The economic value of Cat Tien National Park

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List of acronyms

ASEAN	Association of South East Asian Nations
BMU	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety)
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)
CTNP	Cat Tien National Park
DoNC	Department of Nature Conservation
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross domestic product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (German Agency for International Cooperation)
INRA	Institut national de la recherche agronomique (French National Institute for Agricultural Research)
MARD	Ministry of Agriculture and Rural Development
MEA	Millennium Ecosystem Assessment
MOF	Ministry of Finance
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
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
UFZ	Helmholtz Centre for Environmental Research
VND	Viet Nam Dong (at the time of the study VND 21,149 = US$ 1)

EXECUTIVE SUMMARY

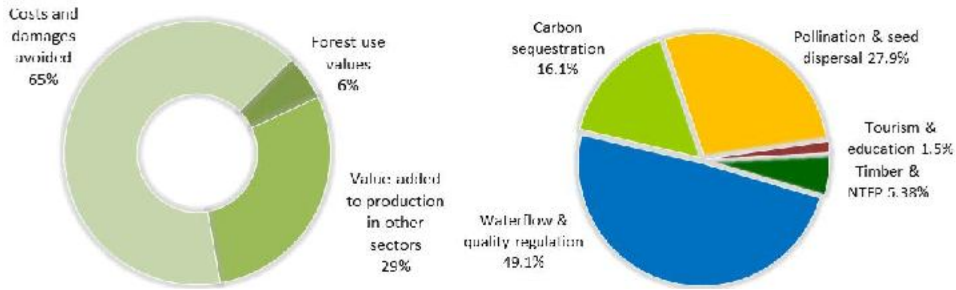
This study was carried out under the GIZ project “ValuES: Methods for integrating ecosystem services into decision-making” and the GIZ/MARD project “Conservation of Biodiversity in Forest Ecosystems in Vietnam”. Its overall aim was to generate information which can assist MARD and other stakeholders to justify biodiversity and ecosystem conservation as an economically beneficial use of public lands, resources and funds. The specific objective was to assess the economic value of conserving biodiversity and ecosystems in Cat Tien National Park (CTNP). CTNP was selected as the study site because it hosts biodiversity of exceptional conservation significance, and yet also faces intense pressures from resource exploitation, land conversion and infrastructure development in both core and buffer zones.

A partial valuation of the services generated by natural ecosystems in the core and buffer zones of CTNP was undertaken. The study focused on the following key ecosystem services, for which sufficient data were available to enable valuation: wood and non-wood forest products, waterflow and quality regulation, carbon sequestration, pollination and seed dispersal, and nature-based tourism, recreation and education.

The study first assesses the baseline (the economic value of ecosystem services that are currently being generated in the CTNP landscape). The changes in land use and land cover that would occur over the next 25 years if the CTNP landscape were to revert to an unprotected status are then modelled. The difference between this “unprotected landscape” scenario and the baseline represents the economic value-added and/or costs avoided that are associated with maintaining Cat Tien as a National Park into the future.

The study finds that CTNP’s ecosystem services generated economic goods and services worth VND 1,091 billion or US$ 51.6 million in 2012.

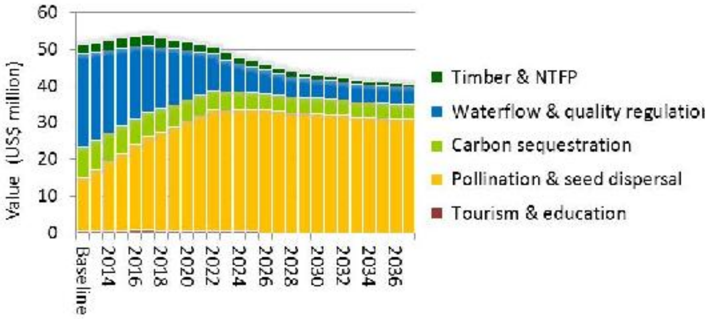
Ecosystem service	VND billion	US$ million
Wood products	8.79	0.42
Plant-based NWFP	34.40	1.63
Animal-based NWFP	15.45	0.73
Waterflow & quality regulation	536.01	25.34
Carbon sequestration	175.54	8.30

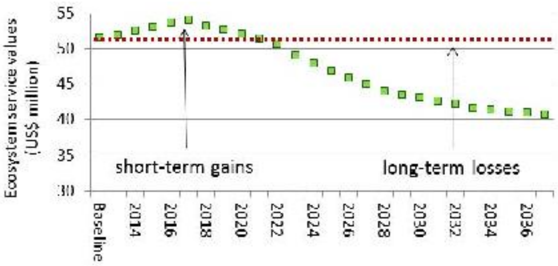


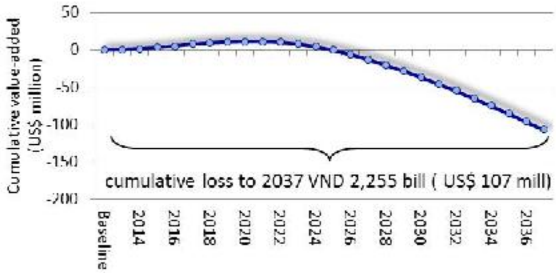
Direct income generated from the utilisation of forest land and resources accounted for only around 6% of this value. By far the largest share (almost two thirds) came from the regulating and supporting services that help other sectors to avoid costs and damages (through the protection of settlements, farms, infrastructure and other production processes, as well as via the mitigation of global climate change). Just over a quarter of the total is accounted for by the value added by ecosystem services to production in other sectors, most notably agriculture and tourism.

In the absence of the National Park and its associated conservation management regime, it is likely that agricultural land uses (particularly perennial tree crops) would expand to fill the area that is currently occupied by CTNP. Natural forest, shrublands, grasslands and wetlands will all gradually be converted to farmland. At the same time, infrastructure and housing will expand in response to the influx of human population and spread of farming into the area that is currently the core zone of CTNP. These land use and land cover changes would impact on the provision of ecosystem services. It is likely that intensifying human demands on land and natural resources will result, initially, in an increase in ecosystem use. However, over time, these values will start to decrease and flatten out, as ecosystems are progressively converted and degraded and the ability of the CTNP landscape to provide key goods and services is gradually eroded.

The decline in ecosystem values that would occur under an "unprotected landscape" scenario makes it clear that maintaining the conservation status of CTNP implies considerable economic value-added and costs avoided.
The cumulative losses and ecosystem values foregone if biodiversity and ecosystems were not protected via CTNP is estimated to be more than VND 2,255 billion (US$ 107 million) over the next twenty five years.







The study also identifies the main challenges and ways forward in applying ecosystem valuation to strengthen protected area conservation and development policy, planning and management. It finds that there is now almost two decades' experience of environmental valuation in Viet Nam. The role of ecosystem valuation in better and more informed conservation decision-making is well-recognised, and emphasised in a number of key government policy documents. It is not yet, however, a required part of either development or conservation planning procedures, and is barely mentioned in the regulatory and decision-making frameworks that govern them.

The most important conditions for moving forward in better using ecosystem valuation to inform conservation policy, planning and management is found to be the need to shift the discipline from the realm of academia and research into a more applied arena, to make greater efforts to communicate the findings of valuation studies more effectively, and to work to integrate requirements for ecosystem valuation into conservation and development decision-making processes and procedures. To these ends, five recommendations are made:

- to strengthen information-sharing via the creation of a simple online database and search tool;
- to foster exchange and dialogue between the sectors, agencies and disciplines that have an expertise, interest or stake in ecosystem valuation through the development of a knowledge hub and network;
- to facilitate awareness-raising and capacity-building for conservation and development decision-makers;
- to work to integrate information on ecosystem costs and benefits into existing planning and decision-making processes such as strategic environmental assessment, environmental impact assessment, calculation of natural resource damages and environmental compensation requirements, investment appraisals and cost-benefit analysis; and
- to offer technical training in ecosystem valuation approaches and techniques at an applied level to conservation and development planners, managers and practitioners.

The project

This study was supported by the GIZ project "ValuES: Methods for integrating ecosystem services into decision-making", funded by the German Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU) and implemented by GIZ in cooperation with the Helmholtz Centre for Environmental Research (UFZ). The ValuES project seeks to strengthen capacities in governmental and non-governmental organisations in partner countries and to impart methodological competences and potential applications, as well as targeted means of communicating results of, ecosystem service analyses.

The study was carried out as part of the GIZ/MARD Project "Conservation of Biodiversity in Forest Ecosystems in Vietnam". The project has the long-term objective of strengthening capacity for the conservation of biodiversity and preservation of forest ecosystems. The first (and current) phase of the project has the short-term objective of "technical, professional, personnel, institutional and legal conditions for biodiversity conservation and preservation of forest ecosystems are improved, particularly at national level and in two National Parks". This is being achieved via three components: capacity development and communication for awareness raising on forest ecosystems and biodiversity; sustainable financing and community-based benefit sharing mechanisms for protected areas; and support to the institutionalisation of policies for forest biodiversity conservation.

Context and objectives

The **overall aim** of this study is to generate information which can assist MARD and other stakeholders to justify biodiversity and ecosystem conservation as an economically beneficial use of public lands, resources and funds.

This topic is of particular importance because the methods that are conventionally used in Viet Nam to plan and appraise investments and to assess and compensate environmental damage do not normally factor in ecosystem costs and benefits. As a result, environmentally-degrading land, resource and investment options are often perceived by decision-makers to be more "profitable" than those which are based on the conservation and sustainable use of nature. Because biodiversity and ecosystem services are undervalued, decisions tend to be made on the basis of partial – and often misleading – information. In the worst case, substantial misallocations of resources have occurred and gone unrecognised, immense economic costs have been incurred, and potentially lucrative development opportunities have been missed.

The specific **objective** of the study is to assess the economic value of conserving biodiversity and ecosystems in Cat Tien National Park (CTNP). CTNP was selected as the study site by the Department of Nature Conservation (DoNC) because it hosts biodiversity of exceptional conservation significance, and yet is also subject to intense pressures and threats from resource exploitation, land conversion and infrastructure development in both core and buffer zones.

The intention is that the study will generate information that can be used to strengthen the economic case for conserving nature in the Cat Tien landscape, at the same time as providing an opportunity to develop, test and apply practical and policy-relevant methods for ecosystem valuation that can be adapted and used in other protected areas in Viet Nam.

The valuation study was carried between July and December 2013. It is based on a desk review of published and unpublished documents, collection and analysis of government statistics and research data, expert interviews and stakeholder consultations.

The study relied on the close cooperation and support provided by MARD and DoNC at both central and local levels. The staff of Cat Tien National Park were of great assistance, and made a substantial contribution to the study. Many other departments and agencies in the Provinces surrounding Cat Tien National Park also provided invaluable information and help. The study relied on the coordination and logistical support of GIZ Viet Nam, and on technical and financial assistance provided by the ValuES project.

Content of the report

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

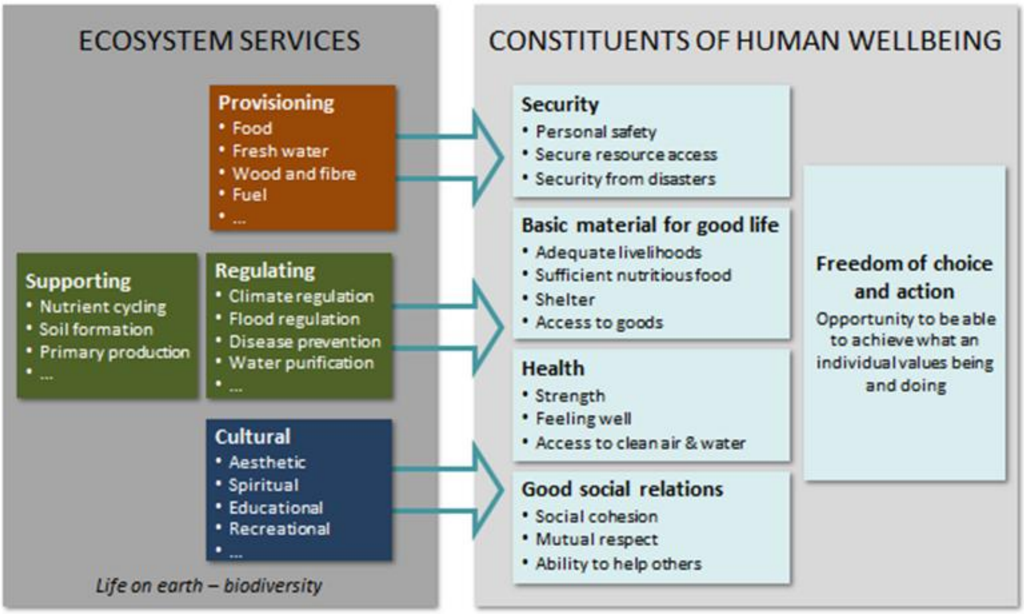
- Chapter 2 introduces the overarching **conceptual frameworks** that are used to categorise ecosystem services, classify economic values, and trace through ecosystem-economic linkages;
- Chapter 3 provides an overview of the **study methodology**, including the steps followed, valuation techniques and data sources, and assumptions used to model future economic scenarios;
- Chapter 4 documents the study's findings on the **economic value added and costs avoided from conserving biodiversity and ecosystem services** in Cat Tien National Park;
- Chapter 5 draws conclusions about **challenges and ways forward** in applying ecosystem valuation to inform protected area conservation and development policy, planning and management in Viet Nam;
- The **references** section lists all the published and unpublished documents and data sources that are referred to in the document; and
- The **annex** provides a detailed description of ecosystem valuation techniques, their suitability and advantages for different types of services and situations, steps in their application, data requirements, needs for analysis and examples of their use for forests and protected areas.

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 elsewhere, 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 according to the four basic categories suggested by the **Millennium Ecosystem Assessment** (MEA) – provisioning, supporting, regulating and cultural services (Figure 1). As described in the MEA, 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 (MEA 2005). It is now commonplace for conservation planners and policy-makers to conceptualise ecosystem services in these terms.

Figure 1: ecosystem services and human wellbeing



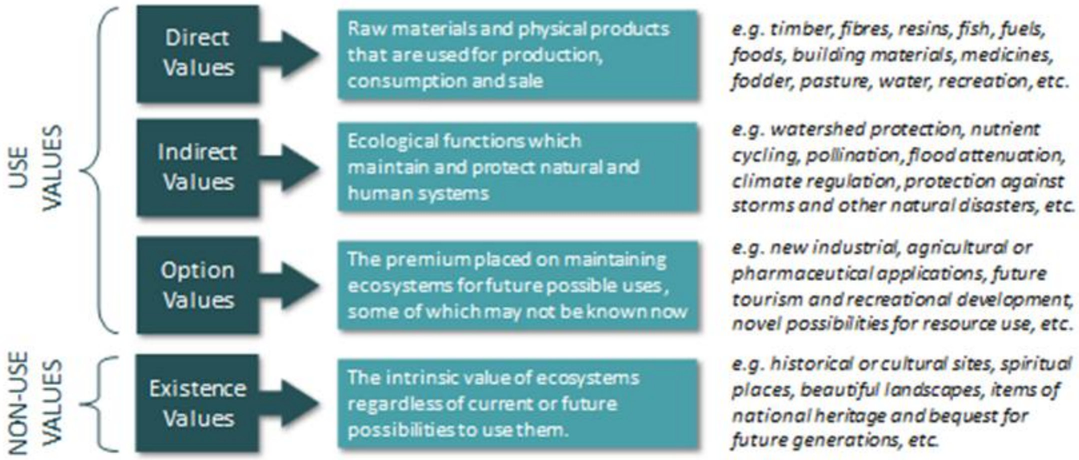
From Millennium Ecosystem Assessment 2005

The concept of **Total Economic Value** (TEV) is used to articulate the value of biodiversity and 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.

