Resource use and livelihood change in Cambodia's dry forests: implications for conservation

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Contents

Abstract

Traditional land management can support important and distinctive biodiversity in landscapes where these practices substitute for lost natural processes. Conservation could work closely with local communities to protect this biodiversity, but how this is achieved depends on the extent to which local people rely on the landscape and the livelihood practices benefitting biodiversity, and the long-term prospects for these practices. We examine these issues in the case of the dry forest ecosystem in northern Cambodia, where domestic livestock and low-intensity rice cultivation benefit a suite of threatened species. We valued the importance of livelihood activities and natural resource use for the forest community and examined early signs and likely impacts of change.

The forest was used by 97.7% of households and accounted for over half of the total net value of livelihoods. Livestock were an important asset to households, particularly in the form of fixed capital which was equivalent to 73.9% of overall livelihood net value in grass-roof and 123.6% in metal-roof households. Livestock capital provided benefits through added livelihood security and financial gain. While the community currently takes substantial benefit from the landscape and the valuable livelihood practices that sustain biodiversity, there were signs of livelihood change. Agricultural mechanisation is occurring through increased use farm machinery and changing markets and attitudes are causing new patterns of livestock use and herd composition.

These livelihood transitions are likely to be augmented by dramatic social, economic and environmental changes in the coming decades. These threaten to irreversibly change traditional livelihood practices, with important implications for the dry forest biodiversity dependent on them. Several will likely face extinction should these practices be lost. Conservationists will need to seek mechanisms that mimic or maintain these practices in the face of such change.

សេចក្តីសង្ខេប

ការគ្រប់គ្រងជីជាលក្ខណៈប្រពៃណីអាចទ្រទ្រង់ជីវៈចម្រុះសំខាន់ៗ និងប្លែកៗក្នុងតំបន់ទេសភាពនានាដែលការអនុវត្តទាំងអស់នេះជំនួសអោយដំណើរនៃការបាត់បង់ធម្មជាតិ ។ ការអភិរក្សអាចធ្វើការយ៉ាងជិតស្និតជាមួយសហគមន៍មូលដ្ឋានដើម្បីការពារជីវៈចម្រុះនេះ ប៉ុន្តែកិច្ចការនេះសំរេចបានយ៉ាងណាគឺអាស្រ័យទៅលើទំហំដែលប្រជាជនមូលដ្ឋានពឹងផ្អែកលើតំបន់ទេសភាព និងការប្រកបរបរបរិញ្ញឹមជីវិតដែលផ្តល់អត្ថប្រយោជន៍ដល់ជីវៈចម្រុះ និងចក្ខុវិស័យរយៈពេលវែងនៃការប្រកបរបរបរិញ្ញឹមជីវិតទាំងអស់នេះ ។ យើងធ្វើការពិនិត្យលើបញ្ហាទាំងអស់នេះនៅតំបន់ប្រព័ន្ធអេកូឡូស៊ីព្រៃស្ងួតភាគខាងជើងប្រទេសកម្ពុជាដែលជាកន្លែងមានការប្រកបរបរមានដូចជា: ការបិញ្ញឹមសត្វគោក្របីធ្វើស្រែតាមបែបប្រពៃណីរួបញ្ចកម្មកំរិតទៀបបានផ្តល់ប្រយោជន៍ដល់ប្រភេទសត្វព្រៃដែលរងការគំរាមកំហែង ។ យើងបានវាយតម្លៃអំពីភាពសំខាន់នៃមុខរបរបរិញ្ញឹមជីវិតទាំងនេះ និងការប្រើប្រាស់ធនធានធម្មជាតិសំរាប់សហគមន៍ព្រៃឈើ និងបានពិនិត្យសញ្ញាលេចចេញជំបូងៗ ព្រមទាំងឥទ្ធិពលនៃការប្រែប្រួល ។

ព្រៃឈើត្រូវបានប្រើប្រាស់ដោយសមាជិកក្រុមគ្រួសារប្រមាណ ៩៧,៧% និងបានរាប់រងជាងពាក់កណ្តាលថ្លៃជើមសរុបនៃការបិញ្ញឹមជីវិត ។ សត្វចិញ្ចឹមគឺជាទ្រព្យសម្បត្តិសំខាន់មួយរបស់គ្រួសារ ជាពិសេសបើគិតជាជើមទុនសកម្មវាមានតម្លៃស្មើនឹង ៧៣,៩% នៃថ្លៃជើមក្នុងការបិញ្ញឹមជីវិតទូទៅក្នុងគ្រួសារដែលមានផ្ទះស្លឹក ១២៣,៦% នៃគ្រួសារមានផ្ទះសង្កសី ។ សត្វចិញ្ចឹមបានផ្តល់ផលប្រយោជន៍តាមរយៈការចូលរួមបង្កើនសុវត្ថភាពនៃការបិញ្ញឹមជីវិត និងការទទួលបានកំណើនហិរញ្ញវត្ថុ ។ ខណៈពេលដែលសហគមន៍បានទាញយកផលប្រយោជន៍យ៉ាងច្រើនពីតំបន់ទេសភាព និងកំពុងប្រកបរបរបរិញ្ញឹមជីវិតដែលមានតម្លៃសំរាប់ជួយការពារជីវៈចម្រុះ សញ្ញានៃការផ្លាស់ប្តូរនូវមុខរបរបរិញ្ញឹមជីវិតក៏បានលេចឡើងផងដែរ ពិសេសគឺការធ្វើកសិកម្មដោយគ្រឿងយន្តដែលកំពុងស្តែងឡើងតាមរយៈការកើនឡើងនូវការប្រើប្រាស់គ្រឿងចក្រកសិកម្ម និងការផ្លាស់ប្តូរទីផ្សារ ដោយឡែកឥរិយាបថផ្លាស់ប្តូរទាំងនេះក៏កំពុងបង្ករជាទំរងថ្មីនៃការប្រើប្រាស់សត្វគោ-ក្របី និងចំនួនសត្វចិញ្ចឹមផងដែរ ។

របទនៃការផ្លាស់ប្តូររបរបរិញ្ញឹមជីវិតនេះហាក់ដូចជាត្រូវបានពង្រីកកាន់តែធំឡើងៗដោយសារការប្រែប្រួលសង្គម សេដ្ឋកិច្ច និងបរិស្ថានដែលកើតយ៉ាងឆាប់រហ័សក្នុងទស្សវត្សនឹងមកដល់នាពេលខាងមុខ ។ កត្តាគំរាមគំហែងទាំងនេះនឹងធ្វើអោយមានការផ្លាស់ប្តូរដោយគ្មានថ្ងៃត្រឡប់មកវិញនូវរបរបរិញ្ញឹមជីវិតជាលក្ខណៈប្រពៃណីដែលធ្លាប់មានមក ហើយដែលរបរទាំងនេះមានតួនាទីដ៏សំខាន់សំរាប់អោយជីវៈចម្រុះព្រៃស្ងួតពឹងអាស្រ័យ ។ ប្រភេទជាច្រើនប្រហែលជាប្រឈមមុខនឹងការជុតពូជប្រសិនជារបរបិញ្ញឹមជីវិតជាលក្ខណៈប្រពៃណីទាំងនេះប្រឈមនឹងការបាត់បង់ ។ អ្នកអភិរក្សចាំបាច់ត្រូវរកយន្តការ ដែលអាចធ្វើត្រាប់តាម ឬថែរក្សាមុខរបរទាំងអស់នេះឆ្លើយតមនឹងការផ្លាស់ប្តូរ ។

Photo: Jonathan C Eames

Chapter 1
Introduction

Integrating biodiversity protection with local community interests has become a dominant narrative in conservation (Adams and Hulme 2001a; Hutton *et al*. 2005). Developing-world conservationists recognise the need to consider local livelihoods and natural resource access for interventions to be accepted locally and achieve success (Adams and Hulme 2001b; Colchester 2000; Schwartzman *et al*. 2000). Nevertheless, exactly how conservationists should involve or negotiate with local communities remains contested. Several approaches, such as integrated conservation and development projects (ICDPs) and community-based natural resource management (CBNRM), have provided incentives for communities to conserve a local environmental resource. In the process of management, the biodiversity sharing this resource is indirectly protected (Barrow and Murphree 2001; Brown 2002). Direct payments for conservation have become popular more recently, these are contracts negotiated with local communities who receive rewards (financial or in-kind) for delivering biodiversity protection (Milne and Niesten 2009; Wunder 2007).

In the developing world these approaches are most frequently applied in ecosystems where humans threaten biodiversity, and conservation goals may not easily align with local livelihood interests in these circumstances (Redford and Sanderson 2000). Modification or substitution of existing livelihoods is required to mitigate biodiversity damage. Schemes such as direct payments typically aim to change local behaviours (Milne and Niesten 2009), giving communities' alternative livelihoods or compensation so that existing, detrimental practices can be modified or replaced. In the cloud-forests of Bolivia for example, farmers are signing contracts prohibiting them from forest clearance and hunting. In return for full compliance they receive beehives and apicultural training (Asquith *et al*. 2008).

There is, however, emerging evidence that existing livelihood practices can be beneficial to biodiversity in the developing world. Open-habitat species may develop strong dependencies on land management practices where these substitute for natural processes in landscapes transformed by human activity. In grasslands, domestic livestock may mimic or substitute crucial ecosystem functions once provided by the wild herbivores that are now extirpated or scarce. Domestic livestock can create suitable vegetation conditions for larks and waders that require grazed habitat to forage and breed (Kamp *et al*. 2009; Maphisa *et al*. 2009). Mixed low-impact agriculture combining pastoralism and low-intensity cultivation can be of benefit too; the Bengal Florican uses traditionally-managed grassland in which to breed and forages in fallow rice fields (Gray *et al*. 2009; Gray *et al*. 2007). Identifying which farming systems and practices are beneficial to biodiversity requires a detailed understanding of the interactions between threatened species and local livelihoods.

Failure to maintain these valuable livelihood practices could result in the extirpation of the threatened species associated with them. Nevertheless, how conservation should involve communities in these circumstances is not yet clear. If communities show a strong dependence on the landscapes and livelihood practices important to biodiversity, conservation may be able to work closely alongside local people to protect their livelihoods and resource access while simultaneously safeguarding biodiversity. However, population, economic and environmental changes may threaten the long-term viability of valuable livelihood practices, in which case conservationists will need to develop new mechanisms to maintain them.

This study investigates the livelihoods of a dry forest community in northern Cambodia, where traditional land use benefits a suite of critically endangered birds and other wildlife. We examine the community's reliance on the landscape and its natural resources, and assess how local people gain value from those livelihood practices important to biodiversity, specifically livestock husbandry. Signs of change and the long-term viability of existing livelihoods are also explored. These findings inform a discussion of the conservation implications of livelihood change and the possible mechanisms that could maintain valuable livelihood practices in this dry forest ecosystem.

Photo: Jonathan C Eames

Chapter 2

Study system

The seasonally dry forests of Indochina represent an open-canopy forest biome dominated by fire-tolerant deciduous dipterocarp tree taxa and grassy understoreys. Dry forests are typically found in a mosaic of semi-evergreen forest and open grasslands, containing a high frequency of small, seasonal waterholes (CEPF 2007). These support a distinct set of biodiversity including 7 critically endangered or endangered mammals and 12 critically endangered or endangered birds (Clements *et al*. 2010). The forest is also home to a growing human population in small but widespread settlements. Cambodia contains some of the most intact dry forest habitats and species assemblages (Loucks *et al*. 2009), but they face a number of threats including plantation agriculture (BirdLife International 2003a), infrastructural projects (BirdLife International 2010), local intensification and expansion of agriculture (CEPF 2007) and logging for local construction use.

