A review of forest economics research in Bolivia

Hjortsø, Carsten Nico Portefee; Helles, Finn; Jacobsen, Jette Bredahl; Bach Friis Kamelarczyk, Kewin; Moraes R., Mónica

Publication date:
2006

Document version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Hjortsø, C. N. P., Helles, F., Jacobsen, J. B., Bach Friis Kamelarczyk, K., & Moraes R., M. (2006). *A review of forest economics research in Bolivia*. (pp. 1-30). Center for Skov, Landskab og Planlægning/Københavns Universitet.

Forest & Landscape

Working Papers
No. 18-2006
Forestry

A review of forest economics research in Bolivia

Carsten Nico Hjortsø , Finn Helles, Jette Bredahl Jacobsen, Kewin Bach Friis Kamelarczyk and Mónica Moraes R.

KVL A UNIVERSITY OF LIFE SCIENCES

Title
A review of forest economics research in Bolivia

Authors
Hjortsø, C.N., Helles, F., Jacobsen, J.B., Kamelarczyk, K.B.F. & Moraes R. M.

Publisher
Danish Centre for Forest, Landscape
and Planning • KVL
Rolighedsvej 23
DK-1958 Frederiksberg C
Tel. +45 3528 1500
Email sl@kvl.dk

Series-title and no.
Forest & Landscape Working Papers no. 18-2006 published on www.SL.kvl.dk

ISBN
ISBN-10: 87-7903-291-5
ISBN-13: 978-87-7903-291-0

DTP
Inger Grønkjær Ulrich

Citation
Hjortsø, C.N., Helles, F., Jacobsen, J.B., Kamelarczyk, K.B.F. & Moraes R. M. (2006): A review of forest economics research in Bolivia. *Forest & Landscape* Working Papers no. 18-2006, Danish Centre for Forest, Landscape and Planning, KVL, 31 pp

Forest & Landscape *is an independent centre for research, education, and extension concerning forest, landscape and planning under the Royal Veterinary and Agricultural University (KVL)*

Preface

This paper forms part of the project FOMABO, a research enhancement cooperation between The Royal Veterinary and Agricultural University (KVL) in Denmark and Universidad Autónoma Gabriel René Moreno (UAGRM) and Universidad Mayor de San Simón (UMSS) in Bolivia, see http://www.sl.kvl.dk/Forskning/Projekter/2006FOMABO.aspx.

The purpose of the paper is to give an overview of the literature regarding forest economics in Bolivia and use this as a basis for identifying future research needs. The focus has been on published studies.

The paper is a modified version of the publication:

Hjortsø, C.N., Jacobsen, J.B., Kamelarczyk, K.B.F. & Moraes R., M., 2006. Evaluación de los recursos forestales en la región andina: una reseña de la investigación de economía forestal en Bolivia. *In*: Moraes R., M., Øllgaard, B., Kvist, L.P., Borchsenius, F. & Balslev, H. (Eds.), *Plantas económicamente importantes de los Andes centrales – incluye paisajes altoandinos, bosques y montañas entre 1.000-6.500 m de Bolivia, Ecuador y Perú*. Instituto de Ecología, Universidad Mayor de San Andrés, La Paz, Bolivia.

Content

Abstract

Economic values play a significant role in social development whether they are made explicit or just perceived by social actors. The perceived value of forest in different uses influences decisions made on forest resources and land. But a forest's value is highly contingent on which user perspective is applied. In this chapter we introduce a comprehensive concept of resource value. Considering *direct use values, indirect use values* and *non-use values* we attempt to encompass the *total value* of forest resources. Taking Bolivia as an example we present a review of forest and environmental economic literature, providing an overview of the state-of-the-art of this research field in an Andean country. The largest contribution has been made in the direct use value category. Indirect use and non-use value studies are scarce. Profitability studies of timber production mainly date back to the debates over the implementation of the 1996 Forest Act. Since then conditions have changed and new legal bases of collective and communal forestry now accompany the well-known concession forestry model. More general studies of these new management forms are highly needed. The impacts of the prevalent illegal logging practices on the local and national economy have evaded scientific enquiry. The economic role of non-timber products is scarcely documented, as are environmental economic aspects of the Bolivian forest resource. An enhanced effort in addressing these issues should be based on a close inter-disciplinary collaboration between natural and social science, aiming at providing holistic and comprehensive answers useful to enterprise and policy decision-makers.

1 Introduction

The purpose of this chapter is to provide an economic perspective on forest resources in the Andes region. Although economic aspects are often intensively discussed in the management of forest resources in the tropics, few studies have been made and often they are very case specific. Economics is a discipline loaded with provisos and assumptions that are not always sufficiently explained or taken into considerations by decision-makers relying on the scientists' results. Erroneous or naïve interpretations of economic studies have led to many sub-optimal decisions in forest management. On the other hand, when adequately used economic studies are highly useful and very important to guiding decision-making at all levels of society. The colonist farmer, the concessionary, the domestic timber industry and exporters all have to consider the economic impacts of their decisions. At a broader scale society has to consider economic impacts of use and non-use of the forest resource. Decisions that generate income and welfare in one sector may have devastating economic effects in other segments of the society, e.g. in terms of negative environmental externalities. Economic value is highly dependent on whose perspective is taken. In the light of this inherent complexity we have chosen to provide a review of the state-of-the-art of economics application to in the Andes region, as exemplified by Bolivia.

The review shows that forest economics is a new discipline in the Andes region and that it is biased towards financial studies rather than total economic analysis. A relatively large number of studies address the enterprise level whereas a more holistic society perspective is rarely applied. This and other observations are used to point to new directions in for the forest economics research. The discipline is far from mature and many problems facing the Andes region still demand answers.

The review includes major published works, predominantly from international journals and reports from different institutions and projects. Students' theses are only included in rare cases. To limit the study we have focused on Bolivian forestry as representative of the Andes region. The main reason for this limitation is the difficulty in identifying relevant literature. The lack of countrywide library systems results in a highly decentralised distribution of literature. We believe that this review is the first attempt to characterise the field of forest economics in a country in the Andes region and hope that our effort will inspire forest economists and other researches to develop the field as well as decision-makers to require adequate and useful research from the scientists.

The review is organised according to a division of forest values into direct use values, indirect use values and non-use values. The identified studies are grouped and presented according to these categories.

1.1 Evaluating forests

Economic values are per definition anthropocentric, meaning that in order to hold an economic value a good or a resource needs to have a value to human beings. This value can be more or less direct, and it can, e.g. be seen as an economic value to know that a certain habitat or species exists even if it is not used. Consequently the total economic value of, e.g. forests consists of both use and non-use values. Figure 1 shows the distinction between such values, which will be followed in this chapter. The main distinction is between use and non-use values associated with the forest resource. Some of the goods might be marketed and thus provide a financial return, whereas others are not marketed and therefore may contribute to the economy (human welfare) but not to the financial part.

Figure 1. *Valuation concepts in forest economics.*

Total economic value of forests	**Direct use values**	*Consumptive uses*	Marketed goods such as timber, Non-timber products
			Non-marketed goods for subsistence use
		Non-consumptive uses	Recreation and tourism
			Science and education
	Indirect use values	*Environmental protection*	Protection of watershed, soil and habitats, and soil productivity. carbon sequestration
		Option value	The same
	Non-use values	*Existence value*	Various forest goods
		Bequest value and altruism	The same
		Option value	The same

Modified from: Gregersen et al. (1995) and Bateman et al. (2002).

The total economic value is seen from a society point of view, i.e. the value for all citizens of a certain society. But very often studies are more case specific and show the economic importance of a certain activity to a single actor or group of actors. For example, the profitability of timber from a given forest could be profitable for a concessionaire, but not for society and vice versa. Economic analyses do therefore not provide exact answers which can easily be transferred, but case-dependent results.

Another important distinction is between stock and flow. Flow,e.g. extraction of timber, provides welfare, whereas stock is not in itself welfare, but may be the basis for flow. Comparing the productive area of the forest and the production, e.g. the timber extracted, gives an indication of the relation between stock and flow. If the flow, or the annual harvest, exceeds the growth in stock, the forest is depleted in the long run. If the flow is too small, the stock increase will in economic terms mean a cost if this value could alternatively be exercised. Based on the potential production, the sustainable production can be estimated. Often the sustainable production is measured per year (annual allowable cut), but it could as well be per day or even per century.

