

Making friends with benefits: an investigation into the use of
incentives for the conservation of forest commons

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A dissertation submitted for the degree of Doctor of Philosophy

Imperial College London

May 2014

Declaration

This dissertation is the result of my own work and includes nothing which is the outcome of work done by or in collaboration with others, except where specifically indicated in the text.

Henry Travers, May 2014

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Abstract

The use of incentives to encourage sustainable natural resource use is widespread in conservation. Yet, the relative or combined effects of conservation interventions on resource use can be difficult to predict. This is particularly so in contexts with weak institutions or poorly defined property rights, conditions that typify forest commons. In this study, I investigate the effect of different policy options, currently being implemented or under consideration in a protected area in Cambodia, on the resource appropriation of indigenous smallholder farmers in order to develop a framework for predicting the effectiveness of conservation interventions.

I begin by evaluating the progress made towards two project targets relating to the security of natural resources important for local livelihoods, showing that, whilst security issues exist, the project has so far been successful in protecting key resources. I also evaluate an existing programme of indigenous land titling, which is shown to be consistent with conservation goals but vulnerable to interference from land grabs.

Using two approaches for predicting behavioural response to planned interventions, experimental games and scenario analysis, I demonstrate that collective performance payments are more effective than individually contracted payments or increased law enforcement effort. Previous research has shown that externally imposed rule enforcement can undermine existing norms for cooperation, particularly in contexts where social cohesion is high. I build upon this research by demonstrating that exogenous rule enforcement, when coupled with reward payments that have been found to encourage high levels of cooperation, can increase resource extraction compared to when payments are offered in isolation.

The research presented highlights the difficulty of predicting the effect of policies designed to reduce resource use, particularly when interventions interact to increase the institutional complexity in which resource use decision-making takes place, but offers a novel framework for the investigation of intervention effectiveness.

Acknowledgements

I am hugely grateful to my two supervisors, E.J. Milner-Gulland and Tom Clements. They have both advised, encouraged and inspired me in equal measure. Put simply, I would not have made it this far without them. Thank you, both of you!

I will also always be indebted to Gareth Edwards-Jones.

So many people at the WCS Cambodia Program have helped me along the way. I would like to thank them all, but particularly Ashish John for challenging me and making me think, Pet Phaktra for allowing me to benefit from his wealth of experience, Phien Sayon for all his help negotiating labyrinthine GIS archives, Tim Solita for her amazing patience and, not least, Tao Sarath and Khuth Channy for putting up with my unconventional accounting. Special thanks go to Tom Evans. His guidance, advice and patience under a barrage of questions have been invaluable.

I could not have completed the fieldwork aspects of this study without the hard work and commitment of Kyle Winney, Yu Kimleng, Orn Samart, Heng Hong, Chum Tevi, Mao Tineul, and Lou Vanny.

The ICCS group at Silwood have been fantastic sounding boards, rivals and supporters. Tim, Joe and, lately, Ben, you have made excellent cohort mates and I feel no shame in ending up with the wooden spoon.

To all my family and friends, I am sorry to have inflicted the last three and a half years on you. Thank you all for your unending patience and support. Mum – I hope that one day you can accept that science does not always have to wear a white coat!

Un grande grazie Tiziana, per il tuo amore e ottimismo infinito.

This work was supported by the Economic and Social Research Council and the Natural Environment Research Council.

Abbreviations and Acronyms

AIC	Akaike Information Criterion
AIC _c	corrected Akaike Information Criterion
BLUPs	Best Linear Unbiased Predictors
CBD	Convention of Biological Diversity
CBNRM	Community Based Natural Resource Management
CCB	Carbon, Community and Biodiversity
CCBA	Carbon, Community and Biodiversity Association
CEDAC	Cambodian Centre for Development and Study in Agriculture
CENTDOR	Centre for Development Orientated Research in Agriculture and Livelihood Systems
CPR	Common Pool Resource
ELC	Economic Land Concession
FA	Forestry Administration
GPS	Global Positioning System
GLM	Generalised Linear Model
GLMM	Generalised Linear Mixed Model
IC	Indigenous Community
ICCA	Indigenous or Community Controlled Area
ICDP	Integrated Conservation and Development Project
ICT	Indigenous Communal Title
IP	Indigenous People
LMM	Linear Mixed Model
MoE	Ministry of Environment
NGO	Non-Governmental Organisation
NTFP	Non-Timber Forest Product
PES	Payments for Environmental Services
REDD+	Reduced Emissions from Deforestation and forest Degradation
SD	Standard Deviation
SE	Standard Error
SPF	Seima Protection Forest
ToC	Theory of Change
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard
WCS	Wildlife Conservation Society

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Chapter 1

Introduction

1.1. *Problem statement*

Following growing recognition, from the 1980s onwards, that the conservation of biodiversity is intrinsically linked to the well-being of people living in areas of biological wealth (Milner-Gulland *et al.*, 2014), a number of policy paradigms have emerged in which the dominant logic rests on resolving trade-offs between the interests of local people and those pursuing an agenda of conservation (Adams & Hulme, 2001; Brown, 2002; Adams *et al.*, 2004; Wells & McShane, 2004; Sunderland *et al.*, 2007; Chhatre & Agrawal, 2009; McShane *et al.*, 2011; Persha *et al.*, 2011). Central to all of these approaches has been the desire to create or alter the level of incentives to reduce the impact of those people whose actions threaten biodiversity, whether through the enforcement of rules restricting resource use (Gibson *et al.*, 2005; Keane *et al.*, 2008), facilitation of alternative, less-damaging sources of income (Brandon, 1996; Salafsky & Wollenberg, 2000), strengthening of property, access or management rights (Singleton, 2000; Carlsson & Berkes, 2005) or, more recently, direct payments or payments for the provision of environmental services (Ferraro & Kiss, 2002; Pagiola *et al.*, 2004; Wunder, 2007; Ferraro, 2011). Whilst all of these approaches seek to change the incentives governing behaviour, their success is reliant upon the institutional context in which they are applied (Barrett *et al.*, 2001; Brown, 2003; Clements *et al.*, 2010). There is, however, currently a paucity of research aimed towards increasing understanding of how to facilitate the establishment of effective conservation institutions, the “rules of the game” which govern human interactions (North, 1990), particularly in the face of social, economic and environmental change, or towards influencing behavioural change in order to achieve positive outcomes for conservation (Cowling, 2014).

In recent years, increasing attention has been given to evidence-based approaches to improving conservation decision-making and to evaluating whether or not conservation policies have been successful in achieving their stated goals (Pullin & Knight, 2003; Sutherland *et al.*, 2004; Stem *et al.*, 2005; Ferraro & Pattanayak, 2006;

Pullin & Knight, 2009). Yet the success of conservation policies is difficult to define or measure and may be highly dependent on the local social, political, economic and institutional context, which can lead to significant uncertainty (Adams *et al.*, 2003; McShane *et al.*, 2010). Despite recent advances, such as the application of quasi-experimental matching approaches (e.g. Andam *et al.*, 2008; Andam *et al.*, 2010; Arriagada *et al.*, 2012; Ferraro & Hannauer, 2014; Clements *et al.*, in press; Clements & Milner-Gulland, in press), impact assessments are difficult to do well, are expensive (Agrawal, 2014) and are conducted after policies have been implemented. As such, even if approaches, such as adaptive management (Salafsky *et al.*, 2002; Stem *et al.*, 2005), have been put in place, opportunities for improvements, time or goodwill may be lost in the interim. Consequently, the ability to estimate the effectiveness of policies prior to implementation (either in absolute terms or relative to alternative policy options), through approaches such as management strategy evaluation (Bunnefeld *et al.*, 2011; Milner-Gulland, 2012; Nuno, 2013), offers the potential to get things right first time and guide policy decision-making to minimise the risk of unnecessary policy failures.

These concerns are particularly relevant for the conservation of tropical forests where current international policy developments are poised to provide substantial additional funding in the next few years through initiatives to reduce emissions from deforestation and forest degradation (REDD+; Ebling & Yasué, 2008; Miles & Kapos, 2008). Hitherto, the clearance of tropical forests has proved challenging to address (Geist & Lambin, 2002; Chomitz *et al.*, 2007). Between 1990 and 2010 alone global forest resources were lost at a net rate of approximately 6.8 million hectares per year (FAO, 2010). With the advent of REDD+ initiatives, there is renewed optimism in some circles that efforts to protect forests can be successfully supported. Yet in order for this to happen, it will be necessary to channel potential carbon revenue effectively to deliver actual behavioural change by those responsible for deforestation (Brown *et al.*, 2008). This is especially difficult in the context of weak institutions (Barrett *et al.*, 2001) and unclear property rights (Hardin, 1968), conditions that typify forest commons and for which resource extraction is most likely to be unsustainable.

