

Falling back on forests: how forest-dwelling people cope with catastrophe in a changing landscape

N. LISWANTI¹, D. SHEIL^{1,2,3}, I. BASUKI¹, M. PADMANABA¹ and G. MULCAHY¹

¹*Center for International Forestry Research (CIFOR). PO Box 0113 BOCBD, Bogor 16000, Indonesia*

²*Institute of Tropical Forest Conservation (ITFC). PO Box 44, Kabale, SW Uganda*

³*School of Environmental Science and Management Southern Cross University. PO Box 157 Lismore NSW 2480, Australia*

Email: n.liswanti@cgiar.org, douglassheil@itfc.org, i.basuki@cgiar.org, m.padmanaba@cgiar.org, g.mulcahy@cgiar.org

SUMMARY

How do tropical forest people cope with natural disasters? We worked with four communities in East Kalimantan (Borneo), Indonesia, before and after a catastrophic flood. We interviewed 42 of 102 heads of households affected by the floods. All 42 households suffered some major loss of property – crops, lands, houses, and/or livestock. Each household adopted one or more coping strategies: increasing their reliance on forest resources; seeking paid employment; relocating their houses; and finding temporary land to establish their crops in upland areas. Immediate reliance on the forest was greatest for those most heavily impacted, the poorest, the least well educated, and those with the easiest access. Overall, those with the fewest resources and alternatives made most use of the forest. But access to such forest benefits is becoming increasingly difficult. The often crucial value of forests to local forest-dwellers needs to be better recognized in the context of current developments. These forest derived safety-values should be maintained or – where necessary – substituted.

Keywords: flood, coping strategies, subsistence, forest-dependent people, reliance on forest

Retour vers la forêt: comment les habitants de la forêt s'adaptent aux catastrophes dans un paysage changeant

N. LISWANTI, D. SHEIL, I. BASUKI, M. PADMANABA et G. MULCAHY

Comment les habitants des forêts tropicales s'adaptent-ils aux catastrophes naturelles? Nous avons travaillé auprès de quatre communautés dans le Kalimantan de l'est, à Bornéo, en Indonésie, avant et après une inondation catastrophique. Nous avons interviewé 42 des 102 têtes des foyers affectés par l'inondation. Chacun de ces 42 foyers avaient souffert une perte majeure de leur propriété-récolte, terres, habitations et/ou bétail. Chaque foyer a adopté une ou plusieurs stratégies pour faire face au drame, en accroissant leur dépendance sur les ressources forestières, en recherchant un emploi rémunéré, en changeant l'emplacement de leur habitation, et en trouvant un terrain temporaire pour établir leur cultures dans les terres élevées. La dépendance immédiate de la forêt était la plus importante chez les personnes les plus touchées, les plus démunies, les moins éduquées, et celles possédant l'accès le plus abordable. En résumé, les personnes possédant le moins de ressources et d'alternatives utilisèrent la forêt le plus fortement. Mais, l'accès à de tels bénéfiques forestiers devient de plus en plus difficile. Il est nécessaire que la valeur souvent cruciale des forêts pour les habitants locaux de la forêt soit mieux reconnue dans le contexte des développements actuels. Ces valeurs de sécurité dérivées de la forêt devraient être maintenues, ou substituées si nécessaire.

Recurrir al bosque: cómo se enfrentan los habitantes del bosque a las catástrofes en un paisaje en evolución

N. LISWANTI, D. SHEIL, I. BASUKI, M. PADMANABA y G. MULCAHY

¿Cómo se enfrentan los habitantes del bosque tropical a los desastres naturales? Trabajamos con cuatro comunidades de Kalimantan oriental (Borneo), Indonesia, antes y después de unas inundaciones catastróficas. Entrevistamos a 42 de un total de 102 cabezas de familias afectadas por las inundaciones. Todas y cada una de las 42 familias sufrieron pérdidas económicas – cultivos, tierras, vivienda, y/o ganado. Cada familia adoptó una o más estrategias para salir adelante: aumentaron su dependencia de los recursos del bosque; buscaron empleo remunerado; trasladaron su vivienda; o encontraron tierras temporalmente donde establecer sus cultivos en zonas más elevadas. La dependencia inmediata del bosque fue mayor para quienes sufrieron un mayor impacto, los más pobres, aquellos con menor educación, y quienes disponían de un acceso al bosque más fácil. En general, quienes hicieron un mayor uso del bosque fueron quienes tenían menos recursos. Sin embargo, el acceso a los beneficios del bosque está siendo cada vez más difícil. Es importante que se reconozca el valor de los bosques, que a menudo es crucial para los habitantes locales del mismo, dentro del contexto de desarrollo actual. Estos valores del bosque que ofrecen una red de seguridad deberían ser conservados o –si es necesario– incluso reemplazados.

INTRODUCTION

How does forest people's reliance on forest change in times of disaster (Takasaki *et al.* 2004, Pattanayak and Sills 2001)? This question is often theoretical, but in 2006 it became a harsh reality for communities in the Malinau watershed in East Kalimantan, Indonesia, when a flash flood struck. Houses, domestic animals, crops, agricultural lands and other assets were destroyed forcing villagers to adopt various survival strategies. Our previous work with these communities indicated that the forest has long been an important source of resources and of land for cultivation (Sheil *et al.* 2003, 2006, and 2008). We were concerned how the communities would cope and wondered what role the forest would play.

Godoy *et al.* (2000) suggest that the general importance of tropical forests as a safety net is exaggerated and argue that "one must be cautious before attaching too much weight to the insurance value of forest." Even those who accept that forests can offer natural insurance, expect that the contribution may diminish with access to other livelihood options (e.g., Marquette 2006). Yet such generalizations can be questioned. It seems clear that such dependencies can vary with circumstances and may be idiosyncratic. Given current knowledge we should not apply results from one site or region to another without careful reflection (Sheil and Wunder 2002).

There is good reason to believe that many people increase their reliance on forest in times of hardship (Hecht *et al.* 1988, Godoy *et al.* 1998, Byron and Arnold 1999, Takasaki *et al.* 2004, Pierce and Emery 2005). Tropical forests are known to provide products and income that can enhance people's lives (Pattanayak and Sills 2001, Byron and Arnold 1999). What is less certain, and seldom studied directly, is how this changes in times of acute hardship. While many authors discuss the role of forests as safety nets (e.g., Byron and Arnold 1999, Warner 2000, Godoy *et al.* 1998), these roles are largely implied by indirect assessments: specific data remain scarce and the nature of dependence has seldom been evaluated directly. Researchers are seldom present to witness and assess communities during periods prior to and following natural catastrophes – and if they are, there may be ethical problems with simply observing from the sidelines. Across large regions, notably including Southeast Asia, the significance of forest in times of hardship remains little documented. Our study brings rare evidence to this important topic.

Our study is unusual. We investigated four communities we had worked with for a decade. While we had not previously attempted to measure communities' dependence or economic relationships with the forest, we had characterized the role that they themselves perceived the forest to play in their lives and value systems (Sheil and Liswanti 2006, Sheil *et al.* 2006 and 2008). This knowledge provides a specific context from which we were able to explore coping strategies, and the role of forest, following a major flood. Our analysis included two key questions: a) Do disasters influence people's reliance on the forest, and b) what livelihood factors influence forest reliance? This is among the first of such studies with forest-dependent communities in Southeast Asia (see also Belsky and Siebert 1983, Völker and Waibel 2010).

