

Lesser used wood species of Bolivia and their relevance to sustainable forest management

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Abstract

Bolivia has extensive forest resources and potential to become one of the world's largest producers of tropical wood. However, this potential is currently constrained due to the depletion of Bolivia's top commercial timber species (mahogany, Spanish cedar, and South American oak). To insure that Bolivia's forestry sector contributes to the growth of the national economy and stimulates investments in sustainable forest management, timber harvests need to include currently underutilized species. Augmenting demand for lesser used species (LUS) is necessary to sustain the value of forest resources. Limiting the potential for LUS is a scarcity and inaccessibility of information regarding their wood properties. This paper discusses the relevance of LUS research and wood property information to countries focusing forest sector development on secondary and value-added forest products. We also list potentially valuable, yet under-exploited timber species in Bolivia and species that need further wood property research.

Bolivia has extensive forests. Many of these forests have been mined for three species of timber: mahogany (*Swietenia macrophylla*), Spanish cedar (*Cedrela odorata*), and South American oak (*Amburana cearensis*). Extraction of these timber species has helped the Bolivian economy generate foreign exchange and cope with past economic crises. However, the sector is now faced with a new challenge: the forests of Bolivia are unable to supply international markets with traditional species due to previous high levels of extraction. The forestry sector needs to utilize more of the "other" timber species. If products utilizing these species are not developed, Bolivia's forestland will likely be converted to other uses, and the potential for Bolivia to remain a major tropical wood producer will be lost.

Bolivia recently made efforts to decentralize the management of forests in

hopes of creating incentives for long-term investments in sustainable forest management. The financing structure for this management depends on forestry revenue. Markets for lesser used species (LUS) could increase the value of forests, contributing to the viability of the new forest concession system. However, the lack of domestic and export markets for LUS limits the profitability of forest management.

Development of markets for LUS is necessary for the implementation of effective national forest management and the future growth of the forest products

sector. There are a number of barriers to the development of such markets in Bolivia. These barriers include 1) lack of working capital for the forest industry; 2) lack of skilled and better trained labor; and 3) high transportation costs.

A major market constraint specific to LUS is the lack of technical information for the development of processing capabilities (Easton and Wright 1998). While there is a substantial amount of information regarding the properties of LUS found in Bolivia, this information is not readily accessible to Bolivian producers.

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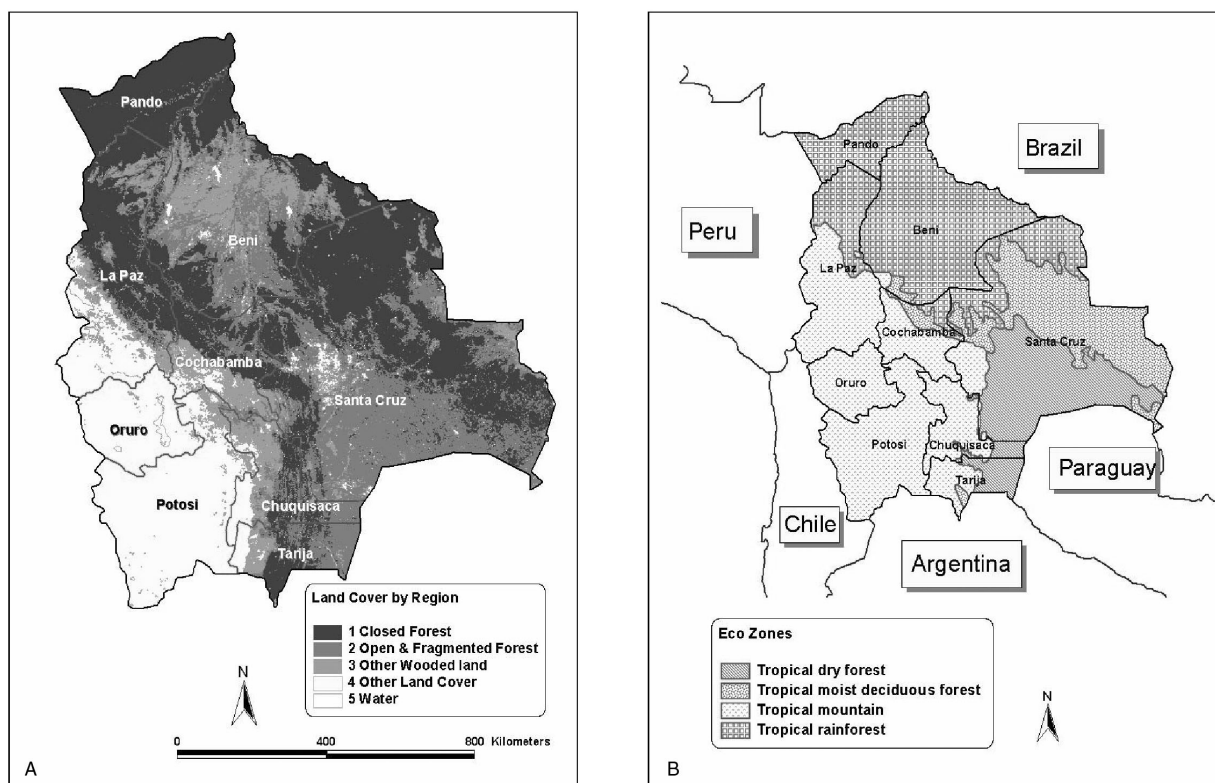