The proximate causes of deforestation are highly complex and governed by wide ranging factors, such as rising human populations, immigration, property rights,

commodity prices, market access, as well as the development and integration of new technologies (Laurance, 1999; Lambin *et al.*, 2001; Geist & Lambin, 2002; Chomitz *et al.*, 2007; DeFries *et al.*, 2010). Due to the complex nature of many of these drivers it is consequently difficult to draw conclusions on the wider importance of different determinants of forest depletion (Scrieciu, 2007), and hence set policy. The evidence with regard to the association between small-scale, rural households, increased market access and deforestation is particularly contradictory. As rural households often have little access to capital or alternative livelihood activities, expansion into marginal open-access forested land is an attractive option (Barbier, 1997). Increased access to capital does not, however, necessarily reduce the rate of deforestation, as it frequently leads to investment requiring or facilitating land clearance (Wunder, 2001; Pendleton & Howe, 2002). In other cases, the creation of new market opportunities can lead to a transition away from agriculture as a primary source of income and reduce pressure on forest resources. As such, it is doubtful that a direct causal link between poverty and deforestation exists in the general case but the fact remains that poor rural households are frequently direct agents of deforestation (Sunderlin *et al.*, 2005). Given this, it is important for policy initiatives, such as REDD+, to consider not only the role of small-scale resource users in forest clearance but also the impact of forest protection measures on rural livelihoods and behaviour (Brown *et al.*, 2008). In areas principally under threat from small-scale deforestation, decision-makers must develop appropriate policy interventions, which seek to maximise the incentives for local people to reduce clearance whilst adhering to the principle of doing no harm.

This study seeks to contribute to our understanding of these issues by concentrating on the complex inter-relationships between human livelihoods, land-use management, and the protection of forests for the purposes of climate change mitigation and biodiversity conservation. This research is focussed on a single protected area, managed for the protection of biodiversity and the enhancement of local livelihoods, in Cambodia, a country with one of the highest rates of percentage forest cover loss globally (Hansen *et al.*, 2013). The study site is currently in the final stages of accreditation as a voluntary REDD+ project and has been identified as one of two national REDD+ demonstration sites. Hence, the findings of this study will contribute directly to management decisions at the study site. Revenue generated by the REDD+ project will be used to fund site management interventions, including benefit sharing

with 20 villages located within or adjacent to the site that have signed agreements to participate in the project. As one of the principal causes of deforestation within site boundaries is the expansion of agricultural land by smallholder farmers from participating villages (WCS, 2013), the success of the project hinges on the ability of site managers to incentivise these farmers to halt forest clearance. As such, the site provides a significant opportunity to study the potential impact of alternative policy options for the prevention of smallholder forest clearance.

1.2. *Aims and objectives*

The overall aim of this study was to investigate the effectiveness of different forest conservation policy interventions currently implemented or planned for Seima Protection Forest in terms of delivering behavioural change amongst small-scale resource users.

The objectives of the study were as follows:

1. Characterise household livelihood strategies and economic well-being and assess progress towards project livelihood targets for the period 2007 to 2012.
2. Investigate household land use and rule compliance under existing conservation management interventions for the period 2004 to 2012.
3. Elucidate individual expectations of changes in land use strategies under a range of future scenarios of conservation interventions and market conditions.
4. Identify implications for incentive-based conservation policy making, and make recommendations for intervention design at the study site.

1.3. *Thesis outline*

In addition to the introduction, the thesis is split into six further chapters:

Chapter 2 provides an overview of the project study site, Seima Protection Forest, and the livelihood strategies and practices of the people who live there, as well as summarising the history and proposed future of conservation management at the site.

Chapter 3 focuses on assessing the livelihoods and economic well-being of households living within the study site and evaluates the progress made towards two site management goals (ensuring household resource security and access to sufficient

agricultural land) during the period 2007 to 2012. Household economic well-being is shown to have improved over this period, even among vulnerable groups, except in the most remote villages which still have limited access to emerging markets. Partial progress has been made in relation to the two management goals: ensuring household resource security and sufficient access to agricultural land, with household resource security and access to agricultural land largely stable. The theory of change based approach, as applied here, is found to be vulnerable to data and indicator selection issues.

The results presented in this chapter appear in:

Travers, H. & Evans, T. (2013) *Development of a social impacts monitoring system for the Seima Core Protection Forest REDD+ Demonstration Site*. Wildlife Conservation Society, Phnom Penh.

Chapter 4 investigates household land use and rule compliance in two villages under one of the principal interventions implemented at the study site, a programme of participatory land use planning and tenure reform. I show that participatory tenure reform can be consistent with positive outcomes for conservation, but that this process is vulnerable to disruption from external interests in the form of immigrant households and powerful land speculators.

This chapter is under revision at *Land Use Policy* as:

Travers, H., Winney, K., Clements, T., Evans, T.D., Milner-Gulland, E.J. A tale of two villages: an investigation of conservation-driven land tenure reform in a Cambodian Protection Forest.

Chapter 5 applies a behavioural games approach to the investigation of resource user behaviour in a commons dilemma under a series of experimental treatments designed to mimic policy options under consideration for the study site. The interaction between rewards and penalties is examined, showing the potential for weakly enforced penalties to “crowd out” reductions in resource use observed when rewards are offered in isolation.

This chapter is under second review at *Ecological Economics* as:

Travers, H., Clements, T., Milner-Gulland, E.J. Applying the carrot and stick in a Cambodian commons: an experimental games approach to the investigation of conservation incentives.

Chapter 6 uses a scenario-based approach to investigate future smallholder land clearance within the study site under a series of potential policy options and market conditions. Collective payments or payments into a communal fund in return for households choosing to halt clearance were found to be most effective at reducing clearance relative to the business as usual baseline scenario, provided that other members of the village reciprocated.

Chapter 7 provides a discussion of the main findings described in preceding chapters and identifies opportunities for further study.

Chapter 2

Seima Protection Forest

2.1. Introduction

The study was conducted in Seima Protection Forest (SPF), a protected area located in the Eastern Plains Landscape of Cambodia, which covers an area of 2,927 km² and is located in north-eastern Cambodia, at the southern end of the endemic-rich Annamite Mountains (Figure 2.1). The site is managed by the Forestry Administration (FA), with technical and financial assistance provided by the Wildlife Conservation Society (WCS) as part of a long-term conservation programme. SPF is located in part of a large former logging concession held by the Malaysian company, Samling International Ltd. Commercial logging operations in this concession were halted in 1999, due to increasing royalties for felled timber, and a nationwide moratorium on logging was introduced in 2002. Since 2002, the site has been managed for biodiversity conservation and local livelihoods enhancement. In September 2009, the area was gazetted as a formal Protection Forest by Prime Ministerial Subdecree #143, which separated the site into a core protection zone (1885 km²) and buffer zone (1042 km²).

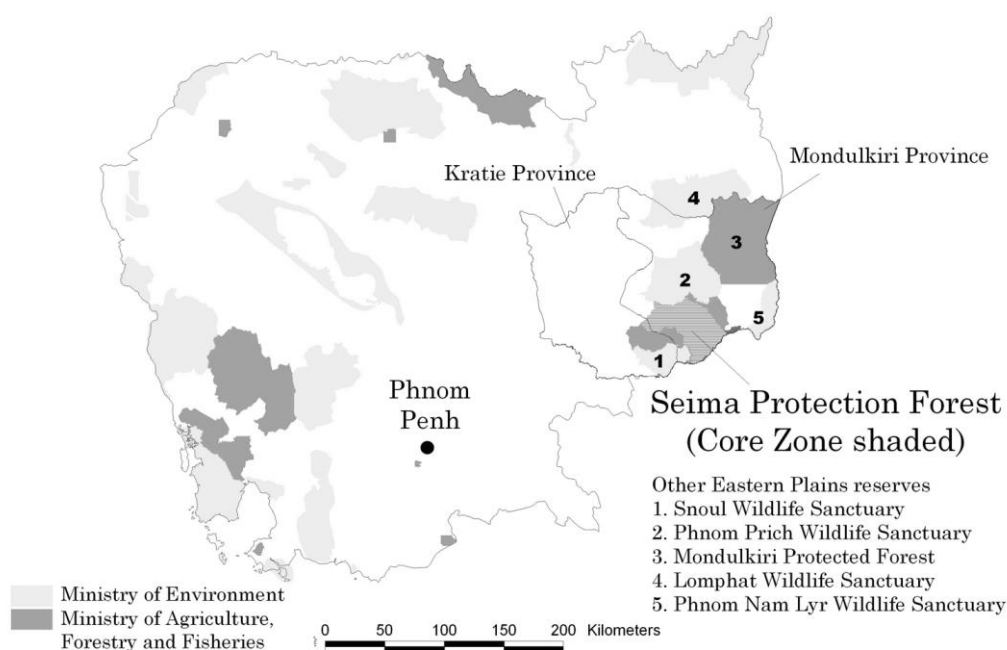


Figure 2.1: Location of Seima Protection Forest in Cambodia (from Evans *et al.*, 2012a).