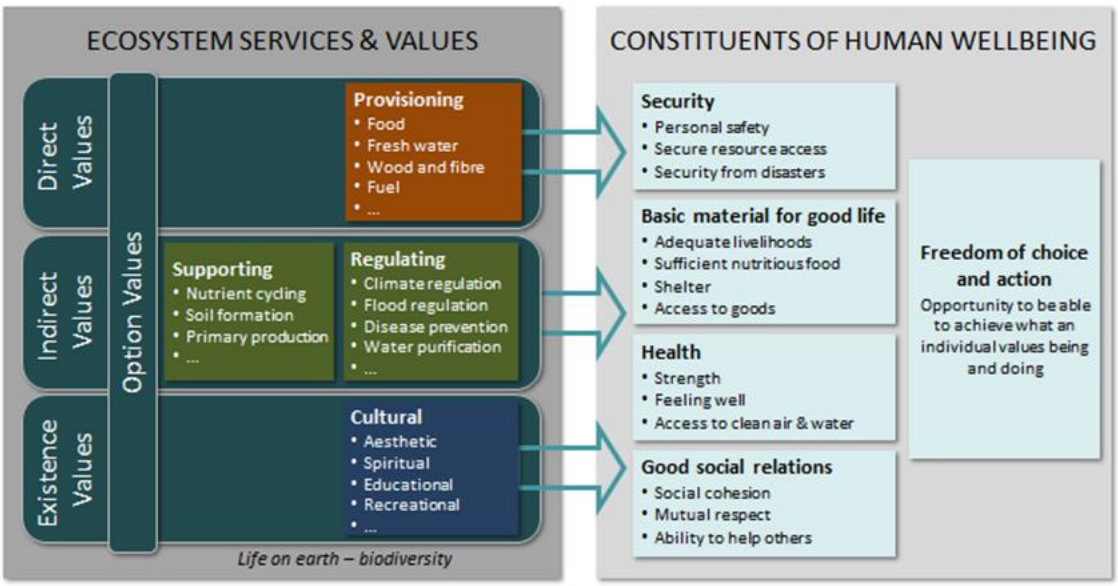
Figure 2: the total economic value of ecosystem services



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

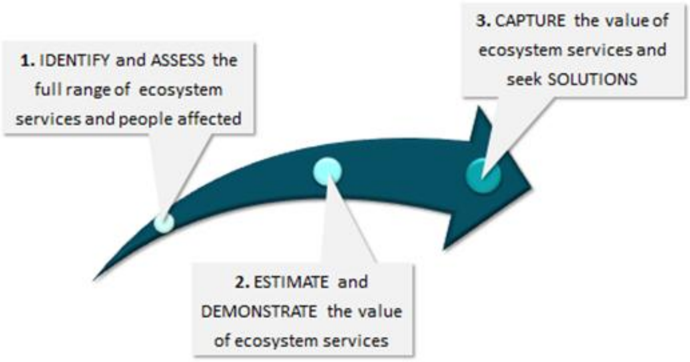


From Emerton 2012

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 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" (TEEB 2008, 2010). The TEEB initiative aims to 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), 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 2 to Cat Tien National Park, the study follows four iterative steps, each aiming to answer a specific question (Figure 5):

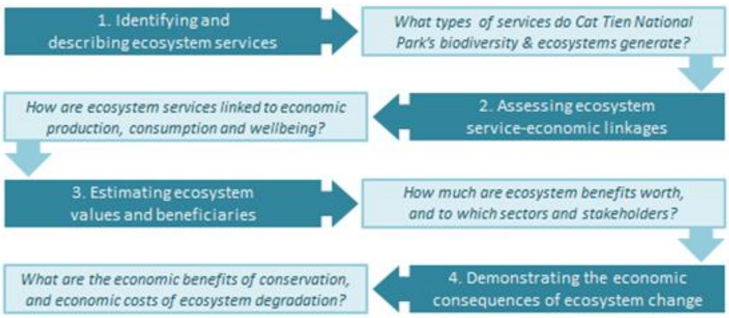
The first step, identifying and describing ecosystem services asks: what types of services do Cat Tien National Park's biodiversity and ecosystems generate?

The second step, assessing ecosystem service-economic linkages asks: how are these ecosystem services linked to economic production, consumption and wellbeing?

The third step, estimating ecosystem values and beneficiaries asks: how much are ecosystem benefits worth, and to which sectors and stakeholders?

The fourth step, demonstrating the economic consequences of ecosystem change asks: what are the economic benefits of conservation and economic costs of ecosystem degradation?

Figure 5: steps in the valuation study



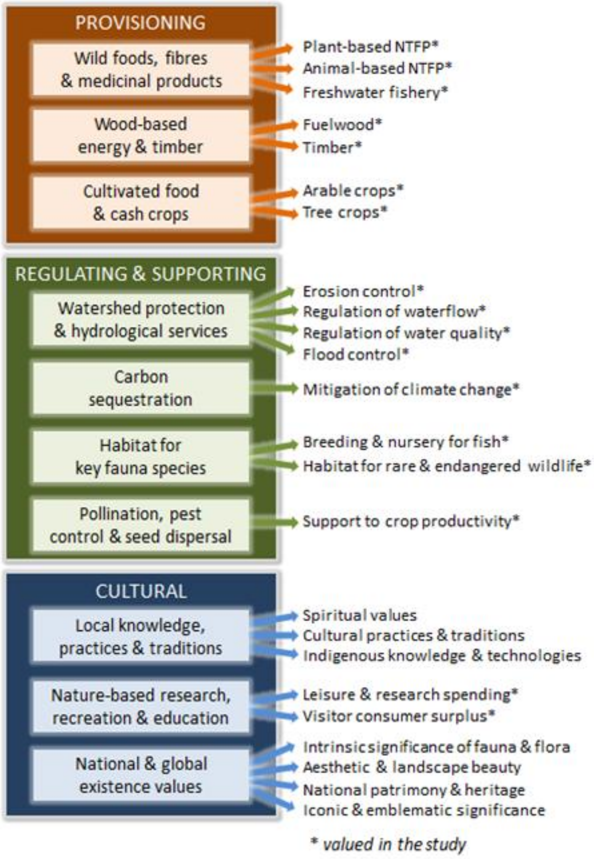
Scope and coverage

The study site is the Cat Tien National Park (CTNP) landscape, comprising South Cat Tien, West Cat Tien, Cat Loc and adjacent/overlapping communes. The core and buffer zones cover a total of 33 communes: this comprises the spatial boundaries of the study area, to which the findings on ecosystem values apply. While the main focus of the study is on the economic value of natural ecosystem services, some consideration is given to those associated with human-modified landscapes and cultivated/domesticated species.

In order to identify the key services associated with Cat Tien National Park's biodiversity and ecosystems, a roundtable meeting was held with key CTNP staff in the early stages of the study. A total of twenty four priority ecosystem services with potentially significant economic linkages or effects at the local, national and/or global level were listed, and recommended for inclusion in the study.

These ecosystem services were subsequently grouped into ten categories for ease of description and analysis (Figure 6): wild foods, fibres and medicinal products; wood-based energy and timber; cultivated food and cash crops; watershed protection and hydrological services; carbon sequestration; habitat for key fauna; pollination, pest control and seed dispersal; local knowledge, practices and traditions; nature-based research, recreation and education; and national and global existence values.

Figure 6: priority ecosystem services in CTNP core and buffer zones



A partial valuation of the services generated by natural ecosystems in the core and buffer zones of CTNP was undertaken. Not of all of the priority ecosystem services outlined above could be fully valued in monetary terms. This is because little or no data were available on the ecological, biological, hydrological and other biophysical processes and linkages in the CTNP landscape which underpin them (for example on the ecohydrological relationships linking changes in ecosystem status to changes in the provision of waterflow/quality regulation and flood control services, between changes in wetland status and fish breeding and nursery, or between changing vegetation quality and cover and soil erosion). Accurate socio-economic information on the rates and levels of use of biological resources was also difficult to obtain.

As the short time frame for the study did not permit any primary data collection or detailed modelling to be carried out, it was necessary to rely on pre-existing statistics and information sources. The study therefore focuses on seventeen ecosystem services that are considered to be of the greatest importance in economic and human wellbeing terms, and for which sufficient data are available to enable monetary valuation. These are indicated in Figure 6, and further elaborated below.

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 was possible to use market price techniques to value selected provisioning services: timber, woodfuel and NTFP harvests, agricultural production, climate mitigation and the spending associated with nature-based recreation and research. The main information sources are Provincial and District government statistics, National Park records, and other data and research held by MARD.

Many 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 CTNP, and some of the provisioning services. For this reason, other valuation techniques must be found.

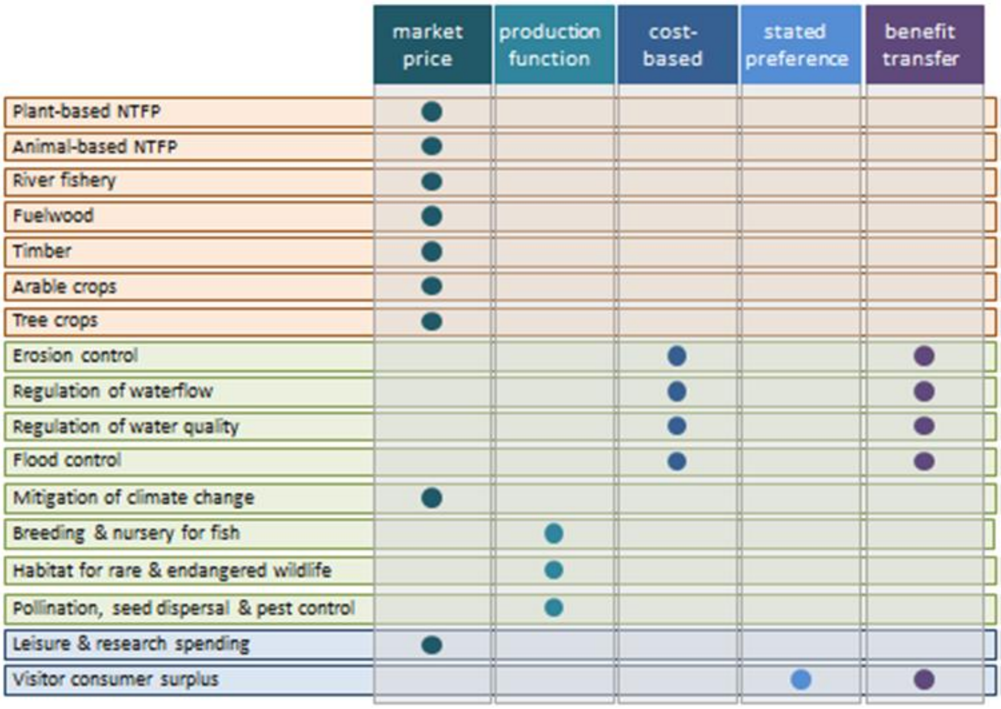
Over recent decades a suite of methods have been developed with which to calculate ecosystem values that cannot be estimated accurately via the use of market prices. These are commonly-accepted and widely-used in most countries of the world, and include (see Annex for further details):

- **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 CTNP's wetlands and forests for fish breeding and as habitat for rare and endangered wildlife are estimated using effect on production methods, as is the value of wild insects, birds and mammals for crop pollination and pest control;
- **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 erosion control, waterflow and quality regulation, flood control and carbon sequestration are based on benefit-transfer values which have been 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 associated with nature-based tourism is based on benefit-transfer values which have been estimated using stated preference methods.

There is no hard and fast "rule" as to which valuation technique should be applied to a given ecosystem service, although each technique has a number of strengths and weaknesses as regards its application in different contexts and in relation to different types of ecosystem services. The specific valuation methods selected for use in CTNP (Figure 7) were chosen depending on the general suitability of different techniques to different types of services. It is outside the scope of this study to provide detailed guidance on environmental valuation theory or methods; there is a large literature dealing with this topic, including its application to protected areas (see, for example, CBD 2002, 2007, DEFRA 2007, Emerton and Bos 2004, Kettunen and ten Brink 2013, OECD 2002, Pabon-Zamora et al 2008, Phillips 1998). The reader is additionally referred to materials prepared for Viet Nam on forest valuation (see Vu Tan Phuong *et al* 2008, 2009), which are consistent with both the international literature and the methods used in the current study.

The annex to this document also provides a brief summary of how and where different ecosystem valuation methods are usually applied, the advantages and disadvantages of particular techniques for different types of services and situations, the steps and methods in applying them, data needs and steps in analysis, and gives examples of their application to forests and protected areas around the world. The choice of valuation technique was also, importantly, determined by the availability of information for CTNP. The specific data used to value different ecosystem services are summarised described in detail and fully referenced below in Table 2 as well as in Chapter 4.

Figure 7: valuation methods used in the study



Applying these valuation methods involves coming up with various indicators of the economic value of the selected ecosystem services and then sourcing the data that is required to quantify these indicators in monetary terms (Table 1). Data collection methods involved working with Central and Provincial Government as well as with CTNP staff and other experts to collect relevant statistics on land and resource use, tourism, and other key economic activities. Individual interviews were supplemented with group consultations and workshops (see section below and Table 2 in relation to data collection for scenario modelling).

Table 1: methods, indicators and data sources used to value ecosystem services in CTNP

Ecosystem service	Component	Valuation method	Indicator of value	Data source
Wild foods, fibres & medicinal products	Plant and animal-based NTFP	Market prices, surrogate prices	Value of harvested fruits, vegetables, nuts, berries, mushrooms, fibres, resins, game, etc.	From District statistics, secondary documents, interviews with local authorities & line agency representative
	Freshwater fishery	Market prices	Value of catch from river and lakes	
Wood-based energy & timber	Fuelwood & timber	Market prices	Value of commercial harvest and wood collected for house construction, fuel and other purposes	
Cultivated food & cash crops	Arable & tree crops	Market prices	Farm gross margins	
Watershed protection & hydrological services	Erosion control, regulation of waterflow, regulation of water quality, flood control	Benefit transfer: replacement costs, mitigative & avertive expenditures, damage costs avoided	Cost savings on mitigation, remediation & physical protection	ADB 2010, Aymui and Chanhda 2009, Bann 1997, Emerton and Kekulandala 2003, Gerrard 2004, Hansen and Top 2006, Kuchelmeister 2003, MARD 2008, Nabangchang 2010, Paris and Ruzicka 1991, Rosales et al 2005, Vu Tan Phuong 2009
			Cost savings from damages to houses, crops, infrastructure and other assets; and physical protection structures	
Carbon sequestration	Mitigation of climate change	Market prices	Market price of voluntary forest carbon	From Vu Tan Phuong et al 2012, Peters-Stanley and

Ecosystem service	Component	Valuation method	Indicator of value	Data source
				Hamilton 2012
Habitat for key fauna species	Breeding and nursery for fish	Effects on production	Reflected in freshwater fisheries value	See above for dependent values
	Habitat for rare & endangered wildlife		Reflected in research & tourism values	
Pollination, pest control & seed dispersal	Support to crop productivity		Value added to farm crops that are dependent on insect pollination	
Nature-based research, recreation & tourism	Leisure & research spending	Market prices	Income generated	From CTNP records
	Visitor consumer surplus	Benefit transfer: stated willingness to pay	Value for tourists visiting CRNP	Ceroni 2007, Dumitras 2008, Dumitras et al 2011, Getzner 2009, Hoa and Ly 2009

As already mentioned above, there is however a critical lack of both socio-economic and biophysical data on these indicators. Aside from district-level statistics on wood, fisheries and agricultural production, and National Park records of tourist numbers and income, there are no pre-existing estimates of the economic value of biodiversity and ecosystem services in CTNP. Due to the short time frame and limited resources available to the study, it was not possible to generate this information via primary data collection, surveys or modelling.