Traditional livelihoods and associated land management play an important role in sustaining threatened dry forest species. Extensive grazing of domestic livestock is especially valuable in the absence of once-abundant natural agents such as Asian Elephant *Elephas maximus*, Gaur *Bos gaurus*, Banteng *B. javanicus* and Wild Water Buffalo *Bubalus bubalus* (Wharton 1968). Grazing and wallowing by domestic water buffalo and cattle is likely fulfilling a key ecosystem function once provided by these now-extirpated large herbivores (Timmins 2008). Removal of vegetation at waterholes is important to waterbirds including the critically endangered White-shouldered Ibis *Pseudibis davisoni*, which requires exposed, sparsely-vegetated substrates to forage in (Wright *et al*. 2010a). Overall persistence of waterholes in the landscape could also be related to constant use by domestic livestock.

Livestock also play a crucial role in sustaining populations such as the critically endangered White-rumped Vulture *Gyps bengalensis*, Slender-billed Vulture *Gyps tenuirostris* and Red-headed Vulture *Sarcogyps calvus* (Houston 1996; Pain *et al*. 2003). The dry forests in Cambodia are now a vital stronghold for these species where they rely on the carcasses of domestic livestock for food – so far free of diclofenac residues (BirdLife International *et al*. 2005). The clear link between livestock and the maintenance of resources for threatened species justifies the particular focus on the importance of livestock to local livelihoods in this study.

Other aspects of local livelihoods may also have value at both species and ecosystem levels. Fallow lands are created by the shifting patterns of low-intensity wet season rice cultivation in the open access forest – the prevalent form of agriculture here. This benefits White-shouldered Ibis which takes advantage of open terrestrial habitats in the wet season (Wright *et al*. 2010b). Anthropogenic fires are a regular dry season feature, lit for the primary reason of encouraging fresh graze for livestock (WWF 2007). These too may be enhancing the availability of non-breeding season habitat for White-shouldered Ibis (HW, unpublished data). The long history of burning in this region suggests that the dry forest biome itself may be anthropogenically derived (Maxwell 2004).

This study was undertaken in Western Siem Pang Important Bird Area (IBA) in northern Cambodia (14 07'N, 106 14'E), an area of 152,825 ha comprising a mosaic of dry dipterocarp, mixed deciduous and semi-evergreen forests at an altitude of 55-186 m above sea level (Seng *et al*. 2003). The annual monsoon cycle brings an average of 2266 mm of rain to the region and temperatures average 32.3 ^{o}C annually (Thuon and Chambers 2006, Wright unpublished data). Small-scale conservation activities have taken place in Western Siem Pang

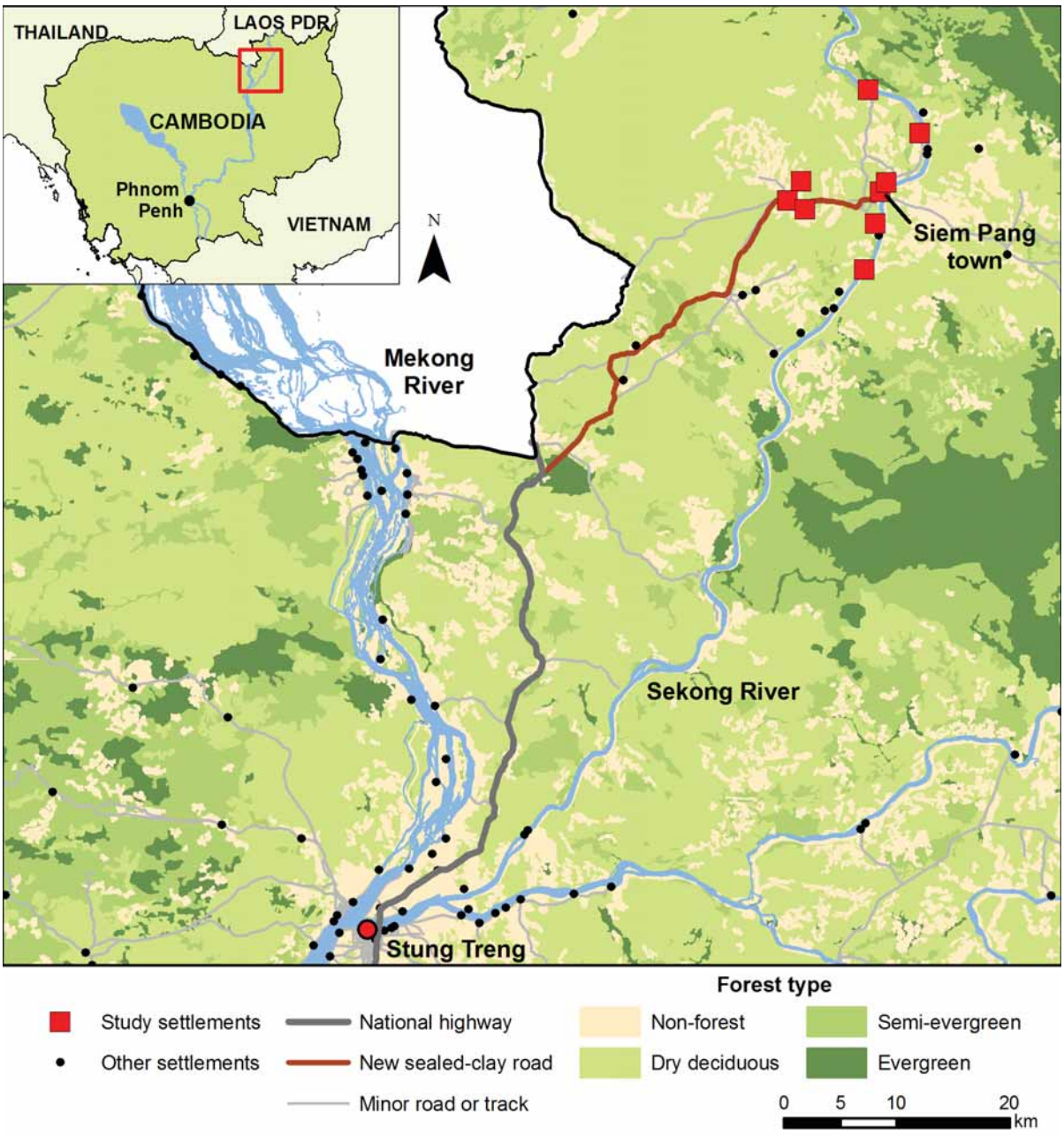

Figure 1 Map of the study settlements in Western Siem Pang IBA and their connectivity with Stung Treng, the provincial town.

IBA since 2003 although the site remains legally unprotected. The IBA contains globally important populations of two critically endangered ibis species and the three critically endangered vultures (Birdlife International Cambodia Programme 2012, Seng *et al*. 2003).

We focused on nine settlements in three communes; six on the banks of the River Sekong and three located *c.* 8 km inland (Fig. 1)[1]. Together they hold a population of 7601 people of which 16.2% live in the small district town of Siem Pang (Ministry of Planning 2007).

[1] Study settlements were Siem Pang, Lun and Ban Moung in Sekong Commune; Pha Bang, Lakay and Nhang Sum in Thmorkao Commune; and Kheh Svay, Kheh Kraom and Pong Kriel in Prek Meas Commune.

Siem Pang contains a small market attracting the vast majority of local trade. At the time of study, these settlements were connected to the nearest large market town (the provincial centre of Stung Treng) by road in the dry season and by river in the wet season, each a distance of *c*. 93 km (Fig. 1). In late 2010 the road was improved to become useable year-round. The majority of imported goods reach Siem Pang via Stung Treng, although the area's proximity to the border with southern Laos PDR enables some trade to arrive from here.

Photo: Jonathan C Eames

Chapter 3
Methodology

The research approach integrated quantitative and qualitative self-reporting techniques to get a comprehensive understanding of the community's livelihood strategies, their reliance on the landscape and its natural resources, and the benefits gained from livestock husbandry in particular. Data regarding each of these themes was collected using a variety of survey methods, with quantitative assessments backed-up by qualitative testimonials. Adopting these two modes of research enabled integrated triangulation of data (Bryman 2008) and cross-verification between different survey techniques.

The nine study settlements were selected to provide a representative cross-section of the community including three ethnic groups (Khmer-Laos, Khmer Kheh and Khmer) and the contrast between riverside and inland villages. Households (identifiable groups of people connected by kinship) were deemed the appropriate unit of analysis to understand livelihood strategies as we assume that livelihoods decisions are made at household rather than individual level (Cavendish 2002). We hypothesised that poorer households may have greatest dependency on the landscape and its resources and so this was investigated using household roof material as a proxy for wealth; grass-roof (the poorer) and metal-roof (the wealthier) households were compared in our analysis.

Understanding livelihood strategies and change

We undertook a scoping survey in 2008-2009 to identify the community's main livelihood activities, and frequency of use, diversity of household livelihood strategies, number of livestock owned and household characteristics (such as floor area). This comprised of a structured questionnaire undertaken with an adult member of each household and lasting approximately 20 minutes. A sample of 103 grass-roof and 155 metal-roof households (n = 258) were obtained from all nine villages, representing 26.2% and 16.1% of total available households respectively. Metal-roof households were selected at random but grass-roof households were oversampled to compensate for the scarcer occurrence of this household type.

Semi-structured interviews with 13 key informants were used to understand community-level trends, motivations for specific livelihood activities and signs of livelihood change. Key informants included villagers, NGO workers and village-, commune- and district-level governmental officials. Informants were selected using a snowball sampling approach (Biernacki and Waldorf 1981), whereby informants recommend other potentially useful interviewees. Interview guides were initially very broad in focus until key themes of natural resource use or livelihood change were identified. Further interview guides were developed and interviewees selected to elucidate and expand on these themes. Special care was taken to probe informants about key issues while avoiding leading questions and maintaining objectivity (Bernard 2011).

Interview transcripts and notes were manually coded following an open-coding approach (Bryman 2008). Responses were categorised into common themes to identify similarities and differences in opinion. Analysis was aided by dividing informants into groups of high and low reliability for a given theme. NGO workers and government officials working closely with the community, as well as villagers with strong expertise in a particular activity, were typically rated highly. Informants' opinions are shaped by their own personal motivations, perceptions and experiences – or "social realities" (Ellen 1984) – and therefore caution was taken when interpreting and generalising their responses to the village and community levels.

Secondary quantitative data was collected from commune chiefs, district officials, and the Ministry of Planning to understand demographic change in the community. Data prior to 2007 was difficult to obtain, and therefore historic patterns of change were investigated using structured interviews with 24 elders in the community (those older than 50 years). Elders were interviewed opportunistically during household surveys and were asked whether, and how, long-term livelihood and environmental change had occurred during their lifetimes. Key themes included human and livestock population change and availability of natural resources.

Household survey of livelihood activity values

The scoping survey identified several key livelihood activities undertaken in the community: rice cultivation; garden agriculture; livestock husbandry; fishing; forest use and formal employment (such as state-paid jobs) or regular business (such as shop-running or transport provision). We assessed their relative importance using the net value that households gained from each activity. A quantitative household survey was undertaken in 2009-2010 to collect economic and resource-use data for each livelihood activity over a one-year period. This included the consumption, cash income, costs and other inputs of each activity. Surveys lasted approximately 45 minutes and were undertaken with household members aged 19 or over (both men and women) ensuring that the respondent was knowledgeable about the household's activities.

Survey households were visited twice each to recall two six-month periods, corresponding to the rice cultivation season (June-November) and the dry season (December-May). Recall over long time periods may cause underestimation of resource use (Cavendish 2002), however we expect the most significant livelihoods contributions to have remained memorable. We used a subset of 70 households randomly selected from the scoping survey sample. However, sample attrition, mainly due to households moving, resulted in a final sample size of 64 households. This comprised 24 grass-roof houses and 40 metal-roof houses (6.1% and 4.1% of total households respectively).