2.2. *Biophysical characteristics*

The site contains a complex mosaic of habitats types, ranging from sparse deciduous dipterocarp forest in the lowland northwest to dense tropical evergreen forest in the eastern region along the Vietnamese border (Walston *et al.*, 2001, Evans *et al.*, 2003). The terrain is largely hilly and elevations range from 100m in flatter lowland areas up to 700m on the Sen Monorom Plateau. The site is of significant importance for biodiversity conservation, containing at least 41 animal species listed as globally threatened (Evans *et al.*, 2012a).

2.3. *Human geography*

History

Cambodia is home to several minority indigenous peoples, the majority of whom live in remote forested upland areas (ADB, 2002), often in and around gazetted protected areas such as the study site. Although little is known about the remote forested areas of Cambodia prior to French colonial rule, it is thought that the study area was sparsely settled by several indigenous groups, who maintained trading links with lowland areas (McAndrew *et al.*, 2003). During French rule, aside from a small number of rubber plantations, the area remained largely autonomous (Evans *et al.*, 2003). However, following independence from France in 1954, Cambodia's minority indigenous peoples came under increasing pressure from successive regimes to integrate into Khmer society, culminating in mass forced resettlements during the Khmer Rouge period (1975-79). At this time, villages within SPF were cleared and the majority of people moved to Khao Gniek District in the lowland north of Monduliri Province (McAndrew *et al.*, 2003). While some households began to return to their villages after the fall of the Khmer Rouge, the majority of returnees did not do so until the 1980s and 1990s.

The study site now supports a rapidly increasing human population. In 2008, population density had reached 5.4 people/km², with the significant majority of households belonging to the indigenous Bunong people (the original inhabitants prior to the Khmer Rouge period; Pollard & Evans, 2008). The remaining population is comprised chiefly of Khmer immigrants, who have moved to the area from neighbouring lowland provinces in search of land, or who belong to former Khmer

Rouge cadres that have been demobilised in the area. In addition to migrants who have settled permanently in the project area, there is also a significant transitory migrant labour force that travels to the uplands from neighbouring provinces as a means of extending the agricultural season. These temporary workers rarely feature in official statistics but are thought to be an important component in the pattern of agricultural expansion seen in the project area because of the extra labour they provide.

Bunong culture and institutions

A typical Bunong household is made up of a married couple, their children (including those who have married but not yet moved out) and any surviving parents who are too frail to live alone. Household members jointly farm their land and mostly share food and income. Many of the households in a typical settlement are closely related by blood or marriage and there are strong traditions of sharing and interest-free loans between family and close neighbours, providing a key livelihood coping strategy (Evans *et al.*, 2003). Most households have two residences, a permanent house in the main settlement and a smaller camp close to their fields, which may be some distance away.

The Bunong have a deep connection with the natural environment. As with most of the minority indigenous peoples in Cambodia, the Bunong have a strong animistic belief system (Kuoy, 2013), which is linked to many rituals and ceremonies throughout the year in worship of the spirits that they believe inhabit the hills, forest and streams around each settlement (Evans *et al.*, 2003). These beliefs are incorporated into customary laws, which prohibit clearance of forest in the immediate vicinity of settlements, in burial forests or in so-called spirit forests (Fox *et al.*, 2008).

Traditionally, the governance structure was village-based, with no higher-level institutions (Scott, 2009). Today, traditional village level institutions survive alongside state administrative roles (e.g. village chief), protected area authorities (e.g. FA, police and military police) and NGOs (e.g. WCS and local development partners), such that institutional controls on behaviour are both formal and informal. Village elders (*purahn ban*) play important roles resolving disputes, presiding over ceremonies and advising other villagers about the harvest of natural resources or clearance of forest (UNDP, 2010). The spokesman for the village elders (*antreahn*)

also performs a key mediation role, brokering resolutions to disputes and awarding sanctions for those considered to have broken rules. Sanctions typically take the form of gifts, such as chickens or rice wine, to aggrieved parties or to the whole village if the offence is judged to be serious. In several villages, these institutions have merged such that the traditional role of mediator often falls to the village chief, a political appointment. Internally within the village, new institutions are emerging through the creation of resource management committees associated with various NGO interventions. While these committees are ostensibly based on traditional institutional structures, with village elders making up the majority of committee members, the roles and responsibilities of the committees are more formalised and larger in scope than would traditionally have been the case.

Livelihoods

Although livelihood strategies throughout the project area depend on the terrain, the majority of indigenous households would traditionally have cultivated hill rice and a diverse range of vegetable and fruit crops to meet their subsistence needs, supplemented by the consumption and sale of forest products (most notably liquid resin collected from tapped dipterocarp trees). In a survey of resin-tappers, Evans *et al.* (2003) found that the sale of liquid resin on average contributed \$338 to total household incomes annually. In upland areas, rice is traditionally grown in rain-fed sloped fields, which are cultivated for a period of two to three years before being allowed to return to fallow. This type of farming is carried out in a rotational system with new fields cleared on a regular basis from land previously set to fallow. However, these rotational periods were severely disrupted by the forced evictions carried out by the Khmer Rouge, with the result that many areas that would previously have been part of the rotational cycle now hold 40 years or more of forest growth. In lowland parts of the project area, there is some rotational farming but the majority of households practice more productive, but sedentary, paddy rice cultivation. As traditional livelihood systems relied heavily on small-scale swidden agriculture, only a modest proportion of communal lands were cultivated at any one time. While swidden land use has often been considered to have a negative impact on forest ecosystems and subjected to efforts to ‘stabilise’ agricultural production (e.g. Lao land reforms; Ducourtieux *et al.*, 2005; Lestrelin, 2010), there is evidence to suggest that such systems can be sustainable (Fox *et al.*, 2000).

Although the majority of indigenous households in project villages maintain traditional livelihood strategies, there has been an increasing trend towards the adoption of commercial agriculture observed throughout the uplands region (Fox *et al.*, 2008; Milne, 2013). This is bringing more and more families into the market economy, although it should be noted that the Bunong have a long history of trading (McAndrew, 2009). The introduction of cashew, and more recently cassava, is thought to have contributed to significant expansion in the area of land farmed per household (T. Evans, pers. comm.). This expansion is also thought to have affected fallow cycles, with many plots now being planted with cashew rather than being allowed to return to fallow.

2.4. *Site management*

The majority of Cambodia's protected area network was created during the 1990s, and is managed by the Ministry of Environment (MoE). However, little was understood about the areas gazetted due to on-going conflict during this period. As such, PAs created at this time were little more than paper parks (Wilkie *et al.*, 2001), and many continue to be so. From 2002, a series of Protected Forests have been created by Prime Ministerial sub-decree and are managed by the FA. Consequently, the Cambodian protected area network is made up of sites managed either by the MoE or FA. Most of these sites are located in remote forested areas, with lower population densities and higher poverty levels than more accessible parts of the country (World Bank, 2009). Under the 2005 Forestry Law and 2008 Protected area Law, livestock grazing and the extraction of "traditional subsistence" levels of timber and NTFPs by local communities are permitted. Commercial logging and clearance of forest are, however, illegal.

The main threats to wildlife at the study site come from the illegal clearance of forest and both commercial and subsistence hunting (Walston *et al.*, 2001, Evans *et al.*, 2003, Evans *et al.*, 2012a). Until 2012, the majority of forest losses were thought to be caused by small-scale agricultural expansion and clearance by immigrant households. In addition to these small-scale land grabs, there has been a significant increase in the area of forest cleared by economic land concessions (ELCs). The granting of these large scale, agro-industrial plantations has increased dramatically across the country, with ELCs covering 381,121 ha granted in 2012 alone (of which over 70% were

within existing protected areas; ADHOC, 2013). In response to growing unrest, a moratorium on the granting of new ELCs was introduced in 2012, although applications that are claimed to have been “in the pipeline” continue to be approved (ADHOC, 2013). In addition to land grabs, another threat to wildlife and local livelihoods is illegal logging. Loggers commonly target high value timber species, including those tapped by local villagers for the collection of liquid resin, and hunt while camped in the forest. Recent discussions with villagers throughout the protected area have highlighted the loss of resin trees as a growing concern, particularly in areas located close to those granted as ELCs (unpublished data). Conservation activities to mitigate these threats have focused on law enforcement, community engagement, biological monitoring and participatory land use planning. Consequently, there are many more controls on resource use than in the past, with timber, land and certain wildlife species subject to legal protection. However, the collection of liquid resin is permitted throughout the site and the trees from which the resin is collected are protected under law. Sanctions for those individuals caught extracting resources illegally are minimal and typically comprise the confiscation of tools and whatever harvest the individuals have been caught with.