Estimates of financial value of forest resources are based on estimates of stocks and flows. The accuracy of such estimates relies on the available knowledge of standing timber, yield and potential increment. In the Bolivian context of highly diverse forests, the lacking possibility to accurately predict future forest states introduces a significant element of uncertainty into valuation studies (see e.g. Rice 1998).

The time horizon of an investment, i.e. a forest operation, is normally taken into consideration by calculating the Net Present Value (NPV) through discounting all future costs and revenues within the investment period (e.g. a rotation period of 20 years) to the present time. The idea behind this is an assumption of growth in the society such that if you receive one dollar today you could invest and receive more tomorrow. According to the definition of total economic value, discounting can also be applied to non-monetary goods, e.g. CO_2 sequestration. For private enterprises the discount rate used reflects the real alternative rate, i.e. the rate obtainable in the best alternative investment. In the studies reviewed discount rates varied between 10 and 30%. Sometimes a social discount rate is used, e.g. for non-monetary goods, but it is beyond the scope of this paper to go into details with this huge topic. In order to compare NPV of different investments, equal time horizons must be applied. This is often done through calculating the Land Expectation Value (LEV), which is the NPV of all costs and revenues of a land use option repeated in perpetuity. Calculating LEV of different investments makes it possible to compare management alternatives with different time horizons since they in principle all start with bare ground and all go to eternity. For natural or semi-natural forests this is not possible since the ground is never bare. Instead Expectation Value (EV) is used, meaning the future flow of net revenue to eternity. This is less comparable since it depends on the stock level – if the forest has just been heavily logged it will have a low EV (since it may take many years until logging is possible again), and at the time just before logging the EV will be high. Many NPV calculations of forestry in natural or semi-natural forests depend on stock level in a similar way, and consequently comparison should be made with precaution – taking into account both stock level and time horizon. A negative NPV indicates that the forest operation does not yield a financial return comparable to similar investment opportunity. A positive NPV may indicate a potential for super-normal profits and in a concession system like the Bolivian such rent becomes a potential subject to taxation. The issue of 'rent capture' – the sharing of super-normal profit between state and concessionaires – is dealt with in several studies (e.g. Rice & Howard 1996, Bojanic 2001, Bojanic & Bulte 2002).

With these economic concepts in mind we provide in the following an overview of the information available on Bolivia. But first we summarise the basis by describing the forest sector of the country.

1.2 The forest sector of Bolivia

The total forest area of Bolivia is approximately 53 million ha, of which potential productive forest-land covers 28.8 million ha. Table 1 shows the regional distribution of the productive forest cover and corresponding timber stock for different value classes (STCP 2000). 6.4 million hectare is used for forest production (FAO 2003a). Most of the forest in production is held by concessions (5.7 million ha), mainly private (5 million ha by 76 concessions) (Pattie et al. 2003). Table 1 illustrates the relatively large differences in stock levels in different regions as well as the significant level of stock with little or no commercial value.

Table 1. *Regional distribution of productive forest area and existing timber stock.*

	Area		**Volume (m^3/ha)[1]**						
	Million ha	**%**	**1[2]**	**2**	**3**	**4**	**5**	**6**	**TOTAL**
Bajo Paraguá	3.8	13	1.20	16.84	9.67	6.30	11.17	5.71	**50.89**
Chiquitanía	6.3	22	3.55	23.63	7.92	0.64	7.20	0.45	**43.39**
Choré	1.6	6	0.68	43.55	18.81	12.79	8.35	4.34	**88.52**
Guarayos	4.2	15	0.45	24.99	10.42	3.03	6.04	2.23	**47.16**
Preandino-amazónico	4.1	14	2.18	30.62	14.76	7.77	15.77	5.99	**77.09**
Amazonía	8.8	30	2.13	21.92	16.70	14.45	33.72	26.62	**115.54**
Total	**28.8**	**100**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

[1] DBH (Diameter at Breast Height) ≥ 20 cm. [2] 1: most valued species; 2: valued species; 3: little valued species; 4: species with potential; 5: species with unknown value; 6: non-timber species. Source: STCP (2000).

The relatively low number of concessions is attributed to the enactment of a new Forest Act in 1996. Historically, the forest production in Bolivia has been characterised by creaming-off logging of the high-value species (Barany et al. 2003). The 1996 Forest Act introduced a new forest management model based on compliance with strict regulations aiming at establishing more sustainable forest management (SFM) practices. The main features of the Act involved i) issuing forest concessions for 40-year extendable periods, ii) introducing an area-based forest fee system, iii) elaboration and approval of general forest management plans, iv) elaboration and approval of relatively detailed annual logging plans, v) introduction of new logging control mechanisms. The legislation in Bolivia allows that 80% of the larger trees are harvested every 20 years (measured per species). The new Act led to the return of 14 million ha to the State, formerly held in concession by the timber industry, due to the low profitability of the more intensive systems compared to former extensive forest management practices. A substantial part of the research identified in this study addresses the changing financial condition facing the sector after the new Forest Act was introduced.

The Forest Act introduced two new types of legal basis for forest operations: *Tierras Communitaria de Origen* (TCO) and *Agrupación Social de Lugar* (ASL). TCOs are areas designated to indigenous people who have exclusive rights to forest utilisation. ASLs are local community groups that can be assigned the right to timber logging in public forest areas designated to municipalities. Table 2 shows the total official timber production in 2002 distributed to legal basis for forest operations. The production amounted to 581,782 m^3 but FAO estimates it to be much higher, around 1.1 million m^3, due to illegal logging. Although illegal logging was reduced by the Forest Act logging has increased lately, probably due to insufficient control in areas such as Beni, Cochabama and Pando (FAO 2003b).

Table 2. Timber flow (2002) distributed to type of legal basis.

Type of legal basis	Volume extracted in m^3			
	Very valuable	Valuable	Less valuable	Total
Concessions	10,852	33,444	177,082	221,378
ASL[(1)]	3,826	12,625	2,514	18,964
TCO[(2)]	45	12,195	5,407	17,647
Private	52,050	138,297	123,742	314,089
Private communal	446	7,306	1,951	9,703
Total	67,218	203,868	310,696	581,782

[(1)] Agrupacion Social de Lugar. [(2)] Tierras Communitaria de Origen. Source: Superintendencia Forestal (2002), ref. in Pattie et al. (2003).

Bolivian forests are highly diverse in terms of potential timber species. Out of more than 300 species less than 100 have been characterised in terms of wood properties and even less have been introduced to the lucrative export market. One of the aspirations of the Forest Act was to stop the creaming-off of the most valuable species and ensure a more intensive harvesting of timber species from a smaller annual cutting area. This has to some degree succeeded. From 1995 to 1999 the percentage constituted by the five most harvested timber species dropped from 56 to 43. At the same time the total number of marketed species increased from 125 to 205 (Superintendencia Forestal, ref. CFB 2002).

2 Values of forests

2.1 Direct use values

The direct use values relate to immediate human use of the resources such as marketed goods from the forests, but they also include non-marketed goods or even non-consumptive goods such as recreation, where the forest is used directly.

2.1.1 Consumptive use value

The bulk of valuation studies related to consumptive use of Bolivian forest address the financial value of timber resources. An overview of studies is given in Table 3, p. 13. The value of timber has been analysed in different management settings including: large-scale private and concession forestry, community and communal forestry, and small-scale colonist forestry. Several studies deal with the financial implications of different forest management regimes, primarily investigating the consequences of changing from traditional extensive selective logging to sustainable forest management (SFM). Another area of analysis is the classical issue of land use changes, e.g. comparing the financial outcome of forest, livestock and rice production. Being the nation in the world with most forest certified (in 2005 the Forest Stewardship Council (FSC) certified area in Bolivia passed 2.0 million ha) the economy of forest certification has also attracted interest. Studies of the financial aspects of non-timber products (NTFP) are relatively rare as are studies of subsistence economy of forest dependent communities. Finally, the total financial value of the Bolivian forests has also been subject to analysis.