STUDY AREA

Research area and people

The upper Malinau is steep and rugged, with primary and selectively logged forest dominating the landscape, along with localized patches of secondary forest and agriculture. Timber concessions cover most of the more accessible areas (Basuki and Sheil 2005) and overlap traditional community forests (Sellato 2001, Sheil 2002). The human population is concentrated in small settlements along or near the banks of the Malinau River.

We worked with two ethnic groups the Punan and Merap. Each has traditionally followed a distinct livelihood. The Merap were largely agriculturalists who cultivated rice and other crops. They also hunted for meat and traded in high value forest products such as gaharu (*Aquilaria* spp.) and bird's nests (genus *Collocalia*). The Punan on the other hand, were semi-nomadic hunter-gatherers (Kaskija 1995, Sheil *et al.* 2003).

In recent years the government has sought to settle Malinau's remoter people in more accessible locations closer to schools and clinics. Education, health facilities, and mass communication are increasingly influential, though access varies greatly with location (Sheil and Liswanti 2006). All the study villages are at a similar distance from Malinau Town (from 30 km for Gong Solok to 57 km for Punan Rian and Paya Seturan) but they vary with regard to the surrounding landscape, proximity and state of forest and ease of access.

Various projects have introduced cash crops such as coffee and cocoa to the Merap and encouraged settled agriculture among the Punan. These projects also included building houses and other village facilities (Basuki *et al.* in press). While the Punan used to live in huts most dwellings are now similar to the raised wooden houses of the Merap, the floors of which are 1–2 m above the ground.

Since the late 1990s, the monetary crisis, governmental decentralization, and the expansion of private companies (oil palm, logging and mining) have brought various changes. Many large scale industrial projects have brought in new markets for various products and new opportunities for paid labour (Boedhihartono *et al.* 2007). In many cases these projects have caused significant environmental impacts, degrading forests and impacting rivers (Levang *et al.* 2007, Padmanaba and Sheil 2007).

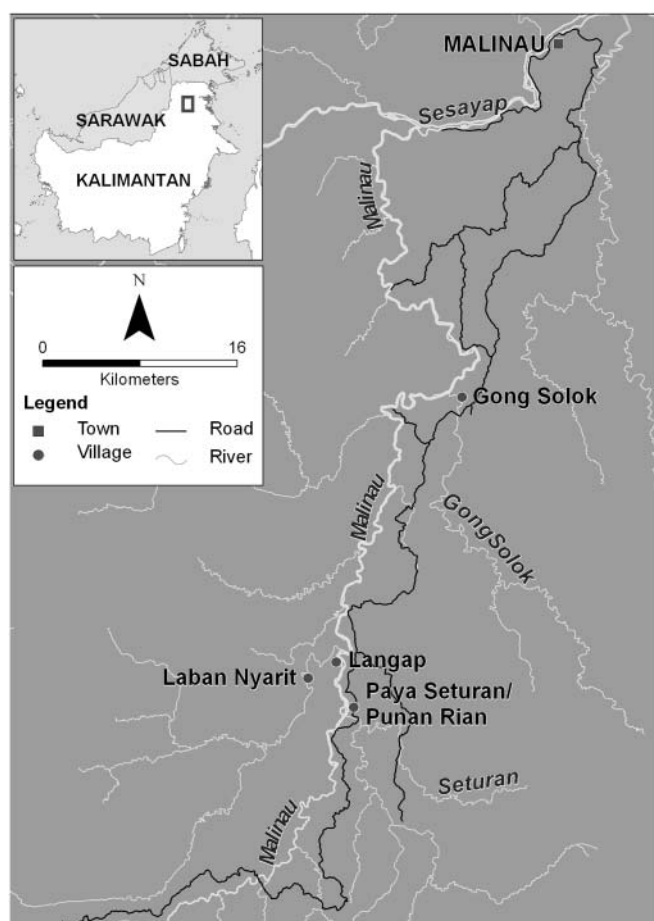
The flood

Severe localized floods are a recognized hazard in this region. In June 2006, a flash flood occurred on the Seturan River, a tributary of the Malinau River. While no one died, the flood destroyed considerable amounts of property. We had previously stayed and worked with seven villages in the affected area for several weeks each (Sheil *et al.* 2003). During these field visits the villagers had recounted village histories involving major floods. In the past, following a destructive flood – as with a deadly disease or other catastrophe – villages would subsequently move location (Sheil *et al.*

unpublished interviews from 1998, 1999, Sellato 2001, Sheil 2002).

News of the 2006 flood prompted us to plan a visit to investigate the event. Our study, which focused on the seven villages we already knew, was conducted a year later (November 2007 and January 2008). This allowed time for the communities to recover though we were still able to see some lasting impacts of the flood for ourselves, e.g., broken houses in Punan Rian and Paya Seturan, ruined school buildings in Gong Solok and damaged rice stores in Punan Rian, Paya Seturan and Gong Solok. Initial investigations showed that only four of the seven villages had been seriously affected: Langap, Gong Solok, Paya Seturan and Punan Rian (Fig. 1). These four are the focus of our account.

FIGURE 1 Location of the study site and communities in the Malinau watershed



Sources: Topography map, TOPDAM; Road map, Inhutani; Malinau Village map, CIFOR; SRTM 3-ArcSecond Data

METHODS

Our data were derived principally from interviews, questionnaires and follow-up discussions. All our respondents were acting heads of households. We excluded households who suffered no damage and those where the adult occupants were absent (see discussion). For each of the households unavailable for interview we documented the reason.

Our questionnaire consisted of both open-ended and closed questions. We assessed each household for the impact of the floods; the nature and extent of damage; and household coping strategies. The importance of sources of food and livelihoods helped describe the context and livelihood constraints, including access to the forest during a crisis.

We asked about the type and degree of flood-related damage. The type was categorized as loss or damage to *crops* (vegetables, fruits, coffee, cocoa, rice, and rice stocks), *agricultural land* (e.g., loss of top soil), *house* (households' capital assets), and *domestic animals* (chickens, ducks, pigs, dogs, and cats). We subjectively classified the degree of loss or damage as minor, medium, or severe (Table 1). We defined coping strategies as the household's response to flood and how they dealt with it. The non-exclusive household coping strategies, which developed from the interview with the respondents, were categorized as: *Increased Reliance on Forest* (IRF); finding *Temporary Agricultural Land* (TAL) to establish their crops in upland areas; *Resettlement* (R); and migration to *Search for Employment* (SE).

Data on education and wealth derived from our census in 2000 were updated during this study. Here wealth includes not only obvious luxury items (as in Sheil and Liswanti 2006), but also generators, chainsaws, boat engines, and canoes. Wealth was defined as the average estimated cash value of capital assets per individual of each household. This was estimated by calculating a mean price for each household item which is then summed per household and divided by the number of household occupants (see Appendix). While we believe that, when aggregated, such data are useful in indicating differences among communities we are cautious in interpreting these simplified data at the household level.

What do we mean by 'dependence'? Operational definitions are problematic (for a review see Byron and Arnold 1999). In our study we consider dependence to be reflected by the relative frequency with which people turn to a given activity from among available choices as an (apparent) means of survival and of maintaining a viable livelihood.

Given the limited sample size and strong association of some factors, not all cause-effect combinations could be statistically separated. We used the ϕ coefficient and Kruskal-Wallis test (Sokal and Rohlf 1995) to explore how the type and severity of damage influenced the choice of coping strategies and to what extent the variables village, ethnicity, occupation, education, and wealth influenced choice. The different context of each village includes distance to and quality of forest. A fuller summary of our data is provided in the Appendix. These analyses were performed using SPSS 9.0.1 analysis package (<http://www.spss.com>).