Proposals for carbon financing of forest conservation in the area are well advanced, and are being led by WCS at the request of the Cambodian government. These proposals focus on the core protection zone, with participating villages located within or in close proximity to this zone (Figure 2.2). These villages are divided into 17 key villages (those with farmland or residential land in the project area) and three other user villages (those documented to have regular, significant forest use in the project area but no agricultural or residential land inside). In the key villages, the whole village is involved in most aspects of the project, as most or all families are natural resource users; in the other user villages project activities are focused only on those families identified as being regular users of the project area (which in certain cases is only a small minority of all families). The majority of villages within the site are comprised of a number of discrete settlements, which can often be located several kilometres from each other but still belong to the same administrative village unit. In many cases similar conditions are found in each of the settlements but in one or two cases livelihood opportunities may be significantly different (for instance if one settlement is more inaccessible than others).

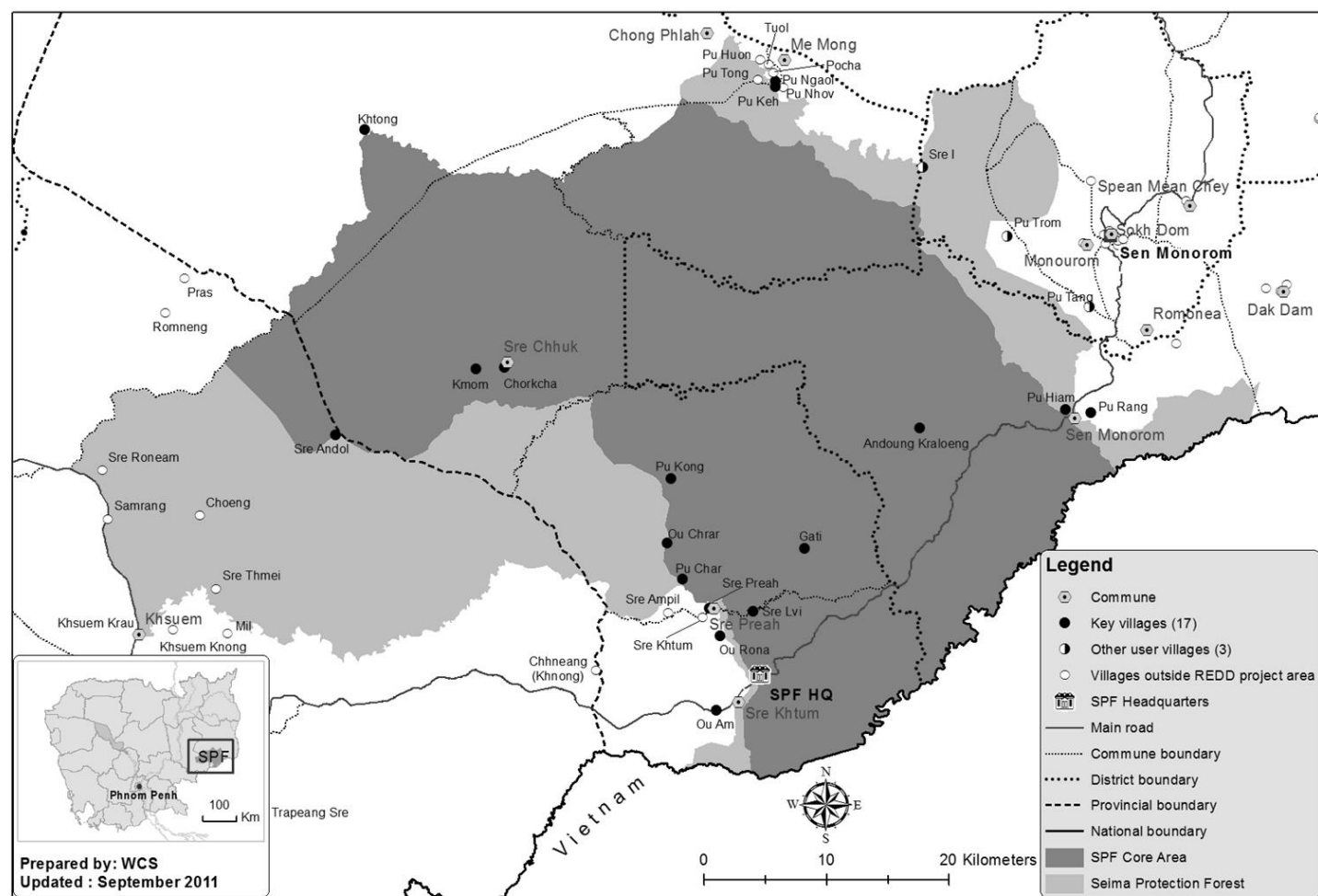


Figure 2.2: Landscape showing the location of the 17 key villages and 3 other user villages participating with the project and identified for inclusion in the social monitoring framework (from WCS, 2013).

Under the Seima Protection Forest REDD+ Demonstration Project, WCS is providing technical assistance to the FA to develop a site-based carbon offset project under the REDD+ framework. Credits will be generated in the core protection area of SPF, which is a designated national REDD+ demonstration site (FA, 2010). The project is currently undergoing validation against the two leading voluntary market standards, the Verified Carbon Standard (VCS), which focuses on quantifying emission reductions, and the Climate, Community and Biodiversity (CCB) Standard, which focuses on assuring social and environmental co-benefits. Conservative projections suggest the site can generate emissions reductions of 300,000 tCO₂e per year beyond baseline levels (WCS, 2013). Revenues from the sale of credits generated by the REDD+ project are expected to expand opportunities for conservation activities, including greater emphasis on incentive based approaches (Milne *et al.*, 2012).

Chapter 3

Assessment of progress towards social targets of the Seima Protection Forest conservation programme

3.1. *Introduction*

There is increased awareness of the need for more effective monitoring and evaluation of conservation outcomes and impacts. Enhanced monitoring would enable conservation practitioners to assess the effectiveness of conservation policies, add transparency and accountability to decision-making, detect potential issues and identify possible remedial actions (Margoulis *et al.*, 1998; Ferraro & Pattanayak, 2006; Stem *et al.*, 2005). Where commitments have been made to minimise or eliminate negative impacts on local people or to deliver positive benefits, effective social monitoring and assessment of impacts is essential (Brockington & Schmidt-Soltau, 2004). To be effective, social impact assessments must be able to differentiate between different groups and measure changes in well-being across groups, particularly those considered to be most vulnerable to environmental change (Adger, 2006; Daw *et al.*, 2011). Such assessments can also bring practical benefits to the implementation of conservation policies, particularly in early stages, by improving understanding of the social context in which conservation operates and identifying existing social and economic trends under current conditions (Brechtin *et al.*, 2002).

One of the key challenges surrounding any impact assessment is the concept of attribution, defined here as the ability to ascribe particular observed social changes, such as household well-being, directly to project activities and not other drivers of change (Richards & Panfil, 2011). As conservation projects typically operate within highly complex and dynamic social environments (Berkes, 2004), the concept of attribution becomes particularly important. Without it, social changes (both positive and negative) may be attributed to project activities, even if these changes would have occurred if no project activities had taken place at all. Such issues can be addressed by using quasi-experimental matched methodologies, in which control areas are identified that resemble the project site but where no project activities are conducted (e.g. Naughton-Treves *et al.*, 2011; Clements & Milner-Gulland, in press; Clements *et*

al., in press). However, these approaches are costly and it can be difficult to identify conditions that closely match project sites or that are not subject to alternative interventions. Matched approaches have also been subject to criticism regarding the ethics of repeatedly surveying people who are not benefiting from project activities (Richards & Panfil, 2011). In development economics, where matching techniques are also applied, there are concerns that matching compares poorly with the results of randomised controlled trials (Duflo *et al.*, 2008). An alternative approach to impact assessment, which is recommended for use in guidance issued by the Climate, Community and Biodiversity Association (CCBA), utilises the theory of change (ToC; Richards & Panfil, 2011). This approach is claimed to overcome the issue of attribution by testing *a priori* hypotheses regarding cause-and-effect relationships between project activities and social outcomes, and relies upon the careful selection of monitoring indicators that reflect attributable social changes. This has the advantage over quasi-experimental approaches that there are no requirements to identify control areas or survey households not directly affected by the project, but attribution is less robust in the absence of a counterfactual.

