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Evaluating the opportunities and limitations to multiple use of Brazil nuts and timber in Western Amazonia

Amy E. Duchelle^{a,*}, Manuel R. Guariguata^b, Giuliano Less^c, Marco Antonio Albornoz^b, Andrea Chavez^{d,e}, Tadeu Melo^f

^a Center for International Forestry Research (CIFOR), Rio de Janeiro, Brazil

^b Center for International Forestry Research (CIFOR), Bogor, Indonesia

^c Centro de Estudos da Cultura e do Meio Ambiente da Amazônia – Rioterra, Rondonia, Brazil

^d University of Florida, Gainesville, USA

^e Universidad Nacional Amazónica de Madre de Dios, Peru

^f Universidade Federal do Acre, Brazil

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ABSTRACT

Multiple-use forest management, which includes timber, non-timber forest products, and environmental services, is considered a promising tropical conservation and development strategy. In the tri-national frontier region of Madre de Dios (Peru), Acre (Brazil), and Pando (Bolivia) in Western Amazonia, we evaluated perceptions of representatives from four stakeholder groups – communities, industries (Brazil nut and timber), non-governmental organizations, and government agencies – on integrated management of timber and Brazil nuts (from the tree species *Bertholletia excelsa*) at multiple scales. A strengths, weaknesses, opportunities, and threats (SWOT) analysis in combination with an analytic hierarchy process (AHP) was used to accomplish this task. Overall, results showed distinct differences in perceptions among stakeholder groups both within and among countries in pursuing multiple-use forestry strategies. Although many stakeholder groups held positive perceptions about multiple use of Brazil nuts and timber, several limitations were associated with implementation of this model. For instance, policy barriers and high management costs were considered the main weaknesses throughout the region. In Madre de Dios and Pando, logging damage to Brazil nut stands was the dominant threat, whereas in Acre, the main threat was reinvestment of forestry income into cattle. Our work shows that despite the high potential for and positive views of many stakeholders in pursuing integrated management of Brazil nut and timber, specific policy, economic, and technical limitations must first be addressed. To this end, we provide recommendations for promoting this multi-use forestry model in the future.

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1. Introduction

Tropical forests have been a source of diverse products for centuries, yet the concept of multiple-use forest management, which includes timber, non-timber forest products (NTFPs), and environmental services, emerged into the international forestry agenda only in the 1990s as part of the sustainable forest management paradigm (Panayotou and Ashton, 1992; Poore, 2003). Moving beyond timber-oriented approaches and managing for multiple goods and services has the potential to include different stakeholders as present and future beneficiaries (Kant, 2004) while promoting effective and equitable conservation. For example, there is

evidence of long-term maintenance of tropical forest cover in locally-managed, multiple-use forestry systems when compared with nearby protected areas (Ellis and Porter-Bolland, 2008).

There are, however, a variety of factors that influence both the implementation and outcomes of multiple-use forestry in the tropics (García-Fernández et al., 2008). In relation to integrated NTFP-timber management, ecological factors such as seasonality of production, habitat type, and management practices can influence compatibility (Salick et al., 1995; Romero, 1999; Guariguata et al., 2009). Economic factors will also determine the attention that integrated management is given at local and national levels, including the financial returns of non-timber and timber production in relation to non-forest uses (Menton et al., 2009), opportunities for product certification (Shanley et al., 2008), and price fluctuations of internationally-traded NTFPs (Pacheco et al., 2009). The success of multiple-use forestry as a whole also hinges on institutional factors, such as national and local forestry policies

* Corresponding author. Address: Center for International Forestry Research (CIFOR), Brazil Office, Rua do Russel 450/Sala 601, Bairro Gloria, CEP 22.210-010, Rio de Janeiro, Brazil. Tel.: +55 21 2285 3341; fax: +55 21 2285 0447.

E-mail address: a.duchelle@cgiar.org (A.E. Duchelle).

that enable concurrent management of multiple products, tenure rights and access to timber and/or NTFPs, and training for national foresters that goes beyond a focus on timber (Guariguata et al., 2010).

The interplay between the above factors will determine the optimal conditions in which policy makers and forest managers are able to implement multiple-use forestry systems. That said, there are few empirical studies that discern which factors may be either more or less conducive to the viability of multiple-use forestry in the tropics. Such studies can assist in the formulation of national forestry policies while enabling social learning and strategic planning for multiple-use forest management. In this context, assessing the perceptions, interests, and values of different stakeholders is deemed essential for multiple-use forestry to become a viable land use strategy (Purnomo et al., 2005; Lawrence, 2007; Ros-Tonen et al., 2008).

A useful technique for evaluating stakeholders' perceptions in natural resource management is a strengths, weaknesses, opportunities, and threats (SWOT) analysis in combination with analytic hierarchy process (AHP) (Ananda and Herath, 2003; Masozera et al., 2006; Dwivedi and Alavalapati, 2009). The commonly-used SWOT method allows stakeholders to identify the positive and negative factors related to a proposed plan or strategy (Wehrich, 1982; Mollenhorst and de Boer, 2004). Its main limitation is that factors cannot be measured quantitatively, making it difficult to assess their relative importance in affecting decision making (Dwivedi and Alavalapati, 2009). In contrast, a combination of SWOT and AHP allows stakeholders to weigh the importance of the factors in relation to one another through pair-wise comparisons (Kurttila et al., 2000; Saaty and Vargas, 2001). The SWOT-AHP method allows for participatory engagement of respondents and can be performed with even a small number of people who are knowledgeable about the issue (see Kurttila et al., 2000). This method has been applied in a variety of natural resource studies, including forest management planning (Kurttila et al., 2000; Ananda and Herath, 2003), evaluation of protected areas (Masozera et al., 2006), and the use of forest biomass for energy production (Dwivedi and Alavalapati, 2009).

The objective of this paper is to apply SWOT-AHP to compare perceptions of representatives from four stakeholder groups regarding integrated management of Brazil nuts (*Bertholletia excelsa*) and timber in the tri-national frontier region of Madre de Dios (Peru), Acre (Brazil), and Pando (Bolivia) of Western Amazonia.

2. Brazil nuts and timber in Western Amazonia

The approximately 300,000 km² tri-national frontier region of Peru, Brazil, and Bolivia offers a unique opportunity for comparative research on perceptions about multiple use of Brazil nuts and timber. Timber exploitation at industrial and community scales occurs in all three countries, and Brazil nut is the most important NTFP in the region. The Brazil nut tree commonly emerges above the forest canopy by attaining up to 50 m in height and 3 m in diameter. The large fruits fall to the ground during the wet season where they are broken open by human collectors or gnawed open by scatterhoarding rodents (*Dasyprocta* spp.) to access the nuts (Ortiz, 2002). Due to its combined ecological and economic characteristics, this NTFP is fundamental in promoting regional forest conservation and forming the livelihood base for rural people (Duchelle et al., 2011).

