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The impacts of selective logging on non-timber forest products of livelihood importance

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ABSTRACT

The potential for combining timber and non-timber forest product extraction has been examined in the context of diversified forest management. Many tropical forests are exploited both commercially for timber and by forest-dependent communities for non-timber forest products (NTFPs). Divergences between these two uses may have significant implications for forest-dependent livelihoods. This article gathers existing examples of conflicts and complementarities between selective logging and non-timber uses of forest from the livelihood perspective. Additionally it draws on three case studies from Brazil, Cameroon and Indonesia to examine by what mechanisms, and to what extent, logging impacts forest resources of livelihood importance, as well as to consider how factors such as logging regime and forest management system may mediate such influences. By doing so we aim to shed further light on a relatively unacknowledged issue in tropical forest management and conservation.

Four specific mechanisms were identified; conflict of use and the indirect impacts of logging being those most commonly implicated in negative effects on livelihood-relevant NTFPs. Eighty two percent of reviewed articles highlighted negative impacts on NTFP availability. Examples of positive impacts were restricted to light demanding species that respond to the opening of forest structure and typically represent a small subset of those of livelihood value. Despite considerable impacts on livelihoods, in all three case studies we found evidence to support the potential for enhanced compatibility between timber extraction and the subsistence use of NTFPs. Drawing on this evidence, and findings from our review, we make specific recommendations for research, policy and management implementation. These findings have significant implications for reconciling timber and non-timber uses of tropical forests.

1. Introduction

Selective logging is a major economic activity in much of the moist tropics and increasing areas of forest are being allocated to timber concessions (Laporte et al., 2007; Guariguata et al., 2010; Wilson et al., 2010). These forests, and the resources that they harbour, are also utilised by rural communities, including many indigenous forest peoples (Byron and Arnold, 1999). Logging has significant impacts on forest structure and function with consequences for many species besides those targeted for extraction (Veríssimo et al., 2002; Asner et al., 2006; Foley et al., 2007). Both positive and negative impacts have been highlighted at the species level, including for Non-timber forest products (NTFPs) (van Dijk and Wiersum, 2004; Guariguata et al., 2010). Additionally numerous commercial timber species possess NTFP values (Herrero-Jáuregui et al., 2009) often being of considerable livelihood importance for forest communities, not only as sources of food, medicine or cash income but as resources of cultural or spiritual value (Posey, 1999; Colfer, 2008).

NTFPs, defined by Arnold and Ruiz-Pérez (2001: 438) as "any product other than timber, dependent on a forest environment", have been a focus for sustainable forest management (SFM) initiatives since the early 1990s (de Beer and McDermott, 1989; Peters et al., 1989; Allegretti, 1990; Nepstad and Schwartzman, 1992; Peters, 1994). Regardless of any commercialisation potential, these resources are vital livelihood components for many forest-dependent communities (Ambrose-Oji, 2003; de Merode et al., 2004; Kaushal and Melkani, 2005; Paumgarten and Shackleton, 2009). Several studies have provided important information

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regarding the social, economic, and ecological effects of logging (e.g. Uhl et al., 1991; Watson, 1996). While impacts on commercial NTFP species have been considered (Guariguata et al., 2008; Herrero-Jáuregui et al., 2009) and the positive impacts on light demanding NTFPs highlighted (Ashton et al., 2001; Guariguata et al., 2010), the implications for the full diversity of NTFPs of livelihood importance, including those of with non-utilitarian value, has received little attention (except see Laird, 1995; Salick and Mejia, 1995; Shanley et al., 2002; Menton, 2003).

The impacts of logging on NTFP availability can be distinguished by four broad categories; conflict of use, competition, the facilitation of unsustainable harvesting, and indirect impacts. While the first three are characterised by negative impacts, the final category can be positive or negative.

1.1. Conflict of use

'Conflict of use' (Laird, 1999), or 'disputed' species (Counsell et al., 2007; Herrero-Jáuregui et al., 2009) refer to those species having both a high commercial and livelihood value yielding both timber and NTFPs. These include species of specific social or cultural importance. Moabi (*Baillonella toxisperma*) and Sapelli (*Entandrophragma cylindricum*) for example, are species with multiple NTFP values. Many are also endangered species; Moabi is listed as vulnerable by the Red List (IUCN, 1996, 2010). Such high value NTFP species are frequently particularly vulnerable to timber exploitation as a consequence of their low densities and often poor potential to regenerate post-logging (Schulze et al., 2008). In the case of Moabi, which occurs at a density as low as <1 tree 20 ha^{-1} and is often highly clustered, a local population can be eliminated in a single logging event (Debroux and Delvingt, 1998; Angerand, 2007). Over 60% of the top commercial timber species exported from Cameroon have important non-wood values (Ndoye and Tieguhong, 2004), similar figures are found elsewhere in Africa as well as in Asia (Limberg et al., 2007) and Latin America (Martini et al., 1994; CFI, 2006; Herrero-Jáuregui et al., 2009; Guariguata et al., 2010).

1.2. Competition

Where an NTFP resource is particularly valuable, logging operations may become involved in its exploitation, competing with, or excluding, local collectors. In Gabon, Okoumé (*Aucoumea klaineana*) resin became sought after following identification of anti-protease and anti-inflammatory properties (Praxede-Mapangou, 2003). Logging companies began to exploit the resin collecting it illegally from felled trees. Export of significant quantities of the resin to Europe by logging concessionaires excluded local communities from benefiting from a potentially valuable new source of income, as well as eliminating a resource of livelihood importance (Robinet, 2003; McGown, 2006). Similarly in Eastern Amazonia, loggers opportunistically extract the oil of copaiba from felled trees (Plowden, 2002). A form of elite capture, they take advantage of the rising price of the NTFP, while removing the resource from the domain of small holders (Dove, 1993).

1.3. Facilitation

Additionally, logging operations can facilitate the unsustainable exploitation of NTFPs. The bushmeat trade provides a classic example (Wilkie et al., 2000; Robinson et al., 1999; Bennett and Gumal, 2001). Bridges, logging roads and vehicles provide greater access for hunters and allow transportation of meat from remote, previously inaccessible forests for sale in urban markets (Robinson et al., 1999; East et al., 2005). The bark of Yohimbe (*Pausinystalia johimbe*) provides a further example. A recent increase in international demand for its use in health supplements has been met by highly unsustainable harvesting facilitated by logging operations (Sunderland et al., 2004).