Although the framework of reduced emissions from deforestation and forest degradation (REDD+) brings little new to the table in terms of how conservation is implemented on the ground (Blom *et al.*, 2010; Clements, 2010), its emergence has been greeted enthusiastically by some conservation organisations and national governments, who perceive its potential to secure funding for the long-term protection of forested areas. Whether or not this potential is realised remains to be seen. Yet due to its regulated nature and significant investment in readiness activities, REDD+ has been well placed to incorporate and develop requirements for the assessment of the social impacts associated with its implementation. At the national scale, a set of seven safeguards for REDD+ implementation was agreed at the Conference of the Parties for the United Nations Framework Convention on Climate Change (UNFCCC) in Cancun in 2010. Included in these safeguards, was the commitment to incentivise the “protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits” (UNFCCC, 2010). This was supported a year later by Decision 12/CP.17 of the UNFCCC Durban Outcome, in which party states agreed to implement a national level safeguards information system to systematically monitor how REDD+ safeguards are being addressed (UNFCCC,

2011), and reiterated by the Warsaw Framework for REDD+ in 2013 (UNFCCC, 2013). These developments have been matched at the project level, where voluntary projects certified as meeting the Climate, Community and Biodiversity (CCB) standards, must demonstrate that there has been a net positive impact on local communities as a result of project activities (CCBA, 2013). As such, REDD+ activities implemented at both national and project scales should benefit local people and include a component to assess the social impacts associated with those activities.

In order to satisfy the requirements for social impact assessment for projects applying for certification under the CCB standards, PA authorities at SPF designed a social monitoring framework for the study site (WCS, 2013). This framework is based on the ToC-based approach to social impact assessment of REDD+ projects recommended by the CCBA (Richards & Panfil, 2011). Under this methodology, “causal chains” are used to conceptualise linkages between project goals and activities. To do this, project proponents made use of a conceptual model previously created in 2006, and updated in 2011 as part of the development of the REDD+ project at the site, which linked project targets to conservation activities and to direct and indirect threats (Figure 3.1; WCS, 2013). Indicators were selected to measure progress towards each target.

In this chapter, I investigate social trends in the 20 villages participating in the REDD+ demonstration project at Seima Protection Forest for the period between 2007 and 2012, utilising the indicators selected for the social monitoring framework described above. The aim of this analysis is threefold:

1. to provide a baseline picture of trends in site demography, household economic well-being and resource security to inform the analyses presented in Chapters 4, 5 and 6.
2. to evaluate the social impacts of activities implemented at the study site in advance of REDD-linked social programmes in relation to two key stated targets of conservation management of the site:
 - increase security and productivity of natural resources to support local livelihoods
 - ensure sufficient farmland to support the livelihoods of current residents

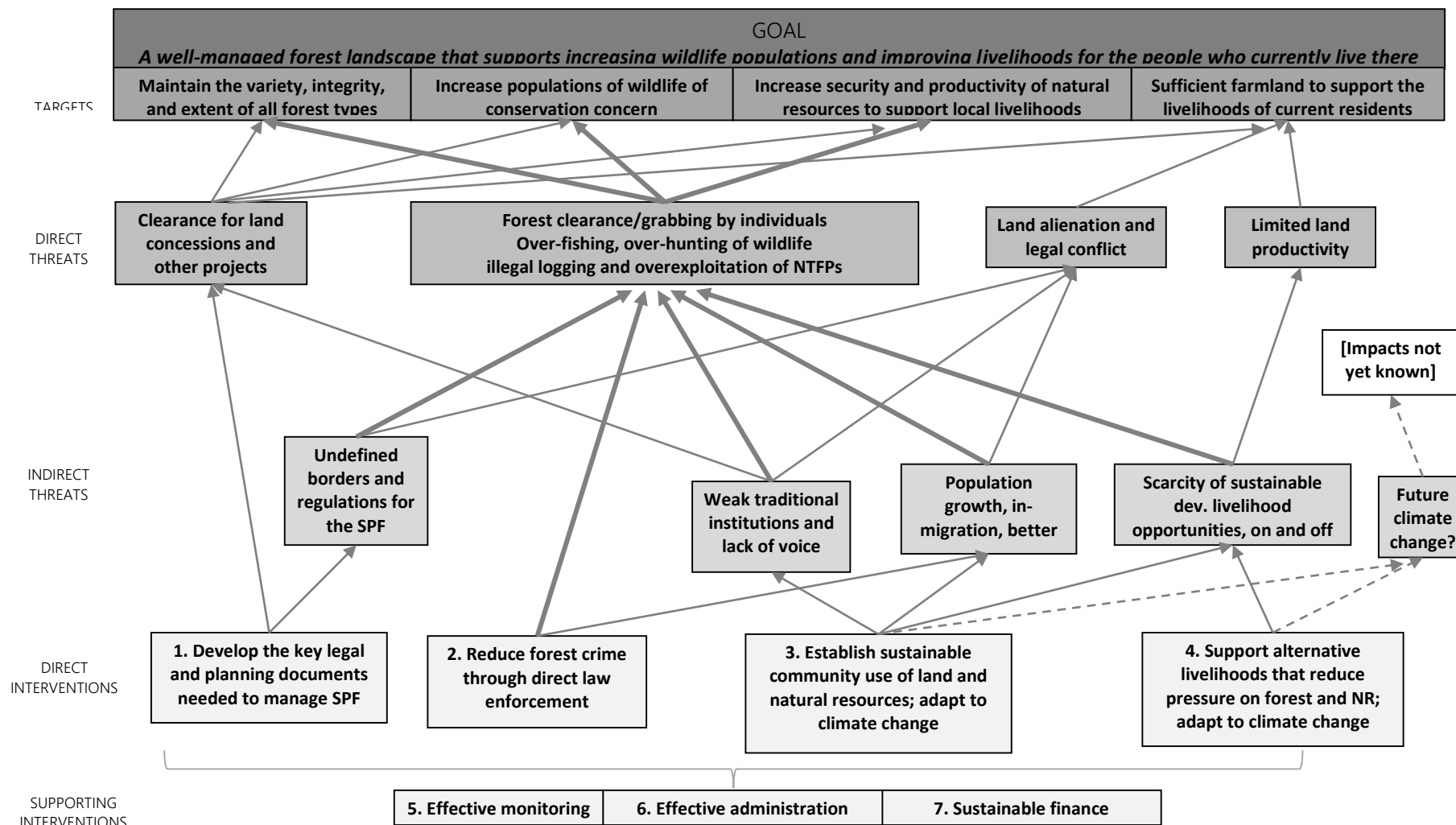


Figure 3.1: Conceptual model developed by PA authorities for Seima Protection Forest REDD+ Demonstration Project (from WCS, 2013)

3. to investigate the appropriateness of the indicators selected for these two targets as part of the monitoring framework for social impact assessment at the site.

For this analysis, I designed a household survey, which was undertaken in 2012, to supplement existing monitoring activities at the study site and to build upon the results of a complementary survey undertaken across the same landscape in 2007. Where data were previously lacking, the 2012 survey creates a baseline for the indicators selected by project proponents for the assessment of social co-benefits and impacts expected to arise from the REDD+ project under development at the site. For data collected in both 2007 and 2012, progress towards project targets is evaluated by assessing the trends in selected indicators. As such, the 2012 survey forms a key component of the social monitoring system developed by PA authorities for the REDD+ project. In addition to the analysis of social trends and impacts of conservation activities at the study site, I present a discussion of lessons learned from the implementation of this survey and associated implications for future social impact assessment at the site.

3.2. *Methods*

Indicator selection

For each indicator selected to measure progress towards the two project targets concerning local livelihoods, I identified the expected trend that would indicate that progress had been made towards the respective project target (Table 3.1). In all cases, the business as usual trend (i.e. in the absence of project activities) was thought to be negative, and so a positive trend was not necessarily required to indicate a positive impact, as a stable trend could indicate that the project was having at least some positive effect. In these cases, however, an observed negative trend would be inconclusive in light of a lack of a counterfactual.

Table 3.1: Selected indicators for the two social management targets identified for Seima Protection Forest. The expected trend that would indicate progress towards project targets is given for each indicator.

Project target	Indicator	With-project expected trend (2007-2012)
1. increase security and productivity of natural resources to support local livelihoods	1. resin tree ownership: <ul style="list-style-type: none"> • 1a. no. of households • 1b. no. of trees per household 1c. reported number of meat meals in a week 1d. reported household resource security	increased or stable security, abundance and productivity of harvested natural resources
2. ensure sufficient farmland to support the livelihoods of current residents	2. land ownership measures: <ul style="list-style-type: none"> • 2a. average holdings • 2b. % landless 	increased average area of household land holdings, stable or reduced proportion of landless households

Target 1: increase security and productivity of natural resources to support local livelihoods

Security of natural resources can be understood in a number of different ways, which may reflect aspects of tenure (i.e. the legal rights of resource users to access, use or claim ownership of resources) or the sustainability of resource use. In the context of the project target evaluated in this chapter, resource security is taken to mean the long-term supply of the forest-derived natural resources upon which local livelihoods depend. The project target is, therefore, interpreted as a stated intention to manage the study site in such a way as to ensure the long-term protection and sustainable supply of key natural resources within SPF. This is a difficult quantity to measure, as changes in the use of different forest products may be caused by a number of factors, such as varying demand or changes in stock levels. For this reason, three separate indicators were selected to measure progress towards the target in addition to a poverty score derived for each household. These included two variables focussed on household access or use of resources (household resin tree ownership and the number of wild meat meals eaten by a household in a week) and a third variable looking at reported perceptions of household resource security as defined above.

