem services

Putting together the figures presented in Chapter 1 gives us a baseline value for forest ecosystem services of MMK 7,083 billion or US$ 7.3 billion in 2012 (Table 3). Meanwhile, the recorded net output of the forest sector is just MMK 158 billion (US$ 163 million), equivalent to 0.4% of GDP (MNPED 2012). Although these values cannot be directly compared (the study estimates gross output, whereas GDP refers to net output from which the value of intermediate consumption has been deducted), there is little doubt that the recorded contribution of forests to GDP massively understates the full value of the sector to the economy.

Table 3: baseline value of forest ecosystem services

Ecosystem service	MMK billion	US$ million
Timber & wood products	565.2	582.1
Non-timber forest products	492.0	506.6
Forest elephants	20.0	20.6
Terrestrial forest watershed protection	700.1	721.0
Mangrove coastal protection	686.6	707.1
Forest carbon sequestration	863.9	889.7
Mangrove fisheries nursery & breeding habitat	1,097.6	1,130.4
Insect pollination	2,649.2	2,728.3
Nature-based recreation & tourism	8.6	8.8
Total forest sector *Of which:*	7,083.0	7,294.6
Direct forest income	1,057	1,088.7
Value-added to production in other sectors	3,755	3,867.5
Domestic costs and damages avoided	1,407	1,448.6
Global costs and damages avoided	864	889.7

The direct income earned from forest products utilisation accounts for only around 15% of this value, MMK 1,057 billion or US$ 1.1 billion (Figure 12, Figure 13). By far the largest share of value – more than half, or MMK 3,755 billion (US$ 3.9 billion) – comes from the forest regulating, supporting and cultural services that add value to production in other sectors: most notably agriculture, fisheries and tourism. Costs and damages avoided within Myanmar (through the protection of settlements, infrastructure and production processes) and globally (due to climate change mitigation) comprise around a third, some MMK 2,271 billion or US$ 2.3 billion.

Figure 12: baseline value by ecosystem service

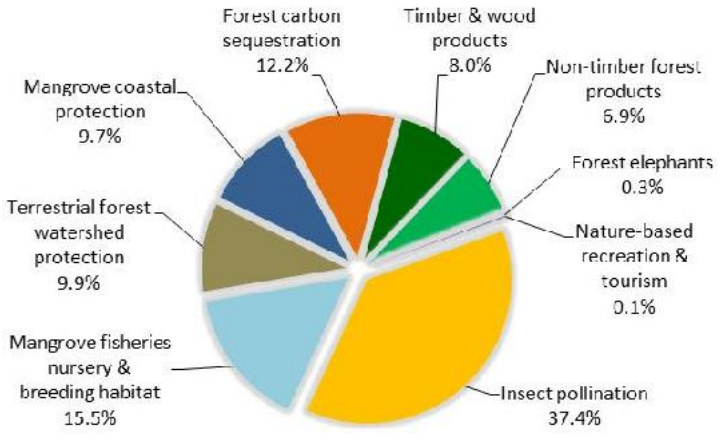
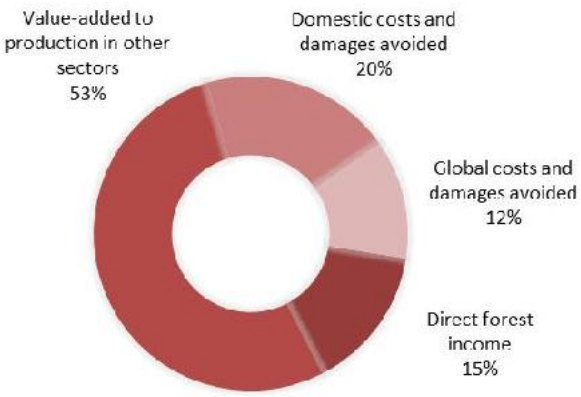