Financial valuation of forest management regimes

Bojanic (2001) and Bojanic and Bulte (2002) provide a study of the financial valuation of timber production in Bolivia (Beni and parts of Pando and La Paz Departments) in relation to concession forestry. The study presents an analysis of the changes following the 1996 Forest Act requiring concessionaries to implement SFM practices. In their base scenario (20-year rotation, 1999 prices, 1% price increase per year and an discount rate of 17%) they show that although SFM maintains a positive NPV (for one rotation) of 49 US$/ha, the level is considerably lower than returns from conventional logging systems (83US$/ha). Bojanic (2001) provides forest rents for economic important species including Mahogany (*Swietenia macrophylla*), Cendro (*Cedrela spp*.) and Roble (*Amburana cearensis*) of 126, 80 and 49 US$/m^3, respectively, assuming a 25% normal profit. Less valued species like Tajibo (*Tabebuia spp*.) and Virola (*Virola sepifera*) are reported to produce negative forest rents of - 46 and -12 US$/m^3, respectively. Depending on future market conditions for lesser know species and price developments it is concluded that the profitability of commercial forestry will drop approximately 25-80% as a consequence of implementing SFM.

Rice and Howard (1996) provide a case study (Beni Department) of concession forestry, performing at different extracting levels ranking from 2,400 to 8,400 m^3/year from a 55,000 ha concession. The two scenarios differ with regard to the level of depreciation of harvest and milling machinery. The study shows how the high value of Mahogany combined with relative low costs of establishing infrastructure provides a rational incentive for concessionaires to open new areas rather than intensify harvest of less valuable species in already opened areas. In Howard et al. (1996) the above model is extended to a 50-year four-scenario model integrating environmental effects from harvest operations and infrastructure construction. The conclusion is that although more intensive and broad species utilisation would result in over-normal profitability, no incentive exists to stop the creaming-off of Mahogany.

A number of authors deal with different economic aspects of transfer of former State forest to indigenous communities and establishment of TCOs. Rice (1998) analyses four alternative scenarios for the Lomerio TCO (Santa Cruz Department) under three management regimes: i) a fixed minimum diameter harvest, ii) a more selective logging, and iii) selective logging of the most valuable species only (traditional practice). Up to 17 species are subject to harvest. Each regime is analysed under different assumptions regarding distribution between national and export markets and number of species included in the harvest. The timber is assumed processed by the Lomario sawmill. The net value of sawn timber varies from 13 and 8 US$/m^3 for Cendro and Roble, respectively, to - 45 US$/m^3 for the least valuable species like Morado (*Machaerium scleroxylon*) and Soto (*Schinopsis brasiliensis*). The author assumes a 30-year time horizon, a discount rate of 25%, 1996/1997 prices and a fixed annual harvest level. Broad-spectre harvest (all 17 species) for the domestic market only produces negative NPVs. When approximately half of the species can be sold on the international market, the NPV raises to 7 US$/ha. The best result is obtained by focusing only on Curupaú (*Anadenanthera macrcarpa*) for the export market (24 US$/ha). The illegal timber market in the region is found to exert a downward pressure on timber prices, resulting in poor performance when producing for the national market. Several authors mention this effect of the illegal logging, e.g. Davies et al. (2000) and Ramírez (2004).

Nebel et al. (2003) address the strategic options facing the Guarayos TCO (Santa Cruz Department) in terms of vertical downstream (value-added chain of timber production) integration and horizontal (competitive scale) business integration. An analytical framework is presented for the chain of timber production. Three scenarios of increasing downstream integration are analysed: i) sale of timber, ii) timber felling and extraction, and iii) production of sawn wood. A 20-year horizon, a discount rate of 20% and a fixed annual harvest level is applied. The study finds average NPV/ha of 27, 33, and 50/135 US$, for the three scenarios. In the third scenario 50 US$ is obtained based on portable sawmilling and 135 US$ based on stationary sawmilling. The authors argue that communities should opt for vertical downstream integration to capture employment opportunities and economic revenues as well as to deal with market imperfections (e.g. illegal logging). Ramírez (2004) provides a detailed account of the market potential and economic factors framing the commercialisation of timber production in Guarayos TCO.

Some economic analyses address the income flow in the society, both at local, national and global perspective, e.g. through the application of supply chain analysis. Min and Zhou (2002) define a supply chain as “an integrated system which synchronizes a series of inter-related business processes” and its objective to be “to enhance the operational efficiency, profitability and competitive position of a firm and its supply chain partners”. Based on a questionnaire study, Soto (1997) gathered detailed price data from the different steps in the supply chain, from harvest operation to retail sale of sawn timber in a major city, for seven major timber species. The study shows a value increase of 620%, 1320% and 1290% for Mahogany, Cedro and Roble, respectively.

Studies of the Bolivian forest sector are rare apart from the annual statistics compiled by the Cámara Forestal de Bolivia. Bojanic (2001) provides a holistic analysis of the forest economy in the Northern Amazon Region. This study will be addressed in section 3. A recent study by Pattie et al. (2003) estimates the total financial value of Bolivian forestry based on its SFM timber production potential. NTFP and subsistence use value are not included. The average NPV/ha is

5.57US$ but varying substantially depending on location. The highest average value is found in the Chiquitanía region (16 US$/ha) and the lowest in the Bajo Paraguá region (-3.65 US$/ha). The study is based on data from 101 forest management plans covering 4.3 million ha and a large number of interviews. The estimates relate to a 10-year time horizon, 2002/2003 prices, and a discount rate of 10%. Approximately 25% of the forest operations show an NPV/ha of more than 10 US$, but more than 50% of the managed forests currently show a negative NPV. The two most significant variables determining profitability are transportation costs and operations efficiency.

A consistent finding in the reviewed studies is the higher profitability of harvest regimes focusing on few high value species compared to SFM harvest prescription that involves cutting a broad range of lesser valued species. The studies reviewed are far from exhausting the central theme of developing management models that ensure long-term ecological as well as financial sustainability.

Forest certification

One of the issues often addressed in relation to certification is whether a price bonus sufficient to cover certification costs is obtainable. Markopoulos (1998) and Nebel et al. (2005) address the economic implication of forest certification. In the case of the Lomerio community forest management project (30,000 ha) initial direct costs of certification were estimated at 1.58 US$/ha (Markopoulos 1998). Sandoval (2000) estimates the direct certification costs at an average of 0.18 US$/ha/year. In the case of Lomerio, a substantial price bonus was obtained in the initial stages - up to four times the Bolivian domestic prices (Markopoulos 1998). In general a price bonus of 83 and 75% were reported for first and second grade timber (Hanrahan et al. 1997). In a study of the Bolivian export market, Nebel et al. (2005) identify a price bonus of 5-51% based on sales figures from 2000-2001, and they conclude that the price premium has at least compensated the forest enterprises for the direct costs of certification. The authors warn that the prices premiums might disappear when the market for certified timber stabilises.

Land use changes

As in many other tropical countries the Bolivian forest resources are greatly influenced by the progressing agricultural frontier. Approximately 200,000 ha of forest are annually converted from forest into agriculture and pasture. One of the factors behind this development is the low financial value of production forest. Pattie and Merry (1999) calculate potential stumpage price[4] through reducing market sales prices (70% export and 30% national market) by actual extraction and milling costs and arrive at values from 184 US$/m^3 (Morado) over 131-81 US$/m^3 (Mahogany, Cedro and Roble) to 73-11 US$/m^3 for lesser known species. Based on varying degrees of obtaining of these potential revenues a linear programming model is used to analyse the forest-to-pasture changes in a 2000 ha theoretical case study estate in six different locations with high productive forest

[4] Stumpage price is the value of the timber while still standing in the forest.

in the Bolivian lowland. It is concluded that deforestation will not take place if potential stumpage prices reach 55-65% of their maximum.

Based on a linear programming model Merry et al. (2002) demonstrate how increasing stumpage prices induce conversion from forest to pasture in a system based on SFM. Up to a certain level, increasing revenues from forest operations will be used to convert land into pasture. Increasing stumpage price up to 6 US$/ha is shown to lead to increasing conversion of a 500 ha case study estate. Stumpage prices between 6 and 9 US$/ha reverse the development, giving decreasing rates of conversion. Stumpage prices of more that 9 US$/ha leave no incentive to convert productive forestland into pasture.