Resin tree ownership:

As liquid resin has previously been shown to provide a significant proportion of household income at the project site (Evans *et al.*, 2003), the trees from which resin is collected are considered to be an important household resource. These trees are subject to customary tenure rules, which give ownership rights to individual households. As such, tree ownership is an important indicator of the security of natural resources that support local livelihoods. The total number of trees that can be tapped is finite and considered to be saturated (i.e. all trees mature enough to be tapped are already owned by a household; Clements, 2012). The transfer of ownership is largely through inheritance. When children reach marrying age and form new families, they are typically given a small number of trees by their parents. Few trees are reported to be sold. The biggest threat to resin trees comes from illegal logging, particularly in areas close to economic land concessions (H. Travers, pers. obs.). Although local communities respect customary ownership of resin trees, illegal logging teams target resin tree species because of the high value of the dipterocarp timber. Consequently, the loss of trees to illegal loggers has the potential to reduce total resin tree stocks and, hence, undermine local livelihoods. Stability in the number of households that own trees and the number of trees owned by resin tapping households would indicate that resin trees are being successfully protected. As resin tree species are some of the most valuable timber species in the project area, resin tree numbers also provide an indication of the success of wider forest protection.

Meat meals:

Wild protein sources are important for rural households, particularly the poor (Milner-Gulland & Bennett, 2003). As such, the number of meals eaten that contain wild meat (including fish) could be an indicator of natural resource security. Stable consumption would indicate that wild meat resources are sufficiently stocked to be able to continue to support extraction, although this would not necessarily indicate that extraction levels were sustainable into the longer term. However, as households within the project area become better off or more farming-dependent, some households may switch to alternative meat sources, such as farmed livestock or imported fish, as has been noted in other contexts (Brashares *et al.*, 2004; Wilkie *et al.*, 2005). A decline in the average number of wild meat meals eaten under such circumstances would not necessarily indicate a decline in wild stocks. However, a decline in the number of

wild meat meals concurrent with a decline in the total number of meat meals eaten (from both wild and farmed sources) could be expected to be indicative of a reduction in wild stock levels. Hence this ratio was chosen as the indicator.

Perceived resource security:

The final indicator selected to measure household resource security was simply the reported perceptions of those households interviewed for the 2012 livelihood survey. Each respondent was asked whether they felt secure about their access to natural resources, including agricultural land, resin trees and other forest resources, and the reasons why they felt this way.

Target 2: sufficient farmland to support the livelihoods of current residents

The second target identified in the conceptual model for the project is to ensure that sufficient farmland is available to support current livelihoods. Limited land productivity is a direct threat to sustainable livelihoods in the project area, as low yields and extensive land use practices increase the demand for smallholder farmers to clear more forest in order to meet their production needs. Two indicators were selected by WCS to monitor this target: average household land holdings and the proportion of households without any land at all.

Household land holdings:

Household land use patterns have changed dramatically in the period between the two surveys in 2007 and 2012. In part this is due to the emergence of cassava, which was introduced in 2005/6 by Vietnamese traders. This crop has changed the prevailing agricultural system practiced in the project area, with a wave of cassava adoption spreading throughout SPF as access to villages improves and the prices offered by traders increase. The emergence of cassava, and to a lesser degree other cash crops, has increased the incentive for farmers to claim extra land by clearing more forest. It is expected that increased land tenure security amongst many of the project villages as a result of project activities will encourage farming households to make the most of this opportunity, whilst restricting encroachment into conserved areas (see Chapter 4). Of the 20 project villages, 15 villages have received or are in the process of applying for communal land tenure in recognition of customary land rights (A. Diment, pers. comm.). Land designated to communal title is managed by a village committee, which

then grants plots to individual households. For many households, this process is expected to give them access to greater areas of agricultural land and, hence, the average area of household land holdings is an important indicator of the success of this programme. However, unrestricted expansion of agricultural lands remains a threat. As such, it is important also to monitor the number of households that hold 5 ha or more land. The threshold of 5 ha was selected, as this is the area that households are limited to by community regulations governing communally titled areas or legally in the case of individual land titles.

Land alienation:

As commercialisation of agriculture spreads throughout the project area, household livelihoods are increasingly dependent upon access to land. As such, households are becoming progressively more vulnerable to land alienation. At the same time, pressure from immigrant households and influential external interests is serving to increase the price of land and draw in additional land speculation. More widely, land disputes between local communities and large companies have increased dramatically throughout Cambodia (ADHOC, 2013). Whilst SPF has largely been unaffected by the impacts of the widespread granting of ELCs, three rubber concessions have recently been granted in the buffer zone, illustrating the increasing threat of dispossession and land alienation to local livelihoods. Minority indigenous communities, such as those found in the project area, are particularly vulnerable to dispossession as a result of debt, misinformation, weak political voice or extortion. In order for the project to achieve its target of sufficient land for local communities, it will be necessary to simultaneously protect communities from the threat of land alienation. As such, the extent of landlessness within the project area is an important indicator against which to measure success.

Vulnerable groups

One of the key requirements of any social impact assessment is to be able to detect project impacts on different socio-economic groups within target communities, particularly those considered most vulnerable to change or adverse impacts. To this end, I identified several potential vulnerable groups (Table 3.2).

Table 3.2: Hypothesised vulnerable and special interest groups identified for the impact assessment. These groups are not exclusive and so it was possible for households to be classified as belonging to more than one group.

Potential vulnerable households	Reason for testing
widow-headed	widow-headed households are likely to be more vulnerable to shocks and have fewer livelihood opportunities.
dependent	households that consist entirely of an elderly couple (and possibly grandchildren) may be more vulnerable to shocks. These households are also likely to have fewer physical resources as these are often given to their children upon marriage.
landless	landless households lack the means to grow their own food and may be dependent on daily wage labour opportunities. Landlessness can also be a sign that the household has fallen into debt and has sold their land as a consequence. Not all landless households are poor, as some households may consciously choose to focus on other livelihood activities.
non timber forest product (NTFP) collectors	NTFP collectors have been classified here as non-timber, non-liquid resin collectors. Commonly collected NTFPs include rattan, bamboo, honey and wild fruit and vegetables. Although there is a degree of overlap between the two groups, many NTFP collectors do not have resin trees to support them. NTFPs are thought to offer a safety net to households that experience hard times, and those households that collect them may be particularly vulnerable to losses in forest resources.
labour sellers	households that are dependent on daily wage opportunities, which are low in some villages, are more likely to have poor access to important resources, such as land and resin trees.
indigenous	as the majority of households in the project area are indigenous, there is little evidence to suggest that they are more vulnerable than any other group. It is possible that this may change in the future, however, as there have been increasing numbers of migrant households and indigenous households can be vulnerable to land alienation.
resin tappers	resin tree owners are not necessarily a vulnerable group, having access to a resource that is less subject to fluctuating yields than some crops. Tappers with few trees are more vulnerable to losses, however, and this group is of special interest to the project as it seeks to protect forest resources with the project area.

Once vulnerable groups were selected, trends for these groups could be investigated in addition to those for the overall population. In some instances, certain groups were

identified for monitoring despite not proving vulnerable overall because of their special interest to the project (e.g. resin tappers, indigenous households).

Household livelihood survey

Twenty target villages were identified through initial consultations between PA authorities and potential forest users in the REDD+ project area. A quantitative household livelihood survey was conducted in all of these villages between April and July 2012. This survey was designed to complement a livelihood survey conducted in 2007 to create a social baseline against which impacts of the REDD+ project could be assessed. As such, the survey was designed for repeated iterations over the period of the REDD+ project, which influenced some aspects of the design. The survey interviews were conducted by a Cambodian organisation, the Centre for Development Orientated Research in Agriculture and Livelihood Systems (CENTDOR), which specialises in independent monitoring and evaluation of rural development projects. The survey was carried out in this way in order to minimise the risk that interview respondents tailored their responses to what they thought PA authorities wanted to hear.