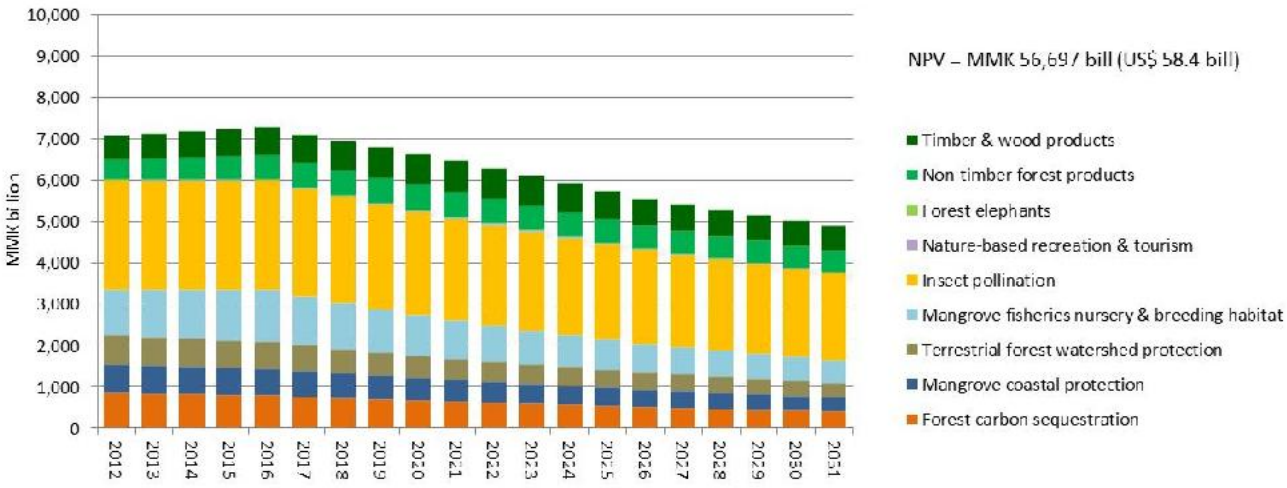
Figure 13: baseline value by type of benefit



The economic implications of continuing forest degradation

Continuing forest degradation will result, initially, in an increase in forest sector values, as the income from intensifying resource use outweighs the progressive decline in the quality and value of forest services. However, over time, values will start to decrease and flatten out, as the ability of forests to provide key goods and services is gradually eroded (Figure 14). Under the forest degradation scenario, the net present value (NPV) of the gross contribution of the forest sector to the economy over the next twenty years is estimated at MMK 56,697 billion (US$ 58.4 billion).

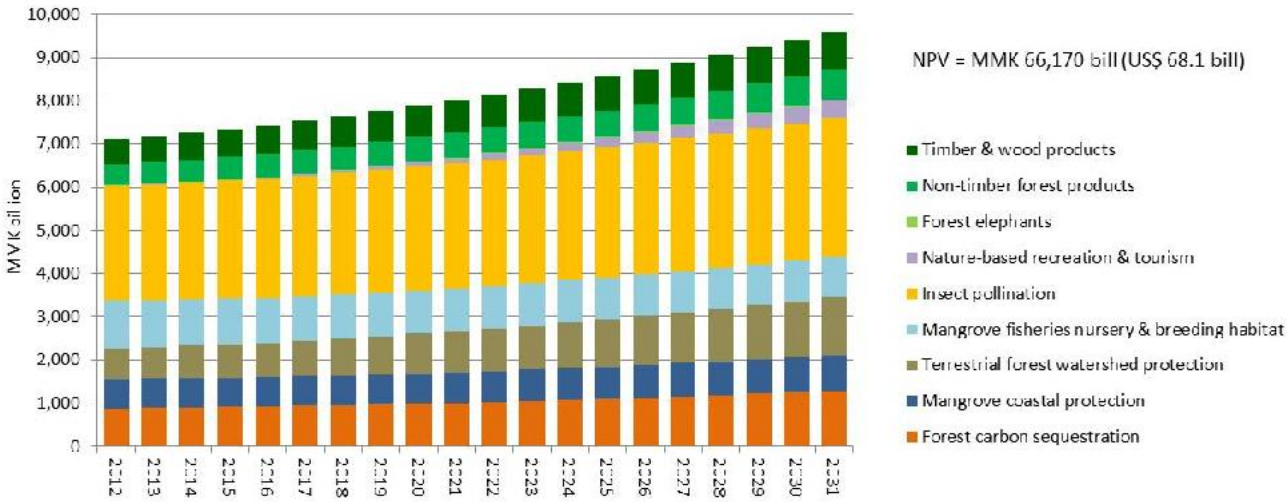
Figure 14: forest ecosystem service values 2012-31 – "forest degradation" scenario



The economic implications of forest conservation

Forest conservation will result in a steady rise in forest sector values, as the quality and value of services continues to improve. Although this increase will be sustained, the rate of growth will slow over time as ecosystem and biodiversity status is restored and as forest conservation and management effectiveness targets are reached (Figure 15). Under the forest conservation scenario, the net present value (NPV) of the gross contribution of the forest sector to the economy over the next twenty years is estimated at MMK 66,170 billion (US$ 68.1 billion).