Davies et al. (2000) address the issue of integrating timber production in colonist farm economy. A gross margin analysis based on a participatory data collection method is used to produce a cost-benefit analysis of a forest management alternative for a colonist community in El Chore (Santa Cruz Department). NPV is calculated for forest blocks of 10 ha managed over a 20-year time horizon and a range of discount rates of 10-25%. NPV varies from 190 to 74 US$/ha. At similar discount rates, cattle ranching produce NPV in the range of 460-300 US$/ha over a 10-year period and rice production has even higher NPV. The authors argue that forestry is a low-profit and high-risk activity, taking into account the time perspective and dependence on local market conditions.

Non-timber forest species and subsistence use

Major non-timber forest product (NTFP) species in Bolivia include, e.g. castaña (*Bertholletia excelsa*), palmitos de asai (*Euterpe precatoria*), las hojas de jatata (*Genoma spp*.), cacao silvestres (*Theobroma cacao*), caucho natural (*Hevea brasiliensis*), aceite de cusi (*Orbignya phalerata*) and a variety of tropical frutes. Castaña and palmito account for approximately 20% of the export value from the forest sector (Bojanic 2002). A number of publications address the use of NTFP, e.g. Norheim 1996, Ponz et al. 2005, but few studies assess the economic value of such forest benefits.

The most important NTFP in Bolivia is the Brazil nut. Bojanic (2001) provides an example of a 30,000 ha estate where the net benefit to the estate owner is 21,750 US$/year, or 1.4 US$/ha/year, equal to an EV of 6.9 US$/ha with a discount rate of 20%.

Godoy et al. (2002) analyse local financial benefits from the use of forest in Bolivia and Honduras. In two Bolivian Tsimane villages (Beni Department) biological forest goods accounted for about half of the total value of household consumption at an estimated value of 6 US$/ha/year. Plants accounted for approximately 16% of the consumption. The annual value from the sales of forest products is approximately 1 US$/ha. An estimated total value of 7 US$/ha exceeds the average value of Bolivian forest timber production, which has been estimated at 5.57 US$/ha (Pattie et al. 2003).

A study of non-timber benefits was carried out in the northern zone of Lomerío in 1996 (Vallejos et al. 1996). The gross value of forest products gathered by the communities over a three month period amounted to approximately 2,500 US$, equivalent to 271 US$ after deduction of the cost of gathering. Main products included firewood, bushmeat, and honey.

The studies show that NTFP contribute significantly to the financial benefits from the forests, sometimes even as the main products, and therefore they should not be excluded when comparing forestry with other land uses.

In general, the reviewed consumptive use value studies apply a relatively short-term horizon and seemingly high discount rates, taking into consideration the assumed time perspective of forest operations. This may lead to an underestimation of NPV and emphasis on short-time gains. A comparison of the profitability levels estimated in the timber production studies is difficult. The studies apply very different assumptions and management regimes and are highly case dependent. Moreover, the studies rarely mention the predicted value and characteristics of the forest at the end of the planning horizon, which may have a substantial impact on the evaluation of management regimes, at least from a national point of view. There is a need for studies indicating the long-term economic effects of the present timber extraction practises.

Several authors draw attention to the substantial loss of financial opportunities due to community authorities' lack of experience in managing forest operations, e.g. Davies et al. 2000 and Nebel et al. 2003. No studies comparing enterprise operation performance were found. Only the study by Pattie et al. (2003) gives an indication of the variety in operation profitability. The value of the forest depends highly on the effectiveness of private and communal operators, and studies of actual performance might provide benchmarks for focusing the sector's on the development of more efficient management.

Another returning theme is the social distribution effects of the widespread illegal timber market (Cordero 2003). A socio-economic analysis of distribution effects related to the imperfection of the timber trade might document a negative environmental impact of poorly defined property rights and insufficient public control. The present condition undermines the profitability of timber production, especially for the smaller and poorest owners, and leads to accelerated land use conversion and disregard of the potential benefits obtainable from forest resource.

Table 3. *Summery of studies of consumptive use value of Bolivian forests.*

Reference	Study location	Context	Economic theme addressed	Methods	Data type
Bojanic (2001)	Northern Amazon Region of Bolivia	Concession forestry	Profitability of concession forestry, cattle ranching, and Brazil nut production Rent capturing by government	NPV, scenario analysis	Primary and secondary
Bojanic (2002)	Bolivia	General	Commercialisation of NTFP	Literature review, interviews	Primary and secondary
Bojanic & Bulte (2002)	Northern Amazon Region of Bolivia	Concession forestry	Profitability of concession forestry Rent capturing by government (concession forestry)	NPV, scenario analysis	Based on Bojanic (2001)
Davies et al. (2000)	El Choré	Colonist farmers	Profitability of timber, rice and cattle production Economic dynamics of land use changes	NPV, scenario analysis	Primary and secondary
Godoy et al. (2002)	Tsimanes, Beni	Household and community	Economic contribution from forest to household consumption and earnings	Household consumption measurement	Primary
Howard et al. (1996)	Chimanes forests	Community forestry	Profitability of concession forestry management regimes Rent capturing by government (concession forestry)	NPV, scenario analysis	Based on Rice & Howard (1996)
Markoploulos (1998)	Lomerio	Community forestry	Impact evaluation of forest certification	Literature review, interviews	Primary and secondary
Merry et al. (2002)	Bolivian lowland	Large scale private landowners	Economic dynamics of land use changes (from forestry to cattle ranching) Effect of land tax on cattle ranching	NPV, linear programming, scenario analysis	Based on Pattie & Merry (1999)
Nebel et al. (2003)	Bolivian lowland	Community forestry	Business strategy Profitability of forest management	NPV, scenario analysis	Secondary
Nebel et al. (2005)	Bolivian lowland	General	Value of forest certification	Literature review, market price analysis	Secondary
Pattie & Merry (1999)	Bolivian lowland	Large-scale private landowners	Economic dynamics of land use changes (from forestry to cattle ranching) Effect of land tax on cattle ranching	NPV (land expectation value), linear programming, scenario analysis	Primary and secondary
Pattie et al. (2003)	Bolivian lowland	Bolivian lowland	Profitability of total production forest	NPV, scenario analysis	Primary and secondary
Ramíres (2004)	Guarayos	Community forestry	Commercialisation of timber from community forestry operation	Literature review, interviews	Primary and secondary
Rice (1998)	Lomerio	Community forestry	Profitability of communal forest management and sawmill operation	NPV, scenario analysis	Secondary
Rice & Howard (1996)	Chimanes	Concession forestry	Profitability of concession forestry management regimes Rent capturing by government (concession forestry)	NPV, scenario analysis	Primary and secondary
Soto (1997)	Cochabamba and Santa Cruz	General	Timber price in different stages of the market change	Literature review, interviews	Primary

2.1.2 Non-consumptive use value

Only few studies relate to the direct value of non-consumptive use of Bolivian forests, which probably stems from the historically little use of and demand for these attributes, such as the scientific and educational value and the forest as recreational destination. However, this trend is maybe changing, as explained in the following.

Ecotourism

Part of the total value attached to forest resources stems from their potential recreational value. In Bolivia ecotourism is a rapidly expanding industry, which doubled from 1999 to 2002 from 35,000 to 70,000 visitors (Robertson & Wunder 2005). The main objective of promoting ecotourism is the dualistic hope that it can improve livelihoods through increased incomes and simultaneously create local willingness to conserve protected areas. Several examples of eco-tourism exist in Bolivia. As most eco-tourism initiatives have the aim of benefiting local communities, the economic value of the forest in this regard is most often presented in terms of revenue gained by the involved communities. Table 4 presents an extraction of examples provided by Robertson & Wunder (2005) on eco-tourism initiatives in Bolivia. It is important to note that the presented annual gross revenue gained from tourist visits alone is not a true measure of the forest's recreational value. Issues such as the number of households that have to share the amount of revenue, operation costs, the opportunity costs from preserving the forest, and the opportunities for additional income also have to be taken into account. It is worth mentioning that the above is a market value of eco-tourism. The non-consumptive value would be much higher if the utility of the tourists were included (assuming their willingness-to-pay (WTP) is higher than the price gained by the local community, at least for some of them). They will, however, for the major part be foreigners and consequently should not be included in the national economic value. This issue is discussed further in section 3.