The quantitative household surveys were undertaken by Cambodian research assistants and used structured questionnaires, containing closed questions, to elicit quantitative answers. To improve their willingness to participate, respondents were informed of the survey purpose and the interviewer's non-affiliation with government or other locally powerful organisations. Anonymity was guaranteed to elicit information that may otherwise be guarded. Despite this, data regarding illegal activities such as collection of luxury timber and hunting of wild animals is likely to underestimate true levels. No attempt was made to value the reportedly strong drug-trafficking trade in riverside settlements.

Pricing goods and services

Livelihood activity valuation requires monetary data for all products and services used by the household. This includes subsistence or 'direct-use' of goods and services, which is a characteristically large part of household resource consumption in forest communities (Cavendish 2002; Shackleton and Shackleton 2000). Imputing a monetary value on goods and services that may never be marketed is controversial and there is little agreement over which methods are most appropriate (Cavendish 2002; Delang 2006; Dovie *et al*. 2005; Gram 2001). In practice, a compromise has to be found that bests suits the realities of the study community.

Local prices were determined for the majority of products using a local market survey of 13 shops and a focus group attended by shop owners and villagers from different settlements, in late 2009. Prices were easily obtained as trade, although sometimes very small-scale, exists for a large proportion of resources used. 'Farm-gate' prices were recorded in preference to market prices, as households, particularly outside of the market town, typically consumed collected or own-produced goods rather than purchased ones. Additional opportunistic data collection took place to corroborate data and gather prices for livelihood activities poorly represented by the market survey and focus group. Another 40 respondents, met during households surveys, were used based on their good knowledge of particular livelihood activities.

Goods without an obvious monetary value included fuelwood and rice straw for livestock fodder. Collection of these products involves use of ox-cart haulage, which has a local hire price. A willingness-to-pay approach was adopted for these goods, asking respondents what haulage cost they would find acceptable to pay per ox-cart of each product. While the plausibility of contingent valuation approaches has been questioned (Delang 2006), particularly for products that local people consider as free, the use of a potentially marketable service such ox-cart haulage in the collection of these goods enabled respondents to give reasonable personal valuations.

Prices from our range of sources were checked for consistency so that anomalous data and data using measurement units not applicable to households were removed. Averages were then calculated to create a single price per product or service. Prices of essential goods and services were surveyed again in May 2010, showing that prices had remained stable during the study period.

Livelihood activity and natural resource valuation

To compare the relative importance of livelihood activities we adapted the income accounting methods of Cavendish (2002) and Babulo *et al*. (2008) to derive the net value of key livelihood activities for a one-year period. Net value of livelihood activities comprises the sum of the value of goods and services consumed and sold by the household (either collected, own-produced or received as gifts), minus costs of production and collection and purchases of goods for consumption. (Babulo *et al*. 2008; Cavendish 2002). This incorporates not only cash income but also household consumption, and includes non-marketable as well as marketable goods and services. The net value is inclusive of the household's own labour costs (Babulo *et al*. 2008).

Goods-consumption and service-use data (in units of weight, volume or time), provided by the quantitative household surveys, were multiplied by their local price (Twine *et al*. 2003). Products that are both an output from one activity and an input to another need careful accounting to prevent double counting (Cavendish 2002). For example, the value of buffalo draught for ploughing rice fields was both deducted from rice cultivation as an input cost, and rebooked to livestock husbandry as an output value. Manure value could not be accounted for as the very casual nature of its use made quantification impossible. The net value of livestock husbandry included not only the products and services gained and inputs used, but also the indirect costs and gains of births, recruitment and deaths (Shackleton *et al*. 2005). Overall herd value was not valued here (see next section).

In addition to comparing the relative importance of different livelihood activities we also examined the use of natural resources versus household own-production (activities in which the household applies its own labour to produce products, namely through cultivation). Total net contribution of natural resources to livelihoods was calculated by summing net values of forest use and fishing activities – the activities derived from the dry forest ecosystem. All components of livelihood income are likely to vary between years (Cavendish 2002) so our valuation of livelihood activities and natural resource use presents only a single snapshot in time.

The role of livestock and herd capital value

Livestock were a particular focus of this study given their important ecological role in the dry forest ecosystem. The community's uses of livestock were determined by assessing motivations to buy and sell these animals. Respondents at the 64 households of the quantitative household survey were asked to list their livestock purchases and sales and their reasons for them. Further information regarding the importance of livestock, livestock husbandry's reliance on the dry forest, and changes to livestock use was gained through 18 key informant interviews. NGO and government official informants were supplemented by livestock owners and local abattoir businessmen. Interviews and analysis followed the approach used for understanding livelihood strategies (above).

The capital value of livestock herds (their total monetary value) provides households with a potentially valuable asset, separate from the net value gained from the inputs and outputs of livestock husbandry. Respondents of the quantitative household survey ($n = 64$) undertook a livestock census, recording the size of their herd using categories of animal type (corresponding to local prices based on animal, age and sex) at the beginning, middle and end of the one-year study period. This data was used to calculate total livestock herd capital value and the extent of capital change (due to births, deaths, recruitment, purchases and sales) per household.

Our data suggested that domestic water buffalo and cattle (the two types of livestock owned in this community) were differently related to household wealth. We tested this using scoping survey data ($n = 258$) to model household wealth with the number of buffalo and cattle per household. We used household floor area (m^2) as an indicator of wealth on the basis that it was readily quantifiable, was correlated with total livelihood value ($n = 64$, $r = 0.266$, $P = 0.033$) and was significantly larger in metal- than grass-roof households ($n = 258$, $W = 2140$, $P < 0.001$).

Testimonials from key informants and personal observations indicated that during our study, an increasing number of households in the community were using hand-tractors (Fig. 2). Hand-tractors are small, two-wheeled, petrol-run machines with versatile attachments used to haul customisable trailers or plough and till soil. We hypothesised that increasing use of hand-tractors would have consequences for livestock husbandry, and studied this using a mixture of survey approaches including participatory rural appraisal methods. A survey of 150 households was undertaken in early 2011 to determine the extent of hand-tractor ownership, the number of livestock being sold and the degree of herd replacement taking place. This used structured questionnaires to elicit mostly quantitative data. No sampling bias was given to grass-roof households in this survey.

Three focus groups in separate villages were used to complement the quantitative data (Bernard 2011) and comprised of 5-8 hand-tractor owners from separate households. These participants were invited to discuss motivations for purchasing hand-tractors and their advantages and disadvantages in comparison to livestock. In one village, a focus group was held twice, before and after hand-tractor owners used their ploughing machinery for the first time, to assess people's willingness and ease in changing their use of buffalo. We also undertook further key informant interviews to understand the rate of increasing hand-tractor ownership and the underlying motivations for these purchases.

Figure 2 A hand-tractor, here being used to transport construction wood.

Photo: Jonathan C Eames

Chapter 4
Results

Livelihood strategies

The livelihood characteristics and natural resource use of households in the study community are now presented, followed by evidence regarding their change.

Diversity of livelihood activities

Grass- and metal-roof households typically adopted multiple activities into their livelihoods (Figure 3a). Seven of the 16 households partaking in only one livelihood activity were involved in formal employment or business with a regular cash income. Similar types of activity were undertaken in grass- and metal-roof houses (Figure 3b), with forest use, rice cultivation and garden agriculture common to the majority of households in both groups. Livestock husbandry was practiced 15.6% less in grass-roof households than metal-roof, but fishing 12.8% more. Formal employment or regular business was comparatively rare. Forest use, including the collection of timber and non-timber products for consumption or sale, was nearly ubiquitous, while 51.9% of all 258 households reported they also used waterholes to collect forest products (a value similar between grass- and metal-roof households).

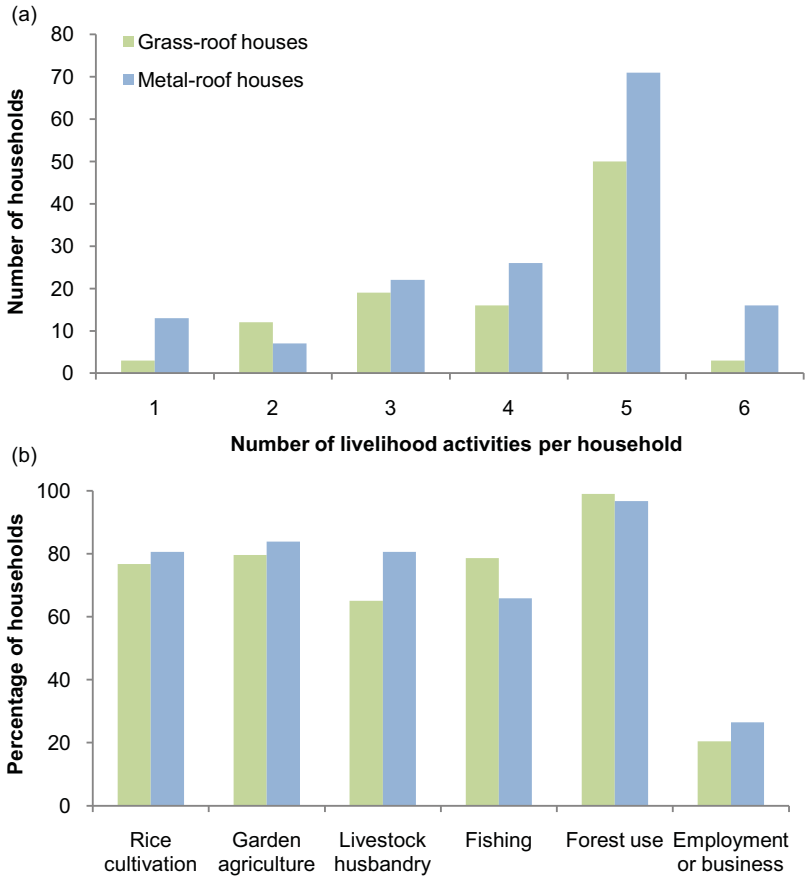

Figure 3 Differences between grass- and metal-roof households in the number of livelihood activities undertaken (a), and the percentage of households involved in livelihood activities of different types (b). Grass-roof households n = 103, metal-roof households n = 155.

Valuation of livelihood activities

Rice cultivation, routine forest use (collection of construction timber, fuelwood, non-timber forest products and animals) and fishing contributed greatest net value to livelihoods (Figure 4). Nevertheless, total livelihood and activity-specific net values were highly variable between households (Figure 5), ranging from a loss of -$938 to a gain of $3,680. Rice cultivation was the most valuable livelihood component ($312.16 ± 347.30 mean ± standard deviation per household), while the value gained from livestock was comparatively small and especially variable (Figure 5), averaging $79.75 ± 457.20, with 16 households making a loss. Livestock husbandry created significantly less net value than rice cultivation (Wilcoxon test $W = 1486.0$, $P = 0.007$) and routine forest use ($W = 1393.0$, $P = 0.002$).

Use of forest resources in the study period was marked by the illegal collection of luxury timber (such as the vulnerable Thailand rosewood *Dalbergia cochinchinensis*) and the legal collection of malva nuts from *Sterculia lychnophora* (known as "*samrong*"), both for trade purposes. Informant testimonials illustrate the recentness of these trades and the potentially very high incomes they generate (Figure 6). While collection of luxury timber has been taking place in this community for several years, this study year was exceptional as many more households, particularly poorer ones, decided to take advantage of the trade. Households utilised whatever means of transport they had, some using tractors or cars, others relying on motorbikes, ox-carts or even bicycles.