1.4. Indirect impacts

Selective logging activities result in significant changes in forest structure, composition and function (Malcolm and Ray, 2000; Hall et al., 2003; Foley et al., 2007). Such changes impact upon the availability and regeneration potential of numerous NTFPs, both positively and negatively. Selective logging can have beneficial effects on biophysical availability, particularly for some vines, palms and herbs (Costa and Senna, 2002). Such NTFP species are known to profit from the enhanced light conditions resulting from enlarged canopy gaps following logging (Guariguata et al., 2010). A few NTFP species even reach their maximum densities in logged-over forests (van Dijk and Wiersum, 2004; Guariguata et al., 2010). Other species however may respond negatively or be affected by collateral damage, for example from tree falls and the passage of machinery (Iskandar et al., 2006). Silvicultural treatments such as climber cutting or undergrowth removal to encourage regeneration of commercial timber species may cause further damage (Laird, 1995; Parren, 2003). Change in local microclimate and fire regimes can have significant implications (Uhl and Kaufmann, 1990; Cochrane et al., 1999; Nepstad et al., 1999). Secondary growth following logging can result in an impenetrable understory restricting movement through the forest and hence limits access to resources (Tieguhong and Ndoye, 2007). Uncontrolled logging operations also lead to river pollution and siltation from soil erosion (DFID, 1999; Douglas et al., 1993) with major impacts for fish stocks (Lapuyade et al., 2000; S. Counsell pers. comm. with LR). NTFP availability can also be affected indirectly by the loss of species to which NTFPs are ecologically associated, this is the case where game-attracting trees species are targeted in timber extraction (Shanley and Rosa, 2004; Uhl and Vieira, 1989).

We review previous studies documenting relationships, both divergences and complementarities, between timber (selective logging) and non-timber (NTFP) uses of forests. We identify common modes of impact, highlight the diversity of NTFPs affected and consolidate existing knowledge on this topic. Additionally we examine three case studies evaluating the impacts of selective logging on NTFPs of livelihood importance. We adopt a holistic interpretation of livelihood (Wallman, 1984; Bebbington, 1999) and therefore consider livelihood importance to refer not solely to resources that are traded or needed for subsistence, but also to those with symbolic and ritual value. All three locations are in forested areas with communities dependent to varying but significant extents on NTFPs and where mechanised selective logging has taken place. These specific examples provide further context for considering opportunities for incorporating the livelihood context of the NTFP-timber relationship into forest management practice and policy.

2. Methods

2.1. Literature review

The current literature on conflicts and complementarities between timber and non-timber forest product uses of forests was reviewed. We conducted a search of ISI Web of Knowledge and CABI abstracts using the terms "selective logging", "logging" or "timber", together with "NTFP" or "Non-timber forest product". These searches obtained a total of 18 relevant documents, i.e. those that specifically identified a divergence or complementarity between timber and NTFP forest values. We conducted a similar

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search using Google Scholar and identified an additional 11 relevant articles within the first 50 records. Additionally we included nine articles identified as part of our background reading but not picked up in the searches that also specifically addressed this topic. This gave a total of 38 articles. Papers were reviewed for the nature (i.e. positive or negative) and mechanism of impact, type of logging (i.e. unplanned or predatory logging, conventional selective logging, or reduced-impact logging (RIL)) as well as the forest management system in operation (e.g. commercial concessions, community–company partnerships or community forestry). We also noted any quantification of identified impacts as well as the category of NTFP investigated and references to any species of threatened status. By way of the search method chosen we recognise that some studies investigating species-specific impacts of logging from the conservation perspective, for example the bushmeat literature, have been excluded but may nevertheless be of particular livelihood relevance.

2.2. Study sites

We draw on data from three case studies to complement the literature review. Research projects in East Kalimantan in Indonesia; southeast Cameroon and Para state in Brazil investigated the impacts of commercial logging activities on forest dependent communities as part of broader research activities. We use previously unpublished material from these studies to highlight specific details regarding the qualitative and quantitative impacts of logging on livelihoods. These three case studies represent forestry models common in the tropics (commercial concessions and company–community partnerships) and were the sole examples available to us that offered quantitative data on this topic.

2.2.1. Ipixuna, Brazil

Located in the eastern Amazonian region of Para, this area is inhabited by *caboclo* communities engaged in river-based trade. These communities possess informal land tenure and previously functioned in a largely subsistence economy. In the 1980s, with the arrival of logging companies, many households sold large numbers of trees for cash. At the outset of logging, intensities of 1–2 high value trees per hectare were typical. With repeated logging events companies removed an increasing number of species as well as trees of smaller diameters. Concordantly communities requested assistance from researchers in understanding the impact of these sales (Shanley et al., 2002). Over a ten-year period (1993–2003) encompassing successive logging events, the consumption of NTFPs described as being of greatest local value was recorded annually by 30 families using a combination of daily diaries, interviews and participant observation and recall. We use mean household consumption of a subset of two of these species to gauge impacts of logging on NTFP availability; ''Piquiá'', *Caryocar villosum*, a nutritious fruit and ''Veado'', *Mazama* sp. (deer). Piquiá is one of the most important fruits for forest communities throughout Brazilian Amazonia and veado a primary source of protein (Menton, 2003) (See Shanley, 2000 for further methodological details).

2.2.2. Zega, Cameroon

The village of Zega is located in an active forest management unit (FMU 10-063) within a commercial concession in Southeast Cameroon. This area has experienced multiple logging events since the 1970's. Two dominant indigenous ethnic groups inhabit the area; the Bantus, a predominantly farming population and the Baka and Ba'Kola who are primarily hunter-gatherers. Between 2005 and 2006 a Rapid Rural Appraisal (RRA) evaluated community perceptions of change in the availability of NTFPs as a consequence of a logging event that had taken place a year previously. Community members identified important species in two categories; plant and animal-based NTFPs, and reported on the availability of these prior to and after the logging event. Groups also identified underlying drivers of change (see Tieguhong and Ndoye, 2007 for further details on the methodology used).

2.2.3. Malinau, Indonesia

Malinau is a heavily forested region in Kalimantan, Indonesian Borneo. The region has been divided into logging concessions but the extreme nature of the terrain has in many cases led to incomplete exploitation and much remote forest remains outside of the range of commercially viable extraction (Barr et al., 2001). In 1999 and 2000 a CIFOR team worked with seven indigenous communities (the Punan and the Merap) to examine the livelihood importance of different species, locations and landscape properties using participatory resource mapping, focus group discussions, household surveys and interviews. As part of these activities, the team recorded information on the uses of specific species and scored the value of logged and unlogged forest. The team also recorded community perceptions of the impacts of logging on access to, and use of, forest resources (for full methods see Sheil et al., 2003).