Table 4. Example of forests used for ecotourism in Bolivia and the annual gross revenue gained by the involved communities from the visits of tourists.

Name of enterprise / project	Location	Sights of special interest	Name of community involved	Annual gross revenue gained by community (US$) in 2003
Chalalán Ecolodge	Madidi National Park	Lake views and forest hikes	San José de Uchupiamonas (600 inhabitants)	323,950
Mapajo Indigenous Ecotourism project	Pilón Indigenous Territory and Biosphere Reserve (TCO)	Cultural tours, forest hikes and river boating	Asunción de Quiquibey (26 households)	83,280
La Chonta	Amboró National Park	Forest hikes and horseback riding	La Chonta (13 households)	6,862
La Yunga Park	Amboró National Park	Hikes in the protected giant ferns grove	La Yunga (35 households)	>1,000

Source: Robertson & Wunder (2005).

2.2 Indirect use values

The indirect use values are values related to the forest, but not extracted or otherwise directly used, e.g. environmental protection values like watershed protection, maintenance of soil fertility and carbon storage. One of the most important indirect use values in Bolivia is watershed protection in the Andean regions and flood prevention on lower lands. Such values are often difficult to quantify, though quite important in order to: i) indicate the value of mountain development, ii) allocate development resources for watershed protection programmes, iii) assist the analysis and design of appropriate land-use incentives for local users, iv) and assessing distributional problems (Richards 1997). The main problems when valuing watershed protection programmes occur because the most important benefits of such initiatives do not have a direct market value. Some of these benefits are termed ‘externalities’ because they are external to the market system. Furthermore, the welfare and environmental consequences are often found outside the area, e.g. downstream. Richard (1997) argues that there is an urgent need for case studies with pragmatic approaches, which are intelligible to decision-makers and which focus on the valuation of more local and tangible environmental benefits.

Ellis-Jones and Mason (1999) studied the benefit of soil conservation to local farmers in the mid-Andean valleys of Cochabamba Department of Bolivia. By adopting conservation technologies consisting of live barriers and cover crops, the farmers could in ten years expect a NPV between 25,362 US$ (at 5% discount rate) and 6,536 US$ (at 25% discount rate). Viability of such a scheme was found only for those households with low discount rates, which excluded the poorest fraction, and only in cases where the conservation initiative resulted in high increase in production. The finding is therefore not directly comparable with the value of establishing forest for soil protection, since forest will inevitably occupy land available for agricultural activities. However, it indicates some of the potential environmental value of forests, as many of the benefits from live barriers also apply to these from forests and tree stands, such as reduced soil erosion, protection against storm damage, material available for mulching and fodder, increased soil moisture and organic matter and non-wood products for household consumption.

Another example of the value of watershed protection in the Cochabamba Department is provided by Richards (1997) where the Programme for the Integrated Management of Watersheds (PROMIC) in Taquiña watershed is used as case study. He finds that the main benefits of the programme are: i) increased farm family incomes in the upper watershed, ii) flood prevention, and iii) increased water availability. He estimates NPV of these (calculating with a project period of 50 years) at between 26 and 34 million US$. In comparison, Southgate and Mache (1989) found the NPV of water catchment protection in Ecuador's Andean highlands to be 11-5 million US$ for the Paute hydroelectric scheme alone.

By using the Contingent Valuation Method, Vargas (2004) estimated the willingness to pay (WTP) for water stabilisation and water quality in Los Negros watershed, partly belonging to the Amboró National Park, Santa Cruz Department, Bolivia. She finds that farmers in the communities of Los Negros and Santa Rosa are on average willing to pay 10.32 US$/year for water conservation, which for the total number of families in the watershed aggregated to 12,487 US$/year. By assuming communities' opportunity cost of leaving forest in situ to be approximately 3 US$/ha/year, she estimates that the aggregate WTP for watershed preservation can help to protect around 4,000 ha of forested watershed per year. In the same river watershed of Los Negros, the NGO Natura began in 2002 to work with communities to create an agreement in which the downstream community of Los Negros pay the upstream farmers of Santa Rosa to protect a share of their forest. Negotiations led to the result that landowners in Santa Rosa, who agreed to set aside 10 ha of primary forest for conservation each year, would in return receive a beehive from the habitants of Los Negros. By using the value of a beehive to represent the value of conserving 10 ha of primary forest, Robertson and Wunder (2005) estimate the NPV between -15.25 and 12.66 US$/ha.

In case study from Sama Biological Reserve, Tarija Department, Robertson and Wunder (2005) use a Contingent Valuation Method in the city of Tarija to measure water consumers' WTP for watershed protection. The results show that every urban household is on average willing to pay 15 US$ annually, which for the total urban population amounts to 381,026 US$ annually. The total WTP of rural residents is found to be 1,031,998 US$. Taking opportunity costs into consideration, they calculate the total value of the environmental service provided by vegetation protection to be 259,115 US$/year.

Often it is not only of interest to identify these externalities, but also to include regulating initiatives like taxes or subsidies. For some indirect use values like, e.g. carbon sequestration, an artificial market has been created. Those developed countries that ratified (annex 1 parties) the Koyoto Protocol (the United Nations Framework Convention on Climate Change), are committed to reduce their emissions of greenhouse gases below 1990 levels by 2008-2012. The protocol includes the Clean Development Mechanism (CDM), which allows annex 1 parties to offset their emissions by financing carbon-emission mitigation and sequestration projects, including forestry in a non-annex 1 country, typically a developing country. (UNFCCC 1997, 2001) In this manner the externalities belonging to greenhouse gas pollution are internalised. One of the first projects on carbon forestry was initiated in Bolivia in 1997, the Noel Kempff Mercado Climate Action Project (NKMCAP) and was an expansion of the existing Noel Kempff National Park by 634,000 ha, from the original 889,446 ha to 1,523,446 ha. The environmental benefits of this expansion lie not only in the carbon sequestration but also in the increased biodiversity protection, both of which stem from the avoidance of deforestation. No direct attempts have been made to value these benefits. Asquith et al. (2002), who focus on the project's impacts on local communities, mention that of the total project costs of 9.5 million US$ (as of 2002), 1.6 million US$ went to buy out concessionaires, 67,000 US$ went to purchase private properties and 1.25 US$ was used for community development projects. If we look at the carbon storage function it self, various calculations are made. Brown et al. (2000) state that 1.5-2.5 Mt carbon will be sequestrated over the project period of the 30 years, while Robertson and Wunder (2005) find that this might be overestimated. Another estimate is made by Angeleri (2005) in a financial analysis of the NKMCAP. According to this study, approximately 4 Mt of carbon will be sequestrated on the expansion area during the project period of 30 years. By using data in Angeleri (2005) we calculate the present value of revenue from the sale of carbon credits to be 8 million US$ (by the use of a carbon price of 7 US$/t$CO_2$), as a realistic estimate, and 39 million US$ from an optimistic point of view. Thus, the selling price of carbon storage per hectare will be between 13 US$ and 63 US$. As Angeleri (2005) also discusses, this increases the total profitability of the forest activities considerably.

Similar estimates are made for other proposals for carbon forestry projects in Bolivia. By establishing 10,000 hectares of tree plantations in the Chaparé it is estimated that 0.9 Mt of carbon would be sequestrated over 30 years (Robertson & Wunder 2005). Two other forest carbon project proposals from the Chaparé estimate the value of carbon sequestration over 30 years: The first estimates the total sequestration value of 3.1 Mt on 10,000 ha of secondary forest to be 400-800 US$ /ha and the second assumes that the value of 10 Mt of CO_2 sequestrated on 25,000 ha of primary forest will be 320-560 US$/ha (both assuming a price of 2.4 US$ per tonne of carbon). Finally, a project proposal in the highlands of the province of Inquisivi claims it will avoid the loss of 2.3 Mt of carbon to deforestation over 31 years, however, no value has been calculated (Robertson & Wunder 2005).