Figure 15: forest ecosystem service values 2012-31 – "forest conservation" scenario



The value-added by forest conservation

It is clear that forest conservation implies sustained, and increasing, forest economic values, while continuing forest degradation will result in a gradual decline in value. Although the value-added by forest conservation as compared to continuing forest degradation is relatively small over the short-term, it progressively increases as the gap widens between the two scenarios (Figure 16). Forest conservation shows a steady, and escalating, value-added over continuing forest degradation. The cumulative gain after twenty years is estimated to be more than MMK 37,725 billion (US$ 38.9 billion) (Figure 17), with a NPV of some MMK 9,473 billion (US$ 9.8 billion).

Figure 16: value-added from "forest conservation" over "forest degradation" scenarios

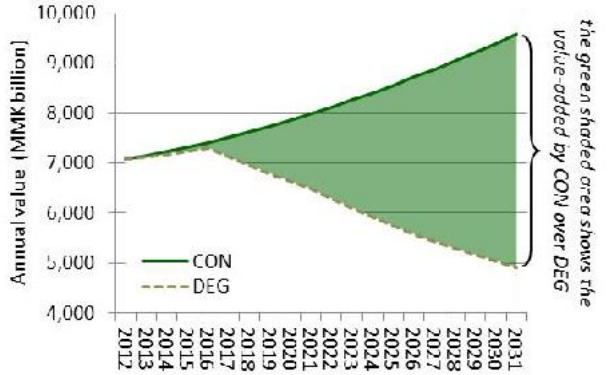
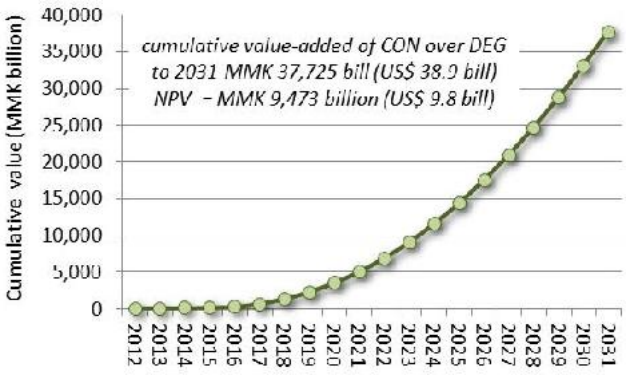


Figure 17: cumulative value-added from "forest conservation" over "forest degradation" scenarios



Meanwhile, choosing to continue forest degradation does not just imply reduced values as compared to forest conservation. It also incurs long-term losses as compared to the current situation. Although initially values will increase, over time they will progressively reduce, as the capacity of forests to generate economically valuable goods and services is eroded. These long-term losses outweigh the short-term gains (Figure 18). The cumulative costs of continuing forest degradation from now to 2031 are estimated at some MMK 16,264 billion (US$ 16.7 billion), with a NPV of MMK 3,966 billion (US$ 4.1 billion). In contrast, forest conservation results in sustained long-term gains over the baseline (Figure 19). The cumulative gains from now to 2031 of forest conservation are estimated at MMK 21,461 billion (US$ 22.1 billion) , with a NPV of MMK 6,454 billion (US$ 6.6 billion).