3. Results

3.1. Literature review: divergences and complementarities between timber and non-timber uses of forests

A total of 38 articles were included in the review (Table 1); two (5%) documented positive impacts from logging, two (5%) no impact, three (8%) both positive and negative impacts and 31 (82%) highlighted negative impacts from logging. The two highlighting positive impacts provided quantitative accounts of an increase in NTFP availability. Ashton et al. (2001) found that a rattan (*C. zeylanicus*) increased in stem density from 2 to over 10 stems ha^{-1} following selective logging, and Salick and Mejia (1995) documented % increases in NTFP species across 15 use categories. Two studies provided qualitative reports of positive impacts or highlighted such findings from elsewhere in more general discussion (Dickinson and Putz, 1992; Guariguata et al., 2010). Aside from Salick and Mejia's (1995) study, all of those documenting positive impacts focused on species that respond positively to increasing light. Additionally these examples focused on a single species, or small subset of species, many of which were NTFPs of commercial value rather than subsistence resources (e.g. Dickinson and Putz, 1992; Ashton et al., 2001; Guariguata et al., 2010). Two explicit impact studies found no negative effect of logging on NTFPs. Romero (1999) looked at the impacts of RIL in Costa Rica on epiphytes nine years following logging. Menton et al. (2009), in considering the impacts of company–community logging contracts on livelihoods, reported no significant decline in game captures or annual forest fruit harvests. However, this study was of short-term duration and communities anticipated future decline in game capture.

Of the 31 'negative' examples 27 demonstrated or made reference to examples of negative impacts on the availability of, or access to, NTFPs of livelihood importance in a purely qualitative manner. However several also qualified these reports by identifying opportunities for enhanced compatibility and concluded with positive statements regarding overall compatibility between timber and non-timber uses (D'Silva and Appanah, 1993; Karsenty and Gourlet-Fleury, 2006; Guariguata et al., 2009, 2010). In terms of the mechanisms behind these negative impacts; 22 examples (50%) were recorded of indirect impacts of logging, 17 cases (40%) of conflict of use, two cases (5%) of competition and two

Table 1
Studies documenting the impact of selective logging on NTFP resources. Studies are listed alphabetically by region.

References	Mechanism of impact (positive or negative)	Location	Quantification of impact	Form of logging (intensity)	Tenure/management system	Livelihood or commercial importance	Species (NTFP/use)
Latin America							
Guariguata et al. (2008)	Indirect (−)	Guatemala, Bolivia	No	RIL, certified (2–3 m^3 ha^{-1} in Guatemala, logging intensity not given for Bolivia)	Community forestry (Guatemala), extractivist communities where timber harvest rights were imposed on top of existing traditional property (Bolivia)	Commercial, harvesting supports livelihoods	Xate (*Chamaedorea* spp.) (leaves), Brazil nut (*Bertholletia excelsa*) (nuts)[b]
Guariguata et al. (2009)	Indirect (−)	Bolivia	63 trees damaged but impact on nut yield not assessed, assessment made 5 months after logging	RIL, certified (4–5 m^3 ha^{-1})	Private timber concessions	Commercial, harvesting supports local livelihoods	Brazil nut (*Bertholletia excelsa*) (nuts)[b]
Herrero-Jáuregui et al. (2009)[a]	Conflict of use (−), indirect (−)	Brazil	No	Selective	Commercial extraction, tenure status not specified	Livelihood and commercial	*Dipteryx odorata*, *Tabebuia serratifolia*, *Tabebuia impetiginosa*, and *Hymenaea courbaril* (bark, seeds), and conflict of use potential for 54 timber species
Menton (2003)	Conflict of use (−), Competition (−), Indirect (−)	Brazil	86% decline in forest-gate value of fruits and nuts, hunting rates declined by 62% (community estimate), assessment 6 years after logging	Conventional	Extractive reserve (logging occurred prior to reserve demarcation)	Livelihood	Multiple species (11 fruits, 17 game)
Menton et al. (2009)	Multiple (no impact on NTFPs, logging raised annual household income)	Brazil	Yes, no significant differences in game captures and fruit harvests	RIL (13–18 $m^3 ha^{-1}$)	Company- community partnership	Livelihood	Multiple species (including Piquiá (*C. villosum*), Jutaí (*Hymanaea intermedia*), and Jatobá (*Hymanaea courbaril*)) (fruits and game)
Osborne and Kiker (2005)	Indirect (−)	Guyana	No	Not specified	Commercial concession	Livelihood	Nibbi (*Heteropsis flexuosa*), (liana)
Rockwell et al. (2007a)	Indirect (−)	Brazil	No	RIL, Certified (7.9 m^3 ha^{-1})	Community forestry	Livelihood	Brazil nut[b], rubber, copaiba (*Copaifera* spp.) and Andiroba (*Carapa* spp.) (edible oil)
Rockwell et al. (2007b)	Not specified (−)	Brazil	No	RIL, certified	Community forestry	Livelihood	Not specified
Romero (1999)	No impact	Costa Rica	No change in epiphyte biomass between logged and control plots, assessment 9 years after logging	RIL	Commercial concessions (in partnership with research organisation)	Commercial	Mosses (*Pilotrichella fexilis, Phyllogonium viscosum, Zelometeorium sp. and Squamidium leucotrichum*), liverworts (*Frullania convoluta*, *Frullania* spp.), and lichens (*Usnea* spp.) (epiphyte biomass for ornamental and horticulture markets)
Salick and Mejia (1995)	Indirect (+ and −)	Nicaragua	Useful plant density increased from 37 (±13) plants/10 m^2 to: 85 (±48) 1 year after logging, and 50 (±10) 9 years after logging.	Selective, with and without Hutchinson Liberation Silviculture treatment	Experimental plots	Multiple	Multiple species
Shanley et al. (2002)	Conflict of use (−), indirect (−)	Brazil	No	Selective	Commercial logging in communities with informal land tenure	Livelihood	Multiple species including copaíba (*Copaifera* spp.) (oil), maçaranduba (*Manilkara* spp.) (latex)
Shanley (2000)[a]	Conflict of use (−), indirect (−)	Brazil	Decline in average annual household consumption of game and fruit of 75%	Selective	Commercial logging in communities, predatory extraction	Livelihood	Multiple species (fruits, fibers, game, medicines)
Africa							
Agom and Ogar (1994)	Conflict of use (−)	Nigeria	No	Conventional	Commercial concessions	Livelihood	Ako (*Brachystegia eurycoma*) (seeds)
Cardoso (2001)[a]	Conflict of use (−)	Congo Basin	No	Conventional	Commercial concession	Livelihood	Moabi (*B. toxisperma*)[b] (oil)