In all bar three villages, at least 30 households were randomly selected for inclusion in the survey, with 622 households interviewed overall. In the remaining three villages, there were insufficient households in the village at the time of the survey to be able to sample at least 30, and so all available households were sampled. For villages that are separated into discrete settlements, the sample was proportionally stratified by settlement. For example, if a village comprised two settlements of 200 and 100 households, the team would survey 20 households in the larger settlement and 10 in the smaller. Within each settlement, households were randomly selected from a list of households kept by the village chief. Where possible, interviews were conducted with those individuals identified as the household head. In cases where the household head was unavailable for extended periods, their spouse was interviewed instead. Interviewers followed a structured questionnaire with a final qualitative section focusing on perceptions of livelihood changes. All interviews lasted for approximately one hour, with respondents compensated for their time.

The 2007 survey was conducted by the monitoring and evaluation unit of Cambodian Centre for Development and Study in Agriculture (CEDAC), which was subsequently

established as CENTDOR in 2008. For this survey, 400 households from 14 villages were interviewed, with sampling approximately proportionally stratified by village, such that the majority of interviews were conducted in more populous villages. As in 2012, households were randomly sampled in each village and interviews were conducted with the household head.

The basic necessity survey

Although the 2012 survey was designed to produce compatible results with those produced by the 2007 survey, there were methodological differences between the two surveys, so that improvements could be made to the protocol used and to the content of the questionnaire. The most significant of these differences was in the handling of household economic well-being. The 2007 survey focused heavily on the collection of income data but as livelihood strategies within project villages are vulnerable to stochastic events, such as poor weather or flooding, income data can be highly variable both spatially and temporally. This can make comparisons between different parts of the landscape or different years difficult. For example, the rice harvest of 2006 was particularly poor and many households who were interviewed during the 2007 survey had been badly affected. Conversely, the rice harvest of 2012 was generally good. Hence, any comparison of incomes between the two years would be biased and likely to suggest a greater improvement in economic well-being than was actually the case.

In order to overcome this issue, an alternative metric of household economic well-being was selected: the household poverty score derived from following the basic necessity survey method (Davies, 1997). This is a survey instrument that provides a participatory poverty index of sampled households, which is derived from ownership and access data for a list of household assets and services. For the 2012 survey, a list of 40 different assets and services was compiled at a workshop held at the FA's Seima headquarters in April 2012 (see CENTDOR (2012) for a more detailed description of the workshop). This workshop was attended by 24 participants from villages located in the three different livelihood zones, who were selected to represent different socio-economic groups with each village by project staff with a good knowledge of each community. Following the adapted definition used by Clements *et al.* (in press), basic

necessities were defined as the “*minimum requirement for living that all households of the community should have and no-one should not have.*”

Each household sampled was asked whether they had access to or owned each item on the list. For each item the respondent was also asked whether they believed that item to conform to the definition of a basic necessity. Each household's poverty score was calculated by adding the weighting for each item (calculated from the proportion of respondents who agreed that an item was a basic necessity) that that household had access to or owned, provided that at least 50% of respondents thought that those items were basic necessities. For example, if a household owned four items, which were thought to be basic necessities by 41%, 22%, 86% and 79% of respondents respectively, their poverty score would be $0.86 + 0.79 = 1.65$. These scores were then converted to a proportion of the total possible score. In 2012, 32 of the original 40 list items were thought to be basic necessities by over 50% of households sampled. Items that less than 50% of people would think were basic necessities were included in the list to make respondents think carefully about whether each item conformed to the definition and to future proof it against potential increases in wealth.

Comparison of 2007 and 2012 household poverty scores

A basic necessity survey component was not included as part of the landscape-wide livelihood survey in 2007, but data were collected on 11 assets and services that appeared as items in the 2012 list. Two methods were tested to derive an adjusted poverty score for 2007, using ownership data for just these 11 items.

The first method simply found a reduced poverty score for the 11 items for which data was collected in 2007 by summing the 2012 weightings for each item owned. This gave a reduced score based on 2012 perceptions of whether or not those items met the definition of a basic necessity. In the second method, a new score for households in 2012 was calculated using the 21 items for which no data was collected in 2007. This adjusted score was then regressed against dummy ownership variables for the 11 items using the linear mixed modelling method described below, which provided linear coefficients for each item plus a best linear unbiased predictor for each village. A predicted poverty score for the 21 items not covered by the 2007 survey was then calculated from these coefficients and added to the score for the 11 items included in

both surveys. This gave an estimate for both time periods of the poverty score derived for all 32 items, as opposed to the score for only the 11 items common to both surveys given by the first method.

Before comparisons could be made between the two time periods, it was necessary to test the extent to which the adjusted poverty scores calculated using the two methods were representative of the score calculated for the full 32 items used to calculate the overall poverty score for each household in 2012. Pearson's product-moment correlations comparing the adjusted scores with the full poverty score were found for households sampled in 2012. These showed that the reduced score derived using the first method provided a closer correlation (correlation coefficient = 0.90) with the original full score and so this method was preferred as the basis for making comparisons between the two time periods.

In order to compare the reduced poverty scores from the two surveys in greater detail, a linear mixed model was constructed following the approach described below, with reduced poverty score as the response variable. The final model included some explanatory variables that were different to those used to investigate the overall poverty score in 2012. Two changes were necessary because the survey data collected in 2007 did not allow for the calculation of household adult male equivalence and no data were collected regarding labour constraints. Consequently, total household size was used as a substitute for adult male equivalence and whether a household was labour constrained was omitted from the model. A third change was made to substitute a dummy variable for landlessness for the reported area of land claimed per household, as landless households are one of the vulnerable groups identified above. Finally, a survey year dummy variable was added to test for changes in poverty score between the two surveys and an interaction term between this dummy variable and the distance to the nearest market was also included.

Data analysis and statistical modelling

One of the main issues that had to be addressed before making comparisons between the results of the 2007 and 2012 surveys was the difference in sampling density between the two surveys and the difference in the villages included in each survey. In 2007, sampling in each village was done on an approximately proportional basis, with the consequence that very few interviews were conducted in some of the smaller

villages. In 2012, the sampling design was modified to make it easier to monitor variations in indicator trends between villages over time. Consequently, different sampling densities were used for the two surveys. For each time period, weighted means and standard errors were calculated for each indicator using sampling weights for each village equal to the number of households in a village at the time of the survey divided by the number of households sampled during that survey. As the number of villages included in the survey was increased in 2012 to ensure that all 20 project villages were monitored, comparisons are made solely on the basis of those villages that were sampled in both surveys but excluding Kmom and Sre Andaol, as land use data for these two villages were considered unreliable for the 2007 survey.

Due to the sampling design of the two surveys and the overall aim of the monitoring programme, analyses of longitudinal trends were based on comparing the results of cross-sectional analyses of each time period (rather than a panel analysis), as it was felt that this approach offered multiple advantages over the length of the REDD+ project. Cross-sectional sampling does not carry the risk of participant attrition to which repeat surveys are vulnerable, nor does it put so much of a burden on respondent households. Furthermore, newly arrived or formed households would continually need to be added to a repeated survey. Finally, it can be very difficult to match households between surveys, particularly if the household head dies, members move away or the children marry and form new households.

Statistical modelling was conducted to give a greater understanding of indicator trends and the socio-economic groups associated with different activities. Continuous variables were analysed using linear mixed models (LMMs) and binomial or Bernoulli variables were analysed using generalised linear mixed models (GLMMs). For each analysis, a number of household demographic and livelihood variables were investigated as explanatory variables (see Appendix A; Table A.2 for a description of the household variables investigated). For analyses in which the data from all sampled households were included, the area of land reported by each household was transformed by taking the natural logarithm of reported area plus the square of the first quantile divided by the third quantile. This constant was added to account for zero values.

Backwards stepwise model selection was carried out on the basis Akaike information criterion values (AIC; Akaike, 1974). If candidate models had a Δ AIC value of less than two then the most parsimonious model was selected, otherwise the model with the lowest AIC was selected (Burnham & Andersen, 2002). Marginal and conditional R^2 statistics were calculated for LMMs following the method proposed by Nakagawa & Schielzeth (2013). These can be interpreted as the variance explained by the fixed effects and whole model respectively. Selected models were checked for residual normality, heteroskedasticity and correlations between fixed effects and the residuals. Over-dispersion in binomial logistic regression models was checked by comparing the sum of squared Pearson residuals with the approximate residual degrees of freedom. No issues were found.