In the large-scale end of studies made on the value of forests’ carbon storage functions, Lopez (1997, ref in Emerton 2003) has made the guesstimate that by permanently protecting 650 million ha of the Amazon forest in order to sequester carbon, the global net benefits will be worth about 70 billion US$.

2.3 Non-use values

Non-use value is value which is not related to the use of goods. It includes existence value, which refers to the value we assign to a forest good due to its mere existence. To many people who have their basic needs satisfied, it is of great value to know that nature exists and they claim that nature should be protected for its own sake. Hence the economic value is not the value of a forest in itself, but the value of knowing that it exists. Intrinsic values can be a part of this, i.e. the value that goods have in and to themselves. Option values refer to the possibility that in the future we might value the good higher than today and therefore we refrain from using it today. However, option value can also refer to non-use values, i.e. the possibly higher existing values in future. Existence and option values will be covered in the following. Apart from this, bequest values and altruism are relevant. Altruism arises from our concern of the availability of the present goods to future generations, and bequest value arises from concerns for letting future generations have the option to make use of the goods (Bateman et al. 2002). Though these values are acknowledged, they are seldom estimated separately, due to the difficulty of measuring them.

2.3.1 Existence value

Existence values cannot be marketed, and is it difficult to imagine the creation of artificial markets like for the CO_2 sequestration. But in order to estimate their size, valuation studies can be performed. Here willingness to pay for (or accept for not having) a certain good, e.g. preservation of a certain forest or species, is estimated. Revealed preference methods analyse actual behaviour and since this is often related to the use of a good, e.g. a national park, it will not cover the existence value.

Existence values are much studied in the USA, and more recently also in other developed countries. Some studies exist of the economic value of non-marketed goods in South America, especially in Costa Rica (e.g. Barton 2002, Hearne & Salinas 2003), but often studies only describe and quantify the benefits.

A Bolivian case of an indication of WTP is from Buena Vista, north of Amboró National Park. Here the ornithologist and conservationist Robin Clark has offered his neighbour direct, continuous and contingent payment for conserving thes remaining forest instead of cutting it down for rice production. Clark wanted to preserve the biodiversity due to his personal interest and because he is the owner of a small lodge for bird watchers (Robertson & Wunder, 2005). Though not valued directly it can be expected that he both had a commercial interest (due to the bird watcher lodge) and a personal interest due to the existence value of the forest (and its birds). As also in this example, existence value is hardly separable from use value, but sometimes it might be possible to isolate it indirectly – by estimating both use and existence value together and then separately estimate the use value, e.g. by travel cost methods. Consequently, the difference must be due to other elements, e.g. existence value.

The case of Buena Vista refers to the WTP of a single person, but naturally the socio-economic value depends on the whole society with all the individuals' different valuation of a certain good. The question arises how to define this society. Traditionally, we define a country or a province as a relevant society. For global goods, e.g. world heritage, it could be argued that the world community is the relevant society since many people in developed countries attach a large value to the existence of, e.g. a tropical rain forest. But as long as such people are not willing to pay for the preservation of the forest (or the revenue forgone by preserving instead of exploiting) they are irrelevant in a national or regional economic context. This topic is frequently discussed (see e.g. Navrud & Ready 2002).

Estimates of existence values can be used in cost-benefit analysis of certain initiatives or in a political context to emphasise a value that exists and is relevant to the public – even if not marketed. If good estimates are made and are used with the necessary caution, they could be included in, e.g. a social account matrix (Marcoullier & Stier 2005), see section 3, or as a tool in other project evaluation studies.

2.3.2 Option values

As has already been mentioned several times, time is an important component when talking about economy, due the idea that growth in the society is the driving force and therefore postponing activities and thereby revenue has a cost. By not postponing revenue we can invest in other activities which can earn a return. But sometimes we get wiser as time goes by and this is the basis for talking about option values. Consider an investment on which we might gain or lose. If we, by postponing the decision, tomorrow will know for sure whether we will lose or gain, it will be of great value to wait making the decision. This is called an option value and is closely related to uncertainty. Many real options are related to the forest sector. An example could be that we see a potential for finding new medicine from some plants in natural forests, which we do not know today. This potential or option has a value, even though we can not know for sure whether we will ever use it. Other examples could be forest areas close to cities, which are not presently used for recreation, but if society becomes richer, they might contain a high recreational value, or more marketable option values related to, e.g. new products. To the best of our knowledge no specific studies have been made, which specifically analyse option values in the forest sector of Bolivia.

A potentially interesting study would be to analyse the option values of postponing the harvest of the presently lesser value timber species due to the possibility that they might be worth more in the future. The economy of lesser value species is strongly influenced by high transportation costs due to long distances and poor infrastructure. The prospect of future improved infrastructure might also influence present decision making. Much of the discussion on SFM has been concerned with the profitability of including lesser value species in the timber harvest, but so far no study has applied an option value perspective on this problem, taking into consideration expectations of future market developments.

3 Total value

The total economic value is, as illustrated in Figure 1, the sum of all the previous aspects, i.e. all values in a society, including non-monetary values. The unit we look at is often the national economy, but it will depend on the aim of a specific study. In this section we discuss how comparisons within the national economy can be made.

3.1 The forestry sector in the national economy

The forestry sector provides benefits to society. In economic terms the sum of all the previous values forms the total value (cf. Figure 1). Often the gross domestic product (GDP) is used as a measure of the marketed value. Using this we find that the forest sector represents around 3% of Bolivia's GDP (FAO 2003 a), contributing 11% to the export and 90,000 jobs (STCP 2000). But it may be of interest to go behind these overall figures, e.g. it can be of interest to know who benefit from the sector and how it develops. Political processes cause changes in the economy, and it is of interest to analyse the consequences of political or resource stock changes. This is the basis for an analysis of the welfare economic impact of a forest sector.

One way to analyse the total economic impact is through a social account matrix (SAM). Such analysis is made by Bojanic (2001) for a part of the Bolivian Amazon. SAM is a matrix, which shows the links between flows in the economy, and consequently it is useful for analysing distributional patterns. The columns show the expenditures and the rows the receipts of each account, e.g. industries, labour etc. This structure is useful for analysing effects across parts of society and consequences of changes in one factor on the other factors.

Bojanic (2001) uses a SAM where he focuses specifically on different groups of households (depending on their poorness) and furthermore he includes environmental factors (CO_2 and 'other factors'), which are analysed economically. The model interlinks economic growth, livelihood (poverty) and the environment in the Bolivian Amazon. Consequently, in the model 'the rest of the world' consists of two components – the rest of Bolivia and the world outside Bolivia. For example, he uses the model to point at parts of the forest sector that have the highest impact on the poorest group of household, who in this case are highly dependent on the production of Brazil nuts, by analysing who contributes to this production. He also finds that the region is highly dependent on export to ‘the rest of the world’.

One problem with a SAM is that it is demand driven and therefore does not account for supply constraints or the possibility of substitution (Alavalapati et al. 1998). The more complex computable general equilibrium models (CGE) can account for this. They often build on information obtained from SAM. An example of a study using a CGE in Bolivia is Zaveleta (2003), which analyses the impact of an expansion in the natural gas sector, e.g. the effect on subsequent labour movement.

The SAM model is a useful tool for analysing economic impacts of different activities. Since the matrix can be extended and reduced depending on specific interests, it can also be used at a very local level to analyse, e.g. the economy in a region, as Bojanic (2001) does, or even at a lower level. But most frequently it is used at a national or regional level. It can be used to analyse poverty alleviation effects of different initiatives or other distributional matters, e.g. between different links in the production chain of timber.

These analytical frameworks do not necessarily include total economic value, i.e. all the components in Figure 1. Externalities can be included (in principle), but as the previous sections have shown still too little is known of their importance.