The study focuses on Brazil nuts and timber, because of the high potential for integrated management of these two products in the tri-national frontier region. In particular: (1) Brazil nut trees and a variety of timber species co-exist across a substantial portion of the region (Myers et al., 2000; Rockwell et al., 2007a; Guariguata et al.,

2009); (2) Brazil nuts and timber are the most important regional commercial forest products in terms of economic value (Stoian, 2000; Pacheco et al., 2009; Cossío-Solano, 2009; ZEE, 2006; Duchelle et al., 2011); (3) regional Brazil nut populations appear to be viable over the medium-term under a range of harvest intensities (Zuidema and Boot, 2002; Wadt et al., 2008), contrasting with Peres et al.'s (2003) finding that long-term commercial harvesting of Brazil nuts may leave insufficient juvenile recruitment; (4) there is temporal segregation of labor since timber harvest occurs in the dry season while Brazil nut harvest takes place in the wet season; (5) Brazil nut trees are legally protected from felling in all three countries; and (6) reduced impact logging norms, which aim to minimize the environmental impacts of timber harvesting (Putz et al., 2008), can be extended to Brazil nut trees (Guariguata et al., 2009).

Despite a similar forest ecosystem across the region, differing policies and market factors in the three countries have resulted in distinctive forest management contexts, affecting the degree to which integrated approaches for these two main forest products may be implemented. We describe these main differences in detail in the following sub-sections.

2.1. Madre de Dios, Peru

Madre de Dios is the third largest department in Peru with an area of 85,300 km², most of which is comprised of lowland wet tropical forest vegetation (INEI, 2007). The Peruvian Forestry and Wildlife Law of 2000 (No. 27308), which was implemented in 2002, established long-term concessions up to 40 years for timber (5000–40,000 ha management units), Brazil nuts (500–1000 ha units), and reforestation/afforestation areas, all of which require forestry management plans (SPDA-INRENA, 2003). As of 2009, Brazil nut concessions covered 10.7% of Madre de Dios (INRENA, 2005), while timber concessions covered 14.9% of the departmental area (Cossío-Solano, 2009; Fig. 1). Brazil nut concessions are usually managed by local community members, while timber concessions are usually managed by private companies.

While the concessions have their primary uses, concessionaires can present complementary plans for other forest uses. For instance, a decree passed in 2004 allowed up to 5 m³/ha of timber to be harvested from Brazil nut concessions. In 2007, however, the volume allowance regulation was abolished based on the argument that there were no credible and accurate scientific indicators to justify an impact of timber extraction on nut harvests (Peña, 2010). Yet timber extraction within Brazil nut concessions still occurs, and in 2009 and 2010, the wood volume extracted from these areas was greater than that extracted from neighboring timber concessions (Cossío-Solano et al., 2011). Since it is the timber companies that usually access the Brazil nut concessions through negotiations with nut harvesters (L.M. Velarde, pers. comm.), there are social, in addition to technical, concerns associated with timber extraction in Brazil nut concessions in Madre de Dios.

2.2. Acre, Brazil

Acre is the largest of the three states in the tri-national region with an area of approximately 164,000 km². Although it represents only 4% of the Brazilian Amazon, and the distribution of Brazil nut trees is limited to about 50% of the state area, Acre produces more Brazil nuts than any other state in Brazil (ZEE, 2006). Nuts are mostly collected by communities in conservation units, such as Extractive Reserves, Agroextractive Settlement Projects, and Federal and State Forests (Fig. 1). Management plans are not required for nut collection (or any other NTFP), although the state environmental agency is currently rewriting the NTFP technical norms, which will guide collection of these products.

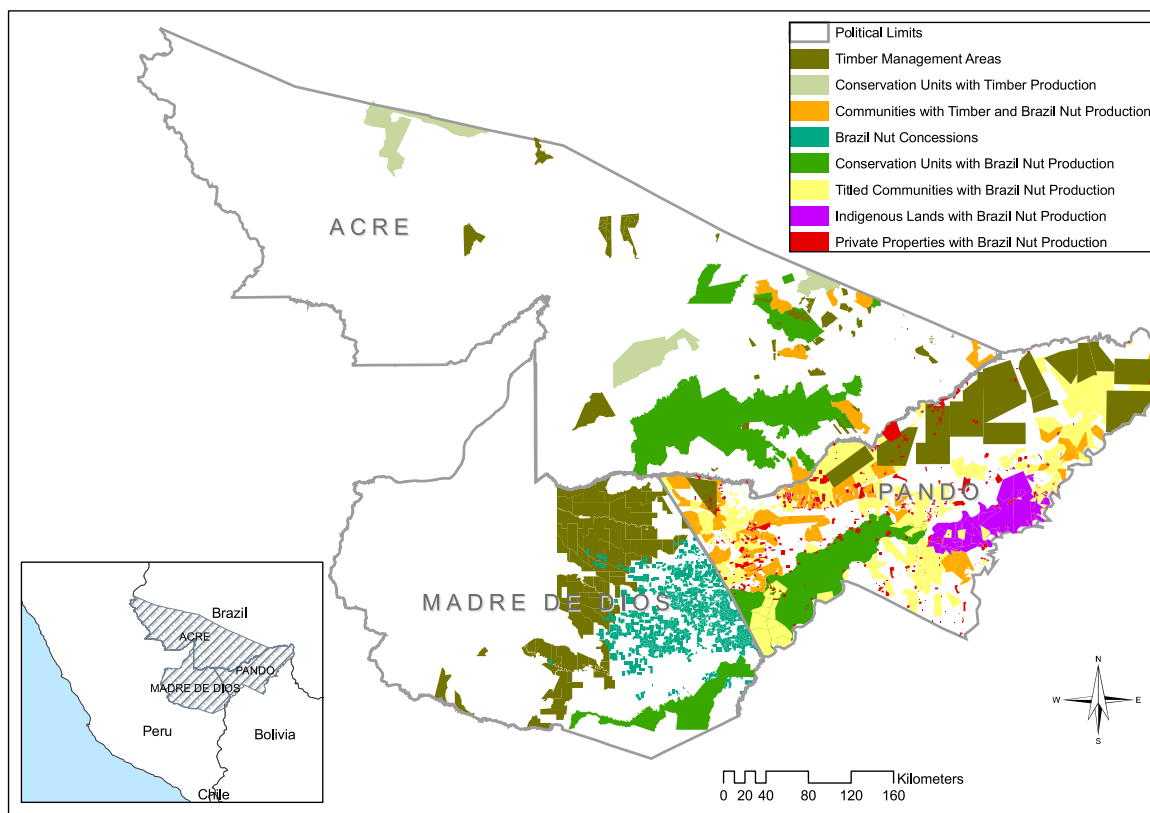


Fig. 1. Map of forest lands managed for timber and Brazil nuts in Madre de Dios (Peru), Acre (Brazil), and Pando (Bolivia) in 2009. Source data: INRENA, ACCA (Madre de Dios), IMAC (Acre), and ABT (Pando). Credit: Andrea Chavez.