Figure 18: losses from "forest degradation" scenario

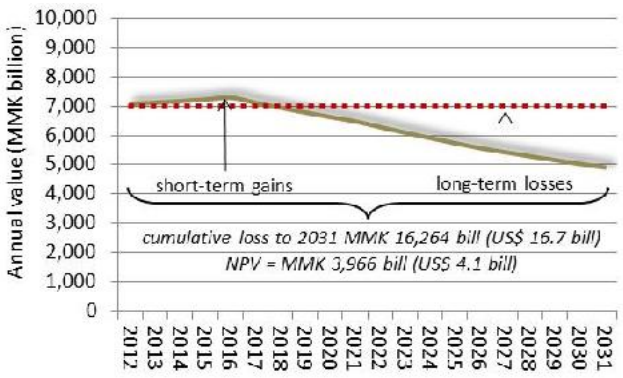
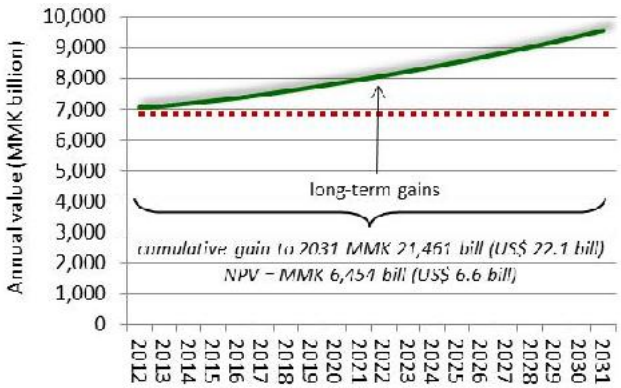


Figure 19: gains from "forest conservation" scenario



Trends in public funding to the forest sector

Chapters 1 and 1 have described the substantial economic values that forest ecosystem service generate, and the considerable gains that arise from their conservation and sustainable use. An important question that now arises is: if forests are so valuable to the economy, and to so many groups and sectors in Myanmar, then how much is actually being invested in maintaining this important asset?

In 2010/11, a budget of just under MMK 150 billion (US$ 152 million) was allocated to the forestry sector by the Union Government (Table 4), worth just under MMK 160 billion or US$ 164 million at 2013 prices. This comprised approximately 3% of total current expenditures and 0.4% of capital spending (MNPED 2012).

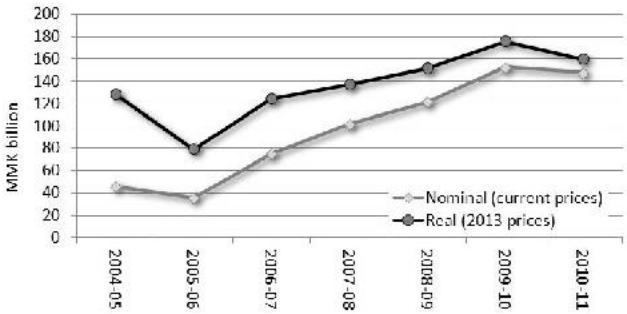
Table 4: current and capital budgets to the forestry sector 2004-11 (current MMK million)

Year	State Administrative Organisations (MOECAF)			State Enterprises (MTE)			Total Union Government		
	Current	Capital	Total	Current	Capital	Total	Current	Capital	Total
2004-05	3,186	1,524	4,710	40,420	1,155	41,574	43,606	2,679	46,284
2005-06	3,865	1,609	5,474	30,227	257	30,484	34,092	1,866	35,958
2006-07	7,863	2,349	10,213	64,814	348	65,162	72,677	2,697	75,375
2007-08	10,242	3,636	13,878	86,999	701	87,700	97,241	4,337	101,578
2008-09	9,845	5,616	15,461	105,349	586	105,935	115,194	6,202	121,396
2009-10	11,328	7,919	19,247	132,506	846	133,351	143,834	8,765	152,598
2010-11	14,102	12,158	26,260	121,221	202	121,423	135,322	12,360	147,682

From MNPED 2012

Overall, public budget allocations (including reinvested revenues) have been rising steadily over recent years (Figure 20). In real terms (in other words, adjusted for inflation and expressed at constant 2013 prices), forest sector budgets have doubled since 2005/06. The real budget allocated to MOECAF in 2010/11 was 2.4 times that received in 2005/06, while that assigned to MTE was twice as high.

Figure 20: nominal and real budgets to the forestry sector 2004-11



From MNPED 2012

The bulk of public expenditures are for current spending, primarily on staff and basic running costs. Over the last seven years, current spending has averaged more than 94% of total forest sector spending (Figure 21). There are, however, significant differences in the balance of capital and current funding between MOECAF and MTE. For MOECAF, the share of capital costs in total expenditures has steadily risen from a

third in 2004/05 to almost half in 2010/11. In contrast, only 0.7% of MTE's budget between 2004-2011 was allocated for capital spending, and this share has been steadily decreasing – to less than 0.2% in 2010/11.