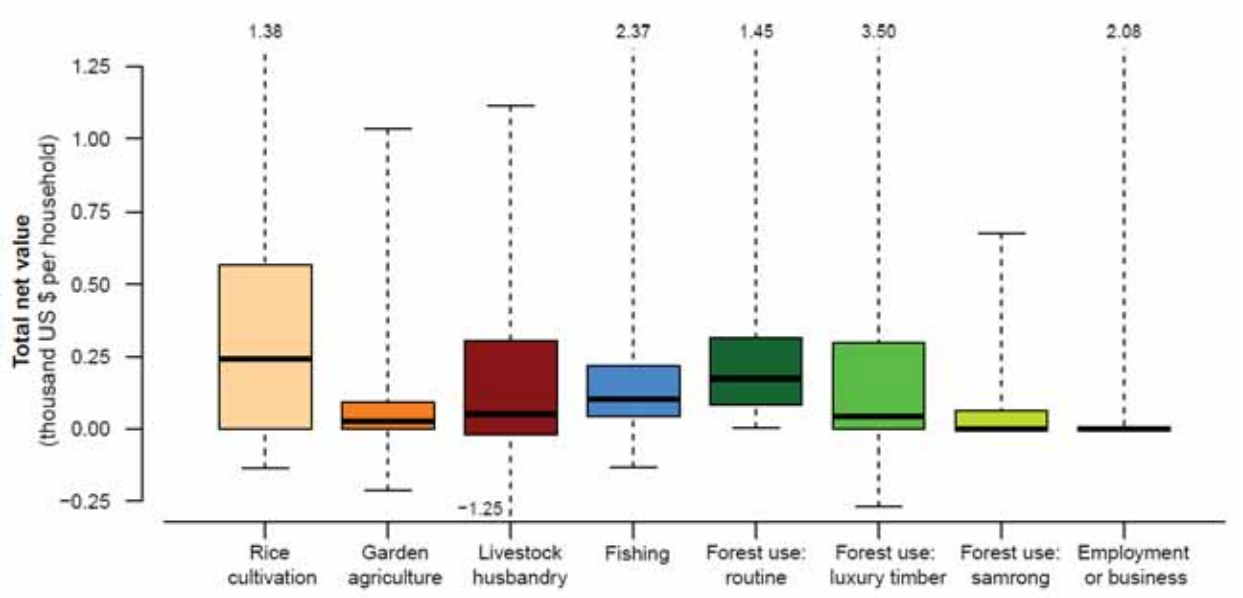

Figure 4 Net values of key livelihood activities, incorporating input and output goods and services for subsistence and market-trade uses combined. Thick, horizontal black lines indicate the median net value across the pooled sample of 64 households. Boxes indicate the inter-quartile range and error bars (with associated integers) the maximum and minimum values. Luxury timber and *samrong* are separated from routine forest reflecting their use as marketable commodities and their special importance in the study year.

Nonetheless, routine use of forest resources was more commonly practised (100.0% of households) and had significantly higher income than luxury timber collection ($W = 2649.0$, $P = 0.004$). *Samrong* collection in our sample was small, with only 19 households (29.7%) trading the fruit compared to 35 households (54.7%) trading luxury timber. Routine forest use largely comprised of timber for local construction (22.1% of total gross routine forest use value), illegal wild animal hunting (19.3%), vegetable and fruit collection (13.9%) and fuelwood collection (9.5%).

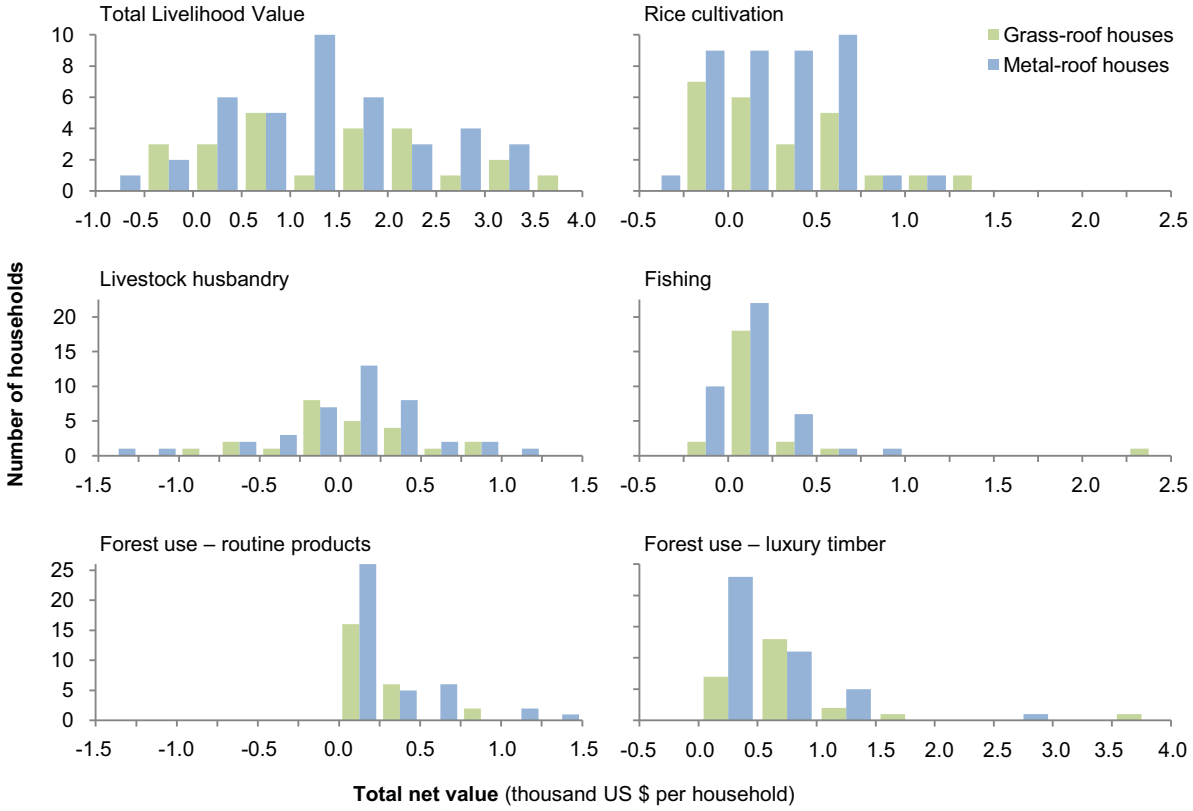

Figure 5 Household frequency histograms comparing total livelihood net value and the five livelihood activities of highest net value between grass- ($n = 24$) and metal-roof ($n = 40$) households.

Grass- and metal-roof households gained similar value from the majority of livelihood activities (Figure 5). The value gained from livestock husbandry was marginally higher in metal-roof households than grass-roof ($W = 349.5$, $P = 0.069$), while the value from luxury timber was marginally higher in grass-roof than metal-roof households ($W = 612.0$, $P = 0.055$). Slightly larger reliance on luxury timber explained why, contrary to expectations, grass-roof households actually averaged higher total livelihood value ($1,459.13 ± 1,139.22) than metal-roof houses ($1,371.92 ± 1009.50), though variability was considerable with no significant difference between the two groups.

I10: This year 80% of men in the village are going [to collect luxury timber] [...] it provides much bigger income than any other activity that people are doing. (Villager, age 35, with 7 years conservation NGO experience working locally)

I12: The last 3 years have seen huge landslide incomes from gathering "*samrong*" fruit [2010 only] and also "g'nyuong" [luxury] wood. This boosted cash [...] this year [2010] the involvement of the poorer households is much greater than it ever used to be. (Director of development NGO with 17 years experience working in Siem Pang)

I21: In recent years [...] going to get [luxury] timber from the forest has become important, this is new [...] people from outside are creating the demand in Siem Pang. (Local man with 10 years experience working with development NGO)

Figure 6 Testimonials of the recent importance of luxury timber and *samrong* collection.

Relative importance of subsistence and market trade uses

Grass-roof households chose to sell 12.7% more of their collected or own-produced products than metal-roof households (Figure 7). This significant difference ($W = 634.0$, $P = 0.033$) suggests that grass-roof households chose to adopt more market-based strategies in product use. However, metal-roof households did not, by implication, adopt more subsistence-based livelihoods, as 15.0% of them gained income from formal, wage-based employment, compared to only 8.3% of grass-roof households.

Motivation to sell products for cash income depended greatly on livelihood activity type (Figure 7). The vast majority of luxury timber and *samrong* was collected for sale, whereas routine forest resources were largely consumed. Wild animals were the most commonly sold routine forest product, accounting for 36.2% of this activity's gross sale income. Rice cultivation and fishing were principally subsistence activities for both grass- and metal-roof households.

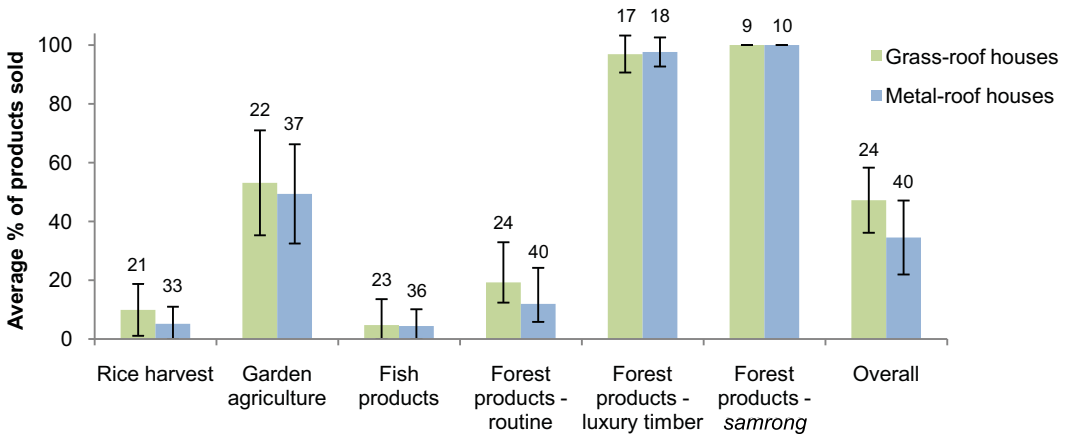

Figure 7 Average percentage of key livelihood products sold for cash income, per household. Only households partaking in a given activity are included and sample size (number of households) is given above the error bars. Livestock products (which comprise selling of whole animals only) are excluded and discussed below.

Natural resource contribution to livelihood value

Natural resources were a fundamental part of livelihoods, contributing 62.8% of average net livelihood value in grass-roof and 52.0% in metal-roof households (Figure 8a). This compares to contributions from household own-production of 24.9% and 27.6% for grass- and metal-roof households respectively and 7.8% and 14.0% for employment and regular business. These estimates are likely to be conservative as the illegality of luxury timber collection may have reduced respondents' willingness to admit to or quantify this activity fully. Natural resource use was split between subsistence consumption, accounting for 44.0% of use across all 64 households, and market trade, accounting for 56.0% of use.

Natural resource use was non-significantly different between grass- and metal-roof households with an average, but variable, contribution of $795.50 ± 698.56 per household (64 households pooled) (Figure 8b). The slightly greater contribution to grass-roof households was largely due to greater collection and sale of luxury timber. Seasonality played a role in the use of natural products, particularly the collection of forest fruits and vegetables for consumption, of which 98.8% were collected between June and November, the wet and early dry seasons. This probably reflects both increased abundance of fruits and vegetables at this time, but also the heavier reliance of households on foods from the forest in the months just prior to the rice harvest.