Karsenty and Gourlet-Fleury (2006)	Conflict of use (−)	Congo Basin	No	Selective (up to 14.7 m^3 ha^{-1})	Not specified	Livelihood	Sapelli (*E. cylindricum*) and Ayous (*Triplochiton scleroxylon*), Moabi (*B. toxisperma*) (food)
Laird (1999)[a]	Conflict of use (−), indirect (−)	Central Africa	No	Selective	Commercial concession	Livelihood	Multiple species
Laird (1995)[a]	Conflict of use (−)	Central Africa	No	Selective	Commercial concession	Multiple	Multiple species
Lewis (2001)[a]	Conflict of use (−)	Congo Basin	No	Not given	Commercial concession	Livelihood	Sapelli (*E. cylindricum*)[b] (bark and outer trunk, Imbrasia caterpillars)
Praxede-Mapangou (2003)[a]	Conflict of use (−), competition (−)	Gabon	No	Selective	Commercial concession	Livelihood	Okoumé (*A. klaineana*)[b] (resin)
Russell and Sieber (2005)	Conflict of use (−)	Africa	No	Not specified	Not specified	Livelihood	Not specified
Schneemann (1995)	Conflict of use (−)	Cameroon	86% decline in oil harvest (perception of change)	Conventional	Commercial concessions	Livelihood	Moabi (*B. toxisperma*) (oil)[b]
Sunderland et al. (2005)	Facilitation (−), Indirect (+)	West/ Central Africa	No	Selective	Commercial concession, artisanal logging	Livelihood	Rattan (*Laccosperma* spp., *Eremospatha* spp.) (fibre)
Sunderland et al. (2004)[a]	Facilitation (−)	Central Africa	No	Selective	Commercial concession	Livelihood	Yohimbe (*P. johimbe*) (bark)
van Dijk (1999)	Indirect (−)	Cameroon	No	Selective	Not specified	Livelihood	*Garcinia lucida* (bark and seeds)
S E Asia							
Ashton et al. (2001)	Indirect (+)	Sri Lanka	*C. zeylanicus* (rattan) increased in stem density from 2 stems ha^{-1} to over 10 stems ha^{-1}, data not given for the other two species, assessment made up to 20 years after logging	Selective (30 m^3 ha^{-1})	Commercial concessions, government administered	Commercial	Rattan (*Calamus zeylanicus*) (leaves), cardommon (*Elettaria cardamomum var. major*) (seeds), fishtail palm (*Caryota urens*) (leaves)
CFI (2006)[a]	Conflict of use (−)	Cambodia	No	Not specified	Not specified	Livelihood	*Dipterocarpus alatus*[b] (resin)
Ďsilva and Appanah (1993)	Not specified (−)	Malaysia	Value of NTFPs from forest declined by 50 dollars ha^{-1} yr^{-1} in a 70 yr rotation cycle	Not specified	Not specified	Not specified	Not specified
Sist et al. (1998)	Indirect (−)	Indonesia	No	RIL	Commercial concession	Not specified	Not specified
Van Valkenburg (1997)	Indirect (−)	Indonesia	No	Selective	Commercial concessions	Livelihood	Multiple
Van Valkenburg (1999a)	Conflict of use (−), Indirect (−)	Indonesia	No	Not specified	Not specified	Livelihood	Multiple
Van Valkenburg (1999b)	Conflict of use (−), Indirect (−)	Indonesia	No	Selective	Not specified	Not specified	Multiple species
Other							
de Beer and Zakharenkov (1999)	Indirect (−)	Russia	No	Not given	Not given	Livelihood	Multiple species
Melick et al. (2007a)	Indirect (−)	China	No	Conventional	Commercial concessions	Livelihood	Bamboo (*Tricholoma matsutake*) (construction), Mushrooms (*Cordyceps sinensis*) (marketable products)
Melick et al. (2007b)	Indirect (−)	China	No	Conventional	Commercial concessions	Livelihood	Multiple species
Global							
Dickinson and Putz (1992)	Indirect (+)	Tropics	No	Not specified	Not specified	Commercial	Rattan
Grainger (1999)	Not specified (−)	Tropics	No	Not specified	Not specified	Not specified	Not specified
Guariguata et al. (2010)	Conflict of use (−), Indirect (− and +)	Multiple	No	Mechanised selective logging	Multiple	Commercial and livelihood	Multiple
Putz et al. (2001)	Indirect (−)	Tropics	No	Not specified	Not specified	Not specified	Game species

[a] Studies found in background reading but not identified in database searches.
[b] Timber species identified as vulnerable or endangered (IUCN, 1996).

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(5%) of facilitation. Many studies noted more than one mode of impact. Indirect impacts included mechanical damage (Menton, 2003; Rockwell et al., 2007a; Guariguata et al., 2008; Menton et al., 2009), river pollution (Van Valkenburg, 1997; de Beer and Zakharenkov, 1999) and fire (Van Valkenburg, 1997, 1999b; Shanley, 2000; Shanley et al., 2002).

The six remaining 'negative' studies provided a quantitative assessment of impacts; either in terms of the extent of change in NTFP availability, or its translation into reduced food security, loss of income or other livelihood assets. Shanley (2000) reported a decline in average annual household consumption of game and fruit by approximately 75% 6 years following logging and related fire in Brazil. Menton (2003) reported a decline in fruit and nut harvests following logging with a reduction in forest-gate value of 86% and declines in hunting rates of 62%. Schneemann (1995) reported a 86% decline in oil harvest following exploitation of Moabi (*B. toxisperma*) in East Cameroon. D'Silva and Appanah (1993) forecasted a 50% decline in the value of NTFPs after simulating a 70-year rotation cycle in Indonesia. Guariguata et al. (2009) recorded the number of Brazil nut trees damaged but did not present information on the implications for nut yield.