Figure 21: share of capital and current expenditures

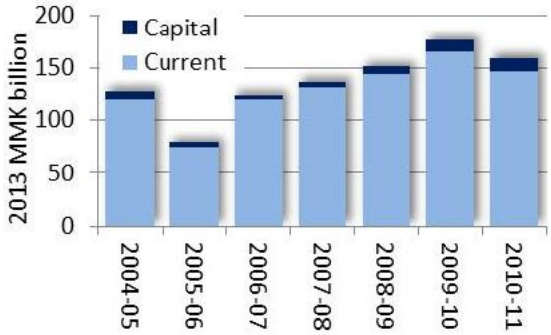
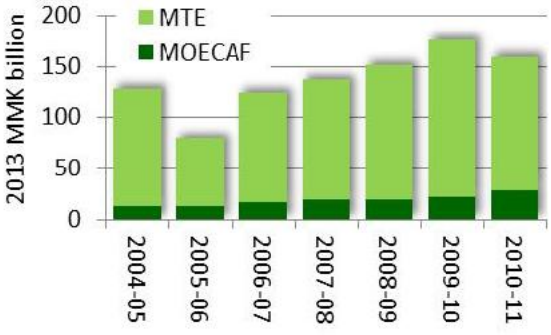


Figure 22: share of MOECAF and MTE expenditures



From MNPED 2012

Forest production activities dominate public spending. More than 80% of the annual government budget to the forest sector is allocated to MTE (Figure 22), in support of timber harvesting, milling, processing and marketing of forest products. Although the proportion of budget being allocated to MTE has – while rising in absolute terms – steadily decreased over time from almost 90% in 2004/05 to just over 80% in 2010/11, MOECAF continues to account for a very small share of total funding. Less than 20% of total funding to the forest sector is currently being spent in support of MOECAF's core functions of forest policy formulation, administration, reforestation, restoration, protection and PA management.

Receipts from taxes on the extraction of forest produce were worth around MMK 4.5 billion (US$ 4.6 million) in 2010/11 (Table 5). Revenues make only a very small contribution to total budget (Figure 24): an average of just 4.2% over 2004-11. Forest revenues have been declining in both nominal and real terms over the last seven years, falling from more than 6% in 2005/06 to just 3% in 2010/11 (Figure 23).

Table 5: forestry sector receipts and expenditures 2004-11 (current MMK million)

Year	Receipts	Expenditures
2004-05	1,932	46,284
2005-06	2,271	35,958
2006-07	4,283	75,375
2007-08	5,645	101,578
2008-09	4,409	121,396
2009-10	4,415	152,598
2010-11	4,491	147,682

From MNPED 2012

Figure 23: nominal and real receipts from charges for extraction of forest produce 2004-11

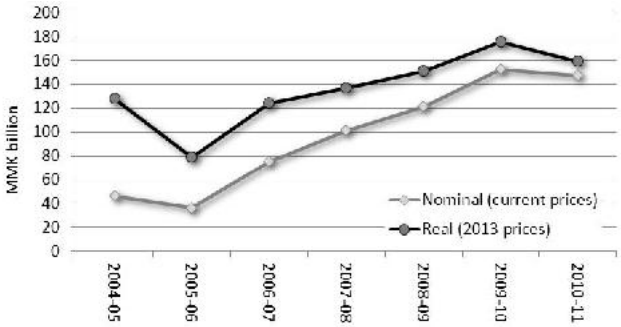
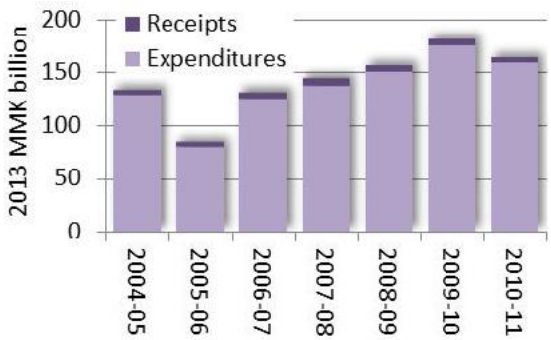


Figure 24: forestry sector receipts and expenditures 2004-11



From MNPED 2012

The role of donor projects

Overseas donors provide some support to forest sector activities. In-country spending is almost entirely channelled through the public budget, and so is included in the figures presented above. The role of overseas aid is minor: between 2006-10, an average of US$ 1.86 million (MMK 1,803 million) a year at 2013 constant prices was contributed by multilateral and bilateral donors to forest and biodiversity activities in Myanmar. This is equivalent to just 1% of the 2010-11 government budget to the forestry sector.