Livestock husbandry was heavily dependent on use of natural resources, namely livestock graze (in the forest and at waterholes) and wallow sites for buffalo. Testimonials from informants indicate the almost ubiquitous use of these resources by livestock-owning households (Figure 9). All livestock types are released into the forest during the dry and latter-half of the wet seasons, with the exception of oxen. Oxen are kept at the home because of their high value (Figure 14), regular use for ox-cart haulage and tendency to go far when released into the forest. Informants felt that the easy access to fodder in the forest was of greatest importance, as this saves households the considerable effort of collecting or producing it. The value of forest resources for livestock is embedded in the livestock husbandry net value. With this included the contribution of natural resources to livelihoods increases slightly to 67.3% for grass and 58.4% for metal-roof households respectively.

Our study year coincided with particularly high use of natural resources as many households took advantage of trade in luxury timber and good crops of *samrong* fruit (Figure 6). Nevertheless, more regular uses of natural resources, such as fishing and collection of routine forest products, also made important contributions, accounting for 30.7% of average livelihood net value in grass-roof households and 33.2% in metal-roof. These figures may in fact be underestimates as increased collection of luxury timber and *samrong* in this study year is likely to have at least partially replaced more regular uses of natural resources (Figure 10). Informants report that dry season activities such as fishing and hunting of wild animals were less than normal in 2009-2010 because households were investing more time into luxury timber and *samrong* collection. Other livelihood components such as rice cultivation and livestock husbandry were much less affected by these activities.

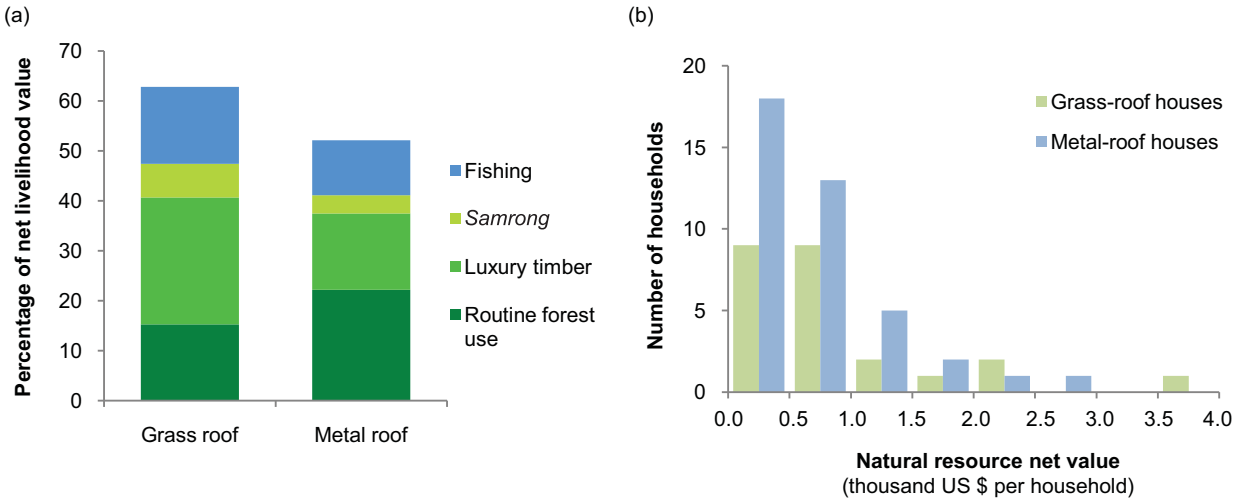

Figure 8 Contribution of natural resources to net livelihood value by natural resource type (a), and household frequency histogram for natural resource total net value (b), for grass- (n = 24) and metal-roof (n = 40) households. Natural resource use is calculated as the sum of all forest use and fishing activity net values.

I6: I let all my cattle go to the forest [...] they all live there without a problem, I don't have to collect grass or provide any [...] straw [...] in the past I had oxen [...] I kept these at home and gave them straw, but all my other animals live in the forest. *(Villager, age 60, owner of 120 cattle)*

I8: When I lived in my homeland [Stung Treng] I kept livestock in a pen and fed them, when I moved here I changed [...] I'm busy doing other jobs so I just let my animals go into the forest [...] it's easier to keep a big herd where there is lots of forest [...] I don't have to feed them now. *(Villager, age 46, owner of 50 cows and 9 buffalo)*

I7: The forest is very important [...] almost all families use the forest, very few keep their animals in the village [...] but in the wet season they tend to tie livestock to the rice fields [..] then they feed on grass around the fields [...] [livestock] use the waterholes to drink and to wallow every month of the year *(Villager and livestock owner, age 61, local vet in the study area for 23 years)*

I10: Everybody lets their livestock into the forest to feed and to drink at the waterholes [...] at the start of the rice season people go [...] and bring them back to the village [...] once the rice is planted many people let their livestock go back into the forest. *(Villager and livestock owner, age 35, with 7 years conservation NGO experience working locally and part-time vet)*

Figure 9 The importance of forest and waterholes to livestock husbandry.

I1: Collection of luxury timber is [...] replacing other more traditional livelihood activities, but it is not completely replacing it [...] *samrong* collection is replacing some activities but this has only be happening for part of the [dry] season (Cambodian research assistant, spent over 2 years living in Western Siem Pang as a participant observer)

I6: The people going to the forest to collect [luxury] timber are dropping other normal activities [...] like collecting other forest products, hunting [...] and fishing [...] but few people have stopped growing rice or stopped keeping livestock. (Villager, age 42, and chief of local NGO community forest project since 2005)

I13: Timber collection is replacing almost all activities this [dry] season [...] hunting is a lot less, fishing is less but other family members can still go and do this [...] people don't collect the timber in the wet season so it doesn't replace rice cultivation (Villager and commune chief, age 57)

Figure 10 The impact of luxury timber and *samrong* collection on other natural resource uses.

Changing use of natural resources

Key informants frequently pointed out the threat to current livelihoods posed by increasing scarcity of natural resources; 22 of 24 elders interviewed reported decreases in wild fish stocks in their lifetimes, and 18 believed wild animal populations had decreased also. Several key informants described recent use of unsustainable collection methods, such as electric fishing and the felling of *Sterculia lychnophora* trees to harvest the *samrong* fruit. While testimonials strongly indicated the reluctance of local people to improve their livelihoods by increasing household own-production, staff from a development NGO (with a 17-year presence at the site) said that greater success had recently been made (Figure 11). While this suggests local attitudes may be changing towards livelihood improvement, NGO staff pointed out that new practices are usually adopted for enhancing subsistence production rather than for market trade.

I6: People here are still dependent on products from the forest [...] people aren't changing because prices [for forest products] are still good [...] people need money and like to get it quickly [...] they don't like waiting for animals and crops to grow. (Villager, age 42, and chief of local NGO community forest project since 2005)

I12: [...] while resources are plentiful in the forest [...] they see no need to make any changes [...] most other methods would require extra work [...] this is now changing [...] as these resources get more depleted. When we first started work [...] with [...] fish ponds, everybody just laughed [...] [and] point[ed] to the river [...] now the fish pond idea is becoming really popular as there isn't so much fish in the river. (Director of development NGO with 17 years experience working in Siem Pang)

I21: People here change but <u>very slow</u> and [...] small scale [...] only a small amount to support their family [...] not enough to take to market. (Local man with 10 years experience working with development NGO)

Figure 11 The community's changing attitudes to livelihood improvement. Underlining represents the respondent's enunciation.

Prospects for livelihoods

While households are currently reliant on natural resources there are signs of potentially irreversible livelihood change in the near future. Key informants believe completion of the main access road could lead to substantial development of the district town and open up trade opportunities for the whole community (Figure 12). Journey times to the provincial centre of Stung Treng have reduced to 1.5 hours all year-round, compared to a boat journey of several hours in previous wet seasons. The community may now benefit from increased volume and regularity of trade with external markets, while families from elsewhere in Cambodia may migrate into this community to take advantage of new opportunities. Population change is also likely to have an impact on livelihoods in the longer-term. Unpublished population data, compiled by commune chiefs, shows a 2.3% per annum increase between 2007 and 2011 in the nine study settlements and the population structure corroborates this expansion (Figure 13).

I1: The new road will probably improve the economy by making it more open [...] [and] provide more opportunities for people from other areas to come and live and make a business (Cambodian research assistant, spent over 2 years living in Western Siem Pang as a participant observer)

I12: [...] the new road means that they can begin to think of cash crops as they have markets now [...] there is a lot of buried cash here from the illegal activities so it has the capacity to go from a very isolated and quite underdeveloped remote district centre to a disproportionally large one with a significant economy (Director of development NGO with 17 years experience working in Siem Pang)

I21: The new road means that benefits people can make from their livelihoods will increase [...] prices in the market have already started getting cheaper (Local man with 10 years experience working with development NGO)

Figure 12 Opinions on the development of livelihoods in the short-term future.

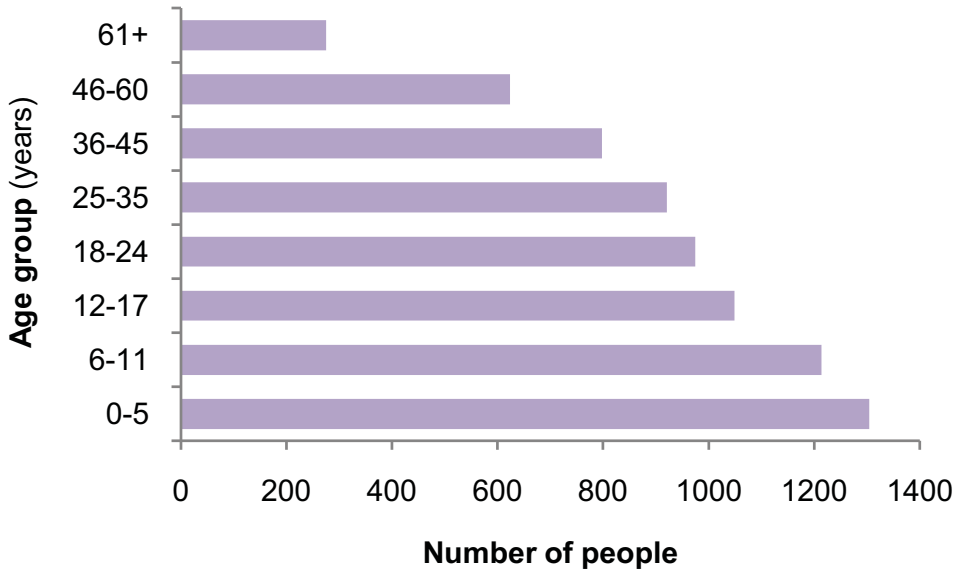

Figure 13 Population pyramid of the nine study villages. Commune Database, Cambodian Ministry of Planning (2007) data.

Livestock capital and change

This section examines further the role of livestock in local livelihoods, particularly as a capital asset. Changes to livestock herds and the rising ownership of hand-tractors are also explored.

Livestock uses

Fifty-seven of 64 households purchased or received livestock as gifts during their lifetimes. Asked about their reasons for each of their past livestock purchases (n = 98 responses), these households reported that ploughing draught for cultivation (63.3% of responses), use of fixed capital – such as security in times of urgent financial need and greater affluence from herd growth (20.4%), and transport draught (16.3%) were the main intended uses. Water buffalo were the mostly widely kept livestock type with ownership at 61.2% of grass- and 77.4% of metal-roof households (n = 258). Cattle were owned by 28.2% and 51.6% of grass- and metal-roof households respectively.

Key informants agreed that cattle chiefly provide households with transport draught (oxen specifically), and that, in current markets, cattle are the best option for pursuing financial gains through herd growth. Buffalo and cattle herd sizes were modelled against household floor area (n = 258 households) to determine which was more related to household wealth. The best model included both buffalo and cattle number (AIC = 390.53); removing cattle from the model resulted in the greatest drop in AIC (Table 1), indicating that they were more closely related to floor area, and by inference to wealth, than buffalo.