The studies reviewed covered both commercial logging concessions as well as community forestry models (independent community logging and company partnerships) but many investigations did not provide sufficient details to allow an assessment of the relationship between the harvesting model or form of forest management and existence or degree of livelihood impact. Twelve studies dealt with Latin America, 12 with Africa, seven with South East Asia, three with other locations and four were global in reference.

In terms of factors influencing the degree of impact or extent of compatibility, Guariguata et al. (2008) found that incompatibility and severe impacts were avoided as a result of temporal, spatial, and social segregation of timber and NTFP extraction activities, the presence of well-defined land tenure systems and, specifically with conflict of use, through legislation. Skill and knowledge of logging teams was identified as an additional influence in the review; Romero (1999) cited carefully controlled logging by highly trained workers as responsible for minimal impacts in Costa Rica. The intensity of logging activities has been identified as key by several authors (Romero, 1999; Rockwell et al., 2007b; Guariguata et al., 2008, 2009), yet no quantitative investigation of this influence was found in the examples reviewed.

Several studies reported specific complementarities between timber and non-timber uses; for example in raising local income levels (Menton et al., 2009) but in general there was little focus on non-ecological aspects of compatibility in the studies we reviewed. However, such influences were clear where particular studies provided variation in governance and/or management characteristics within a single geographic location. For example, Menton (2003, 2009) looked at impacts in two extractive reserves in Para, Brazil. The first documented conflict of use, competition and indirect impacts occurring from logging carried out prior to designation of reserve status. The second was an example of a progressive project based on company–community logging contracts. In the first study, impacts on NTFPs were severe, in the second resources were unaffected. Similarly Guariguata et al. (2008) provided a further informative contrast to her 2003 study, an example where community-favourable governance was associated with a higher degree of compatibility.

3.2. Case studies

3.2.1. Ipixuna, Brazil

Until the late 1970's small-scale loggers extracted only select, high value timber (2–10 species) in this region. During the late 1980's and 1990's, with decreasing quantities of the top timber species available, logging companies began to exploit a wider range of species rising ultimately to approximately 50. Lacking market information, cash-poor families readily sold to loggers and beginning in the late 1980's and 1990's, timber extraction became predatory and company–community interactions paternalistic. Logging had a significant direct and indirect impact on community fruit consumption (Table 2); fruit trees were negatively affected not only by selective logging events but also by associated fire. As the number of species extracted increased, the impact on NTFP consumption rose. During the time frame prior to 1993, community members commented that game capture was relatively high with consumption of fruits relatively stable. However, as logging intensified and became more frequent, the community experienced impacts across a range of NTFPs. Between 1993 and 2004, of a sample of approximately 150 Piquiá trees, over 60% were extracted by loggers from the study communities. In 1993, after five selective logging events, villagers consumed an average of 93 Piquiá fruits per family. In 2003, following eight additional logging events of various intensities and duration as well as related fire in 1997, this had fallen to 15 fruits per family. In 1993, families consumed 14.3 kg of veado (deer) captured from within the community. In 2003 while the total amount was similar, game was captured from distances of 3–5 km outside of the community area within the forest of neighbouring ranches.

3.2.2. Zega, Cameroon

Focus groups identified 38 NTFPs of livelihood importance, including 16 game species. The availability of two of these, the

Table 2
Percentage change in availability of valued NTFP plant species following 10 years of logging in three communities in Eastern Amazonia, Brazil. Uses include food, construction, technology, medicinal, commerce, wildlife food (i.e. attracts game) and spiritual/other. % Change calculated from maps and inventories of key economic species and data from household surveys of NTFP consumption.

Mechanism of impact	Species (local name)	Primary local use (total number of livelihood uses given in brackets)	% Change
Conflict of use	*Endopleura uchi* (Uxi)	Food, wildlife food (5)	−83
	Platonia insignis (Bacuri)	Food, home construction (5)	−81
	C. villosum (Piquiá)	Food, canoe building (4)	−63
	Lecythsis pisonis (Sapucaia)	Food, wildlife food, medicinal (5)	−75
	Virola micheli (Ucuúba)	Medicinal, construction (3)	−65
	Dipteryx odorata (Cumaru)	Medicinal, construction (3)	−70
	Copaifera spp. (Copaíba)	Medicinal (4)	−75
	Carapa guianensis (Andiroba)	Medicinal (4)	−80
Indirect	*Heteropsis* spp. (CipoTtitica)	Construction and technology (4)	−75
	Hymenaea parvifolia (Jutaí)	Wildlife food, construction (4)	−70
Competition	*Manilkara huberi* (Maçaranduba)	Construction (5)	−75
	Eschweileracoriaceae (Maturi)	Construction (5)	−60

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light demanding species of *Aframomum* and rattan, were reported to have increased as a consequence of microhabitat changes associated with logging. Communities identified that roads and trails created by the passage of logging vehicles led to increased light availability favouring the growth of these species. The remaining 36 NTFPs (including conflict of use species) were negatively affected by logging, many substantially (Table 3). Damage associated with the passage of heavy machines and reduced accessibility due to the subsequent growth of dense thickets of the thorny Marantaceae (*Haumania danckelmanniana*) were frequently cited as causal factors. For several species their declining abundance was masked by increased collection effort, often in response to rising local demand associated with logging camps. For example, while logging damage reduced the availability of *Gnetum* spp. and *Irvingia* spp., monthly collection increased dramatically in 2005 (Table 3). Harvested insects, particularly *Imbrasia* sp. caterpillars, were negatively affected as a result of the removal of their host trees (mahogany or sapelli (*Entandrophragma* spp.)). Seventeen of eighteen game species were considered to have declined dramatically; some formerly commonly exploited species were not encountered at all subsequent to the logging activities of 2005 (Table 3). Local people considered decline in game availability to be a consequence of increased hunting pressure, rather than from ecological change resulting from logging operations. Despite detrimental impacts on game, villagers indicated that the most damaging impact of logging on their livelihoods resulted from exploitation of timber species also directly valued for NTFPs.