RESULTS

General overview

During the flood water reached 2–4 m above normal levels (Fig. 2) and impacted 102 households in four villages. We

TABLE 1 Flood damage experienced by four villages in Malinau watershed

Damage	Minor	Medium	Severe
Crop loss	Partial loss of vegetable crops	50% loss of crops, including cash crops	Major loss of crops, up to 100%
Land damage†	Required cleaning of river debris	Minor landslides and soil erosion	Major landslides and soil erosion
House damage	No permanent damage to building or contents	No permanent damage to buildings, but some contents lost	Permanent damage to buildings and total loss of contents
Loss of domestic animals	1–2 domestic animals lost per HH	Approximately 50% of domestic animals lost per HH	Most or all domestic animals lost per HH

Note: HH=household.

† Agricultural land including cash crops.

FIGURE 2 House damaged in 2006 flood in Paya Seturan village



interviewed the heads of 42 these households (see Table 2) – Langap (8), Gong Solok (13), Paya Seturan (11), and Punan Rian (10). In eight cases, women were interviewed as their husbands were absent. Ethnically, the household heads were mostly Merap and Punan (Table 2). Respondents were aged between 20 and 70 years. Interviews with their neighbors indicated that of the 60 impacted households not interviewed because heads of households were absent, 12 were away for wage labour or trade (selling fish, fruit, and cocoa) and 32 for hunting, fishing, and/or cultivation, while 16 had left the village permanently.

All households were, or had been, involved in some cultivation. Our respondents described their primary activity as farming (64%), carpentry (17%), and hunting (14%) (Table 2). Most household heads (69%) had some formal education. The best-educated had attended senior high school (14%). The value of selected assets of all households ranged from 38% with no capital assets to 5% with assets worth an estimated US\$200 or more (Table 2). The Merap had more household assets of higher value than the Punan. The wealthiest households were found in Langap and the poorest in Punan Rian.

The informants in all communities reported that the forest itself had changed and many important species were no

longer as easily available due to exploitation by timber companies and over-collection by the communities themselves. In Table 3, we summarise the plant and animal species judged most important by respondents within the study villages in normal times (i.e., no catastrophes). We gathered this data from the previous study in 1999/2000 and updated it during the 2007/2008 study. The species of concern were not only those used for food, but also included marketable items, those used for construction, and also for basketry. In 2002, all four villages still had reasonable access to good-quality forest, but by 2007 this had changed (Table 2). The more limited access in Langap and Gong Solok was not only due to timber concessions, but also to the clearing of forest by the villagers to claim ownership (Gong Solok), and by current district government regulations restricting access (i.e., official permission must be obtained to cut timber). While forests clearly play an important role in supporting local communities this role is also declining.

Impacts of flood

The flood impacted the 42 households in different ways (Table 4): severe land damage affected 67%, severe crop loss 62%, severe house damage 55%, and severe loss of domestic animals 29%. Nearly 84% of all households (34) experienced medium, or severe, loss or damage to crops, lands, domestic animals, or houses as a result of this flood. Langap suffered less severe damage than the other three villages (Table 5).

Among those households impacted all houses in Paya Seturan (11) and Punan Rian (10) were severely damaged (see Table 4). Most Langap dwellings were located high enough to avoid major damage. In Gong Solok, all households suffered severe land damage and nine households severe loss of crops. In Paya Seturan, 10 households suffered severe land damage and loss of crops. In Langap, all households suffered medium crop damage, because they also planted coffee, cocoa, and vanilla, which are more resilient to flooding than rice and most vegetables. In Punan Rian, most gardens are located on high ground and therefore only four households suffered severe land and crop damage. The 26 households from four villages which suffered minor damage (such as house damage in Langap and loss of domestic animals in Gong Solok,

TABLE 2 Summary of 42 interviewed households in four villages impacted by the 2006 flood

Village	Gong Solok	Langap	Paya Seturan	Punan Rian
Population (<i>n</i> people)	245	666	157	107
Total no. HH	51	132	28	25
HH impacted by flood	25	24	28	25
No. respondents (HH)	13	8	11	10
Ethnic group (No. HH)	M (13)	M (7) Pt (1)	M (5) K (5) Pt (1)	P (9) T (1)
Education (No. HH)	NS (4) ES (7) SS (1) JS (1)	ES (3) JS (2) SS (3)	NS (4) ES (4) JS (1) SS (2)	NS (5) ES (2) JS (3)
Occupation (No. HH)	Farmer (12) Carpenter (1)	Farmer (5) Carpenter (1) Teacher (2)	Farmer (7) Carpenter (4)	Farmer (3) Carpenter (1) Hunter (6)
Value of assets in USD (HH)	No assets (4) >0–100 (7) >100–200 (1) >200–300 (1)	No assets (1) >0–100 (1) >100–200 (5) >200–300 (1)	No assets (5) >0–100 (3) >100–200 (3)	No assets (6) >0–100 (4)
Distance to forest:				
km [†]	0.8	1.2	0.6	0.6
Walking time (h) [‡]	c.4–5	c.6–8	c.3–4	c.1–2

Notes: HH=household(s); M=Merap, P=Punan, K=Kenyah, Pt=Puthuk, T=Timor; NS=No School, ES=Elementary School, JS=Junior high School, SS=Senior high School.

[†] Source: satellite imagery in 2002.

[‡] Source: local perception 2007/08 (satellite imagery not available).

Langap, and Paya Seturan) (Table 4) were mostly farmers (62%). Twenty nine households also suffered more than one form of severe damage (Table 5).

Coping strategies

All 42 households interviewed had adopted one or more coping strategies. We cannot judge their relative importance in each case but we can summarise their frequency (Table 5). Four households adopted one strategy only, 15 employed two, while 7 and 16 applied three and four, respectively. Increased reliance on forest was the most common response (37), followed by finding temporary agricultural land (31), searching for employment (27), and resettlement (24) (see Table 5).

Discussions clarified that households suffering only minor damage generally adopted short-term strategies (one year or less), while those that faced medium and severe damage adopted both short- and long-term strategies (more than one year). Short-term strategies included: (1) increased reliance on forest; (2) search for employment; and (3) finding temporary agricultural land for swidden cultivation. Long-term strategies included resettlement to reduce the risk of future floods and increased reliance on forest by collecting forest products (as in the short-term strategies but maintained for over a year). From interviews with the villagers, we were

told that during and after other times of hardship (e.g., seasonal food shortages), they adopted coping strategies such as finding suitable land for crops, planting other species to avoid disease, or not planting crops during the dry season. In addition, they also borrowed cash or seed from their neighbours or relatives (such mutual support is widespread even without any specific problems having occurred making its role difficult to quantify – see discussion).

In choosing their coping strategies, villagers considered financial implications, access, and hardship. For example, a woman from Langap said, “I prefer working in the neighboring village where I can earn US\$3 per day. It is better than going to the forest, because the forest is too far from home and I often get nothing.” Meanwhile, a group of men from Punan Rian said, “We [now] need to go to the forest every day to hunt pig or deer for food. The forest is the only place where we can find these animals.” In normal times, these men said that they generally went hunting twice a week.

Do disasters influence people’s reliance on the forest?