Of necessity, benefit-transfer techniques were therefore used to value several of the supporting, regulating and cultural services associated with CTNP. "Benefit-transfer" refers to the transferral of value estimates from studies which have been carried out in other sites (see Brander 2014). The valuation of erosion and flood control, regulation of waterflow and water quality and visitor consumer surplus in CTNP relies at least partially on data that has been obtained and extrapolated using benefit-transfer techniques. It applies a "value function transfer" approach, which uses ecosystem value estimates from other sites that are expressed as a value per unit (for example per hectare of forest or per tourist). This is combined with information on the quantity of these units in CTNP, and adjusted to reflect differences between CTNP and the reference site (see below). In turn, the studies from which values are transferred have used various methods for calculating these ecosystem values (see Table 1), including replacement costs, mitigative & avertive expenditures and damage costs avoided (for watershed protection & hydrological services) and stated willingness to pay (for visitor consumer surplus).

It is worth noting that caution must be applied when engaging in benefit transfer, due to the limitations of applying data about one site to another context which might have very different biological, ecological and socio-economic characteristics. For this reason, where these 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 CTNP and Viet Nam. All values have been adjusted to bring them to 2013 Viet Nam price levels, applying a consumer price index deflator to account for domestic inflation, and using appropriate Gross Domestic Product Purchasing Power Parity conversion rates.

The resulting unit values have then been applied to CTNP-specific data 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 other parts of Viet Nam or in nearby Mekong/Southeast Asian countries that share similar economic, institutional and ecological conditions to Viet Nam. 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 and Eastern Europe) have been combined with data from Viet Nam, because international nature tourists in those countries have a similar profile to those visiting CTNP.

Analysis of scenarios and assumptions of ecosystem change

The objective of the current study is to assess the economic value of conserving biodiversity and ecosystems in CTNP so as to justify it as an economically beneficial use of public lands, resources and funds. It is concerned with what CTNP adds or subtracts to local, national and global economies.

Coming up with a single, snapshot figure of "the economic value of CTNP" has little meaning. The National Park has value because it serves to secure, protect and sustain important biodiversity and ecosystem services that would otherwise be degraded and lost. The value of CTNP should therefore be seen in relative, not absolute, terms: as compared to a situation where the area's biodiversity and ecosystems remained unprotected. It is the impact of changes in the flow of ecosystem services over time which has meaning for conservation and development policy, planning and management. It should be noted that this very important point is also emphasised by the global TEEB study, which defines nine key principles of best practice on the valuation of ecosystem services. The first of these principles is that "the focus of valuation should be on marginal changes rather than the "total" value of an ecosystem" (TEEB 2010).

In order to generate these figures, the study first assesses the **baseline**: it identifies the ecosystem services that are currently being generated in the CTNP landscape, and estimates their economic value. The baseline year is taken as 2012 (the most recent year for which development data are available). The study then models the **changes in land use and land cover** that would occur over the next 25 years if the CTNP landscape were to revert to an unprotected status. The difference between this "unprotected landscape" scenario and the baseline represents the economic value-added and/or costs avoided that are associated with maintaining Cat Tien as a National Park into the future. It shows the annual and total loss of economic value of biodiversity and ecosystem services to 2037 that would have been available had CTNP been maintained as it is today. Incremental annual values (value added/cost avoided as compared to the baseline) were calculated for each ecosystem service, and for the National Park and buffer zone as a whole. Data were processed and analysed via a tailor-made spreadsheet model.

The assumptions used in the scenario analysis were informed by the perceptions and advice of both CTNP and Provincial Government staff. When defining the "unprotected landscape" scenario that was to be modelled in the study, efforts were made to involve key stakeholders and experts with experience and knowledge of the Cat Tien landscape, so as to ensure that it would reflect local conditions and trends as realistically as possible. A workshop was held in order to describe (via discussions) and visualise (via maps) how land and resource use and management in the core and buffer zones might change in the future, and how changes in natural ecosystems might affect the supply of key ecosystem services.

During the workshop, discussions were held on land use zonation and planning for the CTNP Provinces and Districts. Land use, settlement and infrastructure development were then described in detail for the years 2016, 2019 and 2022 for each core and buffer zone Commune. Assumptions of the land and resource use changes that might take place were informed by Provincial development plans as well as by the knowledge and perceptions of workshop participants. These trends were then projected forward for an additional fifteen years, up to the end of the twenty five year scenario period.

The information generated at the workshop was combined with data collected from national, Provincial and District statistics as well as from discussions with relevant experts and government staff. Current and future ecosystem values for CTNP were modelled based on this information. Baseline figures were taken from existing government records, while actual past trends and stated future government targets (as articulated in the expert/stakeholder workshop) provide the basis for making projections of what would occur under the "unprotected landscape" scenario (Table 2). The directions of land use and ecosystem change in years 2016, 2019 and 2022 that were indicated for each commune (Table 3) were regularised for consistency and used to construct the 25-year trend lines for change in land use and vegetation cover used in the scenario models. Core and buffer zone land use and vegetation cover from MARD and Provincial GIS data were used to construct the baseline.

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

Variable	Baseline	Land use change scenario
Land use/ vegetation type	From MARD and Provincial GIS data	Changes based on workshop findings, disaggregated to the level of each core and buffer zone commune and regularised for consistency
Forest function		
Forest quality		
Protected Area boundaries		
Topography & slope		No change over time
Core and buffer zone administrative boundaries	From Provincal and District statistical handbooks	
Core and buffer zone population		Increases according to population growth projections, disaggregated by District
Proportion of core and buffer zone population with access to forest products	From District statistics, secondary documents, interviews with local authorities & line agency representative	Decreases over time as forest recedes and shrinks
Levels of household participation in forest product harvesting		Proportion of households carrying out activities gradually decreases over time, as lifestyles and livelihoods change and as alternative products and technologies become more affordable/available.
Timber harvest and prices		Steady increase in harvest as industrial and urban demand grows. Price rises in real terms due to increasing scarcity of resource.
Fuelwood harvest and prices		Harvest decreases gradually, due to shift to other domestic fuel sources. Price rises in real terms due to increasing scarcity of resource.
NTFP harvest and prices		Harvest decreases gradually, due to shift to other product and livelihood sources. No change in real prices.
Fish catch and prices		Catch decreases gradually over time due to overexploitation of stocks. No change in real price due to market substitution from other sources.
Forest watershed protection and hydrological services	Benefit transfer (ADB 2010, Aymui and Chanhda 2009, Bann 1997, Emerton and Kekulandala 2003, Gerrard 2004, Hansen and Top 2006, Kuchelmeister 2003, MARD 2008, Nabangchang 2010, Paris and Ruzicka 1991, Rosales et al 2005, Vu Tan Phuong 2009) applied to forested land >15 slope and wetland flood control areas in CTNP	No change in per unit value, but area from which value is generated decreases over time as forest and wetland habitats degraded and lost.
Wetland hydrological services		
Carbon sequestration	Rates from UN-REDD (Vu Tan Phuong et al 2012), prices from State of the Voluntary Carbon Markets 2012 (Peters-Stanley and Hamilton 2012)	
Number of visitors to CTNP	From CTNP records	Decreases over time as National Park is degazetted, ecosystems are degraded and visitor experience declines
Average length of stay in CTNP		
Recreational prices and leisure spending		
Nature tourists consumer surplus	Benefit transfer (Ceroni 2007, Dumitras 2008, Dumitras et al 2011, Getzner 2009, Hoa and Ly 2009) applied to CTNP international and domestic visitors	
Crop and tree crop yields, production and prices	From Provincal and District statistical handbooks	Small but declining rate of increase, reflecting rise in productivity, new technologies and markets
Insect pollination dependency ratios	From FAO (Gallai and Vaissière 2009) applied to cultivated areas of different crops in core and buffer zone	Dependency ratios stay the same but affected areas decline over time as insect populations decrease

Table 3: directions of land use and ecosystem change in years 2016, 2019 and 2022

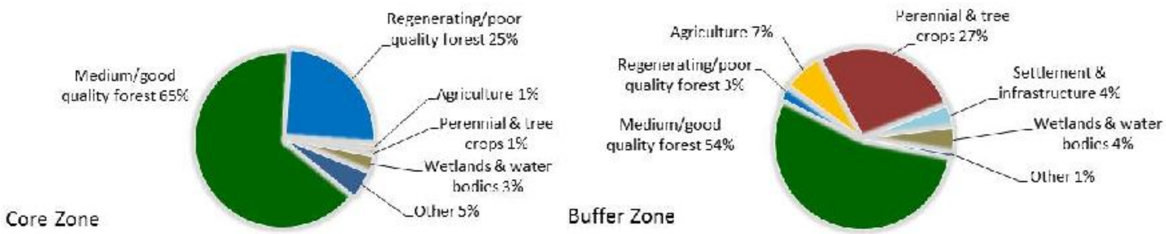
Province	District	Commune	2016	2019	2022
Bình Phước	H. Bù Đăng	Đăng Hà	70% agriculture, 30% mix forest and bamboo in buffer zone	80% agriculture, 20% mix forest and bamboo in buffer zone	almost no forest, 95% agriculture in buffer zone
Đồng Nai	H. Tân Phú	Đắk Lua	core zone: no change; buffer zone: 80% of remaining forest (already a small area) change to agriculture	all forest in buffer zone change to agriculture	no forest in the buffer zone
Đồng Nai	H. Vĩnh Cửu	Phú Lý	30% agriculture, 70% forest	30% agriculture, 70% forest	30% agriculture, 70% forest
Lâm Đồng	H. Bảo Lâm	Lộc Bắc	20% of natural forest conversion to rubber and agri	40% of natural forest conversion to rubber and agri	70% of natural forest conversion to rubber and agri
Lâm Đồng	H. Cát Tiên	Đồng Nai town	no forest	no forest	no forest
Lâm Đồng	H. Cát Tiên	Gia Viễn	only a few % of forest left at buffer zone	only a few % of forest left at buffer zone	only a few % of forest left at buffer zone
Lâm Đồng	H. Cát Tiên	Phước Cát II	no forest left at buffer zone	no forest left at buffer zone	no forest left at buffer zone
Lâm Đồng	H. Cát Tiên	Tiên Hoàng	only a few % of forest left at buffer zone	only a few % of forest left at buffer zone	almost no forest left at buffer zone
Lâm Đồng	H. Đạ Tẻh	An Nhơn	15% of natural forest conversion to rubber and agri	30% of natural forest conversion to rubber and agri	90% of natural forest conversion to rubber and agri
Lâm Đồng	H. Đạ Tẻh	Đạ Kho	all agriculture	all agriculture	all agriculture
Lâm Đồng	H. Đạ Tẻh	Đạ Lây	20% forest cover	10% forest cover	No forest cover
Lâm Đồng	H. Đạ Tẻh	TT. Đạ Tẻh	all agriculture	all agriculture	all agriculture
Lâm Đồng	H. Đạ Tẻh	Hương Lâm	15% of natural forest conversion to rubber and agri	50% of natural forest conversion to rubber and agri	90% of natural forest conversion to rubber and agri
Lâm Đồng	H. Đạ Tẻh	Quốc Oai	15% of natural forest conversion to rubber and agri	30% of natural forest conversion to rubber and agri	90% of natural forest conversion to rubber and agri
Lâm Đồng	H. Bảo Lâm	Lộc Bắc	20% of natural forest conversion to rubber and agri	40% of natural forest conversion to rubber and agri	70% of natural forest conversion to rubber and agri
Lâm Đồng	H. Bảo Lâm	Lộc Bảo	20% of natural forest conversion to rubber and agri	40% of natural forest conversion to rubber and agri	70% of natural forest conversion to rubber and agri
Bình Phước	H. Bù Đăng	Đăng Hà	70% agriculture, 30% mix forest and bamboo in buffer zone	80% agriculture, 20% mix forest and bamboo in buffer zone	almost no forest, 95% agriculture in buffer zone
Bình Phước	H. Bù Đăng	Đoàn kết	no forest conversion, because it's 100% agriculture now	no forest conversion, because it's 100% agriculture now	no forest conversion, because it's 100% agriculture now
Bình Phước	H. Bù Đăng	Đồng Nai	15% of natural forest conversion to rubber and agri	50% of natural forest conversion to rubber and agri	95% of natural forest conversion to rubber and agri
Bình Phước	H. Bù Đăng	Thống Nhất	all agriculture	all agriculture	all agriculture
Lâm Đồng	H. Cát Tiên	Đồng Nai town	no forest	no forest	no forest
Lâm Đồng	H. Cát Tiên	Đức Phổ	no forest	no forest	no forest
Lâm Đồng	H. Cát Tiên	Gia Viễn	only a few % of forest left at buffer zone	only a few % of forest left at buffer zone	only a few % of forest left at buffer zone
Lâm Đồng	H. Cát Tiên	Mỹ Lâm	no forest	no forest	no forest
Lâm Đồng	H. Cát Tiên	Nam Ninh	only a few % of forest left	only a few % of forest left	almost no forest left
Lâm Đồng	H. Cát Tiên	Phù Mỹ	no forest	no forest	no forest
Lâm Đồng	H. Cát Tiên	Phước Cát I	100% agriculture	100% agriculture	100% agriculture
Lâm Đồng	H. Cát Tiên	Phước Cát II	no forest left at buffer zone	no forest left at buffer zone	no forest left at buffer zone
Lâm Đồng	H. Cát Tiên	Quảng Ngãi	all agriculture	all agriculture	all agriculture
Lâm Đồng	H. Cát Tiên	Tiên Hoàng	only a few % of forest left at buffer zone	only a few % of forest left at buffer zone	almost no forest left at buffer zone
Lâm Đồng	H. Cát Tiên	Đồng Nai town	no forest	no forest	no forest
Lâm Đồng	H. Cát Tiên	Tư Nghĩa	all agriculture	all agriculture	all agriculture
Đắk Nông	Đắk Lấp	Đắc Sin	15% of natural forest conversion to rubber and agri	50% of natural forest conversion to rubber and agri	95% of natural forest conversion to rubber and agri

Province	District	Commune	2016	2019	2022
Đắk Nông	Đắk Lấp	Đạo Nghĩa	15% of natural forest conversion to rubber and agri	50% of natural forest conversion to rubber and agri	95% of natural forest conversion to rubber and agri
Đồng Nai	H. Định Quán	Thanh Sơn	10000 ha forest merged to Cat Tien NP core zone as the plan	forest outside NP reduced by 20%	forest outside NP reduced by 40%
Đồng Nai	H. Tân Phú	Đắk Lua	core zone: no change; buffer zone: 80% of remaining forest (already a small area) change to agriculture	all forest in buffer zone change to agriculture	no forest in the buffer zone
Đồng Nai	H. Tân Phú	Nam Cát Tiên	all agriculture	all agriculture	all agriculture
Đồng Nai	H. Tân Phú	Núi Tượng	all agriculture	all agriculture	all agriculture
Đồng Nai	H. Tân Phú	Phú An	all agriculture	all agriculture	all agriculture
Đồng Nai	H. Tân Phú	Phú Lập	all agriculture	all agriculture	all agriculture
Đồng Nai	H. Tân Phú	Tà Lài	all agriculture	all agriculture	all agriculture
Đồng Nai	H. Vĩnh Cửu	Phú Lý	30% agriculture, 70% forest	30% agriculture, 70% forest	30% agriculture, 70% forest

Summary of ecosystem services and economic linkages

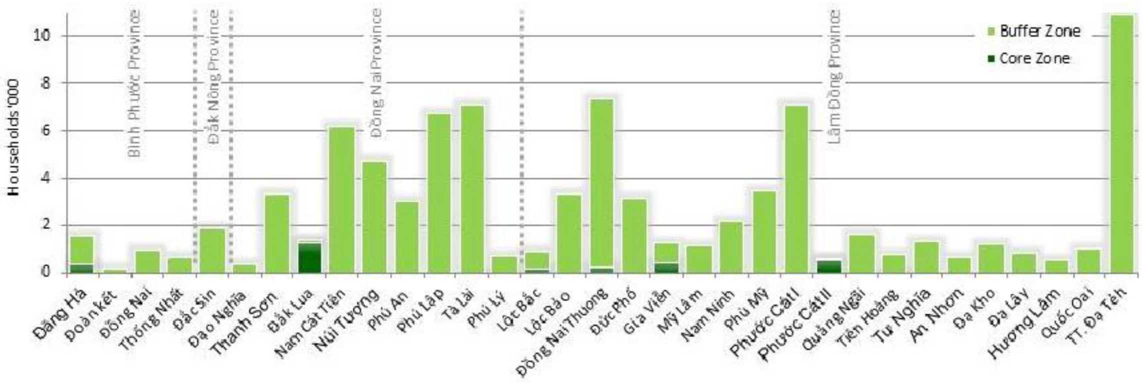
The core zone of Cat Tien National Park, comprising South Cat Tien, West Cat Tien and Cat Loc occupies an area in excess of 710 km^2, and the buffer zone covers more than 2,400 km^2. The CTNP landscape overlaps 33 communes, located in eight districts of Bình Phước, Đắk Nông, Đồng Nai and Lâm Đồng Provinces (Figure 10). While the vast majority of the core zone is covered by forest, the buffer zone contains a variety of land uses: just under 40% of the landscape has been cleared and modified for agriculture, settlement and infrastructure (Figure 8).