Table 1 Modelling buffalo and cattle ownership (number of animals per household) with household floor area as an indicator of wealth.

	ß [a]	2 x SE[b]	AIC
Intercept	3.320	0.113	
Number of buffalo	0.140	0.096	-6.97
Number of cattle	0.210	0.082	-23.81

[a] coefficient estimate of the best model.
[b] confidence interval given by the standard error multiplied by two
[c] change in Akaike Information Criterion (AIC) when the term is removed from the best model

Livestock herd capital

Livestock herds provided households with substantial fixed capital (Figure 14), with average herd capital value equivalent to 73.9% of average total livelihood value in grass-roof households and 123.6% in metal-roof. Overall herd capital value was significantly higher in metal- than grass-roof households ($W = 1392.0$, $P = 0.008$), accounted for largely by significantly higher cattle ownership in the former ($W = 346.5$, $P = 0.046$) (Figure 14 and 15a). Buffalo herd value was marginally higher in metal- than grass-roof households ($W = 350.5$, $P = 0.072$). Buffalo herd composition was similar between these household types but cattle herds were markedly different (Figure 14); adult females were considerably more common and held greater capital value in metal-roof households, suggesting that these households were better equipped to achieve security and financial gain through herd growth.

Change in herd capital during the one-year study period was highly variable (Figure 15b) but the majority of households achieved equal or greater capital value (75.0% of both grass- and metal-roof households). Only three of 64 households lost their entire herd; these all had three or fewer animals at the start of the year. The sector that made largest losses was cattle-owning metal-roof households, which experienced an average change in herd capital of -$90.39 ± 422.29. Change in herd capital was a factor of births, deaths, recruitments, purchases and sales. Patterns of births and deaths were similar between grass- and metal-roof households. Buffalo births (55) numbered higher than cattle births (45) but this was an artefact of higher buffalo ownership; buffalo produce calves only once every 1.5-2 years compared to once a year in cattle.

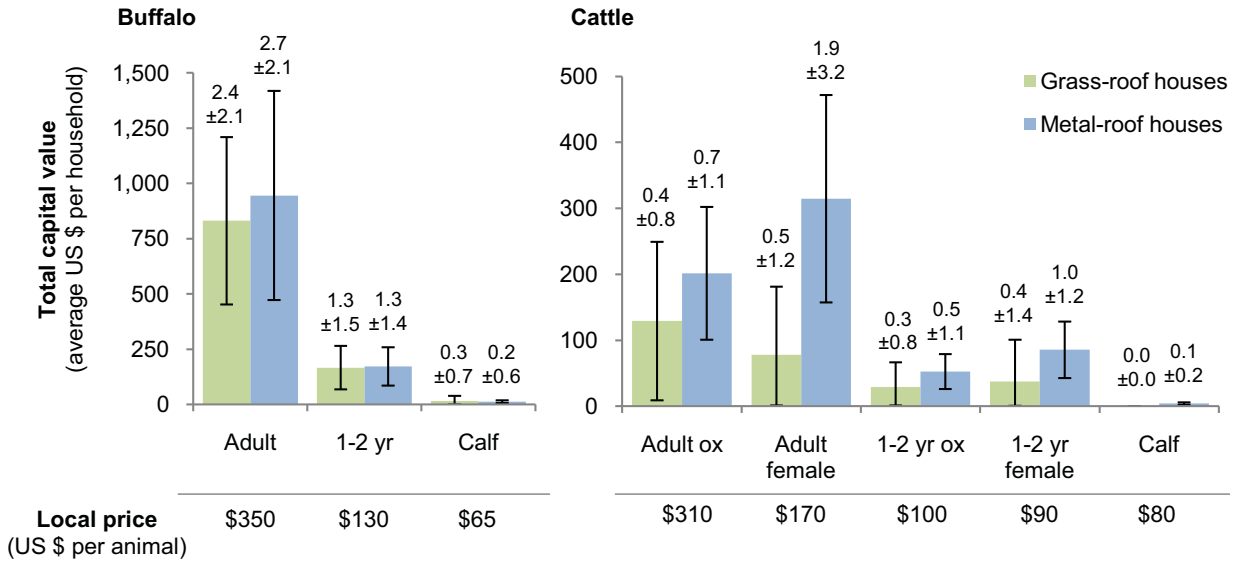

Figure 14 Average capital value of buffalo and cattle to grass- ($n = 24$) and metal-roof ($n = 40$) households by local price classes. Average number of animals owned per household (± standard deviation) is given above each error bar. Livestock herd capital value is calculated for the start of the one-year study period.

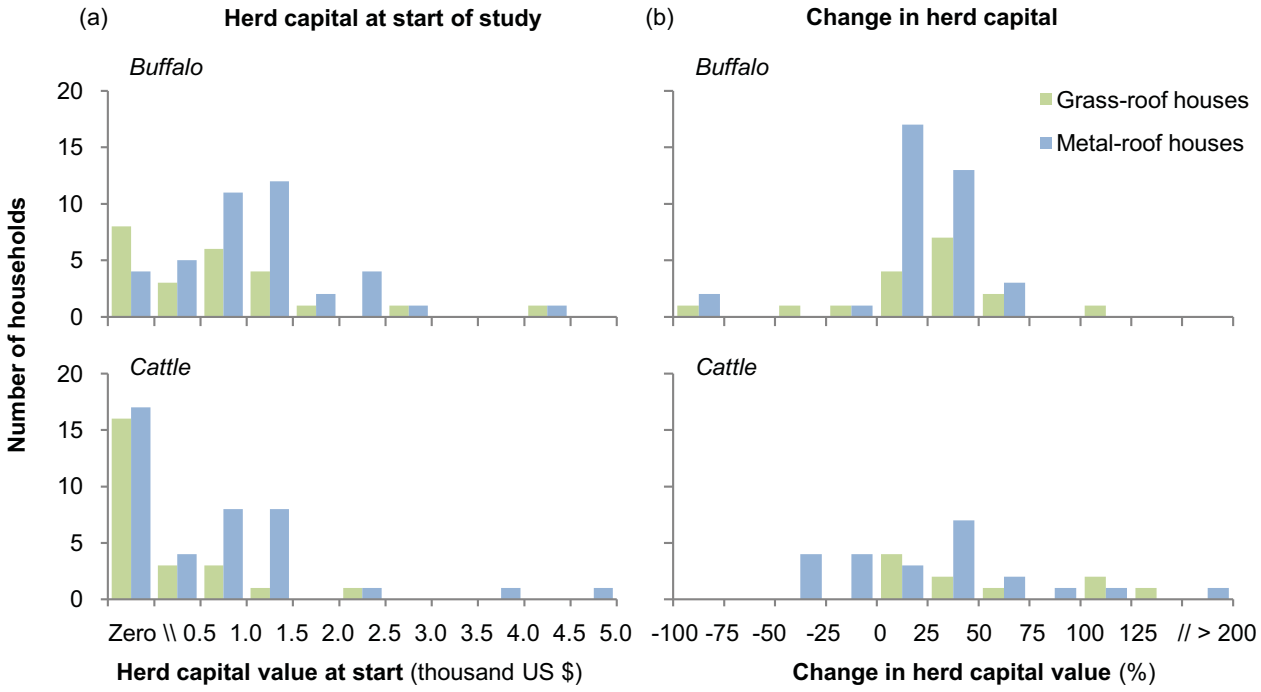

Figure 15 Household frequency histograms comparing herd capital (at the start of the study period) and herd capital change between grass- and metal-roof households, for buffalo and cattle.

Purchases and sales were relatively few for the 64 households in the livestock census (Table 2). Grass-roof households bought more livestock than metal-roof, but only metal-roof houses sold animals, all of which were cattle. While selling livestock may be infrequent, a survey of livestock sales throughout households' lifetimes demonstrates that the ability to sell livestock is of considerable importance to households, particularly during special or unanticipated circumstances. The commonest reason for livestock selling was to cover general living costs in times of hardship (Figure 16). Enhancing fixed capital through purchase of tractors and motorbikes or house building was also common. Four households sold livestock because of concerns over death, injury or loss of animals in the forest.

Table 2 Frequency of households purchasing and selling a given number of livestock. *n* is the total number of households for given roof and livestock types.

			Number of animals bought			**Number of animals sold**			
		n	None	1	2	None	1	2	3
Grass-roof houses	Buffalo	17	15	1	1	17	0	0	0
	Cattle	10	7	2	1	10	0	0	0
Metal-roof houses	Buffalo	36	36	0	0	36	0	0	0
	Cattle	23	21	2	0	20	0	1	2

Figure 16 Respondents' reasons for livestock sales during their household's lifetimes (n = 72 responses from 64 households).

Trends in livestock population and herd composition

Respondents gave inconsistent views on livestock population trends suggesting that no marked change has occurred. Thirteen of 24 elders interviewed reported a decrease, 3 reported no change and 8 reported an increase; key informants provided a similarly inconsistent picture. Nevertheless, informants did widely believe that livestock face large threats. Seven out of eight key informants asked rated disease as the biggest problem for livestock husbandry. This was corroborated by elders, 13 of whom also raised this issue. Lack of livestock graze in the latter half of the dry season, caused by excessively dry conditions, was pointed out by four of the eight key informants, and three informants suggested local people's lack of good husbandry knowledge was also a major problem.

Seven out of eight key informants agreed that livestock herd composition had changed in the last decade, with buffalo becoming less numerous and cattle more so. Informants claimed a combination of factors was responsible for this (Figure 17). Local vets agreed that buffalo have been more susceptible to disease, with epidemics of foot-and-mouth disease and haemorrhagic septicaemia badly affecting buffalo herds in the last eight years. In 2005-2007, traders from other provinces had come to Siem Pang by road and river, buying buffalo at good prices that local people took advantage of. Visits by external traders have subsequently become rarer, but three households in the district town have begun abattoir businesses, buying cattle to sell for meat locally and changing demand from buffalo to cattle. Cattle have become preferred over buffalo by households hoping to achieve financial gain and livelihood security from herd growth, and their higher fecundity is likely to be increasing the population at a greater rate than buffalo.

Interviewer: What is the most common type of livestock trading now?
I4: The abattoir families in Siem Pang are the most common method [...] buying cattle to sell for meat.

I7: Now there are more cattle than buffalo but in the past there were more buffalo than cattle [...] I think it's been this way for at least three or four years now [...] about three or five years ago a big company came [...] sometimes with 2 or 3 trucks a month [...] taking 30 animals in each [...] the price of buffalo increased [...] these traders mostly took buffalo (Villager and livestock owner, age 61, local vet in the study area for 23 years)

I12: There were more buffalo in the past but several years ago lots of buffalo caught an infectious disease [...] some people lost all of their buffalo [...] Cattle are easier to keep than buffalo and easier to sell now. (Villager and livestock owner, age 35, with 7 years conservation NGO experience working locally and part-time vet)

I21: [...] in reality I think people like buffalo more than cattle, but now there is more trade [...] and more demand for cattle so business is increasing and people want to keep them. (Local man with 10 years experience working with development NGO)

Figure 16 Recent changes in herd composition and the factors responsible.

Transition to hand-tractors

Forty-two percent of 150 households surveyed in early 2011 owned hand-tractors, of which 96.8% were metal-roof households. The average price of a hand-tractor was $1919.35 ± 422.27, far exceeding average total livelihood value. Purchases rose steadily from 2000-2009 until a surge in 2010 (Figure 17), with transport (100% of households) and ploughing rice fields (92.1%) the main uses of these machines. Respondents frequently commented on the faster speeds and greater load capacity that hand-tractors made possible, plus the convenience of no longer needing to round up livestock before use, or waiting for sufficient water levels at wallows before rice cultivation could begin. Key informants suggested that concerns about livestock disease were a driver behind the rising ownership of hand-tractors, as well as the desire to modernise and develop technologically (Figure 18). Some also suspected the demand for transport and increased incomes generated by the illegal timber trade was an important factor, though hand-tractor owners themselves were unwilling to discuss this activity.