A household’s choice of coping strategies was influenced by the type and severity of the damage suffered. Due to the sample sizes, we are unable to make a complete evaluation of

TABLE 3 List of forest products utilized by households before and after a flood for specific purposes

English name	Scientific name	After floods		In normal times*	
		Merap	Punan	Merap	Punan
Animals					
Bearded pig	<i>Sus barbatus</i>	F	F	F	F
Sambar deer	<i>Rusa unicolor</i>	F	F	F	F
Red muntjak or Barking deer	<i>Muntiacus muntjak</i>	F	F	F	F
River carp	<i>Tor tambra</i>	F	F	F	F
Palm civet	<i>Paradoxurus hermaphroditus</i>	–	F	–	F
Asian or Lesser mouse deer	<i>Tragulus javanicus</i>	–	F	–	F
Asian leaf turtle	<i>Cyclemys dentata</i>	–	F	–	F
Rhinoceros hornbill	<i>Buceros rhinoceros</i>	M	–	M	M
Plants					
Sago	<i>Eugeissona utilis</i>	F	F	–	–
Bamboo	<i>Gigantochloa luteostriata</i>	F	F	F	F
Ironwood	<i>Eusideroxylon zwageri</i>	–	C/M	C/M	C
Timber	<i>Shorea parvifolia</i>	C/M	C/M	C/M	C
Timber	<i>Dryobalanops lanceolata</i>	C/M	C/M	C/M	C
Rattan	<i>Calamus caesioides</i>	–	B	B	B
Licuala palm	<i>Licuala valida</i>	–	B	B	B
Timber	<i>Hopea dryobalanoides</i>	M	–	M	–
Timber	<i>Dipterocarpus</i> sp.	M	–	M	–

Notes: F=Food, M=Marketable, C=Construction, B=Basketry. * normal times = times during which there are no catastrophes

TABLE 4 Degree of loss or damage for each type of flood damage and the number of households impacted by village

Type of damage	Degree of loss or damage	Village (No. HH)				Overall No. (%)
		GS	L	PS	PR	
Crop loss	Medium	4	8	1	3	16 (38%)
	Severe	9	0	10	7	26 (62%)
Land damage	Medium		7	1	6	14 (33%)
	Severe	13	1	10	4	28 (67%)
House damage	Minor	0	6	0	0	6 (14%)
	Medium	11	2	0	0	13 (31%)
	Severe	2	0	11	10	23 (55%)
Loss of domestic animals	Minor	10	4	6	0	20 (47%)
	Medium	1	4	5	0	10 (24%)
	Severe	2	0	0	10	12 (29%)

Notes: HH=households; GS=Gong Solok, L=Langap, PS=Paya Seturan, PR=Punan Rian.

each combination of damage, but note that each household tended to suffer more than one form of impact (see above). Using the phi coefficient (ϕ), a measure of association based on an adjusted chi-square, two classes of damage – loss of crops ($\phi=0.317$; P value=0.04) and loss or severe damage to

their house ($\phi=0.693$; $P<0.01$) – were significantly associated with increased reliance on forest. Resettlement was highly associated with house damage ($\phi=0.773$; $P<0.01$). While temporary use of new agricultural land was significantly associated with land damage ($\phi=0.383$; $P=0.01$).

TABLE 5 Distribution of flood damage by occupation, number of types of damage, and household coping strategies

	-----Occupation-----				-----Village-----				-----Ethnic Group-----					
	Total (HH)	Farmers	Carpenters	Hunters	Teachers	P. Seturan	Langap	G. Solok	Punan Rian	Merap	Kenyah	Puthuk	Timor	Punan
Total no. households	42	27	7	6	2	11	8	13	10	25	5	2	1	9
Total no. HH with severe damage	34	22	6	6	0	11	0	13	10	18	5	1	1	9
<i>No. type of damage with severe damage (HH)†</i>														
One	5	5				1		4		4	1			
Two	10	7	1	2				7	3	7			1	2
Three	13	7	4	2		10			3	5	4	1		3
Four	6	3	1	2				2	4	2				4
<i>Combination of coping strategies (42 HH)</i>														
IRF	2	2						2		2				
TAL	2	1			1		2			2				
TAL+SE	3	2			1		2	1		3				
IRF+TAL	7	7					2	5		7				
IRF+SE	2		2				1	1		1		1		
IRF+R	3			3					3	0				3
IRF+R+SE	4	2	1	1					4	0		1	1	3
IRF+TAL+R	1	1				1					1			
IRF+TAL+SE	2	2						2		2				
IRF+TAL+SE+R	16	10	4	2		10	1	2	3	8	4			3

† Crop loss, land damage, house damage and loss of domestic animals (only medium and severe damage were considered).

Notes: IRF=Increased reliance on forest, TAL=Temporary agricultural land, SE Search for employment, and R Resettlement.

Search for employment was associated with both the loss of crops ($\phi=0.439$; $P=0.004$) and with house damage ($\phi=0.427$; $P=0.022$). But, according to many informants, income from employment was not considered enough to cover their daily needs and to recover to pre-flood circumstances. Those who suffered severe loss of crops and house damage tended to rely more on the forest for food than for construction and marketable products.

For the most part, the villagers told us that they do not expect or rely on external assistance after a crisis (i.e., government aid or loans). Rather, such floods were something that they felt had happened before, would happen again, and that they knew how to survive and recover from such events without assistance. Nonetheless, village leaders in Langap and Paya Seturan reported that government assistance during the 2006 flood was emergency based, meaning that the communities received just enough to cover their basic needs for a few days (some rice, noodles, clothes, and cash). After that they had to look after themselves. In all cases respondents

were clear that after the flood, most able-bodied household members went to the forest.

Both Punan and Merap men hunted bearded pig (*Sus barbatus*) and deer (*Cervus (=Rusa) unicolor* and *Muntiacus muntjak*), and fished (Table 3), mostly for their own consumption. Hunting animals for sale was not as important for the Punan after the flood as it had been previously – rather they shared the food among themselves. The men also harvested products for house construction (Punan Rian in particular) or to sell for cash (mainly the Merap in Paya Seturan), including ironwood (*Eusideroxylon zwageri*), meranti (*Shorea parvifolia*), and kapur (*Dryobalanops lanceolata*) (Table 3). The Punan women collected plants for basketry more than the Merap. Punan women collected sago (*Eugeissona utilis*) and Merap women bamboo (*Gigantochloa* sp.) for food. Interviews confirmed that sago was consumed by both ethnic groups in this time of crisis.

Both ethnic groups affirmed they could rely on the forest during hardship, although for villages downstream (Gong

Solok and Langap) good forest was further away. Prior to the flood they had all made less frequent use of the forest – e.g., Punan Rian villagers went to the forest two or three times a week and those from the other three villages averaged only once each week. Typically, after the flood, the Punan went to the forest everyday and the Merap two or three times a week though the specific numbers varied among households.

What livelihood factors influence forest reliance?

We analyzed how *village*, *occupation*, and *ethnic group* were related to household coping strategies using the ϕ coefficient, and to *wealth* and *education* using Kruskal–Wallis tests. These variables cannot be fully separated due to co-variation within the data so we cannot separate the combined effect of damage and context. We excluded 8 HH that incurred only minor damage and focused on the 34 HH that suffered medium and severe damage (Table 5). Our results strongly suggest that reliance on forest is associated with village, occupation, education, and wealth (which also vary with ethnic group and village location) (Table 6). Wealthier households also tend to have better education (Fig. 3a) and made less use of the forest following the flood than did less fortunate households.

Resettlement showed significant association with village identity, ethnic group, and occupation (Table 6). Most of the people involved in resettlement were from Punan Rian and Paya Seturan. All households from Paya Seturan (11) relocated close to the main road and those from Punan Rian (10) to higher ground due to concerns over further flooding (about

one hour by canoe from the old settlement) – the district government provided some assistance and guidance to both villages.