3.2.3. Malinau, Indonesia

In scoring exercises local people considered unlogged forest the most important land type while logged forest was given a low preference for nearly all use categories (Table 4). Many use categories were reported to be affected by understory cutting, including medicinal plants, game, and materials needed for basketry and cordage. After logging people stated that physical accessibility was impaired by fallen branches and thick, often spiny, regrowth. Traded NTFPs made a major contribution to income in Malinau. For example, Eaglewood or 'gaharu' (*Aquilaria* spp.), valued for its resin, provides significant cash income (Wollenberg, 2001). Within concessions these trees became open to destructive harvesting by outsiders including forest concession workers and inventory teams who destroyed many trees in their search for gaharu. Availability of this resource was virtually eliminated following logging. 'Bearded' pig (*Sus barbatus*), considered the most important source of animal protein, was said to be significantly reduced in abundance in logged areas. Many highly valued fish species declined, notably two river carp (*Tor tambra* and *T. tambroides* spp.) (Sheil et al., 2006). Key emergency forest foods such as hill sago (*Eugeissona utilis* and *Arenga undulatifolia*) were also impacted. *Eugissonia*, the most important sago grows along the same ridges that are commonly used for extraction therefore machinery and trails lead to heavy damage of this resource (Meijaard et al., 2005; Sheil et al., 2006). Value scoring exercises showed that the communities valued a great many species that had little if any direct value for trade or subsistence (Sheil et al., 2006). A number of these, like clouded

Table 3
Percentage change in availability of valued NTFP plant species following logging in Zega, Cameroon. Uses include food, construction, technology, medicinal, commerce, wildlife food (i.e. attracts game) and spiritual/other. % Change calculated from recall data on average quantities collected and consumed and/or sold prior to and after logging in 2005.

Mechanism of impact	Species (Local/trade name)	Primary local use	% Change
Conflict of use	*Entandrophragma sp.* (e.g. Sappelli)[a]	Medicinal	–
	Triplochiton scleroxylon (Ayous)[b]	Food, commerce	–
	Mielicia excelsa (Bangui, Iroko)	Medicinal	–
	Khaya spp. (Deke, Acajou)[a]	Medicinal	–
Indirect	*Aframomum* spp. (Tondo)	Commerce	+100
	Calamus deërratus (Rattan)	Technology	+40
	Discorea spp. (Wild yams)	Food	−80
	Annonidium mannii (Wild corossolier)	Food, commerce	−50
	Pogo oleosa (Kana)	Food, commerce	−50
	Xanthosoma sagittifolium (Wild cocoyams)	Food	−75
	Termitomyces spp. (Mushrooms)	Food, commerce	−50
	Imbrasia spp. (Caterpillars)	(Consumption, sale)	−93
	Achatina spp. (Snails)	(Consumption, sale)	−80
	Irvingia spp. (Payo, Pekie)	Food, commerce	+55[c]
	Ricinodendron heudelottii (Njansang)	Food, commerce	+275[c]
	Raphia hookeri (Raphia)	Technology, food	+50[c]
	Maranthochloa spp. (Marantacées)	Technology	+60[c]
Facilitation	*Gnetum* spp. (Koko)	Food, commerce	+100
Facilitation and competition	*Cephalophus* spp. (Duiker)	Food, commerce	−95
	Atherurus africanus (Porcupine)	Food, commerce	−95
	Manis tricuspis (Pangolin)	Food, commerce	−94
	Tragelaphus euryceros (Bongo)	Food, commerce	−92
	Viverra civetta (Civet)	Food, commerce	−94
	Cercopithecus spp. (Monkey)	Food, commerce	−93
	Python sebae (Boa)	Food, commerce	−100
	Gorilla gorilla (Gorilla)	Food, commerce	−100
	Tronyx sp. (Tortoise)	Food, medicinal	−90
	Manis gigantea (Giant pangolin)	Food, commerce, medicinal	−100
	Loxodonta africana cyclotis (Forest Elephant)	Food, commerce, medicinal	−100
	Potamochoerus porcus (Bush pig)	Food, commerce	−100
	Varanus niloticus (Water monitor)	Food, commerce, medicinal	−92
	Crocodylus niloticus (Crocodile)	Food, commerce	−92
	Bitis gabonica (Gaboon Viper)	Food, commerce	−100
	Piper guineensis (Bush pepper)	Food, commerce	None
	Honey	Food, commerce	None

[a] Timber species identified as vulnerable.
[b] Timber species identified lower risk concern (IUCN, 1996).
[c] Species negatively affected but impact masked by increased collection effort.

Table 4
Local importance of five forest types across 14 use classes based on community scoring exercises in Kalimantan, Indonesia (scores are out of a total of 100; means per land type, by use-classes for all seven communities, highest assigned values are highlighted in bold text).

Use category	ALL	Food	Medicine	Light construction	Heavy construction	Boats	Tools	Firewood	Basketry/cordage	Ornament/ritual	Marketable items	Hunting materials	Hunting locations	Recreation	Future
Unlogged forest	31.43	38.75	36.29	35.61	50.71	50.71	44.68	29.07	39.04	30.32	35.79	43.5	36.46	34.26	30.68
Logged forest	10.14	8.75	8.18	8.61	5.89	5.89	5.11	15.89	5.86	9.96	8.43	4.93	7.25	8.41	12.71
Secondary forest	15.82	11.18	15.07	23.04	3.96	3.96	4.75	35.57	15.64	26.82	7.07	9.14	11.75	15.34	23.61
Swamp forest	18.86	11.32	12.71	12.11	10	10	14.57	10.14	14.68	12.14	12.36	13.71	15.57	18.19	13.68
Mountain forest	23.75	30	27.75	20.64	29.43	29.43	30.89	9.32	24.79	20.75	36.36	28.71	28.96	23.81	19.32
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

leopard and various hornbill species, are associated with traditional symbolic values and can also be heavily impacted by logging (Meijaard et al., 2005; Cleary et al., 2007).

Discussions with local people suggested that the safety-net value of the forest declined as a result of logging and associated over-hunting. One of us (DS) worked with the Punan Rian during a period of food shortage when their rice reserves were exhausted and observed this value of the forest firsthand. The extent to which this 'safety net' value permeated day-to-day consideration and value of the forest and specific resources was clear. A more recent study in five of the communities that were severely impacted by a severe flood in 2006 showed that most people (>80%) turned to the forest to a higher degree than they had previously. The forest played a major role in sustaining them through both the initial crisis and the subsequent year (Liswanti, unpublished data).