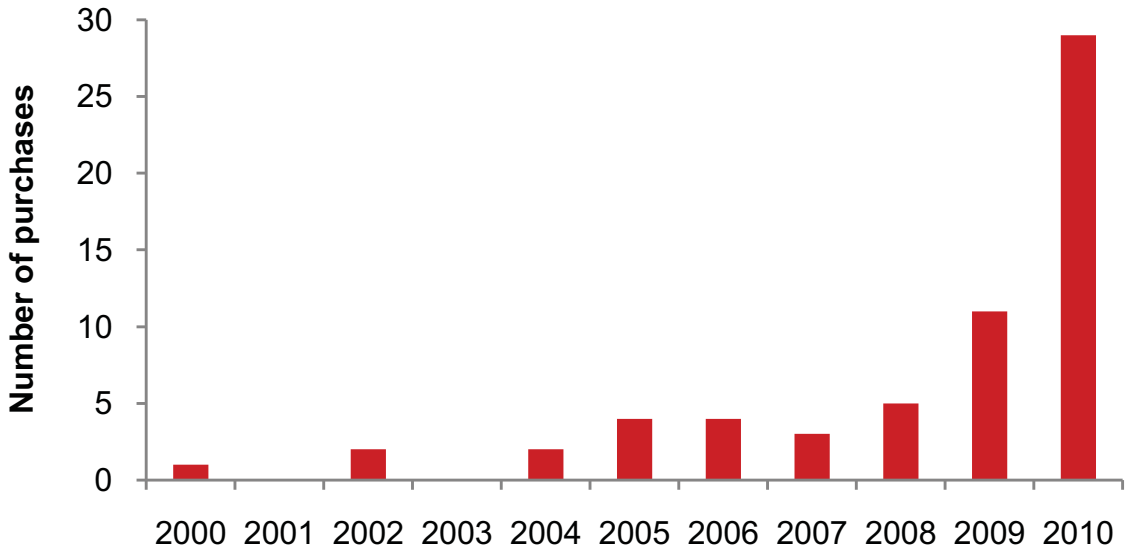

Figure 17 Number of hand-tractor purchases per year, from a sample of 150 households.

The majority (76.2%) of households sold livestock in order to make their hand-tractor purchase, with 61.9% selling buffalo and 54.0% selling cattle. Two households sold all of their livestock but in each case the household only owned two animals. Households selling buffalo sold an average of 43.2% ± 20.2 of their herds and households selling cattle sold an average of 45.1% ± 28.4. While hand-tractors may have partially replaced livestock at these households, livestock do continue to have a use. Twenty-six (54.1%) of the hand-tractor-owning households still used their buffalo for ploughing, primarily due to the prohibitive cost of fuel (51.9% of responses), hand-tractor breakdowns (29.6%) and difficult ploughing conditions (18.5%).

Participants of hand-tractor owner focus groups said they preferred hand-tractors to livestock for ploughing and transport. They agreed that achieving herd growth was now the primary benefit to be gained from livestock husbandry, as this would continue to create financial gain, allow them to buy other goods for the household and give their children livestock in the future. One respondent said his livestock were valuable to afford the regular repairs of his hand-tractor. Participants showed a preference for female animals because of their offspring-producing capacity; some households had sold their oxen, no longer required for transport, but kept their cows for herd-growth purposes. Nevertheless, several respondents highlighted their concern over disease and said they would be quick to sell their remaining livestock should there be another epidemic (Figure 18).

I1: Disease and death for livestock can have [a] major impact on the households' asset ownership, so a tractor is a safer situation [...] the people often say if the tractor breaks down they can repair it, but if the livestock die they cannot be repaired [...] Another factor is the pride that people can take in owning this modern machine (Cambodian research assistant, spent over 2 years living in Western Siem Pang as a participant observer)

I21: People with tractors [...] they probably don't need to use their livestock anymore, but they still keep them to develop a herd (Local man with 10 years experience working with development NGO)

FG1: Using the tractor [to plough] means the female buffalo can be stronger for raising more offspring [...] they won't be worked hard anymore. (Tractor owner at a focus group)

FG2i: [...] I want to keep my livestock but I'm worried about losing them to disease, so I'm not sure whether to keep them or not.
FG2ii: Yes, I really want to keep them [...] so they can produce calves [...] I want to be able to give my children livestock (Tractor owners at a focus group)

Figure 18 Testimonials of the transition to hand-tractors and the changing role of livestock.

Photo: Jonathan C Eames

Chapter 5
Discussion

Livelihoods in this dry forest community employ a combination of natural resource use and household own-production, but are strongly reliant on the landscape's natural products and services for both subsistence and cash income. Households took important benefits from low-intensity rice cultivation and livestock husbandry – the livelihood practices valuable to biodiversity. Livestock husbandry was heavily dependent on the dry forest landscape and enabled households to achieve financial gain and livelihood security through fixed capital and animal draught uses.

Local people are reluctant to alter their existing activities but increasing resource scarcity may force livelihood change. Meanwhile, livestock use is beginning to change due to the interplay of factors including new markets and agricultural mechanisation. Natural resource depletion, human population growth, access to new markets, agricultural transition and perhaps also climate change threaten to force livelihoods along new trajectories in the study community. In the face of such change, conservation will need to find new mechanisms to maintain the livelihood practices beneficial to biodiversity.

Dry forest livelihood strategies

Livelihood strategies in the study community employed a combination of natural resource use, such as fishing and forest resource collection, and household own-production – predominantly rice cultivation supplemented with small-scale garden agriculture. These activities are typical of Cambodian forest communities (McKenney *et al*. 2004). Formal employment and regular business provided income to less than a quarter of households. Households adopted a diverse livelihood strategy typically comprising of five key activities, which were similar between different wealth classes (grass-roof and metal-roof households). Rice cultivation, forest use, fishing and livestock husbandry were the largest contributors to overall livelihood net value, together accounting for over three-quarters of total average livelihood value. On average, low-intensity rice contributed nearly a quarter of total livelihood net value. The contribution of each was nevertheless highly variable between households. Livelihoods of both grass- and metal-roof houses were built upon a combination of subsistence and market strategies. Over 90% of rice cultivation and fishing products were for subsistence use, while forest use was motivated by both subsistence consumption and market trade.

Dependence on dry forest natural resources

Livelihoods showed a strong reliance on the dry forest landscape with natural resource use (combining forest resources and fishing) accounting for more than half of livelihood value and approximately double that of household own-production. Natural resource use maybe slightly greater and own-production slightly lower in this study community than in other dry and semi-evergreen forest communities. Studies in Preah Vihear, Kompong Thom and Mondulkiri provinces found the contribution of own-production to livelihoods to be greater than forest use (Evans *et al*. 2003; McAndrew *et al*. 2003; McKenney *et al*. 2004), however these studies only surveyed cash income not complete use including consumption. Forest use was almost ubiquitous in our study community as greater than 96% of households made use of timber, non-timber and animal products. Nearly three-quarters of our sample benefitted from landscape services, such as livestock graze. Livelihood strategies utilised most landscape features including waterholes, streams, rivers and the forest itself. Natural resource use transcended classes of wealth, with grass- and metal-roof households gaining similar benefits.

Although our results demonstrate the importance of natural resources, they require cautious interpretation as this study provides only a one-year snapshot of livelihood strategies. The especially intense collection of luxury timber and *Sterculia lychnophora* (*samrong*) fruit during our study period may make our estimates of natural resource use unusually high if considered over longer timescales. In spite of this, more routine natural resource use, such as collection of construction timber, fuelwood, non-timber forest products and animals, still contributed at least a third of livelihood value and may well be greater in years of more typical luxury timber and *samrong* trade.

Subsistence and market uses of natural resources were of near equal importance. Products such as fuelwood, construction timber, amphibians and fish were largely collected for consumption, while non-timber forest products (NTFPs) and wild animals were both consumed and traded. Similar use of natural resources has been found in other forests of north and east Cambodia (Baird and Dearden 2003). Luxury timber and high-value NTFPs, namely *samrong*, were almost exclusively collected for cash income with only 3.2% of these consumed by the household. Informants emphasised the importance of environmental factors, such as rainfall and seasonality, and economic factors, such as external demand and market access, in determining the types of natural resources collected and traded. These are not unique factors to our study system and are reported for natural resource use in other Cambodian forests (McKenney *et al*. 2004). While natural resource use is both frequent and widespread, the type of products collected and the nature of their use may be variable within and between years. For example, bamboo shoots, an important forest food item, are only available in the late wet season and early dry season, while good harvests of the *samrong* fruit crop are dependent on the irregular fruiting cycles of *Sterculia lychnophora* (Baird and Dearden 2003), which local informants believed was due to rainfall patterns.

Informants regularly mentioned local people's resistance to livelihood change. As one informant suggested, in the context of plentiful, freely available resources in an open access landscape, it is common sense to continue using natural resources when alternative livelihood strategies would likely require increased effort. The study community has used the dry forest in this way for generations and has developed strong habits. Nevertheless, we found evidence of resource depletion, with most elders in the community reporting that fish and wild animal populations have become much scarcer. Luxury timber species are likely to follow a similar trend; in May 2011, informants report that local people are now collecting smaller and smaller lengths of timber for trade. Baird and Dearden's (2003) study in the neighbouring forests of Virachey also found declining fish stocks, wild animal populations and *Sterculia lychnophora* abundance. Our NGO informant's reporting recent success in encouraging households to create fish ponds in Siem Pang is an indication that traditional use of the forest could be set to change as resource depletion makes these activities increasingly unviable.

The changing role of livestock

Livestock had an important role in the livelihoods of the study community, with livestock purchases historically motivated for use in ploughing, transport and household security and finance. Ploughing of rice fields traditionally uses buffalo draught, and the high incidence of buffalo ownership exceeding 70% of households corresponded with the widespread importance of rice cultivation. Oxen traditionally provide transport draught and were nearly two times as valuable as cows. Mixed herds of buffalo and cattle provided households with substantial fixed capital, on average exceeding total livelihood net value in metal-roof households, and equivalent to nearly three-quarters of the livelihood value in grass-roof households. Higher ownership of livestock, particularly cattle, in metal-roof households than grass-roof is indicative of the relationship between livestock and wealth. While herd capital was highly variable, the majority of households achieved equal or greater capital during the course of the study year.

Herd capital was, on average, 19 times higher than the net value of livestock husbandry (combining all inputs and livestock uses) in the study year, suggesting that livestock importance was related to much more than day-to-day draught use. Although our livestock census data indicated that less than 1% of all herds were sold in the calendar year, households' reasons for sales indicate that livestock herds provide important financial gain and livelihood security. Capital gain from herd growth could be reinvested in other forms of fixed capital, including transport vehicles, machinery for other activities (such as chainsaws and rice mills) and house building. Livestock also provided a form of insurance against unanticipated events, with more than a third of reasons for livestock sales relating to coverage general living costs when shortfalls in the household budget occurred. Studies of other extensive grazing systems, such as communal rangelands in South Africa, also livelihoods benefitting from the insurance policy advantage of livestock ownership (Dovie *et al*. 2006). Selling livestock simply for the possession of monetary value was only reported once, suggesting that livestock are kept primarily for times of special or urgent need rather than financial gain *per se*.