Of the 27 respondents who sought paid work, four migrated to Malinau Town, seven worked locally as carpenters earning about US\$5 per day, and 16 worked in neighboring villages clearing land or planting, earning US\$2.50–US\$3.00 per day. There was no significant relationship between this strategy and any of our explanatory variables (Table 6), but it was somewhat associated with higher education (Fig. 3b).

DISCUSSION

Coping strategies: general patterns and observations

There is a long historical dependence on forests in these communities. This dependence remains – and is especially marked in times of hardship. The 2006 Malinau flood caused substantial losses to many households, the great majority of which subsequently increased their use of the forest. All 42 households evaluated in our study reported significant damage to their property, though this varied in nature and degree. Of these households, nearly 90% (37 households) increased their reliance on the forest and its products in the aftermath of the flood.

An important caveat concerns our inability to interview absent households. Absence *may* have been a response to the flood. It includes those who moved away, temporarily or permanently, to seek wage labour as well as those who were

TABLE 6 Severity of damage and coping strategies by village, ethnic group, education, occupation, and value of assets

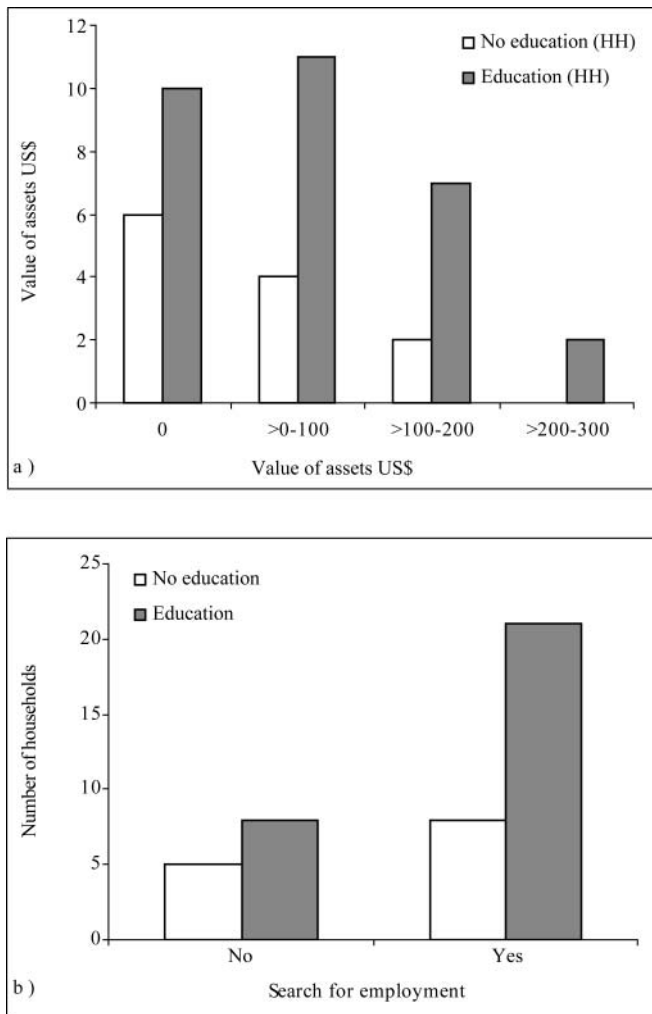
		Variable				
		Village†	Ethnic†	Occupation†	Education‡	Wealth‡
Type of damage	Loss of crops	$\phi = 0.645$ P = 0.001	$\phi = 0.279$ P = 0.514	$\phi = 0.293$ P = 0.309	P = 0.363	P = 0.674
	Loss of house	$\phi = 1.196$ P = 0	$\phi = 0.749$ P = 0.003	$\phi = 0.735$ P = 0.001	P = 0.091	P = 0.263
	Land damage	$\phi = 0.743$ P = 0	$\phi = 0.442$ P = 0.084	$\phi = 0.229$ P = 0.531	P = 0.641	P = 0.434
	Loss of domestic animals	$\phi = 0.971$ P = 0	$\phi = 0.845$ P = 0	$\phi = 0.606$ P = 0.017	P = 0.588	P = 0.72
Coping strategy	IRF	$\phi = 0.58$ P = 0.003	$\phi = 0.27$ P = 0.547	$\phi = 0.626$ P = 0.001	P = 0.009	P = 0.056
	TAL	$\phi = 0.591$ P = 0.002	$\phi = 0.568$ P = 0.009	$\phi = 0.368$ P = 0.128	P = 0.933	P = 0.515
	SE	$\phi = 0.381$ P = 0.106	$\phi = 0.23$ P = 0.696	$\phi = 0.362$ P = 0.138	P = 0.597	P = 0.789
	R	$\phi = 0.866$ P = 0	$\phi = 0.62$ P = 0.003	$\phi = 0.425$ P = 0.055	P = 0.392	P = 0.215

† phi coefficient (ϕ).

‡ Kruskal–Wallis.

Notes: IRF=Increased reliance on forest, SE=Search for employment, TAL=Temporary agricultural land, R=Resettlement.

FIGURE 3 The distribution of heads of household's education in relation to the value of assets (a) and searching for employment (b) in times of crises for all four villages



spending time in the forest. Do these absences bias our results? We briefly review the numbers here. Based on information from neighbours (and from our own observations of the state of the houses), it was evident that less than a third (27%) had moved away permanently. More than half were said to be engaged in normal livelihood activities in the forest and fields. The remaining 20% were directly engaged in activities (trade or labour) related to cash income. Thus, we may have somewhat under-represented those who moved away and were engaged in paid activities. Notably the proportion of households engaged in wage labour in our interviews (27 of 42), was higher than the proportion of absent households reported to be engaged in commercial activities or that had moved permanently (12+16 of 60 – see first paragraph of the results).

We recorded a wide range of circumstances among the households we interviewed. Our data support some basic analyses which seem robust and deserve scrutiny even if a number of important questions remain. Conducting further study would be useful especially to weigh the perceived

importance of the different coping strategies from the villagers' perspectives as well as to explore the role of household wealth and income in greater detail. Another important set of factors that merits consideration is the role of local support between households. Many households in these villages are related and share food and income on a regular basis. Indeed in hunter gatherer communities sharing and mutual support is a cultural norm (e.g., Gurven *et al.* 2001).

Our principle conclusions are clear: these four villages were dependent on the forest before the flood and for the majority of households affected, this dependence increased during and after the flood. The forest helped people through the crisis by supplying not only food and goods, but also marketable products, which in turn provided cash to purchase food and replace items lost in the flood. The emergency collection and sale of marketable forest products has been observed in forest-based communities in other parts of the world: for example, by the Tawahka to cope with the aftermath of Hurricane Mitch in Honduras (McSweeney 2005). In our study forest-use, both before and after the flood, varied by household. Ethnic differences were also apparent: for the Punan, the forest was a major source of livelihoods and in times of hardship a means of survival; the Merap used forest products to supplement their principle income from agriculture.

There have been very few previous studies of forest reliance in tropical Asia. Belsky and Siebert (1983) documented the responses of 27 household to drought in two communities in the Philippines (15 HH in Karila and 12 HH in San Pablo). They reported similar coping strategies to those in our study, involving shifting cultivation (12 HH in Karila and 12 HH in San Pablo), increased reliance on NTFP and timber species (7 HH in Karila and 7 HH in San Pablo), and temporary out-migration (12 HH in San Pablo). As we were finalizing this study an article addressing how communities responded to shocks such as poor human health, or poor agricultural yields, in the mountainous upland of Dak Lak, Ha Tinh and Thua Thien Hue in Vietnam, was published (Völker and Waibel 2010). This study also indicated that extractive forest based activities play a significant support role following crises. Though information remains limited we suspect that such dependency relationships remain common in tropical Asia.