4. Discussion

4.1. The impact of logging on NTFPs of livelihood importance

Laird (1999) raised the issue of conflict of use in the late 1990's, evaluating integrated management of NTFPs and timber as a means to promote compatibility. Recently the issue of compatibility has begun to be reevaluated (e.g. Guariguata et al., 2009, 2010) and addressed in a limited way by select forestry training organisations and governments (Laird et al., 2010). However, given the livelihood importance of NTFPs worldwide, and the vast numbers of rural communities confronted with loss of key tree species through timber extraction, there remains a pervasive lack of attention to these issues. This is likely due to a number of factors: the long held assumption that timber is the most valuable forest product; a research bias toward internationally traded commodities (Shackleton et al., 2007); the invisibility of locally used and traded forest goods (Campbell and Luckert, 2002; Shackleton and Shackleton, 2004); the political marginalisation of forest-reliant communities (Dove, 1994); and a prevailing underestimation of the socioeconomic and cultural importance of NTFPs to rural and urban households (e.g. Cocks, 2006; Cocks and Dold, 2006).

Through conflict of use, competition and the facilitation of unsustainable harvesting, as well as multiple indirect effects, selective logging has significant implications for forest dependant livelihoods through its impacts on NTFP availability. Case studies presented from Brazil, Cameroon and Indonesia illustrate the range and scale of these, with impacts on staple foods, game, medicines, cultural resources and select high value products that provide important sources of cash income. Positive impacts are restricted to light demanding species that respond to the opening of forest structure. While these may be locally important, such species typically represent a small subset of those of livelihood value. Based on these case studies and our review of the literature we argue that such positive examples are currently disproportionately cited. Few quantitative studies have been undertaken to verify whether highly selective logging practices in low-population areas undermine the ability of local populations to meet their NTFP needs. There is little understanding of how communities cope with, or adapt to, changing resource availability. If communities have adapted readily (e.g. through the use of substitutes) then some declines may not be of significant concern for livelihoods, and if they have not, how do changes in resource availability translate into livelihood outcomes? Our example from the flooding in Malinau provides one illustration in this context of which more are needed. Further analysis and research is necessary to understand how changes in resource availability translate into lost income, reduced food security and negative consequences for health and wellbeing. Continued investigation of the full impact of selective logging will

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be important for a meaningful understanding of the changing vulnerability of forest communities post-logging and their associated livelihood adaptations and coping strategies.

4.2. Implications for forest management practice and policy

While our results highlight the mechanisms by which logging reduces local forest values, they also highlight several opportunities for mitigating or avoiding some of these impacts through improved management and logging practices. The number and intensity of logging events appear as critical factors determining impacts on livelihood uses; a conclusion emerging from both our review and results from the Brazilian case study in particular. This is also supported by previous studies (e.g. Foley et al., 2007). Several of the studies we reviewed identified intensity of extraction as a key variable (Rockwell et al., 2007b; Guariguata et al., 2009, 2010). Logging intensities in Indonesia were particularly high explaining the high degree of impact associated with one logging event in comparison to Cameroon and Brazil where impacts were felt at comparable levels after successive extractions. In Brazil, resources declined only after repeated logging and fire events suggesting that level of extraction is a key issue. Where communities exert some influence with respect to decision-making over forest resource use there is a need for greater provision of information on this important factor. Long-term follow-up work in Brazil revealed that dissemination of relevant ecological and socioeconomic data can assist communities in making more informed decisions regarding which species to sell and at what intensity to allow extraction (Shanley, 2006; Shanley et al., 2010). The level of social organisation of communities' and their ability to negotiate are however key to the utility of such information and a necessary component in increasing the transparency of timber negotiations. A strong grass roots social movement and the participation of women have been central to conservation efforts in Amazonia, including in the propagation of such information (Hecht, 2007; Hall, 1997). Reducing harvest intensity of timber species with NTFP value in other locations will depend upon recognition of tenure and property rights, ecologically informed reform of forestry legislation and improved implementation.

The silvicultural benefits of understorey cutting (intended to control invasive weeds that might impede the regeneration of timber species) remain questionable and our findings support earlier work indicating that understorey slashing, or selective climber cutting in the African context (Parren, 2003), is a major contributor to the depletion of forest values from a local perspective (e.g. Sheil et al., 2003, 2006; Sist et al., 2003). This practice had negative impacts on NTFP values in both Indonesia and Cameroon and was a common factor behind indirect impacts in the review. There is considerable potential for further reform of forestry practices and improved implementation to mitigate such impacts. Such issues also have relevance in the context of current climate change discussions, specifically how NTFPs may be affected in silvicultural adaptation measures implemented in response to a changing climate (Seppälä et al., 2009).

The spatial and temporal context of resource use by communities (including how this relates to species ecology and distribution) needs to be taken into greater account in the revision of logging and silvicultural practices. In some cases management of NTFP species with specific ecological niches, such as floodplain environments, may be best accomplished through spatial segregation (Binkley, 1997). Communities in Zega mentioned how their forest use activities are well defined in terms of time and space and community mapping of forest use has already been shown to be highly successful in safeguarding livelihood resources in logging areas (S. Counsell pers. com). Following recent national forestry legislation in Cameroon and the Democratic Republic of Congo, forestry companies and local communities are collaborating to conserve species of local value (Tieguhong and Ndoye, 2007). In Bolivia, villagers have mapped Brazil nut trees as a means to protect their resource from incompatible land use (Cronkleton et al., 2010) and a national law protects Brazil nut trees from logging. However, while such measures can be of value, these are frequently species, as well as region, specific and thus the underlying issues of inequity in forest resource use remain. Additionally, while these approaches focus on the stand-scale where trade-offs are most strongly felt, they are not adequate to address larger scale interactions and mechanisms. For example, many game species exhibit source-sink relationships in response to hunting pressure (Poulsen et al., 2009); our data from Brazil giving some indication of such effects.

We suggest that conflict of use represents the most problematic mechanism of impact; a conclusion previously drawn by Laird (1999) and supported by both the review and our results from Cameroon in particular. While some species are legally protected from logging it is clear that this doesn't it make them "conflict of use" free, for example Brazil nut (Guariguata et al., 2009). In such cases it is unclear how much a logging ban or felling quota can help and such measures may require that compensation mechanisms be established to cover the revenue lost by logging companies. In addition to minimising direct and collateral damage, ensuring the regeneration of species of joint livelihood and commercial value is another area where improvements are required (Schulze et al., 2008). For example, in central Africa current forest management for timber is, at worst, still largely based on exploitation, and at best, focused on maintaining forest structure and protecting ecological functions but rarely on ensuring the regeneration needed for sustained long-term production (Doucet and Kouadio, 2009).