Figure 8: land use and land cover in CTNP core and buffer zones



The core zone of CTNP is divided into functional zones (Figure 11), containing a variety of land uses and vegetation types (Figure 12, Figure 13). Key natural habitats include evergreen, semi-evergreen and mixed forest, bamboo, shrublands, grasslands and lakes/wetlands (UNESCO 2013a). There is a high diversity of fauna and flora, including a number of endemics as well as globally and nationally endangered species. CTNP's notable biological diversity stems from its location in an area between the biogeographically distinct Da Lat Plateau and eastern parts of the Southern Delta (Dinh Thanh Sang *et al* 2012).

Figure 9: population in core and buffer zone communes, 2012



Around 3,100 households reside in the core zone of CTNP, and just under 84,500 households are located in the buffer zone (Figure 9). As described in the paragraphs below, the local population depends heavily on ecosystem services for their livelihoods. Although it is common for households to be engaged in trade, business and paid employment, farming forms the basis of the local economy. Forest products however also provide a vital supplementary source of income and subsistence. Recent socio-economic surveys carried out in and around CTNP suggest that more than 60% of households harvest forest products for home use and around a third generate earnings from selling wild products (Dinh Thanh Sang *et al* 2012).

Figure 10: core and buffer zone administrative boundaries in CTNP

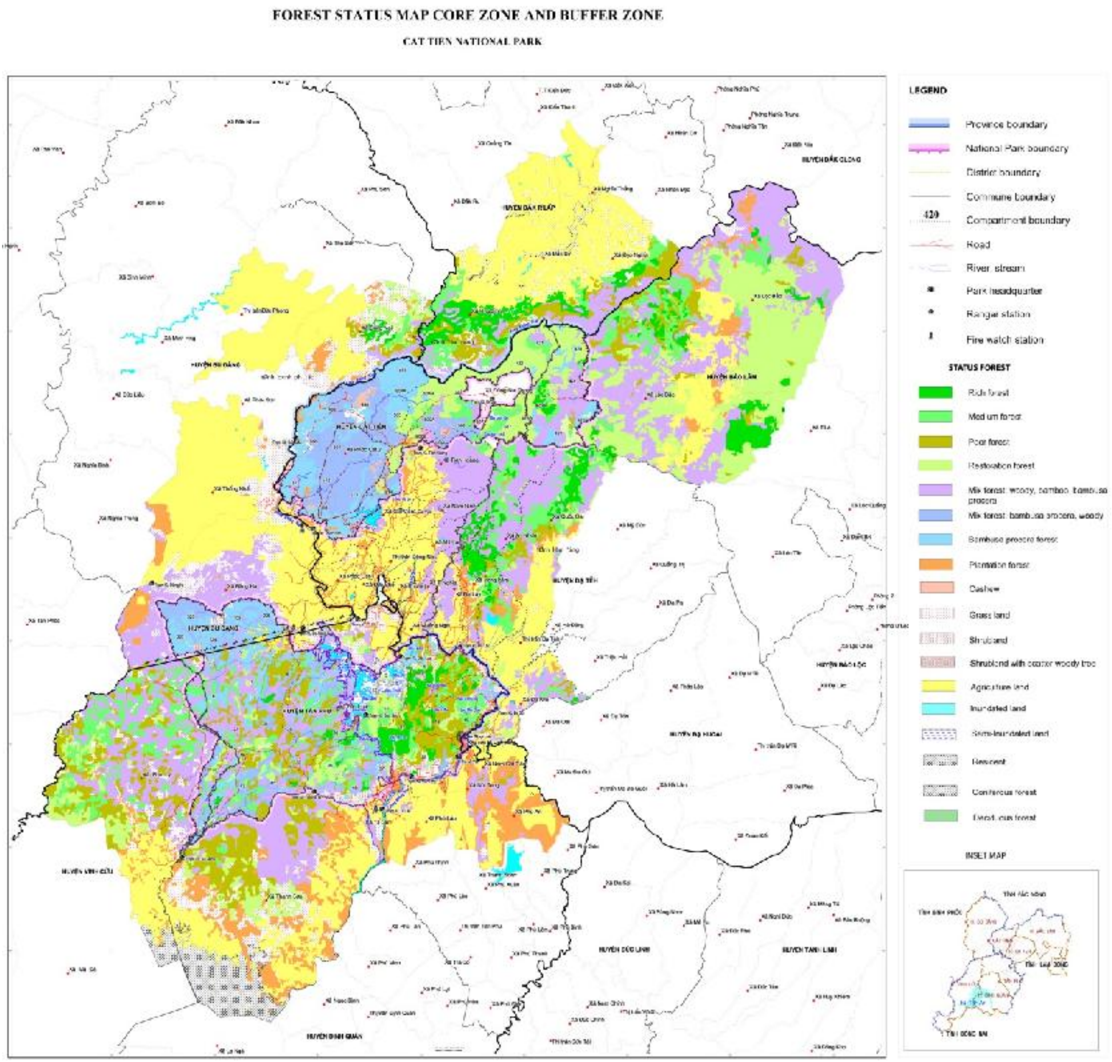


Figure 11: functional zoning in CTNP

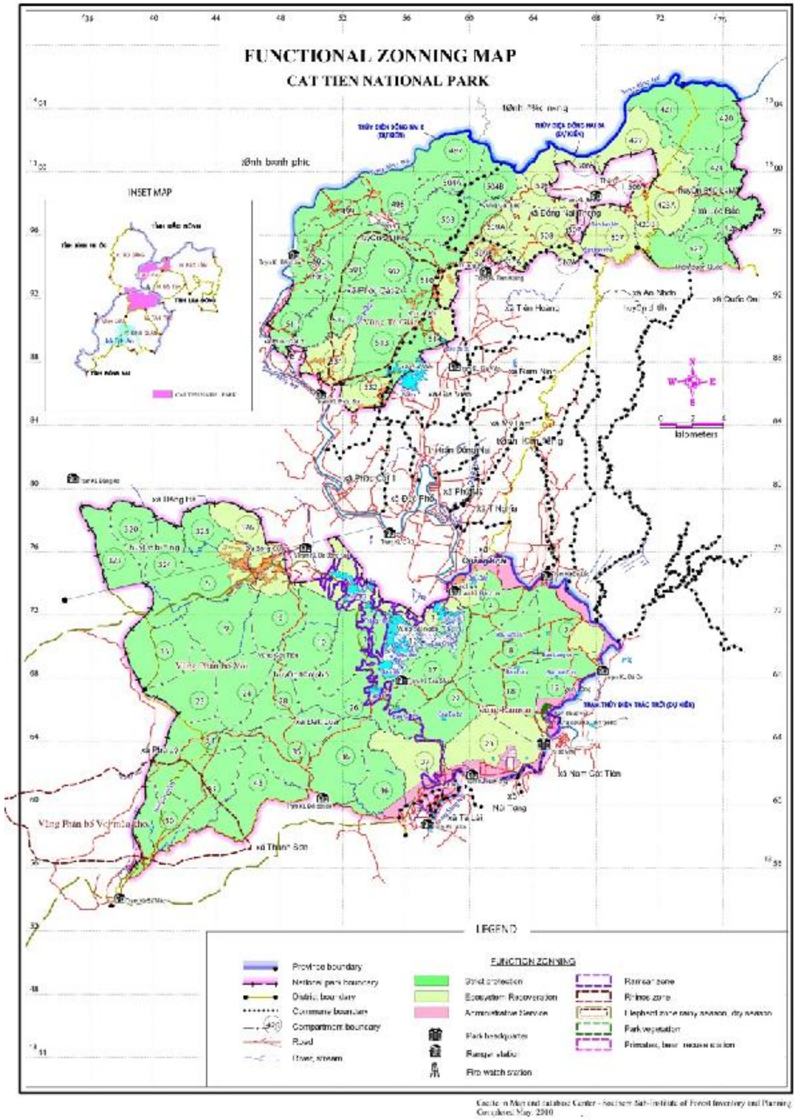


Figure 12: forest status in CTNP

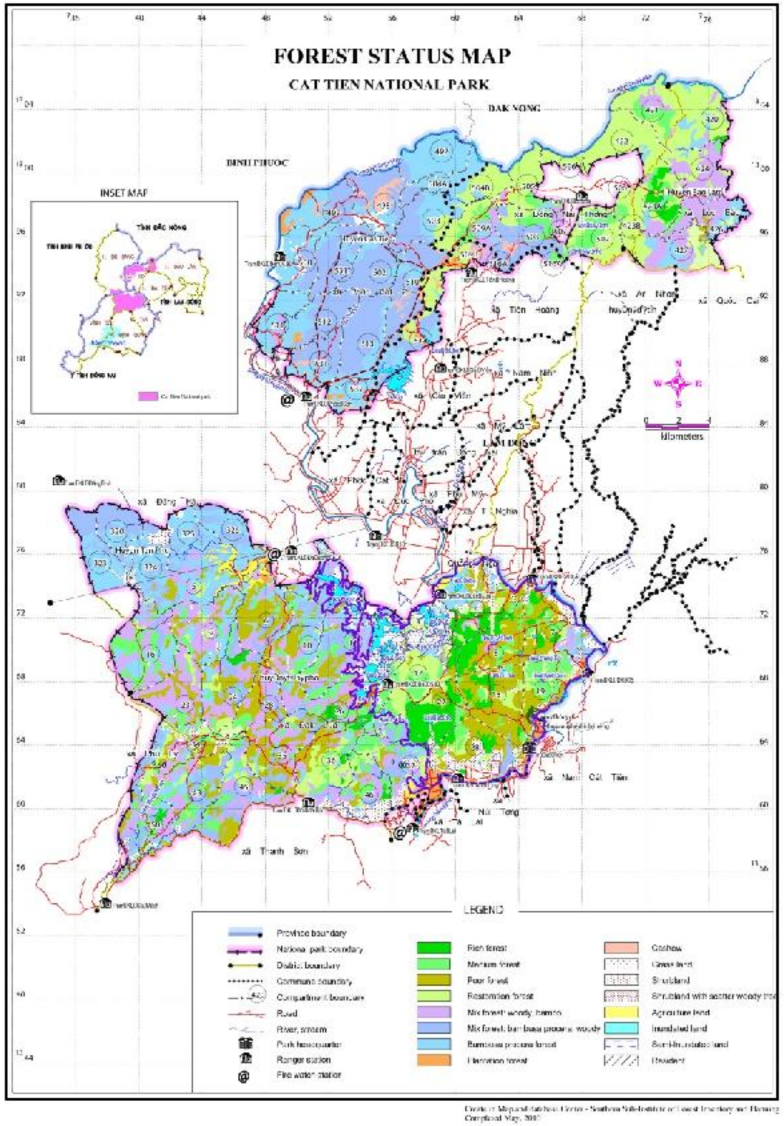
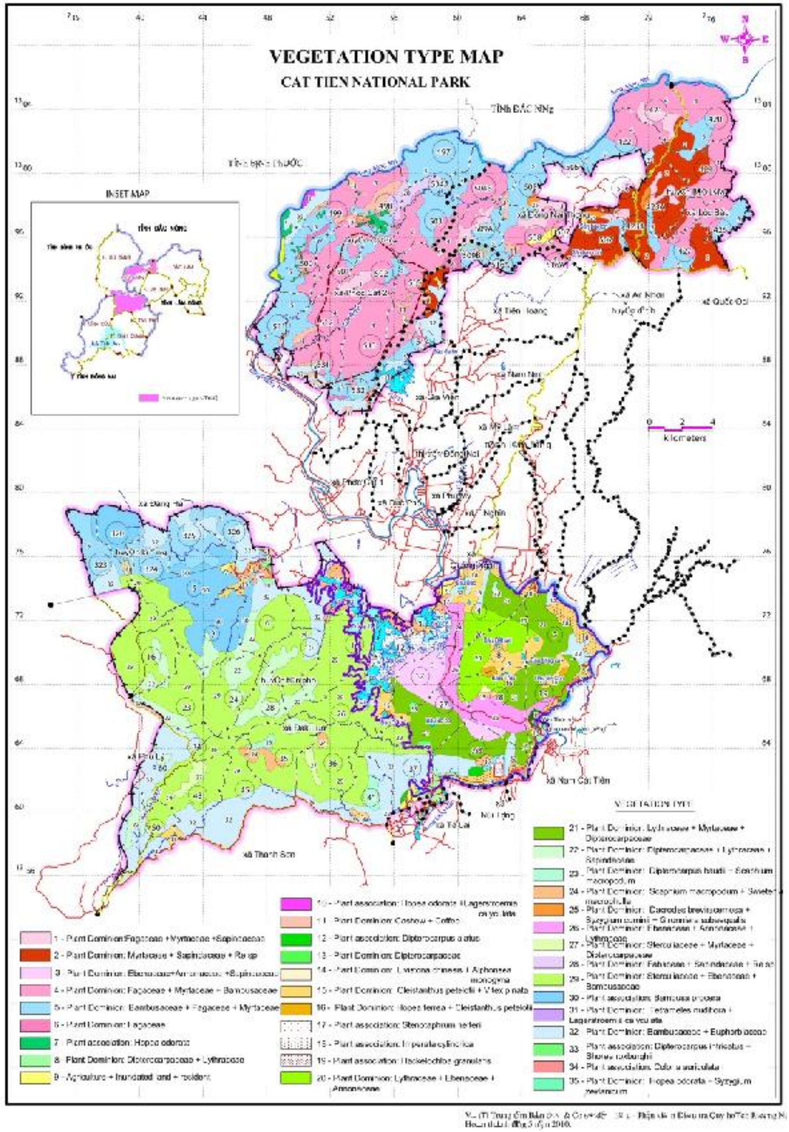


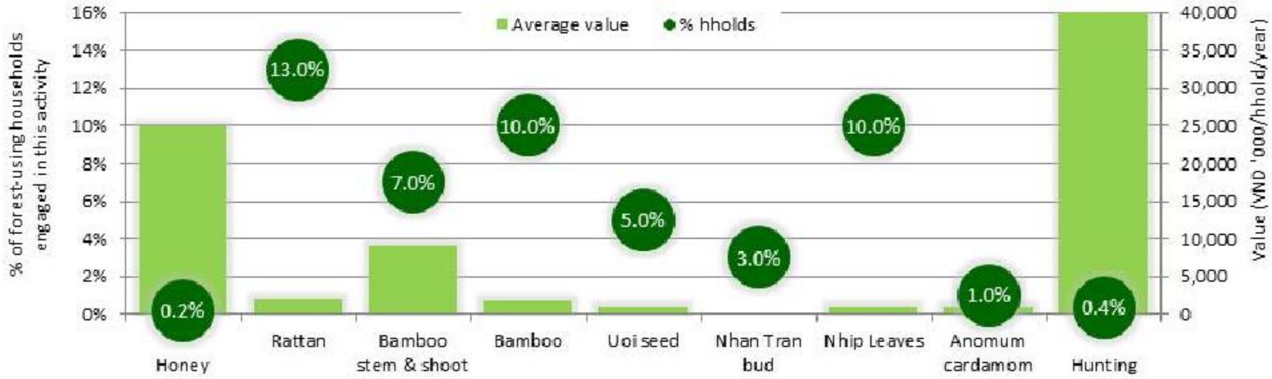
Figure 13: vegetation types in CTNP



Wild foods, fibres and medicinal products

A wide variety of wild plants and animals are harvested for household use and sale. It is reported that more than three quarters of households use NTFP from natural forest areas for subsistence purposes, and around a fifth earn income from them (Dinh Thanh Sang *et al* 2012). These figures are slightly higher than those given in District statistics, which state that around 30% of households in the buffer zone are involved in some way in NTFP collection (it can be assumed that all households living in the core zone of CTNP have access to NTFP). Community members are involved in harvesting plant and animal-based foods, fibres and medicinal products from the forest, as shown in Figure 14. Meanwhile, almost 250 tonnes of fish and shrimp are caught from rivers, lakes and wetlands in the CTNP landscape, to a value of some VND 9.8 billion (US$ 0.46 million).