Results from forest communities on other continents show both similarities and differences with our results. For example Takasaki *et al.* (2004) examined the response to flood damage among 95 households in Peru, where they identified 12 coping strategies. In contrast to our findings of increased reliance on wild foods, including animals, the Peru study found little increase in hunting – this may reflect the relative scarcity of game, the cultural context, that they have better alternatives or some combination of these.

Our assessments indicate that low education and limited assets result in the greatest reliance on the forest following a crisis. Similar results have been reported in other sites across the tropics: for example, a study with forest-edge-dwelling communities in southern Malawi found that a lack of capital assets was associated with increased reliance on forest during

income shock (Fisher and Shively 2005). In the American tropics, too, reviews suggest that greater income and education engender less forest use and dependence (Marquette 2006).

Most households in these Malinau communities already make considerable use of the forest, but this use increases when other sources of food and income are curtailed by events such as destructive floods. All villages in our study collected a similar selection of forest products and species before and after the crisis (Table 3). Nonetheless these similarities hide the marked shifts in the nature and intensity of use. For example some plant species previously used only locally became significant sources of cash income during the crisis. An example is the use of timber species (*Shorea parvifolia*, and *Dryobalanops lanceolata*) by Paya Seturan and Punan Rian – formally this is “illegal logging”, as these species are reserved for concession owners (ignoring any form of traditional tenure, see Sheil *et al.* 2006). There are also species that now appear seldom used, such as sago, but provide vital “famine food” when required (Sheil *et al.* 2006).

Access to forest, forest resources, and alternatives

Access to the forest has changed and continues to do so. It also varies within communities (Table 2). This has implications for people’s options. Natural forests and their resources remain more accessible to upstream than downstream villages. While some studies consider the collection of non-timber forest products (NTFPs) a last resort (e.g., in the Peruvian study of Takasaki *et al.* 2004), in Malinau it remains a normal part of local livelihoods – at least for the communities in our study. Hence, reduced access to forest will have many impacts on these people (Sheil *et al.* 2006).

In our study, access to forest was also related to location (Table 2). In Langap where the distance from the village to reasonably intact forest has increased substantially in recent years, the community (Merap), has been somewhat compensated by other factors such as increased access to paid work, aid, etc. and have been able to take advantage of these opportunities. But many of the poorer communities – having little education – have fewer options in a severe crisis other than to turn to the forest. If the forests, or their key resources, are no longer available to them, people will suffer. Even if paid work is available, forest people are often vulnerable to exploitation and prejudice (this seems to be a global phenomenon for minorities, e.g., in Honduras, McSweeney 2005).

Many of the forest resources that people turn to in times of crises – for example, timber, sago, and wildlife (species that have declined in availability to Malinau’s communities) – are known to be negatively impacted by standard timber concession practices (Sheil *et al.* 2006 and 2008). Until recently, the regulations governing logging activities (the Indonesian Selective Cutting and Planting System, *Tebang Pilih Tanam Indonesia – TPTI*) stated that the understorey must be cleared every year for five years following timber extraction. Our work has already suggested that this practice provides no silvicultural benefits in most circumstances and has a major negative impact on forest species and resources

(Sheil *et al.* 2006 and 2008). We note here that these resources are important for communities, especially following crises. Loss of these resources can increase vulnerability and hardship – especially in the poorest communities.

Further clarification of the role of access to forest would be useful. How close does a forest need to be for a community to gain what benefits and what types of rights are required to assure which types of these? We have not been able to address all the pertinent issues in our study but are aware that access can be a much more complex factor than might sometimes be assumed. Factors such as access to boat engines, fuel prices, and terrain can play a major role. Socially constructed factors such as ownership, rights and cultural aspects are also very influential – as are how concessions are willing to engage with local needs.

Here we suggest that current constraints on access to, or use of, forest resources could be mitigated by improved forest management, including careful planning and practice (e.g., Meijaard *et al.* 2005); protecting forests in the vicinity of villages, especially lands traditionally utilized by and for local communities; revising regulations governing the harvesting of timber species, particularly pertaining to the clearance of the understorey; protecting key resources; and providing employment.

A poverty trap?

Is it fair to describe Malinau’s forests as a “poverty trap” (Colfer *et al.* 2006, Levang *et al.* 2005)? Perceptions are crucial here – who is trapped by their abilities and knowledge, and who is liberated by them? Who better to ask than those at the center of the debate? Our Punan respondents told us that “while we may be poor, we feel secure and safe [in the forest].” Engaging local communities in forest based activities may help them to maintain their livelihoods but it will not necessarily help them to escape from poverty. While we should not idealize the often harsh lifestyle of these people – we should allow them to make choices in the manner they would wish. For the moment most wish to maintain access to their forests (for further review of these concerns see also Padmanaba and Sheil 2007).

Vulnerability

The Malinau communities remain vulnerable to floods. In the past, after any serious catastrophe, villages would simply move location and rebuild (Sellato 2001, Sheil 2002). Proximity to the river is useful for accessing water and river transport (Basuki and Sheil 2005). The district government, after the recent floods, suggested that the villagers resettle on higher ground. Unfortunately, finding suitable locations with both water and access to facilities proved difficult. As a consequence the new settlement of Punan Rian remains at risk from future floods.

The current capacity and resources for post-disaster assistance in Kalimantan remains limited. Self-reliance remains key to local survival and recovery for the foreseeable

future. Undermining such self-reliance poses a very real threat — even though this threat is poorly recognised.

Implications for decision-makers in the context of current trends

The 2006 flood caused real hardship. Many people lacked food and shelter, and turned to the forest. The increased reliance was especially clear for the poorest. In our study, local people's access to forest and valued forest resources has been reduced primarily due to concession development and associated timber harvesting. While some of these losses in forest value may appear inevitable once industrial timber harvesting is permitted, some are not. Forest managers could incorporate timber harvesting regulations and controls that better protect resources such as sago, the species that communities turn to in times of crisis (Meijaard *et al.* 2005, Sheil *et al.* 2006 and 2008).

The factors that would serve to maintain the ecological and conservation value of these forests — environmental planning (Wollenberg *et al.* 2008), reduced impact harvest, etc. — are the same as those that would maintain the forest's security function (see Meijaard *et al.* 2005 for a fuller account). Hence, accommodating local communities' needs can be seen as part of good practice that encompasses a range of accessory benefits. We underline the importance of characterizing these concerns and responses with the involvement and guidance of local people themselves.

District governments should consider the role of forests, along with other livelihood options, when they plan for floods, droughts, and other natural catastrophes. Whether or not this forest safety-net is "sustainable" is a key question. Timber concessions and the local communities have already had an impact. Repeated catastrophes too might lead to depletion. Nonetheless given the low current population densities in the region, and the robust nature of local forest ecosystems we are confident that these systems can and should be resilient if suitably managed.

As forest landscapes are exploited and converted to plantations and other land uses, floods and other catastrophes remain real threats. It remains unclear to what degree local people and local institutions will cope. Forest-dwelling communities have been neglected by past governments. It is imperative that their links to the forests are recognized and valued, and that their needs are better respected in all processes that impinge upon them. The answer is effective participation and representation coupled with sound planning, decision making and management.