It is however useful to analyse trends in the amount and composition of donor funding to forest sector activities over time. One important point to note is that between 1986 and 1997, forest sector projects declined to zero. This reflects the more general withdrawal of overseas development assistance to Myanmar (Figure 25). Restrictions have only recently been eased, and so it is hardly surprising that forest funding from international sources has also remained low in absolute terms over the last decade or so.

Although the last decade cannot be taken as reflecting "normal" spending patterns (sanctions have only been lifted over the last year or so), it is apparent that donor spending on forests declined markedly between 2005 and 2010 – in absolute terms and as a share of total overseas assistance (Figure 26, Figure 27). This is even though there was a steady upward trend in total aid flows to the country.

Figure 25: bilateral and multilateral aid flows to Myanmar 1980-2010

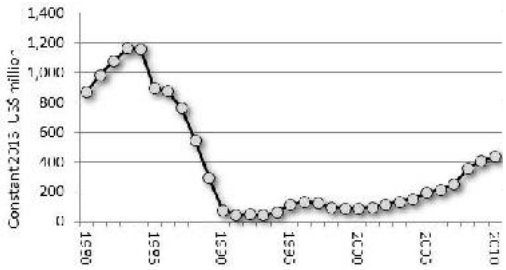


Figure 26: share of forest spending in total bilateral and multilateral aid flows 1980-2010

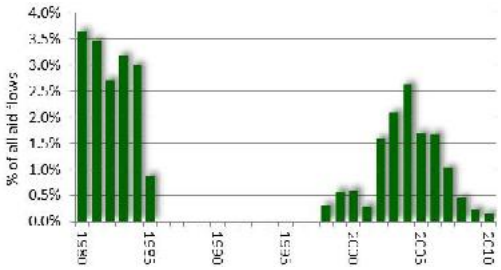
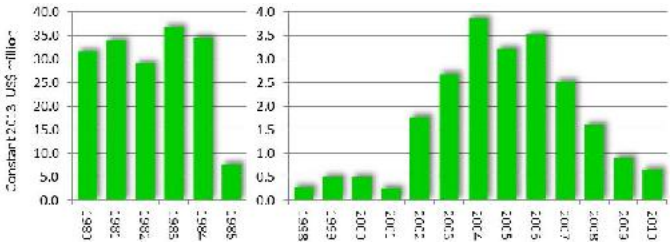


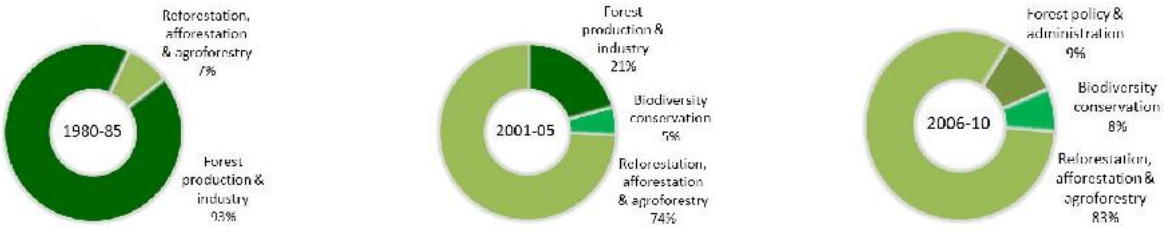
Figure 27: bilateral and multilateral funding to the forest sector 1980-2010



From AidData: http://aiddata.org/export/download?filename=AidData_2fc59bd96cb3a037429aadbe4f4cf0f6.xls.zip; accessed 10/09/13

It is also noticeable that the composition of donor funding appears to have shifted. There has been a move away from the focus on forest production and industry that characterised spending in the first half of the 1980s, with reforestation, afforestation, agroforestry and biodiversity conservation now accounting for the major share of overseas-funded projects (Figure 28).