4 Concluding remarks

As shown in this review, economic value is an ambiguous concept. The value we attribute to timber resources depends on the context, the actors involved and the time horizon applied. In addition, the choice of economic value measure may highly influence the subsequent conclusions, and resource economists should be conscious of developing sound technical solutions taking into account the considerations of the decision-makers. In the words of Sheild and Wunder (2002: p. 5):

> “*Value is not the inherent property of an entity: it is a measure of a relationship between a subject and the object of valuation within a context (time and place, or hypothetical scenario). These basic “terms of assessment” define and delimit the scope of each study and the sphere of any potential research conclusion. There is a fundamental distinction to be made between a valuation exercise that sets out to explain how choices are made by individual resources users and one that seeks to maximize community or societal well-being.”*

In the majority of studies identified in this review, the “terms of assessment” have focused on individual choices and financial aspects of timber extraction. Most of the financial studies date back to the discourse following the enactment of the 1996 Forest Act. The general conclusion drawn from these studies is that the SFM regime has lowered the profitability of forest operations. Few studies view the timber production in an inter-generational perspective, as they are based on relatively short time horizons and inadequate information on the biological processes of the tropical forest. Basic knowledge of the dynamics of natural forest ecosystems is still very incomplete, providing a poor basis for forecasting long-term potential flows from different management schemes. On the other hand, reality is demanding economic estimates of use values. Economists have to their estimates on the existing biological knowledge and the review highlights a need for ecologists, biologists and economists to join forces to develop the best possible long-term economic models of the forest sector of Bolivia.

Since the implementation of the Forest Act in 1996, the financial performance of the forest sector has not improved significantly and there still is a need for economic as well as financial analyses as a basis for further development. The low efficiency in the forest sector could be addressed through studies of the dynamics of business performance. Other enduring issues are the socio-economic and financial effects of the illegal timber market that have totally evaded scientific inquiry, even though the problem of illegal felling is frequently documented in Bolivia's newspapers.

Another underexposed aspect of forest valuation is the economic importance of NTFP. Few studies address this issue. Considering the development of the agricultural frontier, it would be useful to establish a more solid base for evaluating the future role of the forest. What role does the forest play today, and is it realistic to expect the forest to co-exist with agricultural land use? This question is highly linked to analysis of the potential role of the forest as a source of generating development in local communities. Some studies address this issue in relation to TCOs. Little research has been done in relation to ASLs and colonist communities, and results from TCOs cannot be immediately applied here. Following the new Forest Act great expectations have been attached to decentralised management of forest resources. But what is the present situation of these resources and their development potential? These issues have been addressed in a political science perspective but not yet in a socioeconomic perspective.

The environmental economics of forest resources is another area representing many challenges to science. The value of watershed protection functions is often not considered when estimating forest value. In some cases the value of preserving the forest to maintain related externalities may exceed short-term gains from harvesting timber. Failing to adequately analyse and document these holistic interrelationships may lead to sub-optimal decisions at all levels. Environmental economics play a significant role in disclosing the inherent value of ecosystems that may too easily be utilised for generating financial gains for a few individuals but leading to devastating consequences for large groups of the population.

As the natural forest resource of Bolivia is being depleted, forest plantations are gaining increased interest. But no studies of the financial, socio-economic and environmental economic value of forest plantations have been found. From a conservation perspective it could be interesting to compare the future benefits from forest plantations with continued utilisation of natural forests. Moreover, realistic and locally adjusted investment schemes are needed to support decision making on investments in private plantations.

Based on this review of forest economic studies in Bolivia we conclude that many questions are still unanswered. Research is needed especially on direct use value at all levels of the commercialisation of timber resources. Moreover, research is needed on community-level management of forest resources. From a society perspective research is needed on the economic effects of legal as well as illegal timber production. Environmental economic research can contribute to disclose the indirect use values and although some attempts have been made, there still seems to be a long way to go before the total value of the forest sector is adequately estimated applying an economic rather than a financial perspective. To achieve this objective a major precondition is that close inter-disciplinary collaboration is established between natural and social science, aiming at providing holistic and comprehensive answers useful to enterprise and policy decision-makers.

Acknowledgements
We want to thank our colleague Ing. Milton Brosovich, at the Forestry Department of Universidad Autónoma Gabriel René Moreno for his tireless effort to bring about much of the literature used in the present review. Moreover, we would like to thank Alan Bojanic, Preston Pattie and Maria Teresa Vargas for their help and constructive comments.

5 References

Alavalapati, J., White, W., Wellstead, A. & Patriquin, M. 1998. An Economic Impact Model of the Foothills Model Forest. Working paper. Canadian Forest Service, Socio-Economic Research Network.

Angeleri, N. V. C. 2005. Análisis financiero de la mitigación de carbono del proyecto de acción climática Noel Kempff (PAC-NK). Thesis del grado académico. Universidad Católica Boliviana, San Pablo. La Paz, Bolivia.

Asquith, N. M., Vargas R., M. & Smith, J. 2002. Can forest-protection carbon projects improve rural livelihoods? Analysis of the Noel Kempff Mercado Climate Action Project. Mitigation and Adaptation Strategies for Global Change 7: 323-337.

Barany, M., Hammet, A. L. & Araman, P. 2003. Lesser used wood species of Bolivia and their relevance to sustainable forest management. Forest Products Journal 53 (7/8): 1-6.

Barton, D. N. 2002. The transferability of benefit transfer: contingent valuation of water quality improvements in Costa Rica. Ecological Economics 42: 147-164.

Bateman, I., Carson, R., Day, B., Hanemann, W. M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Özdemiroglu, E., Pearce, D. W., Sugden R. & Swanson, J. 2002. Economic Valuation with Stated Preference Techniques. Edward Elgar, Cheltenham.

Bojanic, A. 2001. Balance is beautiful: Assessing sustainable development in the rain forests of the Bolivian Amazon. PhD thesis. Faculteit Ruimtelijke Wetenschappen Universiteit Utrecht.

Bojanic, A. 2002. Comercializacion de productos forestales no maderables. Factores de éxito y fracaso. Marco legal y políticas relevantes para la comercialización interna y de exportación de productos no maderables en Bolivia. DFID R7925. PNUMA UNEP-WCMC & ODI, DFID – FRP. Downloaded November 2005 from: http://quin.unep-wcmc.org/forest/ntfp/docs/ Bolivia_policy_paper.pdf

Bojanic, A. & Bulte, E. H. 2002. Financial viability of natural forest management in Bolivia: environmental regulation and the dissipation and distribution of profits. Forest Policy and Economics 4: 239-250.

Brown, S., Burnham, M., Delaney, M., Powell, M., Vaca, R. & Moreno, A. 2000. Issues and challenges for forest-based carbon-offset projects: a case study of the Noel Kempff climate action project in Bolivia. Mitigation and Adaptation Strategies for Global Change 5(1): 25-37.

CFB (Cámara Forestal de Bolivia). 2002. Anuario Estadistico. Sector Forestal de Bolivia 2002. Santa Cruz, Bolivia

Cordero, W. 2003. Control de operaciones forestales con énfasis en la actividad ilegal. Documento Técnico 120/2003. BOLFOR, Santa Cruz.

Davies, J., Magriños, E., Osinaga, E. & Bonjanic, A. 2000. Is natural forest management a viable land use option in a colonisation zone in Bolivia? Overseas Development Institute (ODI) in collaboration with the Centre for Tropical Agricultural Research (CIAT) and the Research and Promotion Centre for the Peasantry. DFID.

Ellis-Jones, J. & Mason, T., 1999. Livelihood strategies and assets of small farmers in the evaluation of soil and water management practices in the temperate inter-Andean valleys of Bolivia. Mountain Research and Development 19 (3): 221-234.

Emerton, L. 2003. Tropical forest valuation: has it all been a futile exercise? Paper submitted to the XII World Forestry Congress, 2003, Québec City, Canada.

FAO. 2003a. Country information. Downloaded October 2005 from: http://www.fao.org/forestry/site/23747/en/bol

FAO. 2003b: State of forestry in the Latin American and Caribbean region 2002. FAO Regional office for Latin America and the Caribbean. Santiago, Chile.

Godoy, R., Overman, H., Demmer, J., Apaza, L., Byron, E., Huanca, T., Leonard, W., Pérez, E., Reyes-García, V., Vades, V., Wilkie, d., Cubas, A., McSweeney, K. & Brokaw, N. 2002. Local financial benefits of rain forests: comparative evidence from Amerindian societies in Bolivia and Honduras. Ecological Economics 40: 397-409.