CONCLUSION

Our study shows that the forest, while always important, becomes especially significant to those who lack food and shelter in times of crisis. Following a destructive flood people's coping strategies vary depending on the nature of the damage incurred and access to alternative sources of income. Nonetheless forests remained of particular importance for all

four communities evaluated. Our data showed that while most households relied more heavily on the forest after the crisis than they had before it, the households with the fewest capital assets, the lowest levels of education, and those who had suffered the greatest losses, in terms of lost property and damage to land, made the greatest use of the forest. We recommend that wherever local people live in close proximity to forests the related safety values should be recognized, respected, and as far as possible maintained — or where necessary substituted.

ACKNOWLEDGMENTS

We thank Andy Gillison, Carol Colfer, Dede Rohadi, Gen Takao, Kuswata Kartawinata, Manuel Boissiere, Meilinda Wan, Miriam van Heist, Guy Manners, Edith Johnson, Sven Wunder and four anonymous referees for useful comments and contributions to earlier drafts of this paper. We also thank Agus Salim for providing map and Tina Taufiqoh for help with statistical analysis. The EC and CIFOR supported this research.

REFERENCES

- BASUKI, I. and SHEIL, D. 2005. *Local perspectives of forest landscapes: a preliminary evaluation of land and soils, and their importance in Malinau, East Kalimantan, Indonesia*. Center for International Forestry Research, Bogor, Indonesia. 114 p.
- BASUKI, I., SHEIL, D., PADMANABA, M., LISWANTI, N., MULCAHY, G., and WAN, M. 2011. The evolving role of tropical forests for local livelihoods in Indonesia. *International Journal of Environment and Sustainable Development* (In press).
- BELSKY, J.M. and SIEBERT, S.F. 1983. Household responses to drought in two subsistence Leyte villages. *Philippine Quarterly of Culture and Society* **11**: 237–256.
- BOEDHIHARTONO, A.K., GUNARSO, P., LEVANG, P. and SAYER, J. 2007. The principles of conservation and development: do they apply in Malinau?. *Ecology and Society* **12**(2): 2.
- BYRON, N. and ARNOLD, M. 1999. What futures for the peoples of the tropical forests? *World Development* **27**(5): 789–805.
- COLFER, C.J.P., SHEIL, D. and KISHI, M. 2006. Forest and human health: Assessing the evidence. CIFOR Occasional Paper No. 45. Center for International Forestry Research, Bogor, Indonesia. 111 p.
- FISHER, M. and SHIVELY, G. 2005. Can income programs reduce tropical forest pressure? Income shocks and forest use in Malawi. *World Development* **33**(7): 1115–1128.
- GODOY, R., JACOBSON, M. and WILKIE, D. 1998. Strategies of rain-forest dwellers against misfortunes: the tsimane' Indians of Bolivia. *Ethnology* **37**(1): 55–69.
- GODOY, R., WILKIE, D., OVERMAN, H., CUBAS, A., CUBAS, G., DEMMER, J., McSWEENEY, K. and

- BROKAW, N. 2000. Valuation of consumption and sale of forest goods from a Central American Rain Forest. *Nature* **406**: 62–63.
- GURVEN, M., ALLEN-ARAVE, W., HILL, K., and HURTADO, M. 2001. Reservation food sharing among the Ache of Paraguay. *Human Nature* **12**(4): 273–297.
- HECHT, S., ANDERSON, A. and MAY, P. 1988. The subsidy from nature: Shifting cultivation, succession palm forests, and rural development. *Human Organization* **47**: 25–35.
- KASKIJA, L. 1995. *Punan Malinau: The persistence of an unstable culture*. MA Thesis. University of Uppsala, Uppsala, Sweden. 136 p.
- LEVANG, P., DOUNIAS, E. and SITORUS, S. 2005. Out of the forest, out of poverty? *Forests, Trees and Livelihoods* **15**: 211–235.
- LEVANG, P., SITORUS, S. and DOUNIAS, E. 2007. City life in the midst of the forest: a Punan hunter-gatherer's vision of conservation and development. *Ecology and Society* **12**(1): 18.
- MARQUETTE, C.M. 2006. Settler welfare on tropical forest frontiers in Latin America. *Population and Environment* **27**(5–6): 397–444.
- McSWEENEY, K. 2005. Natural insurance, forest access, and compounded misfortunes: forest resources in smallholders coping strategies before and after hurricane Mitch, Northeastern Honduras. *World Development* **33**(9): 1453–1471.
- MEIJAARD, E., SHEIL, D., NASI, R., AUGERI, D., ROSENBAUM, B., ISKANDAR, D., SETYAWATI, T., LAMMERTINK, A., RACHMATIKA, I., WONG, A., SOEHARTONO, T., STANLEY, S. and O'BRIEN, T. 2005. *Life after logging: reconciling wildlife conservation and production forestry in Indonesian Borneo*. Center for International Forestry Research, Bogor, Indonesia. 345 p.
- PADMANABA, M., and SHEIL, D. 2007. Finding and promoting a local conservation consensus in a globally important tropical forest landscape. *Journal of Biodiversity Conservation* **16**(1): 137–151.
- PATTANAYAK, S.K. and SILLS, E.O. 2001. Do tropical forests provide natural insurance? The microeconomics of non-timber forest product collection in the Brazilian Amazon. *Land Economics* **77**(4): 595–612.
- PIERCE, A.R. and EMERY, M.R. 2005. The use of forests in time of crisis: Ecological literacy as a safety net. *Forest, Trees and Livelihoods* **15**: 249–252.
- SELLATO, B. 2001. *Forest, resources and people in Bulungan; elements for a history of settlement, trade, and social dynamics in Borneo, 1880–2000*. Center for International Forestry Research, Bogor, Indonesia. 183 p.
- SHEIL, D. 2002. *Biodiversity research in Malinau*. In CIFOR. Technical report, phase I (1997–2001). Forest, science and sustainability: The Bulungan model forest. ITTO Project PD 12/97 Rev.1 (F), 57–107. Center for International Forestry Research, Ministry of Forestry and International Tropical Timber Organization, Bogor, Indonesia. 168 p.
- SHEIL, D. and WUNDER, S. 2002. The value of tropical forest to local communities: complications, caveats, and cautions. *Conservation Ecology* **6**(2): 9.
- SHEIL, D., PURI, R.K., BASUKI, I., van HEIST, M., WAN, M., LISWANTI, N., RUKMIYATI, AGUNG SARDJONO, M.A., SAMSOEDIN, I., SIDIYASA, K., CHRISANDINI, PERMANA, E., MANGOPO ANGI, E., GATZWEILER, F., JOHNSON, B. and WIJAYA, A. 2003. *Exploring biological diversity, environment and local people's perspectives in forest landscapes. Methods for a multidisciplinary landscape assessment*. Second edition. Center for International Forestry Research, Bogor, Indonesia.
- SHEIL, D. and LISWANTI, N. 2006. Scoring the importance of tropical forest landscapes with local people: patterns and insights. *Environmental Management* **38**(1): 126–136.
- SHEIL, D., PURI, R.K., WAN, M., BASUKI, I., van HEIST, M., LISWANTI, N., RUKMIYATI, RACHMATIKA, I. and SAMSOEDIN, I. 2006. Recognizing local people's priorities for tropical forest biodiversity. *Ambio* **35**(1): 17–24.
- SHEIL, D., van HEIST, M., LISWANTI, N., BASUKI, I. and WAN, M. 2008. Biodiversity, landscapes and livelihoods: a local perspective. Pages 61–90 in M. Moeliono, E. Wollenberg, and G. Limberg, editors. *The decentralization of forest governance: politics, economics and the fight for control of forest in Indonesian Borneo*. Center for International Forestry Research, Bogor, Indonesia.
- SOKAL, R. and ROHLF, F.J. 1995. *Biometry. The principles and practices of statistics in biological research*. Third edition. State University of New York at Stony Brook, New York, USA.
- TAKASAKI, Y., BARHAM, B.L. and COOMES, O.T. 2004. Risk coping strategies in tropical forests: floods, illness, and resource extraction. *Environment and Development Economics* **9**: 203–224.
- VÖLKER, M. and WAIBEL, H. 2010. Do rural households extract more forest products in times of crisis? Evidence from the mountainous uplands of Vietnam. *Forest Policy and Economics* **12**: 407–414.
- WARNER, K. 2000. Forestry and sustainable livelihoods. *Unasylva* **51**(202): 3–12.
- WOLLENBERG, E., CAMPBELL, B., DOUNIAS, E., GUNARSO, P. MOELIONO, M. and SHEIL, D. 2008. Interactive land-use planning in Indonesian rain-forest landscapes: reconnecting plans to practice. *Ecology and Society* **14**(1): 35.