Brazil's Forestry Law of 2006 (Lei 11.284/06) made new lands available for timber management for both companies and communities (Fig. 1). Most timber harvest in Acre is at the industrial scale, and logging companies with timber management plans operate in conservation units (Federal and State Forests) and on private lands. Although still nascent, there are examples of communities in Acre where sustainable timber management has been integrated into local livelihoods (Rockwell et al., 2007a,b), and several are recognized as some of the first communities in the Brazilian Amazon to attain Forest Stewardship Council (FSC) certification (Humphries and Kainer, 2006). These initiatives were part the platform of Acre's forest government in support of community forest management (Kainer et al., 2003), which includes promoting multiple-use forestry. In 2009, there were 15 approved community timber management plans in Acre, but not all of these communities extracted timber due to government regulations (SEF, 2009, M. Brito, Pers. Comm.). In addition, there have been difficulties associated with communities accessing markets, and some producers abandoned their timber harvest operations due to low wood prices because of delayed payments.

There is an ongoing debate about whether or not to allow timber harvest in federally-protected Extractive Reserves, because these areas were created to grant usufruct rights to people engaged in traditional livelihoods, which were based primarily on NTFP collection (Allegretti, 1990; Ehringhaus, 2006). Even though foresters from Acre's forest secretariat helped two communities in the Chico Mendes Extractive Reserve complete timber inventories in 2009 and gain authorization for management plan development in 2010, timber extraction has not yet begun. There are still doubts about the compatibility of managing for timber and NTFPs in the reserve, particularly among resident families (Fantini and Crisóstomo, 2009).

2.3. Pando, Bolivia

Pando is the smallest state in the tri-national region, with an area of 63,827 km², which represents 5.8% of Bolivian territory. Despite its smaller size, Pando is the epicenter of regional Brazil nut production. In Pando, Brazil nuts are mostly collected by residents of agroextractive and indigenous communities and by temporary workers from the region hired to work on private estates. As of 2009, 159 communities and two indigenous territories had been titled by the National Agrarian Reform Agency (J. Urapotina, pers. comm.), along with 1175 private properties where Brazil nut collection takes place (Fig. 1). Although Brazil nut management plans are required under national technical norms for Brazil nut management (Ministerio de Desarrollo Sostenible, 2005), as of 2010, there were only eight operational plans in place in Pando with four under review (all in communities). Within the technical norms for Brazil nut management, there is a controversial provision for establishing "no take" zones of up to 6% of the total area destined for harvest over 5 years, which do not reflect sound *B. excelsa* ecology and are largely inapplicable to the harvest and management reality in Pando where timber extraction also takes place (Guariguata et al., 2008). Since there is little knowledge of these norms by local communities and almost no documented effort to enforce regulations, such legislation has had little effect on modifying nut harvest practices in Pando (Cronkleton et al., 2011).

Official timber management began in Pando in 1995 when the Bolivian national government granted land contracts to timber companies, which later became timber concessions under the Forestry Law of 1996 (Cronkleton et al., 2009; Fig. 1). While most timber management occurs at the industrial scale, in recent years, community-based timber management has been promoted through the creation of community forest organizations and

through funds and training from NGOs and the largest Brazil nut-producing company in Pando. The company's plan is to involve 15–20 nut-producing communities in timber management (with the potential for FSC certification) through a network of timber companies and retailers in Bolivia and the United States. The company has supported these communities in establishing themselves as community forest organizations and developing timber management plans (R. Alvarez, pers. comm.; Fig. 1).

While there is much overlap in areas officially designated for timber and Brazil nuts in Pando, several factors limit integrated management. First, timber harvest is prohibited in the Manuripi National Wildlife Reserve (1.8 million ha), a large conservation unit that encompasses private estates and communities (Künhe, 2004; Fig. 1). Second, approximately 150 large NTFP concessions (primarily focused on Brazil nuts) are being reformulated from private properties where timber harvest would be prohibited. Finally, the main Brazil nut producers' cooperative in Pando has a strong internal norm that its members cannot engage in timber production in organically- and Fair Trade-certified Brazil nut stands, mostly due to the international pressure that they feel from national and international certifying bodies to maintain consumer confidence and avoid environmental damage.

3. Methods: regional implementation of SWOT-AHP

Given these contextual differences, we applied a regional SWOT-AHP analysis to identify critical issues that enable or hinder the implementation of integrated Brazil nut and timber management. We carried out the analysis from August 2009 to May 2010 by targeting four regional stakeholder groups in each country: (1) communities; (2) industries (Brazil nut and/or timber); (3) non-governmental organizations (NGOs); and, (4) government agencies.

Following methods outlined in previous SWOT-AHP analyses (Kurttila et al., 2000; Masozera et al., 2006), we followed three main steps. We first identified SWOT factors related to integrated management of Brazil nuts and timber through consultation with a few key stakeholders (Table 1). Factors were defined based on their applicability for comparison across stakeholder groups and countries. Only one additional threat factor – *reinvestment of forestry income in cattle* (T5) – differed between Brazil and the other countries due to its perceived importance in Acre only.

Secondly, we developed a questionnaire based on these factors and held meetings with individual organizations that represented the four stakeholder groups in each country to conduct the pair-wise factor comparisons. In Madre de Dios, meetings were held with four community organizations, three industries, three NGOs, and three government agencies. In Acre, meetings were held with six community organizations, three NGOs, four government agencies, and two industries. In Pando, meetings were held with five community organizations, four NGOs, three governmental agencies, and two industries. In each meeting, factors were first explained to the organization, and participants were asked to come to a group consensus in assigning relative weights of factors for each pair-wise comparison within a given SWOT category. In each pair-wise comparison, the more important factor was assigned a weight of 2–9 based on its relative importance. A score of one indicated that the two factors were weighted equally. A factor priority score was then calculated for each comparison using an eigenvalue method, and means were calculated for each stakeholder group in each country (see Masozera et al., 2006 for details). The factor with the highest mean factor priority score in each SWOT category was identified for each stakeholder group in each country.