Gregersen, H. M., Arnold, J. E. M, Lundgren & Congtreras-Hermosilla, A. 1995. Valuing forests: context, issues and guidelines. FAO Forestry Paper 127. FAO, Rome.

Hanrahan, M., Grimes, A. & Aguilar, F. 1997. The Cost Benefit of Certified Forest Management in Southeastern Bolivia: the case of Lomerio Community Forest. In: Memoria del Simposio Internacional sobre Posibilidades de Manejo Forestal Sostenible en America Tropical. Santa Cruz, Bolivia, 15-20 de Julio de 1997. BOLFOR Project, USAID, CIFOR, IUFRO.

Hearne, R. R. & Salinas, Z. S. 2003. The use of choice experiments in the analysis of tourist preferences for ecotourism development in Costa Rica. Journal of Environmental Management 65, 153-163.

Howard, A. F., Rice, R. E. & Gullison, R. E. 1996. Simulated financial returns and selected environmental impacts from four alternative silvicultural prescriptions applied in the neotropics: a case study of the Chimanes Forest, Bolivia. Forest Ecology and Management 89: 43-57.

Marcouiller, D. W. & Stier, J. C. 2005. Modeling the regional economic aspects of forest management alternatives. Working paper. University of Wisconsin-Madison.

Markopoulos, M. D. 1998. The impact of certification on community forest enterprises: a case study of the Lomerío community forest management project, Bolivia. Oxford Forestry Institute (OFI). Oxford, UK. 90 p. Downloaded August 2005 from: http://www.frp.uk.com/dissemination_documents/R7285_ The_Impacts_of_Certification_on_community_forest_enterprises.pdf

Merry, F. D., Hildebrand, P. E., Pattie, P. & Carter, D. R. 2002. An analysis of land conversion from sustainable forestry to pasture: a case study in the Bolivian Lowlands. 19: 207-215.

Min, Z. & Zhou, G. 2002. Sypply chain modeling: past, present and future. Computers and industrial engineering 34: 231-249

Navrud, S. & Ready, R. C. 2002. Valuing Cultural Heritage - Applying Environmental Valuation Techniques to Historic Buildings, Monuments and Artefacts. Edward Elgar Publishing, Cheltenham,UK.

Nebel, G., Jacobsen, J. B., Quevedo, R. & Helles, F. 2003. A strategic view of commercially based community forestry in indigenous territories in the lowlands of Bolivia. Conference proceedings from The International Conference on Rural Livelihood, Forest and Biodiversity, 13-23 May 2003, Bonn, Germany. 21 p. Downloaded October 2005 from: http://www.cifor.cgiar.org/ publications/corporate/cd-roms/bonn-proc/pdfs/papers/T2_FINAL_Nebel.pdf

Nebel, G., Quevedo, L., Jacobsen, J. B. & Helles, F. 2005. Development and economic significance of forest certification: the case of FSC in Bolivia. Forest Policy and Economics 7: 175-186.

Norheim, T. 1996. Uso y aprovechamiento tradicional de productos forestales no maderables en la región andina de Bolivia. Centro de Información para el Desarrollo, La Paz.

Pattie, P. & Merry, F. 1999. Forests versus Livestock: an economic assessment of choices facing landowners in the Bolivian lowlands. Technical Document 74/1999. BOLFOR. Santa Cruz. 72 p.

Pattie, P.S, Núñez, M. & Rojas, P. 2003. Valoración de los bosques tropicales de Bolivia. Documento Técnico 130/2003. BOLFOR, Santa Cruz.

Ponz, E., Carpio, G. & Meo, S. 2005. La medicina tradicional de los Tacana y Machineri: conocimientos prácticos de las plantas medicinales. Fundación PIEB, La Paz

Ramírez, C. R. 2004. Estudio de marcado para la comercilización de la producción forestal maderable TCO Guarayos. Centro de Estudios Aplicados al Desarrollo Social (CEADES).

Richards, M. 1997. The potential for economic valuation of watershed protection in mountainous areas: a case study from Bolivia. Mountain Research and Development 17(1): 19-30.

Rice, D. 1998. Analisis financiero de cuatro scenarios alternatives de aprovechamiento para el proyecto de manejo forestal communal de lomerio, Bolivia. Documento Técnico 63. BOLFOR, Santa Cruz, Bolivia.

Rice, D. & Howard, A. F. 1996. Rentabilidad del sector forestal en Bolivia: Estudio de caso del bosque chimanes. Documento Técnico 32/1996. BOLFOR, Santa Cruz.

Robertson, N. & Wunder, S. 2005. Fresh Tracks in the Forest. Assessing Incipient Payments for Environmental Services Initiatives in Bolivia. CIFOR, Bogor.

Sandoval, E. 2000. Bolivia – comportamiento de la certificación forestal. Revista Forestal Centroamericana 31: 23-28.

Shield, D. & Wunder, S. 2002. The value of tropical forest to local communities: complications, caveats and cautions. Conservation Ecology 6(2): 9.

Soto H. A. 1997. Encuesta de precios de venta de madera en diferentes etapas de utilización. Documento Técnico 55/1997. BOLFOR, Santa Cruz.

Southgate, D. & Macke, R. 1989. The downstream benefits of Soil Conservation in third world hydroelectric watershed. Land Economics 65 (1): 38-48

STCP - Engenharia de Projetos Ltda, 2000. Strategic plan for the development of the Bolivian forestry sector. Project CFB-01/99 – Rev. 0. Cámara Forestal de Bolivia and Corporación Andina de Fomento.

UNFCCC (United Nations Framework Convention on Climate Change). 1997. Kyoto Protocol to the United Nations Framework Convention on Climate Change, UNFCCC, Kyoto, Japan.

UNFCCC (United Nations Framework Convention on Climate Change). 2001. The Marrakesh Accords & the Marrakesh Declaration, UNFCCC, Marrakesh, Marokko.

Vallejos, C., Cuèllar, R., Ayala, J. & Ramos, C. 1996. Estudio de valuación del bosque de Lomerío: memoria del taller realizado con representantes de las comunidades Las Trancas y Puesto Nuevo. BOLFOR, Santa Cruz, Bolivia.

Vargas, M. T. 2004. Evaluating the economic basis for payments for watershed services around Amboró National Park, Bolivia. M.A. Thesis, Yale School of Forestry, USA.

Zavaleta, D. 2003. Modelling the economic effects of a natural resource boom in general equilibrium: The Bolivian case. Downloaded October 2005 from: http://www.ecomod.net/conferences/iioa2004/iioa2004_papers/zhang.pdf

Forest & Landscape Working Papers

No. 1 • 2004 Experiences with web-based teaching inforestry

No. 2 • 2004 Distribution of tree seed and seedlings

No. 3 • 2004 Identifying forest-livelihood research priorities in Mozambique

No. 4 • 2004 Breeding for die-back resistant Dalbergia sissooin Nepal

No. 5 • 2005 Farmers' planting practices in Burkina Faso

No. 6 • 2005 Cocoa agroforests in West Africa

No. 7 • 2005 Observations on timing and abundance of flowering and fruiting of woody plants

No. 8 • 2005 Tree seed in Malawi

No. 9 • 2005 Commercial distribution of tree seed in small bags

No. 10 • 2005 Using Soft Sytems Methodology to Develop a Mangrove Forest Management and Planning Decision Support System in a Buffer Zone – The Case af Dam Doi Forest Enterprise, Vietnam

No. 11 • 2005 Integration of Urban Woodland Policies

No. 12 • 2005 Substitute or Complements? – How tropical and non-tropical wood products compete

No. 13 • 2005 Landscape values of rural inhabitants in the Sound region

No. 14 • 2005 Business Clusters in Spatial Planning

No. 15 • 2006 Timing and abundance of flowering and fruiting of woody plants in the Hørsholm Arboretum

No.16 • 2006 Medicinal plant markets and trade in Maputo, Mozambique

No. 17 • 2006 Carbon-Nitrogen Interactions in Forest Ecosystems – Final Report

No. 18 • 2006 A review of forest economics research in Bolivia