Figure 1. — Maps of Bolivia showing land cover by region (a) and forest type (b).

This paper is the result of a project designed to transfer wood property information of LUS to Bolivian producers. The project focuses on LUS suited for use in manufacturing secondary exterior products such as exterior doors, outdoor furniture, and decking. We review potential roles of LUS in contributing to Bolivia's economic growth and sustainable forest management. Efforts to collect sources of pre-existing information regarding the LUS of Bolivia are described. A list of promising but underutilized species found in Bolivia's forests is presented along with suggested candidates for new wood property research.

Background

Bolivia's forests

Bolivia, the third largest country in South America (Fig. 1a), has 48.9 percent forest cover (FAO 2001). Part of the Amazon basin, most of the northeastern third of Bolivia is covered by lowland tropical rainforests and palm savannahs (Fig. 1b). In the southeast are extensive amounts of tropical dry forest and tropical moist deciduous forest. The Andes highlands in central and southwestern Bolivia along the Peruvian and Argentinian

borders are scattered with stands of tropical montane forest. These extensive and diverse forests have the potential to place Bolivia among the top producers of tropical wood products (Darby 1999).

Forestry and the Bolivian economy

Rapid increases in timber extraction, particularly in regions traditionally unexploited, coincided with the decline of the Bolivian economy and the related economic restructuring that occurred in the mid-1980s (Kaimowitz et al. 1998). Between the mid-1980s and 1992, timber production in northern Bolivia increased over 200 percent to a volume of 64,000 m³ (Stoian 2000). Likewise, annual timber exports rose from US\$1.2 million in the mid-1980s to about \$20 million by 1997. Timber production helped buffer Bolivia's third rubber crisis, avoiding the major social turbulence that had accompanied previous crises (Stoian and Henkemans 2000). According to the Bolivia Forest Chamber, Bolivia's forest sector accounted for 11 percent of exports in 1998, providing employment for 100,000 (CFB 1999), thereby playing an important role in buffering the volatility of Bolivia's

economy. However, this recent rise in timber exports has depleted natural stocks of the most valuable species.

Timber harvesting in Bolivia has been characterized by high-grading and extremely selective harvesting of a few high-value species. This dependence on a small number of tree species has significantly constrained productivity. Over the last decade, the volume of mahogany timber has accounted for 63 percent of timber value (Landell-Mills 1998). Together with Spanish cedar, and South American oak, these three species comprised 91 percent of the 1992 total cut (Stoian 2000). As a result of over-exploitation, Bolivia was unable to meet the demand of U.S. importers for mahogany in 2000, and importers had to turn to Brazilian suppliers (Anon. 2001). Dependence on mahogany, Spanish cedar, and South American oak is no longer a viable option for the growth of Bolivia's forestry sector.

Acknowledging that Bolivia's forest sector is limited by the depletion of these species, the government ratified the 1996 Forest Law, which was designed to establish better forest management through the concession of forests and the transfer of government involvement

from direct ownership of forest rights to regulation of private sector forest management (Landel-Mills 1998). The success of this law in curbing unsustainable utilization of Bolivia's forest resources depends on the government's ability to enforce forest management regulations. This in turn depends on the percentage of revenue generated from Bolivia's forestry sector earmarked for forestry development (CFB 1999). However, the ability to generate revenue is limited now that supplies of the three main commercial timbers have not been managed sustainably in many areas.

The low inventory of Bolivia's traditional commercial export timber species restricts the financial feasibility of the 1996 Forest Law and the low values associated with previously exploited standing forests provide little revenue to pay for concessions. It is more profitable to build roads and infrastructure to log new areas for mahogany only, than it is to use the existing infrastructure to harvest LUS (Gullison 1995). Opening up more forest is problematic considering that Bolivia is experiencing the worst economic crisis since the mid-1980s (Enever 2001), and decreases in employment could lead to an increase in migration to the forest frontier. Frontier migration ultimately leads to forest conversion (Godoy et al. 1997) as rural populations strive to meet their immediate needs for food and income through agriculture (FAO 1998). To ameliorate the current situation and foster a productive forestry sector, there is a need to identify underutilized timber species that could generate revenue in the long-term.