Figure 14: average household participation and values from NTFP harvesting activities



<u>These calculations give a baseline value of VND 34.4 billion for plant-based NTFP and VND 15.45 billion for animal-based NTFP: a total of VND 49.85 billion (US$ 2.36 million).</u>

Wood-based energy and timber

Surveys carried out in and around CTNP conclude that there is a high rate of dependence on firewood in the core zone: that 60% or more of households gather fuelwood from natural forest, with harvest volumes averaging more than 10 m^3/household/year (Dinh Thanh Sang *et al* 2012). Far fewer households in the buffer zone depend on wood as their primary source of energy for cooking, and it appears that much of the firewood that is consumed comes from farmland, plantations and forest that has been cleared for agriculture (Nguyen Trung Thong and Enright 2012). District sources cite somewhat lower figures, stating that around 10% of households in the buffer zone and 30% of households in the core zone harvest firewood from natural forest areas, with an average annual harvest of 1.8 m^3 per household.

The literature also suggests that significant volumes of timber are harvested from natural forest areas, including the National Park itself (see for example Dinh Thanh Sang *et al* 2012, Nguyen Trung Thong and Enright 2012). *Afzelia xylocarpa* (Go do), *Dipterocarpus intricatus* (Dau long), *Dipterocarpus alatus* (Dau rai)), *Dalbergia mammosa* (Cam lai), *Lagerstroemia calyculata* (Bang lang), *Sindora siamensis* (Go mat) and *Tectona grandis* (Go d tech) are all mentioned as being obtained from the CTNP landscape. It is reported that up to a quarter of forest-adjacent households are involved in illegal logging activities, mainly as labourers or transporters, and that almost three quarters harvest timber for subsistence purposes (Dinh Thanh Sang *et al* 2012). According to District-level records around 2,000 m^3 of timber was harvested from natural forest areas in the CTNP landscape in 2012, around 90% of which was for household use.

These calculations give a baseline value of VND 1.23 billion for fuelwood collection and VND 7.56 billion for timber extraction: a total of VND 8.79 billion (US$ 0.42 million) for wood-based energy and timber harvests.

Watershed protection and hydrological services

Forest dominates the CTNP landscape, and the Bau Sau wetland system, located within the National Park, comprises a complex of permanent and seasonal lakes, marshlands and flooded forest. Numerous studies carried out in similar areas of Viet Nam underline the contribution that forests and other natural habitats play in the regulation of waterflow and water quality and the control of soil erosion, downstream siltation and sedimentation (Vu Tan Phuong 2009). The natural ecosystems of the CTNP landscape likewise provide a number of important hydrological services (UNESCO 2013b).

Forested areas of CTNP play a key role in protecting the Đồng Nai River and associated water courses, and the natural wetlands both function to regulate water quality and serve as a floodwater retention reservoir. More than 21 km^2 or 3.1% of the core zone of CTNP and around 4% or 110 km^2 of the buffer zone is occupied by rivers, streams, lakes and inundated areas. The The Đồng Nai River marks the boundary of the National Park and crosses the landscape before running southwards through Viet Nam, where it provides an important source of freshwater for households, industry, agriculture, aquaculture and hydropower in downstream Ho Chi Minh City, Dong Nai and Ba Ria-Vung Tau Provinces.

The value of forest and wetland erosion control, regulation of waterflow and quality and flood control are calculated using benefit-transfer techniques. As already explained above in Chapter 3, "value function transfer" is applied, drawing on ecosystem value estimates generated via recent studies carried out in comparable areas of Cambodia, Lao PDR, Philippines, Sri Lanka, Thailand and Viet Nam (ADB 2010, Aymui and Chanhda 2009, Bann 1997, Emerton and Kekulandala 2003, Gerrard 2004, Hansen and Top 2006, Kuchelmeister 2003, MARD 2008, Nabangchang 2010, Paris and Ruzicka 1991, Rosales *et al* 2005, Vu Tan Phuong 2009).

The resulting average of VND 9.3 million per hectare per year for combined forest erosion control, waterflow and water quality regulation is applied to medium and good quality forest located on slopes of more than 30 degrees, while half this value is applied to poor quality and regenerating forest and grassland. Average values of VND 36.1 million per hectare for flood control and VND 4.6 million per hectare for water purification are applied to the estimated 6,500 ha of wetlands and water bodies (approximately half of the total) that are estimated to perform these functions.

These calculations give a baseline value of VND 270.27 billion and VND 265.73 billion respectively for forest and wetland watershed protection and hydrological services: a total of VND 536.01 billion (US$ 25.34 million).

Carbon sequestration

Forests in the CTNP landscape constitute an important carbon sink. The gross value of forest carbon sequestration is calculated according to estimates prepared for Central Highland region of Viet Nam for evergreen, deciduous, mixed and bamboo forests, shrubland, woodlands, grasslands, wetlands and agricultural land (Vu Tan Phuong *et al* 2012). Annual sequestration rates, expressed as tC/hectare/year are applied to the relevant areas under each vegetation type in the CTNP landscape. The average voluntary market price for forest carbon (the most applicable price currently pertaining to forest carbon in Viet Nam) is applied to the estimated 1.6 million tonnes of C that are sequestered by CTNP vegetation each year.

These calculations give a baseline value of VND 175.54 billion (US$ 8.3 million) for carbon sequestration.

Pollination, pest control and seed dispersal services

Agriculture is the dominant land use in the CTNP buffer zone and surrounding area. More than 20% or 660 km^2 of the land area of the CTNP landscape is occupied with perennial tree crops, while annual crops account for 6% or 177 km^2. Major annual crops include paddy, maize, cassava, sweet potato, sugar cane and vegetables, while perennial tree crops such as cashew, coffee, pepper and rubber provide a key source of income for many households (Nguyen Trung Thong and Enright 2012, To Xuan Phuc *et al* 2013).

Forest insects, birds and mammals contribute significantly to the pollination, pest control, nutrient burial and decomposition processes that support and enable crop production (Losey and Vaughan 2006). 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 provided by many insect species, as well as several species of birds and bats (Bauer and Wing 2010).

The gross value of wild animal pollination, pest control and seed dispersal services to 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 wild insect pollination services. The tool is applied to district records of production, yields and prices for the 837 km^2 of land in the core and buffer zone planted with paddy, other annual crops and tree crops.

These calculations give a baseline value of VND 304.16 billion (US$ 14.38 million) for wild insect crop pollination, pest control and seed dispersal services.

Nature-based research, recreation and education

CTNP is a popular and well-known tourist destination. In 2012, more than 3,500 international tourists and almost 15,000 domestic visitors spent a total of 30,000 days in the park, carrying out various recreational activities. In addition, three major research projects were carried out, with a total budget of VND 1.4 billion.

Calculations of the gross value of nature-based tourism includes entry fees and the leisure spending on food, accommodation and guided tours that is injected into the economy from visitors to CTNP as well as their consumer surplus. Visitor numbers and prices are taken from CTNP records. Spending on scientific research carried out in CTNP is also obtained from government statistics.

Consumer surplus figures are obtained using benefit-transfer techniques. As already explained above in Chapter 3, “value function transfer” is applied, drawing on ecosystem value estimates generated via recent studies carried out which deal with similar visitor and PA profiles in Viet Nam and Central, Eastern and Southern Europe (Ceroni 2007, Dumitras 2008, Dumitras *et al* 2011, Getzner 2009, Hoa and Ly 2009) to estimate a per-trip visitor consumer surplus of VND 89,000 and VND 819,000 for domestic visitors and international visitors respectively.

These calculations give a baseline value of VND 16.33 billion (US$ 0.77 million) for nature-based research, recreation and education.

The baseline economic value of CTNP ecosystem services

Putting together the figures described in the paragraphs above gives us a baseline value for the ecosystem services that were able to be valued in the study of VND 1,091billion or US$ 51.6 million in 2012 (Table 4).

Table 4: baseline value of CTNP ecosystem services

Ecosystem service	VND billion	US$ million
Wood products	8.79	0.42
Plant-based NWFP	34.40	1.63
Animal-based NWFP	15.45	0.73
Waterflow & quality regulation	536.01	25.34
Carbon sequestration	175.54	8.30
Pollination & seed dispersal	304.16	14.38
Nature-based research, recreation & education	16.33	0.77
Total	1,090.67	51.57

Direct income generated from the utilisation of forest land and resources accounts for only around 6% of this value: VND 60.5 billion or US$ 2.9 million (Figure 15, Figure 16). By far the largest share – almost two thirds, or VND 711.5 billion (US$ 33.6 million) – comes from the regulating and supporting services that help other sectors to avoid costs and damages within Viet Nam (through the protection of settlements, infrastructure and production processes) and globally (due to climate change mitigation). Just over a quarter of the total (VND 317.6 billion or US$ 15.1 million) is accounted for by the value added by ecosystem services to production in other sectors, most notably agriculture and tourism.

Figure 15: baseline value by ecosystem service

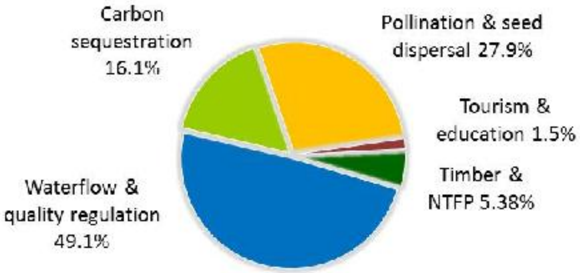
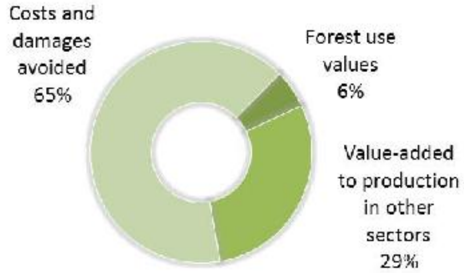


Figure 16: baseline value by type of benefit



The economic implications of biodiversity loss and ecosystem degradation

In the absence of the National Park and its associated conservation management regime, it is likely that agricultural land uses (particularly perennial tree crops) would expand to fill the area that is currently occupied by CTNP.

This represents a continuation of the land use changes that have actually been happening in the buffer zone over recent years. It also reflects the focus in existing Provincial Development plans on improving land use efficiency, exploring more intensive cultivation techniques, and introducing farming practices and technologies to improve crop productivity, in particular adding value to perennial crops. While there is now less emphasis on the continued expansion of cashew (which is no longer considered a “strategic” crop), rubber, tea and coffee are all highlighted as areas for future development. Other sources of land use change, such as mining, infrastructure development and the spread of urban settlements, trading centres and housing would exert a lesser, although still pronounced, influence over land use patterns.

This scenario also concurs with what is reported in the literature. The expansion of tree crops is widely cited as having been the major cause of deforestation (see, for example, Ogonowski and Enright 2013, To

Xuan Phuc *et al* 2013), and it is stated that many of the hills surrounding CTNP have already been stripped of trees and converted to farming (Dinh Thanh Sang *et al* 2012). Land conversion and degradation is also reported to have made forests more vulnerable to illegal loggers (Nguyen Trung Thong and Enright 2012).

Under a scenario in which biodiversity and ecosystems were not protected, and CTNP was to revert to an unprotected status, it is therefore envisaged that natural forest, shrublands, grasslands and wetlands will all gradually be converted to agriculture. At the same time, infrastructure and housing will expand in response to the influx of human population and spread of farming into the area that is currently the core zone of CTNP. It is also likely that the forest resource harvests will, at least initially, intensify. The impact of these changes on land use and land cover in core and buffer zone communes, based on the commune-level projections for 2016,2019 and 2022 defined during the workshop, are shown below (Figure 17, Table 5).

Figure 17: change in land use/cover under an “unprotected landscape” scenario, 2013-37

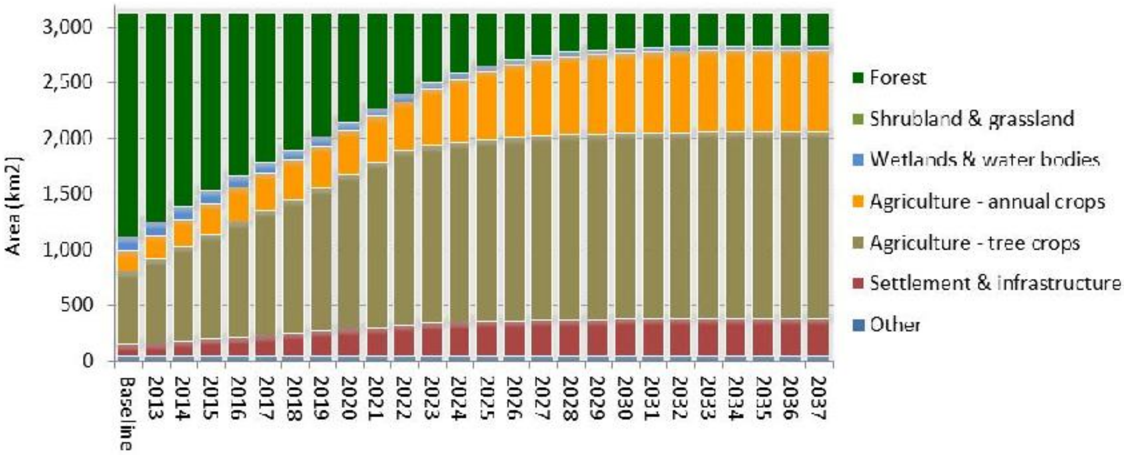


Table 5: change in land use/cover under an “unprotected landscape” scenario, 2013-37 (km^2)