Finally, we conducted follow-up meetings with each organization and performed a second round of pair-wise comparisons using

Table 1
SWOT factors related to integrated management of Brazil nuts and timber in Western Amazonia.

Strengths
S1: <i>Additional income</i>
– increased forest revenues; income diversification
– increased employment
– access to loans or credit
S2: <i>Management benefits</i>
– harmonized inventories
– improved silvicultural practices for timber and Brazil nuts
– increased desire to adopt reduced impact logging practices to protect variety of services
S3: <i>Access to infrastructure and public services</i>
– roads (primary and secondary)
– community infrastructure (e.g. wells, bus stops, electricity)
– health, education, other social services
S4: <i>Capacity-building (communities, industry, forestry personnel)</i>
– improved management skills; technical advancement
– opportunities to cultivate leadership in communities
Weaknesses
W1: <i>Policy barriers and lack of enforcement</i>
– incompatible forestry laws and norms
– lack of control of timber operations
– insecure property rights for communities
W2: <i>Incompatible certification rules (or interpretation of rules)</i>
– FSC for timber; organic/Fair Trade/FSC for Brazil nuts
W3: <i>Lack of trained forestry personnel for multiple-use forestry</i>
– professional foresters disinterest in or lack of skills for multiple-use forestry
W4: <i>High management costs and minimal financial benefits</i>
– too expensive to implement
– more time needed
– low price for timber (income not necessarily to land owner); low price for Brazil nuts
Opportunities
O1: <i>Inclusion of diverse values and actors</i>
O2: <i>Forest conservation</i>
– increased value of standing forest
O3: <i>Poverty reduction</i>
– increased livelihood benefits for rural communities
O4: <i>Decrease in illegal activities (e.g. logging)</i>
Threats
T1: <i>Logging damage to Brazil nut stands</i>
– post-logging understory growth that inhibits Brazil nut collection
– illegal felling of Brazil nut trees
– lower fruit production
T2: <i>Enhanced fire risk</i>
– logging leaves debris that becomes flammable
T3: <i>Increased resource conflicts</i>
– theft of Brazil nuts or timber
T4: <i>Wildlife decline</i>
– loss of wildlife with logging (+ hunting)
T5: <i>Reinvestment of forestry income in cattle</i> (Brazil only)
– conversion of forests to pasture

only the four most important SWOT factors that had been defined in the previous step. This second comparison allowed for the calculation of a scaling factor for each SWOT category, which in conjunction with the initial factor priority scores, was used to calculate an overall priority score for each factor per stakeholder group per country. Consistency ratios, a measurement of the error in response regularity, were below 0.1 for all comparisons, which is considered the maximum acceptable level of error for this type of analysis (Kurttila et al., 2000).

4. Results

The relative importance of each factor within the SWOT categories provided important insights about stakeholders' perceptions of integrated management of Brazil nuts and timber across the region. A summary of the factor priority scores from the first round of pair-wise comparisons is shown by country in Table 2. A visual representation of the overall priority scores, calculated in the final

Table 2

SWOT factors and their factor priority scores for communities (Comm), non-governmental organizations (NGO), government agencies (Govt), and industries (Ind) in the three countries. Numbers in bold correspond to the highest factor priority scores in each SWOT category from the first round of pair-wise comparisons.

SWOT Category	Madre de Dios, Peru				Acre, Brazil				Pando, Bolivia			
	Comm	NGO	Govt	Ind	Comm	NGO	Govt	Ind	Comm	NGO	Govt	Ind
<i>Strengths</i>												
S1: Income	0.393	0.304	0.166	0.106	0.125	0.099	0.112	0.347	0.287	0.171	0.214	0.139
S2: Management	0.182	0.235	0.295	0.486	0.146	0.283	0.325	0.243	0.171	0.222	0.233	0.309
S3: Infrastructure	0.116	0.064	0.101	0.091	0.329	0.191	0.257	0.248	0.124	0.100	0.126	0.202
S4: Capacity-building	0.309	0.397	0.438	0.318	0.399	0.427	0.306	0.162	0.418	0.507	0.427	0.350
<i>Weaknesses</i>												
W1: Policy barriers	0.286	0.409	0.558	0.306	0.335	0.397	0.542	0.226	0.196	0.352	0.378	0.521
W2: Cert. incompatible	0.076	0.088	0.043	0.286	0.058	0.049	0.107	0.245	0.156	0.080	0.123	0.097
W3: Lack foresters	0.154	0.170	0.245	0.094	0.138	0.225	0.141	0.145	0.172	0.145	0.189	0.206
W4: High costs	0.484	0.332	0.154	0.313	0.470	0.328	0.210	0.384	0.476	0.422	0.310	0.176
<i>Opportunities</i>												
O1: Diverse values	0.106	0.135	0.300	0.134	0.365	0.528	0.364	0.132	0.184	0.391	0.276	0.302
O2: Conservation	0.357	0.520	0.325	0.397	0.268	0.110	0.158	0.281	0.295	0.166	0.251	0.442
O3: Poverty reduction	0.422	0.203	0.178	0.373	0.158	0.159	0.266	0.378	0.419	0.277	0.288	0.077
O4: Less illegality	0.115	0.143	0.196	0.096	0.209	0.202	0.212	0.209	0.103	0.166	0.185	0.180
<i>Threats</i>												
T1: Logging damage	0.473	0.455	0.441	0.331	0.076	0.093	0.109	0.063	0.432	0.245	0.444	0.319
T2: Fire risk	0.180	0.222	0.228	0.131	0.217	0.247	0.154	0.078	0.133	0.310	0.111	0.213
T3: Resource conflicts	0.191	0.153	0.115	0.318	0.163	0.178	0.220	0.178	0.121	0.260	0.240	0.213
T4: Less wildlife	0.156	0.171	0.216	0.220	0.209	0.167	0.155	0.128	0.314	0.185	0.204	0.254
T5: Investment cattle	-	-	-	-	0.334	0.315	0.362	0.553	-	-	-	-