Households are very strongly reliant on the landscape to achieve benefits from livestock; almost all households released their livestock into the forest in the dry season with the exception of oxen. Although livestock are brought back to rice fields during the ploughing and planting stages of rice cultivation, many families release them again once planting is complete. Testimonials from livestock owners indicated that livestock graze, wallowing sites and water sources present in the landscape created little need for inputs or labour in livestock husbandry. Nevertheless, rearing livestock in the forest does have risks and key informants overwhelmingly reported that disease was the biggest current threat. Communities in the forests of Kompong Thom and Preah Vihear provinces have also shown strong concern over livestock disease (McKenney *et al*. 2004). Informants also suggested that disease was a factor in people's eagerness to sell livestock, and following two epidemics in the last eight years, several respondents spoke of their plans to sell their herd quickly should another epidemic occur. Allowing livestock to roam freely in the forest may increase disease risk, but local people's poor knowledge of livestock health and husbandry techniques may be additional factors.

While informants and elders did not agree on a change in overall livestock number in the recent past, the majority of informants described a community-wide change in herd composition. Testimonials indicate that buffalo have declined through external trade influences and disease, while higher fecundity and changing preferences in animals kept for herd growth have favoured cattle. Indeed, cattle were found to be more strongly related to wealth than buffalo, when modelled using household floor area as a wealth indicator. This changing preference probably relates to an increased market for cattle as recently established abattoirs now create a constant demand; perceptions that buffalo are harder to keep and more susceptible to disease may also play a part.

A potentially more fundamental change is the transition to hand-tractors, replacing the need for animal draught and at least partially replacing households' livestock herds. Tractor ownership has dramatically increased since 2009 to over two-fifths of the community. Informants' opinions suggest this is motivated by the demands of the timber trade, concerns over livestock disease and a desire for technological development. While around half of hand-tractor-owning households still had occasional use for buffalo draught ploughing, herd growth is now a greater motivation, providing financial gain, livelihood security and the ability to pass on livestock to the household's children. With cattle now the favoured animal for achieving herd growth, the transition to hand-tractors may also be enhancing changes in herd composition. Should hand-tractor ownership and disease concerns continue to increase, the overall livestock population may decline in coming years. This could impact the economic security of households as few other insurance mechanisms appear available in the community.

Livelihood prospects under environmental change

Existing livelihoods, in this study community and across Indochinese dry forests, are likely to undergo substantial changes in the coming decades. Nevertheless, considerable uncertainty surrounds these changes and their outcomes, making accurate and detailed predictions not yet possible. Transition could be forced, at least in part, by environmental changes such as natural resource depletion and global climate change. Increasing scarcity of natural resources is likely to lead to greater adoption of own-production activities (such as cultivation) with reduced reliance on natural resources. Such a transition may be just beginning in the study community, indicated by the recent uptake of aquaculture.

Global climate change is emerging as a potentially major threat to ecosystems in Indochina (CEPF 2007). Likely effects are not yet fully understood, though predictions for South-East Asia expect higher temperatures, drier conditions (for at least the next 2-3 decades) and increased frequency and severity of climatic patterns such as *El Niño* and drought (ADB 2009). The impacts could be substantial in an ecosystem where water is already naturally scarce in the dry season.

Livestock husbandry may be particularly vulnerable to the effects of climate change (Thornton *et al*. 2009). Livestock fodder in the forest could become scarcer; a problem that is already occurring according to the local livestock owners we interviewed. Domestic water buffalo health could be badly affected by increased water scarcity and higher temperatures as they require very regular access to water and are prone to heat stress (Shafie 1985). Should droughts become substantially more severe, people may be forced to stop keeping livestock

altogether, with only riverside households able to continue feeding and providing water to their animals. Livestock disease may also be affected by climate change, but the response is likely to be complex and is currently not well understood (Thornton *et al*. 2009).

Changing phenology and overall abundance of seasonally available resources such as forest fruits and vegetables (Corlett and Lafrankie 1998) and perhaps also fish, eels and amphibians, may create new problems for local livelihoods. Should forest products become scarce at times when households require them for sustenance (such as just prior to the rice harvest), livelihoods may have to adapt by cultivating more produce. Changing rainfall patterns, including the increasing unpredictability of monsoon timing and precipitation level could heavily impact on low-intensity wet season rice cultivation, making other forms of rice cultivation more favourable (Chinvanno *et al*. 2006). Irrigated dry-season rice cultivation is becoming common in other parts of Cambodia and reduces reliance on rainfall patterns but with considerably more damage to biodiversity (Gray *et al*. 2009). Alternatively, livelihoods could become more dependent on cash crops that require less rainfall, such as cassava.

The dry forest community's resilience to environmental changes is not yet clear. Areas of north and east Cambodia have been highlighted as some of the most vulnerable regions to climate change South-East Asia due to poor adaptive capacity (EEPSEA 2009). Nevertheless, this study found that the majority of households were adopting varied livelihood strategies and this diversity may help in adapting to environmental change. Local people have already tailored their livelihoods to cope with strongly seasonal climate and resource availability, and to some of the fluctuations of external markets, qualities that may also help to create resilience. Even those households with only one livelihood activity may not necessarily be vulnerable; nearly half of these households were in employment or regular business (such as running local shops), activities that could perhaps be sustained or easily adapted under different environmental futures.

Livelihood prospects under social and economic change

Social and economic changes are likely to have a significant impact on dry forest livelihoods, perhaps exceeding those of environmental change in both of immediacy and magnitude. Large-scale plantation agriculture would create the most dramatic economic change. Land concessions have been granted to major development companies for the study site and much of Cambodia's dry forest (BirdLife International 2003b; CEPF 2007). Concessions will eradicate the majority of the open access resource that local people depend on, forcing livelihoods to become much more reliant on household own-production or to try and seek wage-labour employment in plantations, as has been witnessed in Indonesia (Dewi *et al*. 2005). This scenario would likely extirpate a large proportion of dry forest biodiversity and must be conservationists' first priority in protecting the dry forest ecosystem.

Social change and agricultural development are likely to have important impacts on livelihoods, regardless of whether economic land concessions are halted. The population of the study community is growing rapidly at 2.3% per annum and the high proportion of young people suggests this will continue. This growth will create major pressures on agriculture to increase food supply or provide sufficient incomes with which food can be bought. The need

for agricultural modernisation is recognised nationwide to improve Cambodia's food security problems in the face of the growing population (Kim *et al*. 2002). Furthermore, traditional natural resource use and low-intensity rice cultivation may become economically unviable as greater access to markets and technology provide opportunities for more intensive and profitable forms of rice or cash crop cultivation. Agricultural mechanisation and development is perhaps already occurring in our study community, suggested by the increasing ownership of hand-tractors and data from informants suggesting that the improvement of the main road is creating access to new markets.

Conservation implications

The contribution of natural resources and forest services to livelihood net value and livestock husbandry demonstrate the study community's dependence on the dry forest ecosystem. Households also take substantial value from both the key livelihood practices of benefit to biodiversity: extensive farming of livestock and low-intensity rice cultivation. These appear to be favourable conditions for an alliance between conservation and the local community. Protection of the open access forest and livelihood practices valuable to both local people and wildlife would be mutually beneficial. However, the viability of the livelihood practices important to biodiversity is in doubt. This study found that some livelihood changes are already occurring. Natural resource depletion, human population growth, economic transformation of agriculture and potentially climate change may lead to further, dramatic livelihood transformation in coming decades. These livelihood changes will have implications for conservation and new methods of sustaining valuable livelihood practices may be required.

Our results indicate a recent change to livestock herd composition, causing increasing numbers of cattle relative to domestic water buffalo. This is likely to have important ecological effects in the dry forest ecosystem. Domestic livestock may now be mimicking the ecological functions historically fulfilled by now-extirpated wild herbivores, such grazing of vegetation at waterholes (Timmins 2008; Wright *et al*. 2010a). The more aquatic habits and wallowing action of buffalo make them more important agents of waterhole habitat modification than cattle (HW pers. obs.). Decreasing numbers of buffalo could therefore be affecting waterhole habitat, with knock-on detrimental effects for an array of threatened and near-threatened waterbirds that forage at waterholes, including Sarus Crane *Grus antigone*, Greater Adjutant *Leptoptilos dubius*, Lesser Adjutant *Leptoptilos javanicus*, Black-necked Stork *Ephippiorhynchus asiaticus*, Giant Ibis *Thaumatibis gigantea* and particularly the critically endangered White-shouldered Ibis *Pseudibis davisoni*, which requires grazed habitat in which to feed (Wright *et al*. 2010a).

Factors such as the increasing use of hand-tractors, livestock disease concerns, economic transition and climate change impacts could potentially cause an overall decline in livestock population, with further implications for dry forest biodiversity. Three species of critically endangered vultures are now dependent on the carcasses of domestic livestock to feed (BirdLife International *et al*. 2005; Pain *et al*. 2003). With very few large-bodied wild animals left in the dry forests, severe declines in livestock populations could cause the extinction of these vultures. Wider ecosystem-level impacts could also occur, such as the gradual sedimentation of waterholes, or changes to the structure of dry deciduous forests should a lack of livestock mean a concomitant decrease in local people's use of understorey fires.

Populations of domestic livestock must be maintained until restoring wild herbivores becomes feasible. In the short-term conservationists could provide the community with free veterinary services and help or advice with husbandry techniques. This would reduce disease risk, preventing livestock deaths, and also help to restore local people's motivation to keep livestock and buffalo in particular. Nevertheless, if the extensive rearing of livestock becomes economically unviable in the longer term, conservationists may need to provide local people with direct payments as incentives to sustain this form of pastoralism. Direct conservation payments are already being implemented in Cambodia's dry forests (Clements *et al*. 2010), but generally for mitigation of damaging livelihood practices rather than the maintenance of existing ones.

The large areas of fallow land created by low-intensity rice cultivation benefit species such as White-shouldered Ibis and Bengal Florican *Houbaropsis bengalensis,* which uses these habitats in the non-breeding season (Gray *et al*. 2009; Wright *et al*. 2010b), and commoner waterbirds such as Woolly-necked Stork *Ciconia episcopus* and Asian Openbill *Anastomus oscitans.* While this study did not find evidence for change in cultivation, the increasing use of hand-tractors, access to new markets, a growing human population and the imminent potential threats of climate change could force the community to adopt different forms of crop production. Loss of agricultural fallows could be detrimental to waterbirds and other open-habitat species. White-shouldered Ibis may be particularly affected in dry dipterocarp forests where fallow land provides a significant proportion of suitable, sparsely-vegetated habitat in the non-breeding season, such as in Lomphat Wildlife Sanctuary (HW pers. obs.).

Paying farmers to continue low-intensity rice cultivation, while compensating them for the lost opportunity of agricultural development, could prove too costly and challenging. Other forms of agriculture may become much more economically competitive and increasing local food demand will likely create major incentives for intensification. Substituting this livelihood activity through full intervention by conservationists could be more effective. Suitable habitats could be created by restoring or re-creating grasslands and areas of open understorey within the forest landscape. Management techniques could potentially be informed by the livelihood practices traditionally used by dry forest communities, such as the use of livestock and fire within the forest itself.

Conclusion

The dry forest community studied here shows strong reliance on the landscape and the livelihood practices of benefit to biodiversity, but livelihoods appear on the verge of transformation due to changing social, economic and environmental conditions. This situation may not be unique to the dry forests of Cambodia, as agricultural development is likely in most traditional, smallholder farming systems (Pingali 2007). Traditional land management, upon which many open-habitat species now depend in the absence of natural processes, is likely to be threatened in many agricultural landscapes of the developing world. Conservationists must identify the anthropogenic landscapes supporting threatened species and develop new mechanisms to sustainably maintain or mimic the livelihood practices important to this biodiversity. Options could include paying local people to continue these practices or full intervention by conservationists to assume the responsibility of land management from communities undergoing dramatic economic transition.

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