Figure 28: composition of bilateral and multilateral funding to the forest sector 1980-2010



From AidData: http://aiddata.org/export/download?filename=AidData_2fc59bd96cb3a037429aadbe4f4cf0f6.xls.zip; accessed 10/09/13

The need and rationale to capture ecosystem values as conservation funding

Public investment in forest conservation yields high development and economic returns. The study has found that the annual value of selected forest ecosystem services may be as high as MMK 7 trillion or US$ 7 billion. Meanwhile, public budget allocations to the forest sector are worth just under MMK 160 billion or US$ 164 million at today's prices. This indicates that, in total, every MMK 1 invested by the government in the forest sector is helping to leverage more than MMK 40 worth of benefits to Myanmar's economy and population each year. If we exclude the spending and income associated with industrial timber production, the development and economic returns to investing in forest conservation rise still further: in excess of MMK 200 of benefits are generated for every MMK 1 spent in support of MOECAF's forest activities.

Many different groups and sectors stand to gain from the continued provision of forest ecosystem services, and run the risk of incurring substantial costs if they are degraded and lost. Water, tourism, energy, industry, agriculture and fisheries are all examples of economically-important sectors which depend on forest ecosystem services for their production and output. Forest ecosystem services also underpin key cross-cutting national development goals such as diversifying rural livelihoods, reducing poverty, enhancing food security, improving access to basic services, strengthening resilience and disaster risk reduction and adapting to climate change. Much of the estimated MMK 16 trillion (US$ 17 billion) costs that would result if forests continue to be degraded over the next 20 years would be felt as losses to these sectors. In contrast, if forests are conserved and sustainably managed, these sectors stand to gain benefits worth an estimated MMK 21 trillion (US$ 22 billion) over the same period.

MOECAF is essentially subsidising the supply of valuable inputs and services to the broader economy. Although a large number of groups and sectors in Myanmar gain in economic and commercial terms from forest ecosystem services, or avoid significant losses, they receive these benefits at low or zero cost. Yet forest conservation is not cost-free: expenditures must be incurred to ensure the continued provision of forest ecosystem services. The bulk of these costs are met from MOECAF's budget.

It is not certain that current financing levels are sufficient to ensure that forest ecosystem services will be sustained into the future. Currently, an average public budget of just under MMK 5,000/ha/year (US$ 5) is allocated to the forest sector in Myanmar. The bulk of this money is spent on production forest development and utilisation. The funding available for managing and conserving forests in protected areas, watersheds and multiple use zones averages around MMK 2,250/ha/year (US$2.5). This is far lower than either the global average of US$ 7.5 or the average for Asian countries of more than US$ 20 (FAO 2010). There remains a critical shortage of funding for essential management activities, and managers face pressing budget constraints which constrain their ability to conserve forests effectively. Deforestation and forest degradation continue apace, and threats to forest ecosystems are intensifying.

The forest sector is not being managed to its full economic potential: there remain untapped opportunities to increase the level of revenues generate from forest ecosystem services. Forest conservation funding depends almost entirely on the State budget. The sole source of public revenues is from the extractive utilisation of forest products and, to a limited extent, from protected area entry fees. This means that only a very small proportion of forest values is being captured as income flows: the total estimated value of forest ecosystem services is around 1,500 times higher than the amount of revenue that is actually being collected.

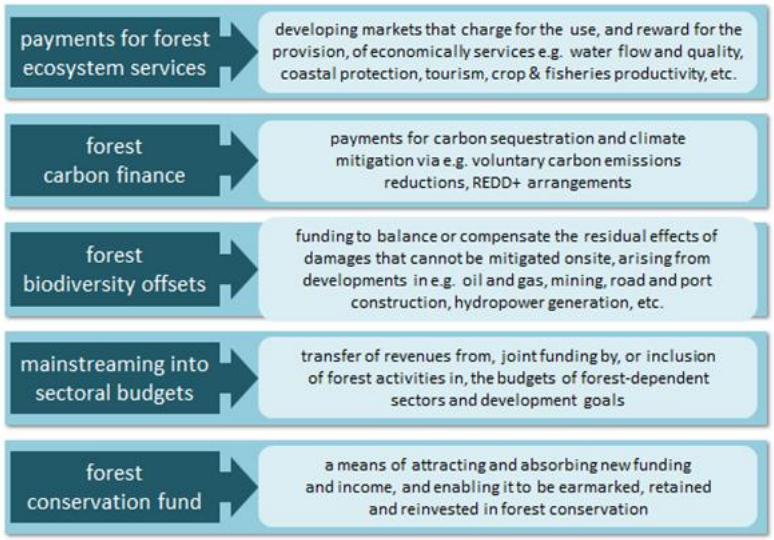
It can be concluded that there is **a strong justification, clear need and considerable potential to increase and diversify the public funding base for forest conservation** through better capturing forest ecosystem values as financing flows**.**