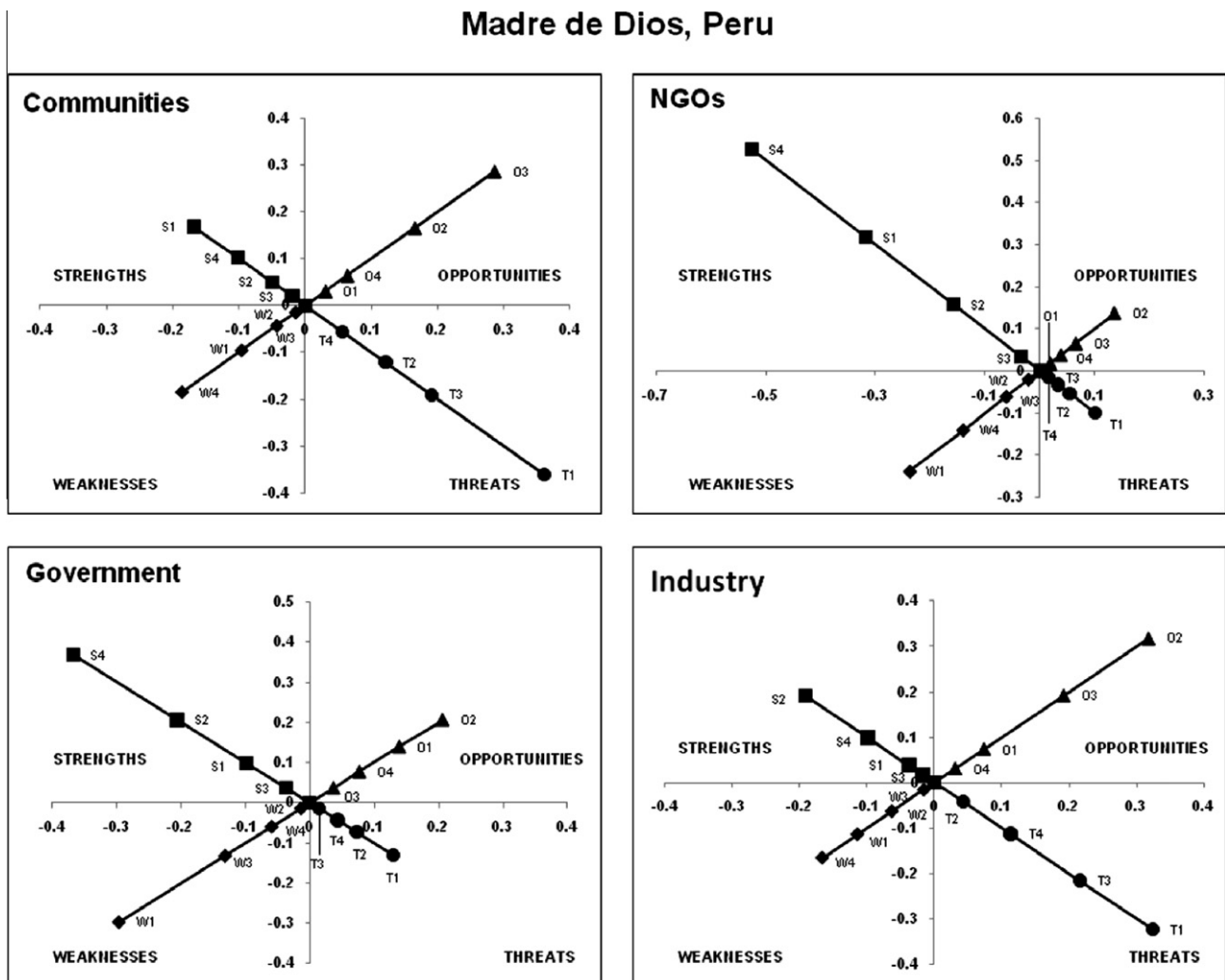


Fig. 2. Perception maps of four stakeholder groups in Acre, Brazil. The different vector lengths represent the overall priority scores calculated using the scaling factors from the second round of pair-wise comparisons and the initial factor priority scores.

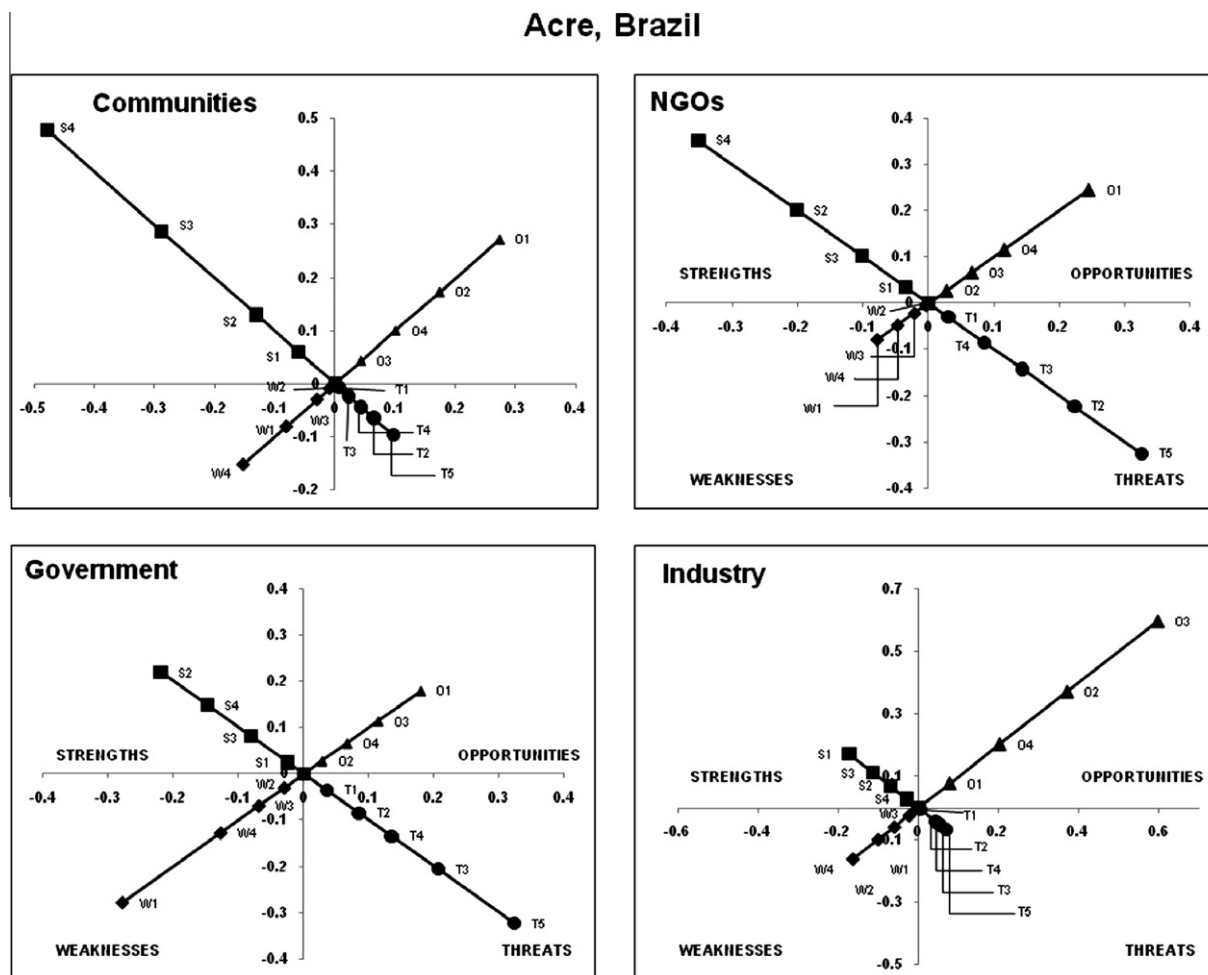


Fig. 3. Perception maps of four stakeholder groups in Acre, Brazil. The different vector lengths represent the overall priority scores calculated using the scaling factors from the second round of pair-wise comparisons and the initial factor priority scores.

step of the analysis, is provided in the perception maps of the different stakeholder groups by country (Figs. 2, 3 and 4). Overall, results showed distinct differences in perceptions among stakeholder groups both within and among countries in pursuing multiple use of Brazil nuts and timber.