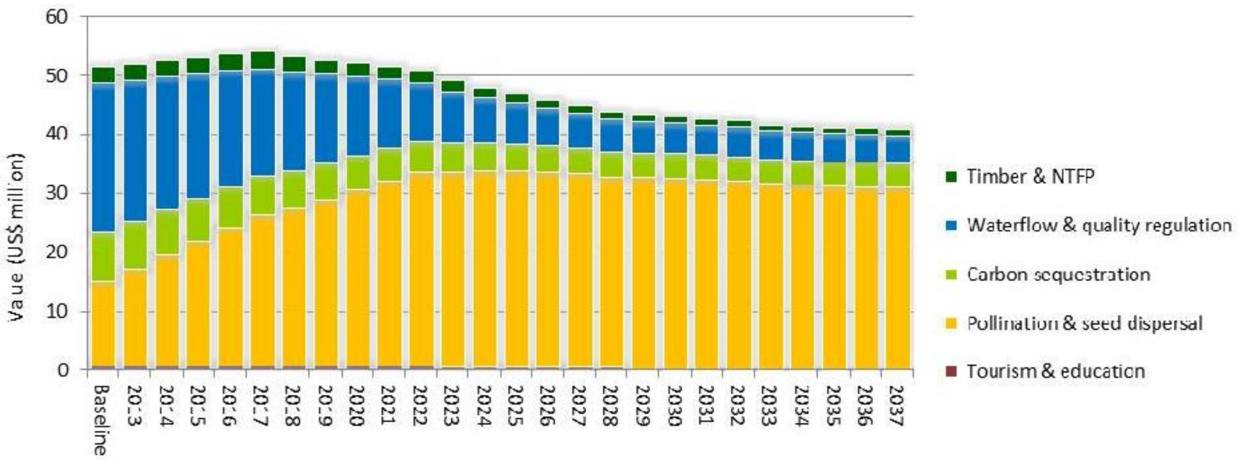
	Baseline	2013	2014	2015	2016	2017	2018	2019
Forest	2,017	1,878	1,740	1,602	1,464	1,347	1,230	1,114
Shrubland & grassland	0.10	0.08	0.06	0.04	0.01	0.01	0.01	0.01
Wetlands & water bodies	130	125	119	113	108	101	94	87
Agriculture - annual crops	176	210	244	278	313	333	353	373
Agriculture - tree crops	660	753	847	941	1,034	1,120	1,205	1,290
Settlement & infrastructure	97	113	130	146	162	180	199	217
Other	46	46	46	46	46	46	46	46

	2020	2021	2022	2023	2025	2026	2027	2028	2029
Forest	986	859	731	626	477	426	389	360	340
Shrubland & grassland	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wetlands & water bodies	79	72	64	58	47	44	41	39	37
Agriculture - annual crops	395	416	437	510	616	652	679	698	713
Agriculture - tree crops	1,385	1,479	1,574	1,599	1,634	1,646	1,655	1,661	1,666
Settlement & infrastructure	236	255	274	287	306	313	318	321	324
Other	46	46	46	46	46	46	46	46	46

	2030	2031	2032	2033	2034	2035	2036	2037
Forest	326	316	310	305	303	302	301	300
Shrubland & grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wetlands & water bodies	36	35	35	34	34	34	34	34
Agriculture - annual crops	723	730	735	738	739	740	741	741
Agriculture - tree crops	1,670	1,672	1,673	1,674	1,675	1,675	1,675	1,676
Settlement & infrastructure	326	327	328	329	329	329	329	329
Other	46	46	46	46	46	46	46	46

These land use and land cover changes would impact on the provision of ecosystem services. As described in the paragraphs above, natural forest, shrublands, grasslands and wetlands will progressively (although not entirely) be converted to human-modified agricultural and settlement landscapes. Over time, provisioning, regulating, supporting and cultural unit values due to the degradation of natural ecosystems. It is likely that intensifying human demands on land and natural resources will result, initially, in an increase in the level of use of certain services (such as tourism, forest products and agriculture-related services). At first this growth in use levels will outweigh the decline in unit value, meaning that some ecosystem service values will increase. However, over time, these values will start to decrease and flatten out, as ecosystems are progressively converted and degraded and the ability of the CTNP landscape to provide key goods and services is gradually eroded (Figure 18).

Figure 18: ecosystem service values 2013-37 under an “unprotected landscape” scenario



Value-added and costs avoided by continuing to conserve CTNP

The decline in ecosystem values that would occur under an “unprotected landscape” scenario makes it clear that **maintaining the conservation status of CTNP implies considerable economic value-added and costs avoided**. Although there may be short-term gains from forest conversion, long-term losses will arise due to the reduction in economically valuable ecosystem services that would have otherwise remained available should CTNP have maintained its present status (Figure 19). The cumulative losses or ecosystem values foregone if biodiversity and ecosystems were not protected via CTNP is estimated to be more than VND 2,255 billion (US$ 107 million) over the next twenty five years (Figure 20).

Figure 19: changes in ecosystem services values under an “unprotected landscape” scenario

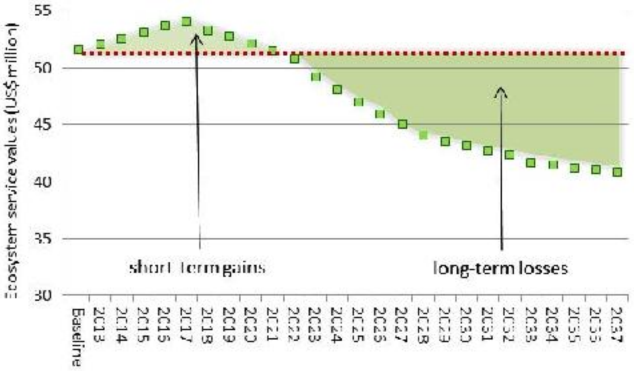
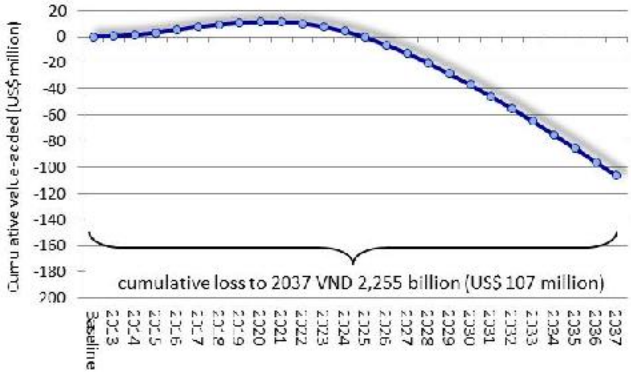


Figure 20: cumulative losses under an “unprotected landscape” scenario



In reality, the benefits of conserving CTNP in terms of ecosystem service values added and costs avoided are likely to be considerably higher than this. One reason is that the current study is only a partial valuation exercise: the figures given represent only a fraction of the total economic value of CTNP. Another important consideration is that, rather than remaining constant at today's baseline, it is highly likely that value of ecosystem services will rise over time due to improvements in the way in which the National Park is managed and biodiversity benefits are shared with surrounding communities.

This is reinforced by the conclusions of the scenario development workshop. There was a general consensus among key experts and stakeholders that, **in the future, CTNP will be better protected**. It is envisaged that the gazetted area of the National Park will expand by 15%, and that forest cover will increase due to reforestation and new regeneration areas. The quality of forest will also be improved due to improved protection. There will be policies and investment plans for more complete infrastructure for patrolling and conservation, an animal rescue centre, a botanical garden, and adequate research equipment. Traffic infrastructure including bridges and roads will be enhanced in order to better serve tourism activities. Local authorities and adjacent human communities will be offered enhanced opportunities to participate in and benefit from biodiversity conservation, and efforts will be made to better capture and optimise the values arising from ecosystem services. These changes are also inferred in the various current planning documents which lay out future land use, development and conservation goals for the wider CTNP landscape.

It is also important to note that there are also **opportunity costs to biodiversity and ecosystem conservation**. Choosing to conserve and sustainably use biodiversity and ecosystems implies foregoing other land and resource use options which would result in the conversion, degradation or unsustainable exploitation of wild species and natural habitats. Most basically, in the scenario described above, the opportunity costs of conservation and of CTNP comprise the additional income that could be generated from crops grown on land that is currently occupied by unmodified natural ecosystems, as well as the value of timber harvested from converted forest land. It should be noted that the current study did not value these opportunity costs or alternative values: its focus was on the change forest ecosystem service values.

Three important management conclusions that can be drawn from the above analysis and information, and which have been highlighted by DoNC/CTNP are:

- If CTNP is to be conserved effectively into the future, so as to secure these economically-important ecosystem values, then **sufficient budget** must be made available with which to do this. This encompasses budget needs for conservation research and studies, biodiversity monitoring, climate change adaptation, community outreach and participation, sustainable livelihoods and so on.
- While the conservation of CTNP's biodiversity and ecosystems generates benefits which accrue to multiple sectors and stakeholder groups, different sectors sometimes also have competing or contradictory development goals. There is a need to establish some kind of a **multi-sectoral coordination mechanism**, involving different line agencies, Provinces and stakeholder groups, with which to ensure that joint actions are taken to conserve ecosystem services, and to avoid conflicts of interests.
- Ongoing land use change in the buffer zone is threatening the provision of important and valuable ecosystem services. The analysis of ecosystem values, and of the losses arising from forest conversion and degradation, shows that – in particular – there would be **considerable economic gains and costs avoided if plans for the conversion of forest land to rubber plantations were reconsidered**.

Study limitations and lessons learned

Although largely meeting its objective ("to assess the economic value of conserving biodiversity and ecosystems in Cat Tien National Park"), the study has faced a number of challenges. The two greatest constraints have been the lack of a clear management focus and questions to answer, and the unavailability of the socio-economic and biophysical information upon which ecosystem valuation depends.

The study was originally envisaged to serve as an illustrative example of how the value of ecosystem services could be demonstrated for a Special Use Forest in relation to a specific management challenge, issue or question. According to the terms of reference, the intention was that "the study results shall contribute to a discussion of a policy case relevant for the study site". After some discussion between the project and DoNC, Cat Tien National Park was selected as the case study site for ecosystem valuation.

The identified management and planning issue to be addressed via the valuation study was to estimate the economic costs of biodiversity loss and ecosystem degradation that would arise from the planned construction of two hydroelectric plants in the National Park, so as to generate figures that could be factored into the cost-benefit analysis of the project and/or used to indicate minimum levels of compensation for environmental damages. This issue did not, ultimately, prove feasible to address – initially because no information was available on the projected ecological and biological impacts and damages of the planned hydropower plants (thus meaning that it would be impossible to value economic costs), and ultimately because the two developments were cancelled (thereby rendering the analysis redundant).

This meant that the study went ahead without a well-defined policy or management focus, and in the absence of a clear set of ecosystem use and management alternatives to be valued and compared. The study therefore remained rather vague and general. An important lesson learned is that, in order to be practical and policy relevant to decision-makers, ecosystem valuation studies need to be rooted in, and responsive to, real-world challenges and issues. Valuation is not an end in itself, but a means to an end – better and more informed decision-making. When the relevance of the valuation study to real-world decision-making is unclear, the use and application of the information it generates will usually also remain limited.

A second challenge was that in many cases available socioeconomic and biophysical data contained gaps, were sometimes of doubtful quality and accuracy, or showed significant inconsistencies (and even contradictions) between different sources. Although this is not an uncommon problem in valuation studies, and the study was able to generate acceptable and credible estimates of the value of CTNP's biodiversity and ecosystem services, the figures remain somewhat rough and preliminary because they are based on such limited data sources.

It should also be emphasised that the study was a partial valuation of the services generated by natural ecosystems, focusing on key ecosystem services for which data existed (or could be reliably transferred from other sites). While this is the usual situation as far as ecosystem valuation is concerned – there are no credible studies in the literature which value each and every ecosystem service associated with a given site

– it is hoped that as better data become available, additional ecosystem services might be able to be added to this list.

In most cases, a valuation study would expect to contain provisions for a far greater level of (and time for) data collection and information generation, and to also include ecological, biological, hydrological and other expertise on the team. Despite benefiting greatly from a high level of economic, social and GIS competence on the team, as well being able to access excellent technical support from CTNP and DoNC staff, the study suffered from a lack of other scientific expertise that would have enabled more accurate and detailed modelling and analysis of ecosystem service status and trends.

The inclusion of scenario modelling played an important part in the study not just as a key analytical step, but also as a process which facilitated the participation and inputs of key experts and stakeholders. The scenario development workshop, in particular, offered a useful tool for conservation managers, line agency staff and local authorities to predict and think through the trade-offs that arise in relation to land and resource management. Importantly, it also served to promote awareness, dialogue, participation and buy-in among the various groups and agencies involved in managing the core and buffer zone of CTNP.

Although vital to the valuation study, the identification and analysis of an "unprotected landscape" scenario involved a number of technical challenges. Extrapolating current ecosystem values into the future is both imprecise and risky, and involves many unknowns. This was especially the case given the poor quality of the biophysical data that was available to the study. As interesting (and hopefully useful) as the aggregate numbers presented are, they 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 that the scenario modelling could 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 also affect ecosystem values, but were able to be predicted with relatively more certainty.

It should also be noted that the study refers to ecosystem service values that are generated by the CTNP landscape in its entirety. They arise from a series of complex interactions and interdependencies between different species, habitats and ecosystems across the landscape. Total values cannot simply be divided by the area of the National Park in order to come up with per hectare values or per hectare losses. Estimates also should not be seen as referring to a definitive or total economic value of CTNP: the quality and coverage of available data has not permitted all services to be valued. Rather, figures should be seen as a minimum estimate of selected ecosystem values.

While the study showed that a simple, stepwise approach to valuation can be applied and can generate useful information, even with such incomplete data, limited resources and unclear management focus, 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. The figures 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 biophysical and socio-economic data for CTNP becomes available, these value estimates can be updated and improved.

Review of studies carried out on ecosystem valuation in Viet Nam

There is now almost two decades' experience of environmental valuation in Viet Nam, and a fairly substantial – and growing – body of literature on the economic value of biodiversity and ecosystem services has emerged. A selection of just under twenty published papers was reviewed as part of the current study (Table 6).

Table 6: summary of published biodiversity and ecosystem valuation studies carried out in Viet Nam

Ecosystem	Study location	Service(s) valued	Authors
Coral reef	Hon Mun Natural Reserve, Khanh Hoa Province	Tourism total value and consumer surplus	Pham Khanh Nam & Nguyen Nam Thang 1999
Coral reef	Nha Trang Bay Marine Protected Area	Fisheries, recreation, international and domestic option/existence value	Nama 2005
Forest	Bac Glang & Lang Son Provinces	Watershed services to paddy, micro-irrigation and fisheries	Kuchelmeister 2003
Forest	Bac Giang, Phu Tho, Yen Bai, Thanh Hoa, Quang Binh, Thua Thien Hue, Binh Dinh, Gia Lai, Dong Nai	Timber, NTFP, soil erosion protection, water control, carbon storage	Vu Tan Phuong 2008
Forest	Bidoup Nui Ba National Park	Timber, NTFP, carbon storage, watershed protection, soil erosion prevention, existence values	Do Nam Thang 2013
Forest	Cuc Phuong National Park	Tourism total value and consumer surplus	Nguyen Duc Thanh & Le Thi Hai 1999
Forest	Lam Dong Province	Water regulation for downstream hydropower	MARD 2008
Forest	National/ Cat Tien National Park	Species existence value for Vietnamese Rhinoceros	Truong Dang Thuy 2007
Forest	Nghe An Province	Local non-timber forest products	Phuong and Duong 2007
Forest	Quang Nam, Thua Thien Hue & Quang Tri Provinces	Local non-timber forest products, water quality regulation, watershed protection, soil erosion control, carbon storage	ADB 2010
Forest	Yen Bai, Tuyen Quang, Bac Kan, Ba Be Nation Park; Thac Ba Lake; Na Hang Nature Conservation Region	Timber, NTFP, soil erosion protection, water control, carbon storage, landscape, existence values	Vu Tan Phuong 2007
Mangroves	Can Gio – Ho Chi Minh City	Local direct use	Vien Ngoc Nam 2002
Mangroves	Can Gio Mangrove Biosphere Reserve	Local use of wood products, Nipa palm for thatch, aquatic produce use and trade (fish, crabs, indigenous shrimps and shell fish)	Tri 2000
Mangroves	southern Viet Nam	Protection against extreme weather events	Tri et al 1998
Mangroves	Ca Mau, Kien Giang, Ninh Thuan, Binh Thuan	Direct use, coastal protection, carbon sequestration, landscape, support to aquaculture	Vu Tan Phuong 2012
Wetlands	Dong Rui – Tien Yen, Quang Ninh province	Direct, indirect, option and existence values	Nguyen Ngoc Binh 2001
Wetlands	Tram Chim National Park	Non-use values	Do and Bennett 2007
Wetlands	Xuan Thuy National Park, Nam Dinh Province	Direct use, coastal protection, carbon sequestration, option value	Dinh Duc Truong 2009

Almost all of these studies are based on the total economic value framework (as described in Chapter 2) and utilise a standard toolbox of valuation techniques (as described in Chapter 3). In this sense, the Vietnamese literature on biodiversity and ecosystem valuation draws on the same conceptual and methodological frameworks as those which are commonly accepted and applied in other parts of the world.