Financing mechanisms with potential for development in Myanmar

There are several obvious and immediate opportunities to better capture forest values as conservation funding flows. In particular, the principles of "user pays", "cost-recovery", "cost-sharing" and "market development" can be extended to ecosystem services. The underlying rationale is that the sectors and industries that benefit from forests should (where they are economically able to do so) contribute towards the costs of ecosystem services provision, and pay for their use – just as they do for the other inputs, facilities and services that they consume or use to generate production. In turn, any revenues generated should be reinvested in forest conservation, so as to ensure the continued supply of economically valuable ecosystem services.

Various market, economic and policy instruments are already widely used in other parts of the world to generate revenue from ecosystem services so as to fund forest conservation. Five financing mechanisms are recommended as having particular potential for development in Myanmar (Figure 29), and are described below. These provide a means of supplementing the financial resources available to MOECAF for forest conservation activities, and also offer opportunities to generate funding and incentives that can be shared with forest land and resource managers at the local or community level.

Figure 29: financing mechanisms with potential for development in Myanmar



Introducing **payments for forest ecosystem services (PES)**. PES typically target those ecosystem services which have a particularly high value for users, but which do not currently have a market or price. In Myanmar, examples include the regulation of waterflow and quality, coastal protection, the provision of sites for tourism and recreation, insect pollination and fish breeding habitats. PES may involve cash or in-kind payments being made directly by beneficiaries (e.g. bulk water users, hydropower facilities, greenhouse gas emitting industries, tourism companies, fishers and farmers), or budgetary transfers of a portion of the revenues earned by other sectors (e.g. fees and charges collected by water, tourism, industry, energy, fisheries and agriculture agencies).

Accessing **forest carbon finance**, including REDD+. This is a special form of PES for forest carbon sequestration and climate mitigation services. Several voluntary carbon finance initiatives are already under development in Myanmar, directed at buyers in Southeast and East Asia, Western Europe and North America. Myanmar is also currently in the early stages of developing a REDD+ Readiness Roadmap, anticipating future global payments for reduced deforestation and forest degradation.

Developing **forest biodiversity offset** funding. Biodiversity offsets are a means of generating finance for forest restoration, rehabilitation and conservation. Funding is provided by developers to balance or compensate the residual effects of damages that cannot be mitigated on-site, by investing in equivalent forest resources or habitats elsewhere. Their main application is in relation to the disturbance to forests caused by extractive industries and infrastructure – in Myanmar, possible participants include oil and gas, mining, roads, ports and hydropower sectors.

Mainstreaming forests into the budgets of other sectors. This typically involves either (at the central budget policy and planning level) the earmarking and transfer of a portion of the revenues earned from forest-dependent activities or the establishment and funding of inter-sectoral programmes on forest conservation, and (at the sectoral policy and planning level) the inclusion of forest conservation activities and budget lines within existing programmes and projects. In Myanmar, budgetary mainstreaming has particular relevance to forest-dependent sectors such as water, tourism, energy, industry and agriculture, as well as in relation to cross-cutting policy objectives such as climate change, desertification and disaster risk reduction. It also implies efforts to "make the case" for the economic wisdom of investing in forest conservation to the Ministry of National Planning and Economic Development, Ministry of Finance and Revenue and other line ministries.

Establishing a **forest conservation fund**. The aim is usually to set in place a mechanism which is separate from, and additional to, the annual budget framework. Forest conservation funds aim to provide a facility which will attract and absorb new funding and income, and enable its earmarking, retention and reinvestment for forest conservation purposes. Forest funds are typically capitalised and replenished from a variety of sources, including fees and charges, other income or revenues, public budget, donor and private sector contributions and voluntary donations.

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