4.3. Reconciling timber extraction with livelihood use of forests

While approaches such as certification and RIL have promoted and achieved important environmental benefits in timber extraction, they remain deficient in taking full account of critical social and cultural factors (Guariguata et al., 2008; Shanley and Stockdale, 2008) or in being applicable to the full range of timber extraction models. For example, guidelines for RIL direct the bulk of attention to the ecological function of forests as opposed to their livelihood value and are not well suited to smallholder forestry (Rockwell et al., 2007b). As tropical forests are increasingly required to satisfy multiple (and in some cases conflicting) demands for timber and non-timber forest products (NTFPs) as well marketed and non-marketed ecosystem services (Kant, 2004; TEEB, 2010), further work will be needed to broaden the range and understanding of alternative use regimes and to weigh the full costs and benefits on forest-reliant communities.

To varying degrees, timber certification efforts incorporate social concerns and NTFP values as well as encouraging multiple use forest management, however, non-commercial species often continue to be overlooked by certification auditing teams, researchers and policy makers. Furthermore, the social issues encountered during NTFP certification are generally more difficult to navigate than the already challenging ecological issues (Pierce and Laird, 2003). Technical and legislative factors limit the application of certification to NTFPs as most NTFP gatherers have no land title, a prerequisite for many certification systems (Pierce et al., 2008). Compounding this, auditing teams generally have insufficient experience and training to comprehend the complex livelihood implications of logging and the diverse and valuable NTFP species impacted by timber extraction (Guariguata et al., 2008; Pierce et al., 2008).

While scientific understanding regarding the ecology and use of many locally consumed NTFPs remains superficial, much local knowledge on the autecology of individual species, the spatial

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and temporal context of their use and the differing modes of impact from logging may be available and should be more frequently drawn upon (Donovan and Puri, 2004; Rist et al., 2010).

Improved management can reduce impacts on some forest NTFP values but resolving conflict of use in the case of high value timber species will necessitate greater tradeoffs. Where species such as Moabi or Piquiá continue to be targeted commercially, logging and livelihood uses are only likely to be compatible at low NTFP-harvest rates. The preservation of a select number of trees sufficient to meet demands for household consumption, but not sufficient for sale and marketing to provide cash income, being one possible outcome. In such cases the issue comes down to one of whose costs and whose benefits feature in decision-making over forest utilisation, and additionally, who has the power to make these decisions. In many locations where logging occurs the benefits and costs generally do not accrue to the same individuals. While RIL may provide specific benefits, including a sustained source of timber and therefore income, the degree to which this may be offset by reduced NTFP values is unclear, both due to uncertainties over the full ecological impacts (Barreto et al., 1998; Pearce et al., 2003; Guariguata et al., 2010) as well as institutional or socioeconomic characteristics typical in some of these locations. To rectify such incongruities over high value species, improved communication and collaboration will be needed between policy-making bodies at the international and national levels followed by concomitant local enforcement. In some cases, state level governments, which may have a better comprehension of the local relevance of NTFPs, can take the lead, as in Brazil, where the state of Amazonas enacted regulations prohibiting the extraction of medicinal oil tree species (Kluppel et al., 2010).

4.4. Forest governance

Subsequent to the research in Malinau the team gauged local views and priorities in relation to forest values and conservation but found that these were not reflected in the land use changes occurring. Local people were aware of, and concerned about, logging companies and the local government was aware of these concerns. The development and enforcement of regulations was the biggest barrier to action (Padmanaba and Sheil, 2006). There is little on-the-ground presence or law enforcement in such remote regions and little clarity over how this situation might be improved. There is a need for more consultative and responsive land use planning, more effective implementation of regulations and improved governance independent of certification efforts, and ultimately for greater in country interest in policing and monitoring forest management. In particular, the regulation of commercial concessions currently focuses on inputs, primarily planning documents, placing little emphasis on actual outcomes, either ecological or social. Most regulations prescribe certain forest practices rather than the sustainable outcome to be achieved; in this respect there is a need for more objective and transparent forestry regulations (Bennett, 1998).

Policy or management practices to date have given little attention to reconciling multiple forest uses and minimising impacts on forest dependant livelihoods (except see Guariguata et al., 2009; Laird et al., 2010; Guariguata et al., 2010). One of the challenges in legislation surrounding NTFPs is that multiple sectors, agriculture, finance, environment, education and culture impact access to, and use of, non-timber forest products. Weak communication between governmental sectors routinely poses challenges to effective legislation involving NTFPs. Cross-regional case studies indicate that, given the vast social and ecological complexity involving forest resources, minimal legislation which complements and/or builds upon customary regulations is often best for small holders and NTFPs (Laird et al., 2010).

5. Conclusions

Literature highlighting conflicts between timber and livelihood-based non-timber uses of forest is scant. We reviewed previous studies on this topic and using findings from three case studies reviewed relationships between these two forest uses from the livelihood perspective. Our results demonstrate the principally negative effects of logging on NTFPs of livelihood importance; however, it remains unclear to what extent these three case studies are typical of their region or country and many knowledge gaps remain to be addressed. The majority of existing literature focuses on commercial and traded products rather than those of livelihood importance and our findings clearly show the need to address this imbalance. It is critical that researchers and policy makers strive to better understand and respect the diversity of species which give rise to forests, particularly those inhabited by people. This level of understanding will require research projects which are directed, at least in part, by community-driven questions and needs. Documenting and building upon the often subtle land use management practices of local people can provide an effective foundation for broader forest management planning.

Responsible and ecologically-sensitive logging can be a source of livelihood benefit for forest communities. However, logging can also degrade not only resources of livelihood importance but key ecosystem services, such as carbon storage in biomass and soils, the regulation of water balance and river flow, the modulation of regional climate patterns, and the amelioration of infectious diseases. The impact of such environmental changes for forest dependent or adjacent communities, as well as those on cultural and spiritual forest values must also be factored into decision-making on the role of timber exploitation in rural development strategies. Over the last two decades the tendency towards a predominately economic appraisal of the role of NTFPs in rural livelihoods has neglected to factor in the cultural role of NTFPs as well as their pivotal function in local trade and subsistence livelihoods. A failure to take into account the non-timber forest resources that serve the daily nutritional, housing and health care needs of tens of millions of rural people worldwide can misguide policy, funding and research recommendations. Reconciling the needs of forest dependent people and timber extraction is cited as a one of the most pressing issues facing forestry in the Congo Basin (Ndoye and Tieguhong, 2004), the issue is equally pressing in SE Asia (Meijaard et al., 2005; de Beer and Guerrero, 2008) and Amazonia (Guariguata et al., 2009; Cronkleton et al., 2010).

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