No. of respon-dents	Village	Family members	Ethnic group	Gender	Age	Education	Occupation	Mean Wealth	LoC	LoH	LD	LoDA	R	TAL	IRF	SE
1	PS	6	Merap	M	56-70	NS	Farmer	>100-200	severe	severe	severe	medium	yes	yes	minor	yes
2	PS	10	Merap	M	46-55	ES	Carpenter	0	severe	severe	severe	medium	yes	yes	major	yes
3	PS	7	Kenyah	M	31-45	SS	Carpenter	>100-200	severe	severe	severe	minor	yes	yes	major	yes
4	PS	5	Kenyah	M	31-45	ES	Farmer	>0-100	severe	severe	severe	minor	yes	yes	major	yes
5	PS	3	Kenyah	M	31-45	JS	Carpenter	>0-100	severe	severe	severe	minor	yes	yes	major	yes
6	PS	6	Kenyah	M	56-70	NS	Farmer	>0-100	medium	severe	medium	minor	yes	yes	minor	no
7	PS	2	Merap	M	31-45	ES	Farmer	0	severe	severe	severe	minor	yes	yes	minor	yes
8	PS	1	Merap	M	31-45	ES	Farmer	0	severe	severe	severe	minor	yes	yes	minor	yes
9	PS	5	Putuk	M	31-45	SS	Carpenter	>100-200	severe	severe	severe	medium	yes	yes	major	yes
10	PS	5	Merap	M	31-45	NS	Farmer	0	severe	severe	severe	medium	yes	yes	major	yes
11	PS	6	Kenyah	M	31-45	NS	Farmer	0	severe	severe	severe	medium	yes	yes	major	yes
12	L	5	Merap	M	46-55	SS	Teacher	>100-200	medium	minor	medium	medium	no	yes	no	yes
13	L	3	Merap	M	31-45	JS	Farmer	0	medium	minor	medium	medium	no	yes	no	no
14	L	6	Merap	M	56-70	SS	Farmer	>100-200	medium	minor	medium	medium	no	yes	no	yes
15	L	2	Merap	F	46-55	ES	Farmer	>200-300	medium	medium	medium	partial	yes	yes	minor	yes
16	L	4	Puthuk	M	56-70	SS	Carpenter	>100-200	medium	minor	medium	minor	no	no	minor	yes
17	L	7	Merap	M	56-70	ES	Farmer	>0-100	medium	minor	medium	minor	no	yes	minor	no
18	L	7	Merap	F	31-45	JS	Teacher	>100-200	medium	minor	medium	minor	no	yes	no	no
19	L	4	Merap	M	31-45	ES	Farmer	>100-200	medium	medium	medium	minor	no	yes	minor	no
20	GS	4	Merap	M	31-45	NS	Farmer	>0-100	severe	medium	severe	minor	no	yes	major	no
21	GS	7	Merap	M	56-70	NS	Farmer	0	severe	medium	severe	minor	yes	yes	major	yes
22	GS	7	Merap	M	31-45	ES	Farmer	>0-100	medium	medium	severe	minor	yes	yes	major	yes
23	GS	13	Merap	M	31-45	ES	Farmer	>0-100	severe	medium	severe	minor	no	yes	minor	yes
24	GS	8	Merap	M	31-45	JS	Farmer	>0-100	severe	medium	severe	minor	no	yes	major	yes
25	GS	6	Merap	M	31-45	ES	Carpenter	>0-100	severe	severe	severe	severe	no	no	minor	yes
26	GS	5	Merap	F	46-55	NS	Farmer	>100-200	severe	severe	severe	severe	no	yes	no	yes
27	GS	2	Merap	M	20-30	NS	Farmer	0	medium	medium	severe	minor	no	no	major	no
28	GS	3	Merap	M	31-45	ES	Farmer	>200-300	severe	medium	severe	minor	no	yes	major	no
29	GS	3	Merap	M	31-45	ES	Farmer	0	medium	medium	severe	minor	no	yes	major	no
30	GS	4	Merap	M	31-45	ES	Farmer	>0-100	medium	medium	severe	minor	no	yes	major	no
31	GS	6	Merap	F	31-45	SS	Farmer	>0-100	severe	medium	severe	medium	no	yes	minor	no

No. of respondents	Village	Family members	Ethnic group	Gender	Age	Education	Occupation	Mean Wealth	LoC	LoH	LD	LoDA	R	TAL	IRF	SE
32	GS	6	Merap	M	31-45	ES	Farmer	0	severe	medium	severe	minor	no	no	minor	no
33	PR	3	Punan	F	31-45	NS	Farmer	>0-100	severe	severe	medium	severe	yes	no	minor	yes
34	PR	2	Punan	F	20-30	ES	Hunter	0	severe	severe	medium	severe	yes	no	major	no
35	PR	2	Punan	F	20-30	JS	Hunter	0	severe	severe	medium	severe	yes	no	minor	yes
36	PR	3	Punan	F	20-30	JS	Farmer	>0-100	severe	severe	severe	severe	yes	no	minor	yes
37	PR	5	Punan	M	46-55	NS	Farmer	>0-100	severe	severe	severe	severe	yes	yes	major	yes
38	PR	7	Punan	M	56-70	NS	Hunter	0	severe	severe	severe	severe	yes	yes	major	yes
39	PR	2	Punan	M	20-30	ES	Hunter	0	severe	severe	severe	severe	yes	yes	major	yes
40	PR	3	Punan	M	20-30	ES	Hunter	0	medium	severe	medium	severe	yes	no	major	no
41	PR	7	Punan	M	31-45	NS	Hunter	0	medium	severe	medium	severe	yes	no	major	no
42	PR	5	Timor	M	31-45	JS	Carpenter	>0-100	medium	severe	medium	severe	yes	no	minor	yes

Notes: PS=Paya Seturan, L=Langap, GS=Gong Solok, PR=Punan Rian; F=Female, M=Male; NS=No School, ES=Elementary School, JS=Junior high School, SS=Senior high School; C=Catholic, P=Protestant; LoC = Loss of crops; LH = Loss of house, LD= Land damage; LoDM= Loss of domestic animals; R=Resettlement; TAL= Temporarily Agricultural L.,and Increased Reliance on Forest (IRF); Search for Employment (SE).