4.1. Stakeholder perceptions in Madre de Dios, Peru

In Madre de Dios, while the perceptions of all stakeholder groups were characterized by positive and negative factors, there were some interesting similarities and differences between groups (Table 2, Fig. 2). The overall perception of communities and industries in Madre de Dios was characterized by threats and opportunities. Within the threat category, both community and industry representatives prioritized *logging damage to Brazil nut stands* (47% for communities; 33% for industries). The main opportunities for both groups were *poverty reduction* (42% for communities, 37% for industries) and *forest conservation* (36% for communities, 40% for industries). In contrast, the overall perceptions of NGOs and government agencies focused on the strengths of integrated management. Within the strength category, both groups heavily prioritized *capacity-building* (40% for NGOs and 44% for government). While NGOs also prioritized *additional income* (30%), government agencies were more focused on *management benefits* (30%). Although government agencies expressed an overall positive view of integrated Brazil nut and timber management, their perception was also characterized by weaknesses, notably *policy barriers* (56%).

4.2. Stakeholder perceptions in Acre, Brazil

In Acre, the different stakeholder groups held more homogenous perceptions of integrated Brazil nut and timber management (Table 2, Fig. 3). For instance, the overall perception of communities and industries was extremely positive, and that of government agencies was extremely negative. Only the overall perception of NGOs was characterized by both positive and negative factors. For communities, the positive view was represented by strengths and opportunities, namely *capacity-building* (40%) and *inclusion of diverse values and actors* (37%). For industries, it was determined by opportunities, namely *poverty reduction* (38%) and *forest conservation* (28%). The overall negative view of government agencies focused on threats and weaknesses. For government representatives in Acre, the threat category was heavily determined by *reinvestment of forestry income in cattle* (36%) and the weakness category by *policy barriers* (54%). The overall mixed perception of NGOs focused on strengths and threats. Strengths consisted of *capacity-building* (43%) and *management benefits* (28%), while threats were *reinvestment of forestry income in cattle* (32%) and *enhanced fire risk* (25%).

4.3. Stakeholder perceptions in Pando, Bolivia

In Pando, the overall perceptions of all stakeholder groups were characterized by more positive than negative factors. Of the stakeholder groups in Pando, NGOs and government agencies held the most positive perceptions of multiple use of Brazil nuts and timber,

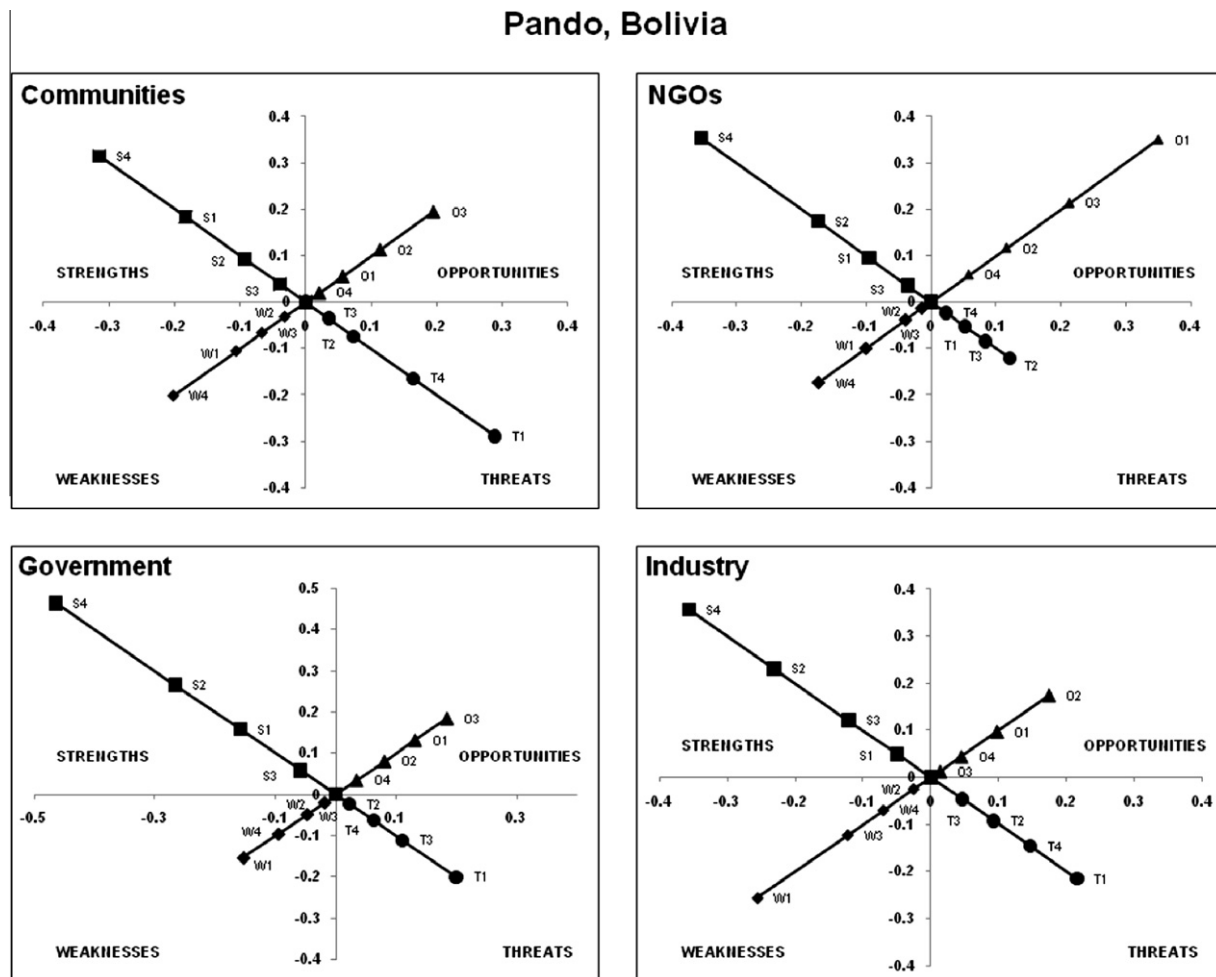


Fig. 4. Perception maps of four stakeholder groups in Acre, Brazil. The different vector lengths represent the overall priority scores calculated using the scaling factors from the second round of pair-wise comparisons and the initial factor priority scores.