Sustainable production

Utilization of LUS is one of the key elements in achieving sustainable forestry (Youngs and Hammett 2000). A study in Bolivia's Chapare region found that only 1 percent of felled trees was used, and the "uncommercial" wood was burned off (OAS 1984). Transforming this uncommercial wood into valuable products is the current focus in development of Bolivia's forest sector. Utilizing LUS to manufacture value-added secondary products such as furniture, doors, and decking can maximize the revenue from natural stock LUS, providing the needed incentive to manage lands for these species and hence maintain forest cover.

Bolivia is making the transition from dependence on logging and primary processing to the development of secondary products such as furniture and doors. Wood doors and wood furniture, respectively, have \$2.01 and \$2.91 more export value than sawn mahogany per unit weight (CADEX 2000). Through forest products certification, there is further potential to increase Bolivia's market access for secondary products. A survey of certified forest products enterprises in the United States found that sales of certified wood products had increased at rates of up to 15 percent (Merry and Carter 1996), but overall volume of this trade was still small. Bolivian manufacturers are positioning themselves to take advantage of this growing market as Bolivia has one of the largest areas (more than 660,000 ha) of natural tropical certified forests (CFB 1999). Utilization of LUS is important in achieving the international standards of sustainable forest management necessary for forest certification (Darby 1999).

Having a large number of commercially viable tree species can help achieve silvicultural sustainability (Gullison 1995) by giving the forest manager effective control over canopy opening, by increasing the likelihood of sufficient regeneration on a site after harvest, by concentrating the utilization of the resources, and by requiring fewer roads (Buschbacher 1990). The silviculture of mahogany illustrates the benefits of LUS to sustainable timber production. Because plantation production of mahogany is severely limited by the mahogany shoot borer (*Hypsipyla* spp.), mahogany production depends on natural forest management. A study (Gullison 1995) in the Chimanes Forest, Beni, Bolivia, found that harvesting methods to ensure regeneration would require a 52-year harvest cycle. Because this rotation length is not economically viable, companies would need to augment their harvest with other timber species. As mahogany regeneration depends on large disturbances such as flooding, fires, or hurricanes, gaps created by extraction of LUS could release mahogany. For the use of LUS to contribute to sustainable forest management, there must first be markets. This requires, among other things, information on species wood properties.

Lack of wood property information

A study in the Philippines found that the availability of technical wood-processing information was one of the two most important factors in promoting the acceptance of LUS by manufacturers (along with long-term resource supply) (Smith 2000). Wood-processing information is needed to ensure that species have the characteristics necessary to manufacture products of uniform quality for each application. Selection of species for a chair will depend not only on its high strength and low movement values, but also on its appearance, especially color, as well as machining characteristics. For products with exterior uses, it is desirable that species have high natural durability or be permeable to preservative treatment (Desch and Dinwoodie 1981). Wood property information is also necessary to meet quality standards of international markets.

In Bolivia, the use of LUS for manufacturing purposes is hindered by the inaccessibility of wood property information and the poor diffusion of research results. The following section describes our efforts to compile wood property information needed for the manufacturing of LUS secondary forest products in Bolivia.

Methods

The term "lesser used species" does not imply that the species are unknown. There have been numerous studies, most of them decades old, regarding the wood properties of lesser known Latin American tropical species. Because there exists a considerable amount of comprehensive information regarding the species of specific regions within Latin America, it was necessary to first compile a list of Bolivian tree species. The next step was to conduct an extensive literature review to identify the wood properties of these species. These references were then searched for information regarding Bolivian species.

Because assurance of long-term supply is one of the main necessities in encouraging LUS acceptance among manufacturers, a subset of the Bolivian tree species list was adapted from a forest inventory that averaged the metric volume of timber in 68 inventories over an area of approximately 3.5 thousand ha throughout 6 different regions of Bolivia

Table 1. — Species reported “durable” to “very durable” and corresponding volume in Bolivia’s growing stock (Superintendencia Forestal 1999).