The literature spans a fairly wide range of ecosystem types, locations and services/values. Terrestrial forests appear to be the most studied ecosystem, with coastal and wetland ecosystems also well-covered. A broad range of services are also dealt with, and a wide variety of valuation techniques are used. There appear to be no major gaps in coverage. Most valuation studies are however quite narrow in their focus. No studies were located which attempt to provide national-level estimates of biodiversity and ecosystem values: all dealt with (in most cases) a single site or location or (in fewer cases) regional or Provincial territories or ecosystems. Likewise, the majority of studies remain fairly focused in the type and range of ecosystem services that they attempt to value. There are few, if any, attempts to make a comprehensive or full total economic valuation of a particular site or ecosystem, or to generate value estimates across several types of ecosystems.

While most of the literature reviewed is of an acceptable technical quality and credibility, it is noticeable that a number of common weaknesses (and in some cases errors) emerge, and are repeated across several studies. One set of issues relates to the questions of attribution and incrementality. A general concern remains that many studies have a very weak scientific basis. In particular, the assumptions they make about the links between ecosystem status and the provision of given ecosystem services (including the sustainability and threshold issues mentioned above) are not substantiated or based on credible and coherent ecological, biological, hydrological or other biophysical data.

There seems to be a tendency for studies to attribute the generation of particular services to an ecosystem – or to the full area of a particular site − even when there is insufficient evidence to do so. In most cases, it is also wrongly assumed that ecosystem values can be taken as being absolute – in other words that service values would fall to zero if a particular ecosystem or protected area were degraded or lost. This misses the point that even highly degraded or modified ecosystems generate some level of services. This, combined with the tendency to generate single "snapshot" figures rather than estimates of the marginal or incremental changes in value arising from a change in ecosystem status, often leads to a problem of apparent misattribution and overestimation of ecosystem values.

There is also often confusion about whether a study is measuring the stock, capital or asset value of an ecosystem, or the values associated with the flow of services that it generates over time. Several studies mix up these figures, for example combining estimates of the total stock of carbon stored in a forest and the total value of standing timber with figures for the annual value of watershed protection and NTFP harvests. Again, this frequently leads to the economic value of a particular site or ecosystem being massively over-estimated.

Notwithstanding these limitations, there is little doubt that this existing literature provides an extremely useful body of information and set of examples of how valuation methods can be applied in a Vietnamese context. It is however less certain whether the studies which have been carried out to date have generally had any great impact on real-world policy and practice. This is because most have been implemented (and are subsequently communicated) at a fairly academic level rather than as part of an actual conservation or development policy formulation, planning or management decision-making process. As a result, most studies are not geared towards providing recommendations for uptake and implementation by decision-makers and planners.

Constraints and opportunities for moving forward in using ecosystem valuation to inform conservation policy, planning and management

The role of ecosystem valuation in better and more informed conservation decision-making is already well-recognised in Viet Nam. It is emphasised in a number of key government policy documents, including the Forestry Strategy, National Green Growth Strategy 2012, and National Action Plan on Biodiversity up to 2010 and Orientations towards 2020. Various uses and applications of ecosystem valuation are mentioned in relation to Protected Areas and Special Use Forests, including as a means of justifying conservation investments and budgets; guiding the pricing of payments for forest environmental services and other charge and fee systems; analysing needs and niches for conservation incentives and benefit-sharing arrangements for forest-adjacent communities; identifying biodiversity-based business and market opportunities; weighing up the desirability of land, resource and investment options; feeding into cost-benefit analyses and environmental impact assessments of developments; and assisting in assessing natural resource damages and calculating environmental compensation requirements.

Although considered desirable and potentially useful, ecosystem valuation is not a required part of either development or conservation policy, planning and management, and is barely mentioned in the regulatory and decision-making frameworks that govern them. Thus although the concept of “forest price” is defined in the 2004 Law on Forest Protection and Development, and Decree No. 48/2007/ND-CP and Circular 65/TT-BNNOBTC of 2008 deal with principles and methods for valuing and determining prices for different forest types, the main focus is on timber and other extractive use values. As yet there is no explicit inclusion of the economic valuation of other types of forest provisioning, regulating, supporting and cultural ecosystem services. Aside from the literature mentioned in the section above, there is also as yet only a very limited body of information on ecosystem values and valuation methods in Viet Nam (recent work carried out under the Research Centre for Forest Ecology and Environment (Vu Tan Phuong 2009) does however make a first attempt to develop a harmonised forest ecosystem valuation framework that can be applied in different regions of the country).

The lack of an agreed framework and methods for forest ecosystem valuation is often perceived to constitute a barrier to valuation being more widely used to guide and inform conservation policy, planning and management in Viet Nam. It is not, however, considered to be a major constraint. This is because a toolbox of ecosystem valuation methods and techniques already exists which is widely accepted and commonly used, within Viet Nam and internationally. It would not be correct to assume that there are no agreed or tested methods for forest ecosystem valuation.

The same holds for the various analytical frameworks and processes that are also available and being used to organise and carry out ecosystem valuation (for example the TEEB framework mentioned earlier in this report, the Natural Capital Accounting approach which has recently been applied in Viet Nam under the WAVES project, or the Ecosystem Capital Accounting processes which are emerging as a response to the CBD 2011-2020 Strategic Plan and Aichi Targets). These already-existing, tried-and-tested methods, techniques, frameworks and processes are perfectly adequate and fit for purpose to serve most ecosystem valuation needs. There are considerable merits to continuing to allow for this level of flexibility and choice, rather than imposing a standardised “one size fits all” framework within which ecosystem valuation must be carried out. It is also extremely questionable whether any kind of standardised or generalizable set of ecosystem value estimates is in fact feasible or useful, given the high degree of variation between sites in socio-economic and biophysical conditions and in the scope and nature of ecosystem services generated.

The most important conditions for moving forward in better using ecosystem valuation to inform conservation policy, planning and management would seem to relate to the need to shift the discipline from the realm of academia and research into a more applied arena, to make greater efforts to communicate the findings of valuation studies more effectively, and to work to integrate requirements for ecosystem valuation into conservation and development decision-making processes and procedures. However good the data and “science” of ecosystem valuation may be, the resulting information has little relevance if it is not mainstreamed into decision-making processes, or planned and communicated effectively to decision-makers in a form that is both practical and policy relevant and credible to them.

Recommendations to strengthen the application of ecosystem valuation

To these ends, five practical recommendations are made on strengthening the use of ecosystem valuation to inform conservation policy, planning and management in Viet Nam.

1. The first recommendation is to strengthen information-sharing. There is an urgent need to better communicate and disseminate the results and findings of existing valuation studies. Although these contain important and useful information, the majority (although by no means all) of this remains relatively inaccessible to decision-makers and the general public. At the same time, the sharing of key data relating to the biophysical and socio-economic relationships that underpin the provision and use of ecosystem services in Viet Nam would provide an invaluable source of data for researchers, and for incorporation into future valuation studies (Vu Tan Phuong 2012 provides a good model for this). This could be accomplished via the creation of a simple online database and search tool that would summarise and provide access to already-existing information on ecosystem services and valuation studies, and which could be updated on a regular basis as new information becomes available.

2. The second recommendation is to foster exchange and dialogue between different sectors, agencies and disciplines that have an expertise, interest or stake in ecosystem valuation. There is a clear demand for and interest in ecosystem valuation not just within the agencies concerns with nature conservation and environmental management (most importantly MARD and MONRE), but also among economic and development planning agencies (notably MOF and MPI), and in the sectoral and line agencies whose actions depend or impact on biodiversity and ecosystem services. At the moment there are few, if any, opportunities for these different groups to engage ion discussion, exchange or information-sharing on ecosystem valuation. The creation of a knowledge hub or network which brings together academics and researchers as well as conservation and development planners, managers and decision-makers could serve as an important mechanism for dialogue between different stakeholders, and help to build consensus and dialogue on how and for what ecosystem valuation can be used. This could also serve as a means of information-sharing (see recommendation #1), as well as a forum for the provision of awareness and training (see recommendations #3 and #4). Ongoing national-level initiatives such as WAVES and TEEB could also provide institutional partnerships for the development of such a forum or hub.

3. The third recommendation is to facilitate awareness-raising and capacity-building for conservation and development decision-makers. This would cover both the applications and the limitations of ecosystem valuation (including dismantling some of the more unrealistic expectations that currently exist about ecosystem valuation), and would also serve to inform decision makers how, where and when valuation can be used to strengthen policy and management planning and practice. Targeted awareness raising for decision-makers could also help to leverage much-needed support to encourage the further operationalization of ecosystem valuation as a decision-support tool and its integration into real-world planning frameworks (see recommendation #4).

4. The fourth recommendation is to promote and operationalise the actual use of valuation as a decision-support tool, through the integration of information on ecosystem costs and benefits into existing planning and decision-making processes. This includes the use of valuation to strengthen environment-oriented planning and decision-making tools (such as strategic environmental assessment and environmental impact assessment, and the calculation of natural resource damages and environmental compensation requirements), as well as the tools that are routinely used to weigh up development decisions (such as investment appraisal and cost-benefit analysis). It could also focus on further elaborating and extending the provisions on pricing and valuation that are laid out in forest sector

regulations, and in the legislation relating to payments for forest environmental services. While (as mentioned several times above) there is not seen to be a need for the development of new methods or frameworks, there is a need to demonstrate how already-existing, accepted and tested approaches can be combined with more conventional planning tools, and used to generate practical and policy-relevant information to inform decisions. Initially, a number of case studies carried out to supplement already-ongoing decision-making processes could provide a practical way of demonstrate these applications of ecosystem valuation, and can also be tied in with related awareness (see recommendation #3) and training (see recommendation #5) activities.

5. The fifth recommendation is to offer technical training in ecosystem valuation approaches and techniques to conservation and development planners, managers and practitioners. Although there is a growing body of expertise in ecosystem valuation in Viet Nam, this is mostly found in universities and research institutions, where the main focus is primarily on more theoretical and academic studies. There is an urgent need to also develop this capacities and knowhow at an applied level, within the institutions and agencies that are responsible for commissioning, overseeing and verifying ecosystem valuation studies (for example MARD, MONRE, MPI, MOF and Provincial agencies). Academics and researchers with experience in valuation will be important resource persons and trainers, and will be key to embedding this knowledge in the agencies that are responsible for conservation and development policy, planning and management.

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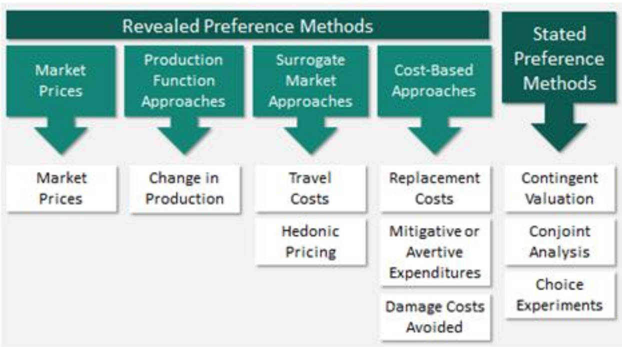
Figure 21: commonly-used techniques for biodiversity and ecosystem valuation



Change in production techniques

Description of the method, strengths and advantages

Change in production techniques look at the way in which changes in the quantity or quality of ecosystem services affect the production of other outputs or income flows. Downstream hydropower and irrigation schemes for example depend on upper catchment protection services, fisheries depend on wetland habitats for breeding and nursery, and many sources of industrial production utilise natural products as raw materials. They are particularly useful for valuing ecosystem goods and services that clearly form a part of other, marketed, sources of production – such as insect pollination, as illustrated in the box below. Their main weakness or difficulty in application relates to the fact that it is often difficult to collect sufficient data to be able to accurately predict the biophysical impact and relationships between a change in ecosystem status and off-site production processes.

Using change in production to value insect pollination services

Effect on production techniques were used to value the vulnerability of world agriculture to insect pollinator decline, considering the 100 crops used directly for human food worldwide as listed by FAO. The study measured the economic impact of pollinators on agricultural output via the use of dependence ratios quantifying the impact of a lack of insect pollinators on crop production value. It calculated the vulnerability of each crop, and of the agricultural industry in a given region when faced with pollinator decline. The study found that the total economic value of insect pollination worldwide amounted to €153 billion, which represented 9.4% of the value of world agricultural production used for human food in 2005. *From: Gallai et al 2007*

Summary of data collection and analysis requirements

There are three main steps to collect and analyse the data required for change in production techniques to value ecosystem goods and services:

1. Determine the contribution of ecosystem goods and services to the related source of production, and specify the relationship between changes in the quality or quantity of a particular ecosystem good or service and output;
2. Relate a specified change in the provision of the ecosystem good or service to a physical change in the output or availability of the related product; and
3. Estimate the market value of the change in production.

Change in production techniques rely on a simple logic, and it is relatively easy to collect and analyse the market information that is required to value changes in production of ecosystem-dependent products (see above, market price techniques). The most difficult aspect of this method is determining and quantifying the biophysical or dose-response relationship that links changes in the supply or quality of ecosystem goods and services with other sources of production. For example, detailed data are required to relate catchment deforestation to a particular rate of soil erosion, consequent siltation of a hydropower dam and reduced power outputs, or to assess exactly the impacts of the loss of wetland habitat and water purification services on local fisheries production. To be able to specify these kinds of relationships with confidence usually involves wide consultation with other experts, and may require situation-specific laboratory or field research, controlled experiments, detailed modelling and statistical regression.

Travel cost techniques

Description of the method, strengths and advantages

Travel cost techniques look at how much money people spend to visit an ecosystem or to enjoy its facilities, including entry fees, time spent, food, accommodation, fuel and other costs of the visit. This information is used to construct a demand curve relating the number of visits to the costs of travel, to model visitation rates to different prices, and to calculate visitor "consumer surplus" (the benefit over and above what is actually paid to enter and use the ecosystem). They are particularly useful for valuing the recreational attributes of ecosystems, especially if these are not priced, and for setting entry fees and user charges – as illustrated in the box below. Their main weakness or difficulty in application is that they require extensive visitor surveys, large data sets, and quite complex analysis.

Using travel costs to value PA recreation and tourism in Costa Rica

The Monteverde Cloud Forest Biological Reserve in Costa Rica is an important recreational destination for both foreign tourists and domestic visitors. A study was carried out to estimate the domestic recreational value of Monteverde, using travel cost techniques. Survey questionnaires were prepared and distributed to visitors, and collected at the Reserve Headquarters. These obtained a variety of information about the costs of visiting Monteverde, and the socio-economic characteristics of the respondent. The opportunity to win wildlife photographs was offered as an incentive for visitors to fill in the survey forms. Travel costs per kilometre were calculated to include out-of-pocket expenses, a proportion of fixed costs, and travel time. A linear demand function was then constructed relating visitation rates to these travel costs, yielding an annual consumer surplus of between $2.4 million and $2.9 million, or about $35 per domestic visit. *From: Tobias and Mendelsohn 1991.*

Summary of data collection and analysis requirements

There are six main steps involved in collecting and analysing the data required to use travel cost techniques to value ecosystem goods and services:

1. Ascertain the total area from which recreational visitors come to visit an ecosystem, and divide this into zones within which travel costs are approximately equal;
2. Within each zone, sample visitors to collect information about the costs incurred in visiting the ecosystem, motives for the trip, frequency of visits, site attributes and socio-economic variables (such as the visitor's place of origin, income, age, education and so on);
3. Obtain the visitation rates for each zone, and use this information to estimate the total number of visitor days per head of the local population;
4. Estimate travel costs, including both direct expenses (such as fuel and fares, food, equipment, accommodation) and time spent on the trip;
5. Carry out a statistical regression to test the relationship between visitation rates and other explanatory factors such as travel cost and socio-economic variables; and

6. Construct a demand curve relating number of visits to travel cost, model visitation rates at different prices, and calculate visitor consumer surplus.