while the views of industries and communities were mixed (Table 2, Fig. 4). The overall positive perception of NGOs was determined by strengths and opportunities, and that of government agencies was determined by strengths. Again, the main strength for both groups was *capacity-building* (51% for NGOs, 43% for government). NGOs prioritized *inclusion of diverse values and actors* (39%) and *poverty reduction* (28%) as the main opportunities. The overall mixed perception of industries in Pando was determined by both strengths and weaknesses. Industry representatives considered the dominant strengths to be *capacity-building* (35%) and *management benefits* (31%), with *policy barriers* (52%) as the dominant weakness while creating optimism among decision-makers, may create fear among producers weakness. The overall mixed perception of communities was determined by strengths and threats. Communities heavily prioritized *capacity-building* (42%) as a strength, followed by *additional income* (29%). The main threats for communities were *logging damage to Brazil nut stands* (43%), followed by *wildlife decline* (31%).

5. Discussion

5.1. Differences between stakeholder groups between countries

Our results showed that most stakeholder groups in the three countries held mixed views about implementation of integrated Brazil nut and timber management. Of the 12 stakeholder groups, the overall perception of more than half was characterized by both

positive and negative elements. Only four groups had more homogenous views: The overall perception of NGOs in Pando, and of communities and industries in Acre, was mostly positive; while that of government agencies in Acre was mostly negative.

In our comparison between countries, we noted certain similarities in stakeholder perceptions between Madre de Dios and Pando, which contrasted with groups in Acre. In Madre de Dios and Pando, while NGOs and government agencies were quite positive about integrated management, focusing primarily on the strength of *capacity-building*, producers at both communal and industrial scales were more mixed in their views, highlighting both positive and negative factors. In Acre, the results were opposite. Producers (communities and industries) in Acre were extremely positive about multiple use of Brazil nuts and timber, whereas NGOs held mixed views, and government agencies were downright negative.

This contrast is likely due to important contextual differences. First, in Madre de Dios and Pando, there is little experience with intentional multiple-use forestry approaches, which may create optimism among decision-makers and fear among producers who have the most to lose. The longer history of promoting multiple-use forestry in Acre – with mixed success – may be a reason behind the skepticism of government agencies and certain NGO representatives, even though representatives of communities who have engaged in the approach expressed tangible benefits. Secondly, perceived threats between stakeholders in Madre de Dios and Pando versus Acre were distinctly different. In Madre de Dios and Pando, the primary threat was damage to Brazil nut

stands through mechanized, selective logging, especially among community-level producers, which was almost non-existent in Acre. In Acre, the predominant threat was reinvestment of forestry income in the cattle sector, which especially concerned NGO and government representatives. Despite the high potential for and positive views of many stakeholders in pursuing integrated management of Brazil nut and timber in the region, the weaknesses and threats identified in our study could interfere with the wider implementation of this multiple-use forestry model.

5.2. Limitations to multiple use of Brazil nuts and timber in Western Amazonia

Based on the detailed discussions with each stakeholder group that ensued during the SWOT–AHP exercises, we were able to grasp at many of the reasons behind the consistent prioritization of certain weaknesses and threats. The most commonly cited negative factors were: (1) policy barriers and lack of enforcement; (2) high management costs and minimal financial benefits; (3) logging damage to Brazil nut stands (in Madre de Dios and Pando); and, (4) reinvestment of forestry income in cattle; which we discuss in turn below.

5.2.1. Policy barriers and lack of enforcement

The weakness of *policy barriers and lack of enforcement* was prioritized particularly by NGOs and government agencies in Madre de Dios and Acre and by government and industry representatives in Pando. Policy barriers largely focused on inappropriate legislation, excessive bureaucracy, land tenure uncertainty, problems with law enforcement, and legal discrimination against smallholders and communities. Overall, stakeholder groups across countries agreed that national legislation for timber, and especially for NTFPs, was inappropriate for local realities, often lacked a sound technical basis, and therefore did not enable integrated management. The clearest example of this incongruence was the inclusion of “no take” zones in the Bolivian technical norms for Brazil nut harvest. Even though these norms are largely ignored in practice (Cronkleton et al., 2011), nearly all groups agreed that they needed reform, especially when these zones overlap with areas formally assigned for timber harvest.

In Acre, the lack of clear policies for NTFPs was considered a major weakness to advancement of this sector (and eventually for integrated management approaches), including by government agencies. Also, community representatives felt that the state government had fallen short of its goal to promote community-based timber management. In Acre, extensive bureaucracy and problems with land tenure regularization were identified as major barriers to implementing timber management plans, particularly for communities.

In Madre de Dios, the most common policy-related complaint was overlapping land uses (especially between mining and forestry concessions), which resulted in conflicts. Such overlap was largely perceived to be the result of deficient cadastral information and lack of cross-sectoral coordination, even though required by law.

A lack of law enforcement was also considered particularly problematic. For instance, in Madre de Dios, although most groups (aside from conservation-focused NGOs) were not directly opposed to allowing timber harvesting in Brazil nut concessions, they were opposed to how this practice enabled the illegal harvest of timber and the manipulation of Brazil nut harvesters by timber companies through easier access and inflation of timber volumes. In Acre, stakeholders agreed that communities were often discriminated against through heavier law enforcement, even while illegal forestry was happening all around them. Such discrimination was reflected in Pando where community-level producers perceived that the government favored large timber companies over community

operations. Even the seemingly innovative efforts in Bolivia to promote community forest organizations was considered by some community and cooperative groups to be a top-down mechanism that could lead to dominance of timber companies through lack of capacity-building of small producers and low values obtained by communities for the resource.

5.2.2. High management costs and minimal financial benefits

The weakness of *high management costs and minimal financial benefits* in pursuing integrated Brazil nut and timber management was prioritized by communities in all three countries, by industries in Madre de Dios and Acre, and by NGOs in Pando. These groups agreed that complying with forestry legislation was much more time consuming and expensive than engaging in informal forestry activities. Such costs, especially in regard to timber, were associated with the creation of management and annual harvest plans.