Species	m ³ /ha
<i>Cariniana estrellensis</i>	5.27
<i>Dipterax odorata</i>	4.21
<i>Anadenanthera colubrina</i>	3.09
<i>Astronium urundeuva</i>	2.75
<i>Calophyllum brasiliense</i>	2.65
<i>Hymenaea courbaril</i>	1.85
<i>Caesalpinia pluviosa</i>	1.83
<i>Aspidosperma</i> spp.	1.6
<i>Calycophyllum multiflorum</i>	1.13
<i>Guarea</i> spp.	0.98
<i>Aspidosperma australe</i>	0.68
<i>Pterogyne nitens</i>	0.27
<i>Cordia allidora</i>	0.06

Table 2. — Species reported “moderate” to “low durability” and corresponding volume in Bolivia’s growing stock (Superintendencia Forestal 1999).

Species	m ³ /ha
<i>Hura crepitans</i>	23.73
<i>Terminalia oblonga</i>	7.37
<i>Cedrelinga catenaeformis</i>	4.14
<i>Erismia uncinatum</i>	3.77
<i>Clarisia racemosa</i>	0.6
<i>Sterculia apetala</i>	0.37

(SF 1999). From this subset, species were selected based on their potential use for specific exterior end uses (outdoor furniture, doors, decking). To choose species that may be suited for outdoor furniture and doors, we used “natural durability” as the primary criteria for selection. Durability is a classification given to a wood species according to the resistance of the wood to decay fungi, insects, and marine borers (Chudnoff 1984). The decision to use this requirement was based on the potential for Bolivia to export secondary products for exterior use. Bolivia has a market advantage for durable species because merchantable sizes of durable timber in the north contain high percentages of sapwood (FPL 1989). Decay in use is one of the greatest disadvantages of wood as a raw material (Tsoumis 1968), and according to Maeglin (1991), an effort should be made to evaluate the natural durability of LUS.

While broad groupings based on natural durability are useful when information is based on service records, lab tests, and experience (FPL 1989), pre-

cise ratings of decay resistance of heartwood of different species are not possible because of differences within species. There are also contextual differences in the use of the terminology. In the tropics, natural durability is a reflection principally of the resistance of the heartwood of a timber to termite attack, while in temperate regions it is a measure of the resistance of the heartwood to decay fungi (Desch and Dinwoodie 1981). The scientifically accepted measurement of the natural durability of timber has been derived in terms of the life (in years) of 50- by 50-mm stakes planted in the ground, together with practical experience: very durable (more than 25 yr.), durable (15 to 25 yr.), moderately durable (10 to 15 yr.), non-durable (5 to 10 yr.), and perishable (less than 5 yr.).

Results

We compiled a list of 421 timber species found in Bolivia and examined 33 wood property references. Of the 421 species, 247 were cited in the literature concerning wood properties. Of these 247 species, 29 were present in the for-

est inventory (SF 1999). Species inventoried but not found in the references are considered priority research species. These species exist in relative abundance, yet little if any comprehensive information exists regarding their wood properties.

The first and second subsets (Tables 1 and 2) include those species for which there was adequate information in the reference material. These species are divided into two groups based on their durability. There are 13 species grouped into the durable category (Table 1). These species are listed in descending order according to their volume per hectare. The second subset (Table 2) lists those species that are considered to have moderate to low durability and were therefore omitted from further consideration.

The third and fourth subsets (Tables 3 and 4) include species for which there exists no comprehensive information. The 10 species listed in the third subset are species that were cited in the literature three times or less; they may or may not be suitable for targeting (based on durability). It may be efficient to make inferences regarding their performance before choosing which species should be researched. For example, though *Ficus* spp. is very abundant in Bolivian forests (9.21 m³/ha), one of the two references to this species reported it suitable for interior use. This suggests that the wood is not very durable. On the other hand, *Apuleia leiocarpa*, also relatively abundant (4.33m³/ha) is referred to as suitable for exterior use, which suggests that it is durable. If durability is the desired wood property, future wood property research efforts may want to consider this species.

Subset four (Table 4) includes six species that were listed in the forest inventory, but for which we found no existing information in the literature. These species are also outstanding candidates for wood property research. *Tabebuia chrysantha*, *Virola peruviana*, and *Schinopsis brasiliensis* are all relatively abundant. *Tabebuia chrysantha* and *Schinopsis brasiliensis* are classified under genera that have notably durable species. Excluding *Virola*, this holds true for all the species within the fourth subset. Species may be selected for research using their density in forest stands as well as inferences about their

Table 3. — Species that were only referenced in three or less sources, rendering selection inconclusive and corresponding volume in Bolivia's growing stock (Superintendencia Forestal 1999).