Travel cost techniques depend on a relatively large data set. Quite complex statistical analysis and modelling are required in order to construct visitor demand curves. Basic data are usually collected via visitor interviews and questionnaires, which make special efforts to cover different seasons or times of the year, and to ensure that various types of visitors from different locations are represented.

Hedonic pricing techniques

Description of the method, strengths and advantages

Hedonic pricing techniques look at the difference in prices of property or wage rates that can be ascribed to good environmental quality and the existence of ecosystem services. They are particularly useful for valuing the landscape and aesthetic attributes of ecosystems – such as wetland landscape services, as illustrated in the box below. Their main weakness or difficulty in application is that they require a large amount of data to be collected on property prices or wage rates under different conditions, and that it is often very difficult to isolate environmental or ecosystem affects from other determinants of property prices or wage rates.

Using hedonic pricing to value wetland landscape services in the USA

Hedonic pricing techniques were used to calculate urban residents' willingness to pay to live close to wetlands in Portland metropolitan region, Oregon. The study used a data set of almost 15,000 observations, with each observation representing a residential home sale. For each sale information was obtained about the property price and a variety of structural, neighbourhood and environmental characteristics associated with the property, as well as socio-economic characteristics associated with the buyer. Wetlands were classified into four types: open water, emergent vegetation, forested, and scrub-shrub, and their area and distance from the property were recorded. Results showed that wetland proximity and size exerted a significant influence on property values, especially for open water and larger wetlands. *From:* Mahan 1997.

Summary of data collection and analysis requirements

There are five main steps involved in collecting and analysing the data required to use hedonic pricing techniques to value ecosystem goods and services:

1. Decide on the indicator to be used to measure the quality or quantity of an ecosystem good or service associated with a particular job or property;
2. Specify the functional relationship between wages or property prices and all of the relevant attributes that are associated with them, including ecosystem goods and services;
3. Collect data on wages or property prices in different situations and areas which have varying quality and quantity of ecosystem goods and services;
4. Use multiple regression analysis to obtain a correlation between wages or property prices and the ecosystem good or service; and
5. Derive a demand curve for the ecosystem good or service.

Hedonic pricing techniques require the collection of a large amount of data, which must be subject to detailed and complex analysis. Data are usually gathered through market observation, questionnaires and interviews, which aim to represent a wide variety of situations and time periods.

Replacement cost techniques

Description of the method, strengths and advantages

Replacement cost techniques look at the costs of replacing or replicating a particular ecosystem good or service with artificial or man-made technologies or infrastructure. For example, constructed reservoirs can replace natural lakes, gas can replace fuelwood, or sewage treatment plants can replace wetland wastewater purification functions. They are particularly useful for valuing ecosystem indirect values – such as wastewater treatment services, as illustrated in the box below, and are relatively simply to apply and analyse. Their main weakness or difficulty in application is that it is usually impossible to find perfect replacements or substitutes for ecosystem goods and services that would provide an equivalent level of benefits to the same beneficiary population.

Using replacement costs to value wastewater treatment services in Uganda
Replacement cost techniques were used to value the wastewater treatment services provided by Nakivubo Swamp, Uganda. Covering an area of some 5.5 km2 and a catchment of over 40 km2, the wetland runs from the central industrial district of Kampala, Uganda's capital city, passing through dense residential settlements before entering Lake Victoria at Murchison Bay. The study looked at the cost of replacing wetland wastewater processing services with artificial technologies. Replacement costs included two components: connecting Nakivubo channel to an upgraded sewage treatment plant which could cope with additional wastewater loads, and constructing elevated pit latrines to process sewage from nearby slum settlements. The study found that the infrastructure required to achieve a similar level of wastewater treatment to that provided by the wetland would incur costs of up to $2 million a year in terms of extending sewerage and treatment facilities. *From: Emerton et al 1999.*

Summary of data collection and analysis requirements

There are three main steps involved in collecting and analysing the data required to use replacement cost techniques to value ecosystem goods and services:

1. Ascertain the benefits that are associated with a given ecosystem good or service, how it is used and by whom, and the magnitude and extent of these benefits;
2. Identify the most likely alternative source of product, infrastructure or technology that would provide an equivalent level of benefits to an equivalent population; and
3. Calculate the costs of introducing and distributing, or installing and running, the replacement to the ecosystem good or service.

Data collection is relatively straightforward, and usually relies on secondary information about the benefits associated with a particular ecosystem good or service and alternatives that are available to replace it. In most cases this can be ascertained through expert consultation and professional estimates, supplemented with direct observation.

Mitigative or avertive expenditures techniques

Description of the method, strengths and advantages

Mitigative or avertive expenditures techniques look at the costs of dealing with the effects of the loss of an ecosystem good or service, in terms of what has to be spent to mitigate or avert any negative impacts. For example the loss of upper catchment protection can make it necessary to desilt reservoirs, or the loss of flood control services may require the construction of flood barriers. They are particularly useful for valuing ecosystem indirect values – such as nitrogen abatement services, as illustrated in the box below, and are relatively simply to apply and analyse. Their main weakness or difficulty in application is that the response measures that are employed when an ecosystem service is lost do not always provide an equivalent level of benefits, and that in many cases it is questionable whether in fact such expenditures would be made or would be seen as worth making.

Using mitigative expenditure to value nitrogen abatement in Sweden

Poor quality drinking water supplies is a major problem in Gotland, Sweden, and is related to the high levels of nitrates in water – which are about double the WHO-recommended safe concentrations. This study aimed to value the services that natural wetlands provide in terms of reducing nitrate levels in water, using mitigative expenditure techniques which looked at the different measures that can be employed for nitrogen abatement. In addition to wetland restoration, it considered reducing farmers' applications of chemical fertilisers and manure, and increasing the capacity of domestic and industrial sewage treatment plants. This enabled the total value of investments in wetlands for nitrogen abatement to be calculated, and compared with the costs of upgrading sewage treatment facilities and reducing fertiliser use. The study found that the total value of investing in wetland restoration and management is at least twice as high as the costs of implementing mitigative or avertive measures. *From: Gren 1995*

Summary of data collection and analysis requirements

There are four main steps involved in collecting and analysing the data required to use mitigative or avertive expenditure techniques to value ecosystem goods and services:

1. Identify the negative effects or hazards that would arise from the loss of a particular ecosystem good or service;
2. Locate the area and population which would be affected by the loss of the ecosystem good and service, and determine a cut-off point beyond which the effect will not be analysed;
3. Obtain information on people's responses, and measures taken to mitigate or avert the negative effects of the loss of the ecosystem good or service; and
4. Cost the mitigative or avertive expenditures.

Data collection and analysis is relatively straightforward, and usually relies on a combination of interviews, surveys, direct observation and expert consultation.

Damage costs avoided techniques

Description of the method, strengths and advantages

Damage costs avoided techniques look at the costs and losses that occur when the loss of ecosystem services leads to disasters or damage to property and economic activities. Examples include floods, food shortages, destruction of infrastructure and disease. They are particularly useful for valuing ecosystem indirect values that protect human settlements and economic processes – such as flood control services, as illustrated in the box below, and are relatively simply to apply and analyse. Their main weakness or difficulty in application is that in most cases the estimates of damages avoided remain hypothetical, and thus may not be accurate – they are based on predicting what might occur, usually under considerable uncertainty.

Using damage costs avoided to flood control services in Malawi and Zambia

The damage costs avoided approach was used to calculate the value of wetland flood control services in the Zambezi Basin, in southern Africa. Because they store water, and release it slowly, many wetlands in the region play an appreciable role in minimising downstream flooding during times of high rainfall. The study found that the Lower Shire wetlands in Malawi help to avoid average damage costs with a net present value of $13.3 million in terms of expenditures on coping with the displacement of local populations in flood-prone areas, and damage to road and rail infrastructure. Meanwhile the marshes and swamps of the Barotse Floodplain save farmers in both Zambia and neighbouring Namibia damages to farms and livestock facilities, roads, houses and other buildings, with a net present value of around $1.5 million. *From: Turpie et al 1999*

Summary of data collection and analysis requirements

There are four main steps involved in collecting and analysing the data required to use damage cost avoided techniques to value ecosystem goods and services:

1. Identify the protective services of the ecosystem, in terms of the degree of protection afforded and the on- and offsite damages that would occur as a result of loss of this protection;
2. For the specific change in ecosystem service provision that is being considered, locate the infrastructure, output or human population that would be affected by this damage, and determine a cut-off point beyond which effects will not be analysed;
3. Obtain information on the likelihood and frequency of damaging events occurring under different scenarios of ecosystem loss, the spread of their impacts and the magnitude of damage caused; and
4. Cost these damages and ascribe the contribution of the ecosystem service towards minimising or avoiding them.

Data collection is for the most part straightforward, usually relying on a combination of analysis of historical records, direct observation, interviews, and professional estimates. Predicting and quantifying the likelihood and impacts of damage events under different ecosystem scenarios is however usually a more complex exercise, and may require detailed data and modelling.

Contingent valuation techniques

Description of the method, strengths and advantages

Contingent valuation techniques ask people directly how much they would be willing to pay for ecosystem goods and services, or accept in compensation for their loss. They might for example ask how much people would be willing to contribute to a fund for the conservation of a beautiful landscape or rare species, or how much they would be willing to see their water bills increase in order to conserve watershed forests. They are particularly useful for valuing ecosystem goods and services that have no market price, close substitutes or clear effects on other production processes – such as wildlife and National Parks, as illustrated in the box below. Their main weakness or difficulty in application is that they rely on extremely complex survey and data analysis techniques, and typically require high budgets and specialised expertise to carry out.

Using contingent valuation to value wildlife and National Parks in Kenya
A contingent valuation study was carried out to determine the value to foreign tourists of Kenya's National Parks and the wildlife they contain. This was done via a questionnaire administered to a sample of tourists at several protected areas, and at the airport. The questionnaires began by asking general questions about the respondents' interests in wildlife and nature. Next, country of origin and component travel cost information was gathered, plus questions on days spent in parks, parks visited, length of safari and other destinations visited in Kenya. Respondents were then asked to consider the costs of park management and the problems facing conservation, and given the option of higher entrance fees as a possible solution to wildlife loss. Finally, the questionnaire asked for basic socio-economic information; income, age, sex, member of conservation group, education, as well as information on how respondents thought higher fees should be charged. The survey showed a consumer surplus attached to protected areas by foreign visitors at some $450 million per annum. The estimate is additional to current financial returns from tourism. *From: Moran 1994*

Summary of data collection and analysis requirements

There are five main steps involved in collecting and analysing the data required to use contingent valuation techniques to value ecosystem goods and services:

1. Ask respondents their willingness-to-pay (WTP) or willingness-to-accept compensation (WTA) for a particular ecosystem good or service;

2. Draw up a frequency distribution relating the size of different WTP/WTA statements to the number of people making them;
3. Cross-tabulate WTP/WTA responses with respondents' socio-economic characteristics and other relevant factors;
4. Use multivariate statistical techniques to correlate responses with respondent's socio-economic attributes; and
5. Gross up sample results to obtain the value likely to be placed on the ecosystem good or service by the whole population, or the entire group of users.

This valuation technique requires complex data collection and sophisticated statistical analysis and modelling, which are described in detail elsewhere. Most contingent valuation studies are conducted via interviews or postal surveys with individuals, but sometimes interviews are conducted with groups. A variety of methods are used in order to elicit people's statement or bids of their WTP/WTA for particular ecosystem goods or services in relation to specified changes in their quantity or quality. The two main variants of contingent valuation are: dichotomous choice surveys, which present an upper and lower estimate between which respondents have to choose; and open-ended surveys, which let respondents determine their own bids. More sophisticated techniques are also sometimes used, such as engaging in trade-off games or using take-it-or-leave it experiments. The Delphi technique uses expert opinion rather than approaching consumers directly.

Conjoint analysis techniques

Description of the method, strengths and advantages

Conjoint analysis techniques ask people to consider the status quo, and alternative states of biodiversity conservation or ecosystem services. It describes a specific scenario for the future, including various ecosystem goods and services between which they have to make a choice. Respondents give information about their own preferences between various ecosystem and biodiversity alternatives, at different prices or costs to them. They are particularly useful for valuing ecosystem goods and services that have no market price, close substitutes or clear effects on other production processes – such as water quality, as illustrated in the box below. Their main weakness or difficulty in application is that they rely on extremely complex survey and analysis techniques, and typically require high budgets and specialised expertise to carry out.

Using conjoint analysis to value water quality in South Africa

The conjoint analysis sought to ascertain the tourism value of rivers in the Crocodile Catchment in terms of revenues to Kruger National Park, South Africa. A combination of a representative range of relevant river attributes (the number of crocodiles and hippos, number of waterbird species, diversity of the riverscape, and density of riparian trees) were presented, and four levels were defined for each depending on ecological catchment management practices. Two contingent valuation-style questions provided values for the 'ideal' and 'worst' scenarios relative to the status quo: (1) If all of the rivers in the Kruger National Park dried up completely, so that there were no crocodiles, hippos or waterbirds present, there were no riverine trees, but everything else in the park were the same, would you spend less time in the Park? Please estimate how much; (2) Consider the fact that the rivers in the Park are used upstream, and are presently not in their original state. If, hypothetically, the rivers were to be restored to their original state - that is, they contained high numbers of crocodiles, hippos, waterbirds, etc, diverse habitats, including lots of riverine trees, do you think that you would spend more time in the Park? The study estimated that the current value of Kruger National Park tourism is about $17 million in terms of on-site expenditure, $33 million in terms of economic impact, and $125 million in terms of consumers' surplus. It was found that about 30% of tourism business would be lost if rivers were totally degraded. *From: Turpie and Joubert 2001*

Summary of data collection and analysis requirements

Conjoint analysis is a somewhat complex technique to apply so the steps are not summarised here.

Choice experiments techniques

Description of the method, strengths and advantages

Choice experiments techniques give the respondent a series of alternative resource or ecosystem use options, each of which are defined by various attributes (such as species mix, ecosystem status, landscape, size of area) including price or cost. These attributes are varied across the different alternatives, and respondents are asked to choose their most preferred alternative. They are particularly useful for valuing ecosystem goods and services that have no market price, close substitutes or clear effects on other production processes – such as woodland recreation, as illustrated in the box below. Their main weakness or difficulty in application is that they rely on extremely complex survey and data analysis techniques, and typically require high budgets and specialised expertise to carry out.

Using choice experiments to value woodlands in the UK
A choice experiment study, administered via a postal survey, was used to ascertain conservation and recreational values for Forestry Commission woodlands in South East England. The aim was to get a better understanding of people's preferences and values of forests. Three major dimensions of forest management were investigated in the valuation study: nature conservation (wildlife preservation and ecological functions), provision for public access (recreational activities) and experience of nature (appreciation of woodlands for the opportunity of having direct contact with nature). A fourth dimension was also added: distance, which reflected the location of the woodland relative to the place of residence. The findings of the study revealed strongly expressed preferences towards higher levels of woodland conservation and lower levels of provision for public access in the form of recreational facilities. *From: Manukyants 2005*

Summary of data collection and analysis requirements

Choice experiments is a somewhat complex technique to apply so the steps are not summarised here.