The issue of timber and Brazil nut certification arose in relation to the question of high costs and few financial benefits of multiple-use forestry. For instance, participating stakeholders in Acre agreed that certification for communities was not yet viable due to non-consolidated Brazil nut production chains and the high costs of timber certification for communities that outweighed the potential benefits. The lack of confidence in Brazil nut certification in Acre is likely due to past negative experiences there, especially when compared to the positive outcomes of organic and Fair Trade nut certification in Pando (Duchelle, 2009).

5.2.3. Logging damage to Brazil nut stands

Logging damage to Brazil nut stands was the leading threat associated with multiple use of timber and Brazil nuts among most stakeholder groups in Madre de Dios and Pando. In Madre de Dios, such damage was directly linked to illegal (usually unplanned) timber activities in nut concessions. In Pando, while it has been shown that planned logging (coupled with low timber harvesting intensities) can minimize damage to Brazil nut trees in certified timber concessions (Guariguata et al., 2009), local communities involved in timber harvesting may have little power to influence the practices of third-party loggers towards minimizing such damage (Cronkleton et al., 2011). Interestingly, NGOs were the only group in Pando that did not prioritize *logging damage to Brazil nut stands* as a threat. Some NGO representatives felt that research had not backed up communities' claims of logging damage to Brazil nut trees. Nevertheless, the application of reduced impact logging norms is warranted in Brazil nut-rich forests to ensure their long-term productivity. These norms may also facilitate the collection of Brazil nuts on the forest floor by keeping at a minimum the amount of post-logging, understory re-growth (e.g., Wunderle et al., 2006).

Importantly, *logging damage to Brazil nut stands* was not considered relevant in Acre among any stakeholder group. Only one government agency mentioned damage to trails from skidders, but also stated that these damages were minimal. The relatively greater concern about logging damage to Brazil nut stands in Pando and Madre de Dios could be due to the more central role of Brazil nuts in local livelihoods there, when compared to Acre (Duchelle et al., 2011). It could also be due to increased pressure to harvest timber in areas that not long ago were largely used only for Brazil nut collection in Pando (Cronkleton et al., 2011) and Madre de Dios (Cossío-Solano et al., 2011). Finally, this finding could also be due to more extensive and uncontrolled selective logging in Madre de Dios and Pando; especially when compared with community lands in Acre where timber harvest is heavily regulated and restricted to very small annual logging compartments (Rockwell et al., 2007a).

5.2.4. Reinvestment of forestry income in cattle

In contrast with Madre de Dios and Pando, all stakeholder groups in Acre considered *reinvestment of forestry income in cattle* to be the dominant threat associated with integrated management of Brazil nuts and timber. This finding reflects the situation in Acre where the cattle economy has one of the highest growth rates in the Brazilian Amazon (Valentim et al., 2002). The growth of small-scale cattle ranching has been observed in the Chico Mendes Extractive Reserve, even among rubber tappers who initially fought against cattle ranchers to maintain access to their forested landholdings (Gomes, 2009; Vadjunec et al., 2009). The prioritization of this threat by all stakeholder groups in Acre is ironic, since the strategies associated with bolstering Acre's forestry sector—including promotion of community-based timber management—were designed precisely to increase the value of standing forests and curtail deforestation for other land uses (Kainer et al., 2003).

6. Conclusions

Our study highlights interest and experience by a diversity of stakeholders across the tri-national frontier region of Peru, Brazil, and Bolivia in pursuing multiple-use forestry strategies in community and industrial forests. Our results also reiterate the well-known fact that for sustainable forest management to become a viable land use option, the objectives and interests of relevant stakeholders need to be accommodated, since the magnitude of these tradeoffs tends to exacerbate when moving from timber-dominated to multiple-use models (Nasi and Frost, 2009; and papers therein). Although other authors have previously assessed multi-stakeholder perceptions in the context of forest management objectives (e.g., Purnomo et al., 2005), we believe our study is unique in identifying factors that enable or hinder the implementation of tropical multiple-use forestry from an empirical standpoint. We view this quantification and comparison of local stakeholders' perspectives as an important first step in identifying particular tradeoffs for integrated Brazil nut and timber management in Western Amazonia.

Given the diversity of perspectives among different stakeholder groups and across countries, as seen through our results, there is clear validity in promoting multi-stakeholder dialogue and mutual learning between local industries, governments, NGOs, and communities in the framework of adaptive co-management (Plummer and Armitage, 2006). To address the prominent weaknesses of policy barriers and high management costs, one application of such multi-stakeholder dialogue would be the creation of working groups to seek windows of opportunity to reform and simplify national and state laws for enhancing the compatibility of timber and NTFP management, as well as local norms. For example, the many positive environmental and social outcomes in the community forest concessions of Petén, Guatemala (Bray et al., 2008), currently managed for (certified) timber and a series of NTFPs with high commercial value, are thought to rely, to a large extent, on sustained efforts to develop innovative structures and methods for negotiation, consensus building, and collective action (Universidad para La Paz, 2007; Taylor, 2010). A similar approach could be adopted in the tri-national region through more proactive use of the existent MAP (Madre de Dios–Acre–Pando) initiative, a regional platform that was designed to promote dialogue between decision-makers, resource managers, and members of civil society (<http://www.map-amazonia.net>). Additionally, to make multiple-use forestry more cost-effective, regional dialogue about forest product certification is needed. In Bolivia, for example, there has been a certain degree of success in Brazil nut certification when compared with the other two countries, which could be better shared regionally (Duchelle, 2009).

Our results further highlight several other strategies that may enable multiple use of Brazil nuts and timber in the region. First of all, training on directional felling and basic road layout in communities and industrial operations may be needed to minimize logging related damage to Brazil nut trees during timber harvesting, as well as diminish the risk of increased susceptibility of fire in logged stands (Holdsworth and Uhl, 1997; Blate, 2005). Secondly, in some cases, spatial segregation of timber and Brazil nut harvesting may be needed when the co-existence of these two activities at the stand level go against national policies (e.g. NTFP concessions), biophysical constraints, or local norms (e.g. the cooperative norm in Bolivia that prohibits timber harvesting in organically certified Brazil nut stands). Finally, more information is needed about the investment of forest-based income in agricultural land uses in the region, since if indeed forestry income is reinvested in cattle expansion in Acre, multiple-use forestry may not promote forest conservation across the landscape. In conclusion, in light of the clear potential for integrated management of Brazil nut and timber, as well as the strengths and opportunities expressed by stakeholders, the specific policy, economic, and technical limitations highlighted in this study must be addressed to glean the ecological, economic, and social benefits associated with this multiple-use forestry model.

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