Species	m ³ /ha
<i>Ficus</i> sp.	9.21
<i>Apuleia leiocarpa</i>	4.33
<i>Pouteria nemorosa</i>	1.93
<i>Schizolobium amazonicum</i>	1.14
<i>Calycophyllum spuceanum</i>	1.13
<i>Machaerium scleroxylon</i>	0.96
<i>Copaifera chodatiana</i>	0.95
<i>Swartzia jorori</i>	0.49
<i>Centrobium microchaete</i>	0.33
<i>Vochysia lanceolata</i>	0.16

Table 4. — Species for which no information existed in the literature and corresponding volume in Bolivia's growing stock (Superintendencia Forestal 1999).

Species	m ³ /ha
<i>Tabebuia chrysantha</i>	2.76
<i>Virola peruviana</i>	2.09
<i>Schinopsis brasiliensis</i>	1.71
<i>Aniba quianesis</i>	0.68
<i>Ormosia nobilis</i>	0.66
<i>Pithecellobium corymbosum</i>	0.26

durability made from available information regarding species under the same genera. However, selection of durable wood species for quality secondary wood products should not be made without conducting further wood property research on the species in the third and fourth subsets.

Discussion

Although more than two hundred Bolivian tree species are represented in wood property literature, only about one-tenth of these species are regularly utilized (with three species providing the majority of wood). Clearly the major obstacle to increasing utilization of Bolivian LUS is not wood property research per se, nor is it harvestable stock. Instead, the utilization of Bolivian LUS is most likely constrained due to the following:

- the inaccessibility of information to the manufacturers;
- the information that exists does not represent species abundant in Bolivia's standing stock;
- species for which information exists are not suitable for the desired end uses;

- the market for LUS remains weak despite information available to manufacturers.

Overcoming the need for information on LUS utilization requires the transfer of information and marketing of new woods. The first step should be to make available wood property information to manufacturers. This information dissemination should focus on a few suitable species, based on inventory and end use. Even a slight increase in the number of species harvested from a stand could greatly increase the total harvested volume. Second, wood property tests on those species for which there is no information but that are dominant in the forest inventory should be conducted. This may not only provide the forest products industry with suitable woods, but having a wider selection of species suitable for harvest will allow for more silvicultural techniques to optimize forest management options. And finally, promotional efforts are needed in order to help processors and buyers of manufactured products become familiar with these species; without these efforts, markets for LUS will remain limited.

Conclusion

Bolivia, like many countries in the tropics, has tremendous potential to produce tropical woods. However, the lack of forestry development limits this potential. There is a gap between the growing dominance of LUS in forest inventories and the lack of markets for these species. It is evident that information regarding the processing of these woods plays a crucial role in forestry development.

Out of the hundreds of potentially valuable wood species in Bolivia, only a few dozen have been historically used, and only three species are predominant. This dependence on a limited number of species has meant their depletion in natural stocks. This ultimately decreases the value of forest resources and leads to conversion of forestland to other uses. Such conversions are detrimental to industry as well as society at large. Governments and the private sector are recognizing that reliance on key species eventually leads to the depletion of forest resources as a whole, and therefore it is necessary to widen species utilization to increase value and profit, without expanding the area of harvest.

Crucial to the widening of species selection is market demand. Bolivia is pursuing this by focusing on the processing of secondary wood products. Unlike the export of unprocessed timber, the manufacturing of furniture, doors, and decking allows for the utilization of LUS that might otherwise not have a demand on the international market. Furthermore, processing these woods creates a domestic demand for species abundant in forest inventories while increasing the returns necessary to cover the costs associated with Bolivia's efforts toward sustainable forest management.

The processing of formerly underutilized woods requires information regarding wood properties. While there is comprehensive wood property information regarding species throughout Latin America, this information remains relatively inaccessible, particularly to those operating mills or managing forests in developing countries. The information compiled and sorted in this project will help address this problem. This information will be useful to wood products manufacturers in Bolivia and even throughout the region, as many of the species are widely distributed. Because

manufacturers in Bolivia depend on international demand, this paper can also help potential buyers of these woods become familiarized with promising woods.

The next step in this process is dissemination of wood property information. This is necessary so that the wood products manufacturers can become familiar with new woods that may be available at good prices. Increased access to LUS wood property information will lead to increased export markets for these species. As demand grows for these woods, so will the value of forest resources that are currently undervalued due to the previous depletion of main commercial timbers. This increase in value is important for the sustainable management of Bolivia's forests and the future of its forest products industry.

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This study provides a conceptual background concerning the relevance of lesser used species (LUS) to the development of forest products industries in developing countries and the significance of wood property information in the development of LUS markets. It also provides Bolivian timber species suitable for the manufacture of secondary products for exterior use. Several species are suggested for wood property research.