3.3. *Results*

Population and immigration

In 2006, the total number of households in the project villages and settlements for which data are available for both time periods (17 villages plus two settlements) was 1838 (Evans, 2007). In 2012, the household population for the same villages and settlements had grown to 2768, representing an overall annual growth rate in the total number of households of 7.1%. However, this growth was not distributed equally between the project villages. Three villages (O Am, O Rona and Sre Preah) alone account for 75.3% of the increase in the total number of households and if these villages are excluded from the calculations, the resultant annual growth rate in the total number of households is reduced significantly to 3.8%. As these three villages are located closest to the district capital of Keo Seima District (Figure 2.2), this result suggests that much of the overall increase in the number of households is due to immigrant Khmer households from other provinces moving into the project area in search of land. This is further evidenced by the resultant shift in the proportion of indigenous households in the project area. In 2006, the percentage of indigenous households in comparable project villages (i.e. those with sufficient data in both time periods to be able to make a comparison) was 67.2% but this had dropped to 54.6% by 2012, a reduction of over 10% in just 6 years. Until a recent drive to title household claims to land in 2012/13, the vast majority of land claims from migrant households were illegal. However, land claimed by immigrant households was

excluded from negotiations over indigenous land title, which reduced the legal entitlement of the native Bunong communities to the natural resources on which their livelihoods depend. As of yet, this wave of immigration has been restricted to the southern lowland part of the protected area but recent improved road access to other parts of the project area has already increased the level of immigration (H. Travers, *pers. obs.*). As such, any conservation activities planned for the project site must take account of the effect that migrating households may have.

Household poverty score

The main metric used for assessing the economic well-being of households from the 20 participant villages was the score derived from the basic necessity survey, which ranges from 0 to 1 (with higher scores indicating better off households). The poverty scores for households sampled in 2012 range from 0.10 to 0.82 (for weightings used to calculate household poverty scores see Appendix A; Table A.1). This clearly illustrates the extent of the difference in economic well-being between the poorest and best off households in the project area. The distribution of scores is approximately normal with a mean score of 0.44 (SE = 0.13; Figure 3.2). Once differences in the number of households in each of the villages across the project area were accounted for, the adjusted average household poverty score for the landscape increased to 0.47 (SE* = 0.04).

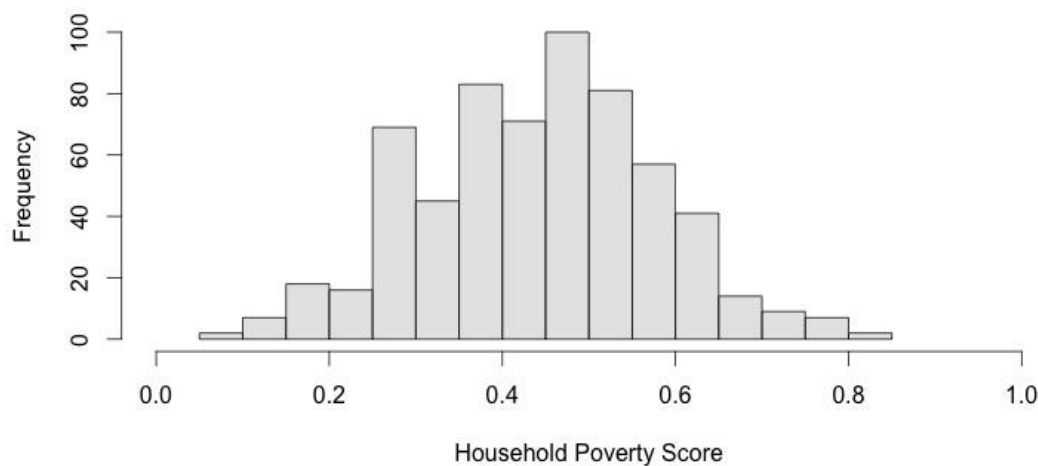


Figure 3.2: Distribution of full household poverty scores from the 2012 quantitative household livelihood survey.

A linear mixed model was constructed in order to investigate the demographic and livelihood factors that were most strongly correlated with household economic well-

being, with household poverty scores as the response variable and village as a random effect (Table 3.3). Included in the final selected model were nine explanatory variables: three related to household demographics and six related to livelihood strategy or opportunities. This correlates very closely with a similar analysis of basic necessity poverty scores for households in northern Cambodia (Clements *et al.*, in press).

Table 3.3: Coefficient estimates for the LMM with the full household poverty score for 2012 as the response variable. Standard errors are given in parentheses. $R_m^2 = 0.363$, $R_c^2 = 0.416$. Resin tree ownership at the intercept was taken to be 0-50 trees.

Variable	Estimate	t value
intercept	0.487 (0.018)	27.148
adult male equivalence	+0.005 (0.002)	2.203
widow	-0.038 (0.012)	-3.127
ln(area of land + 0.3738)	+0.050 (0.006)	8.073
owns 51-150 resin trees	+0.031 (0.011)	2.943
owns > 150 resin trees	+0.055 (0.017)	3.164
shop owner	+0.080 (0.014)	5.585
labour seller	-0.064 (0.009)	-7.355
employed	+0.034 (0.012)	2.892
service provider	+0.034 (0.015)	2.268
labour constrained	-0.025 (0.008)	-3.036
distance to nearest market [km]	-0.002 (0.000)	-5.850

The resultant linear coefficients estimated by the model provide a useful guide to understanding which socio-economic groups are most economically vulnerable. The results suggest that the most disadvantaged households with respect to poverty scores were households with little or no productive land, households with few or no resin trees, households in which the husband had died, households that were part of the wage labour market and households that reported being labour constrained. Of the seven hypothesised vulnerable groups presented in Table 3.2, only widow-headed, landless and labour selling households were found to have reduced poverty scores. Ethnicity was not a significant explanatory factor of household poverty score. This is likely to be due in part to other variables associated with being an indigenous household that were included in the model (e.g. resin tree ownership) but also the fact that indigenous households are the majority ethnic group within the project area. Interestingly, no effect was found from being an NTFP user despite the collection of NTFPs commonly being associated with poorer households (Wunder, 2001), although

this is possibly because households with many resin trees (and hence wealthy) spend longer in the forest and will collect other NTFPs at the same time.

The strongest effect on household poverty score of all those identified was for the reported area of productive land claimed by each household. As reported areas were log transformed and a constant added to account for skewness and the presence of zero values respectively, interpretation of the resulting coefficient estimate is not straight forward. Plotting the estimated relationship between household poverty score and reported productive areas overcomes this problem and shows that the reported area under cultivation is strongly associated with economic well-being for the range of areas reported in the survey (Figure 3.3). It is also clear that households with little or no land were strongly disadvantaged.

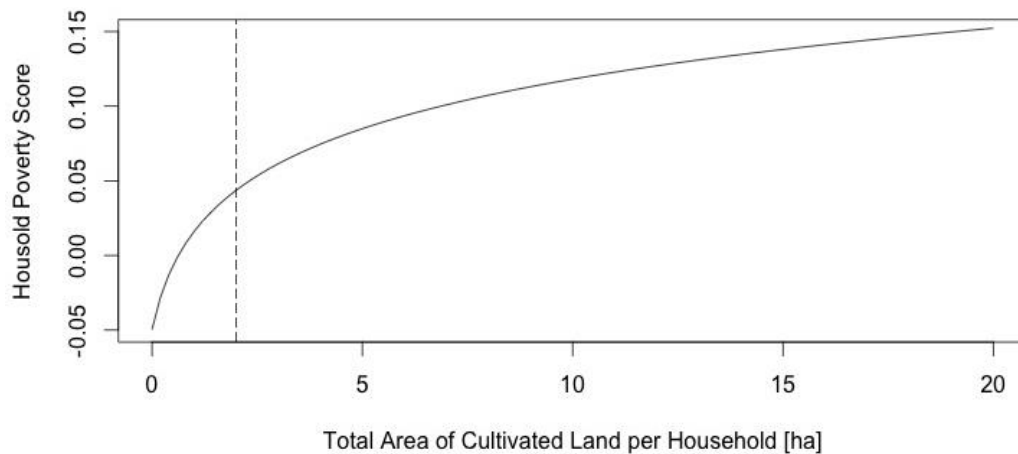


Figure 3.3: Estimated relationship between the full household poverty score and the total reported area claimed per household. The vertical dashed line is drawn at the mean area of productive land claimed per household.

In addition to the effects of household explanatory variables, much of the variation in household poverty scores was accounted for by the inclusion of the village that each household was resident in as a random effect in the model and the distance of the village from the nearest all day market. The effect of distance to the nearest market, which is a good proxy for the remoteness of each village, is such that for the most remote village, Sre Khtong, household poverty scores decrease by 0.16. This is strongly indicative of the reduced livelihood opportunities in more remote villages, as fewer traders come to those villages and the cost of transporting goods is higher. The residual effect associated with each village can be seen through estimating best linear unbiased predictors (BLUPs) for the village random effect, which for the purposes of

this analysis can be conceptualised as the equivalent of the linear coefficients found for the explanatory variables. Plotting the BLUPs for each village shows that, despite quite large 95% confidence intervals, there is significant difference in the effect that the conditions in different villages (excluding remoteness) have on household poverty scores (Figure 3.4).

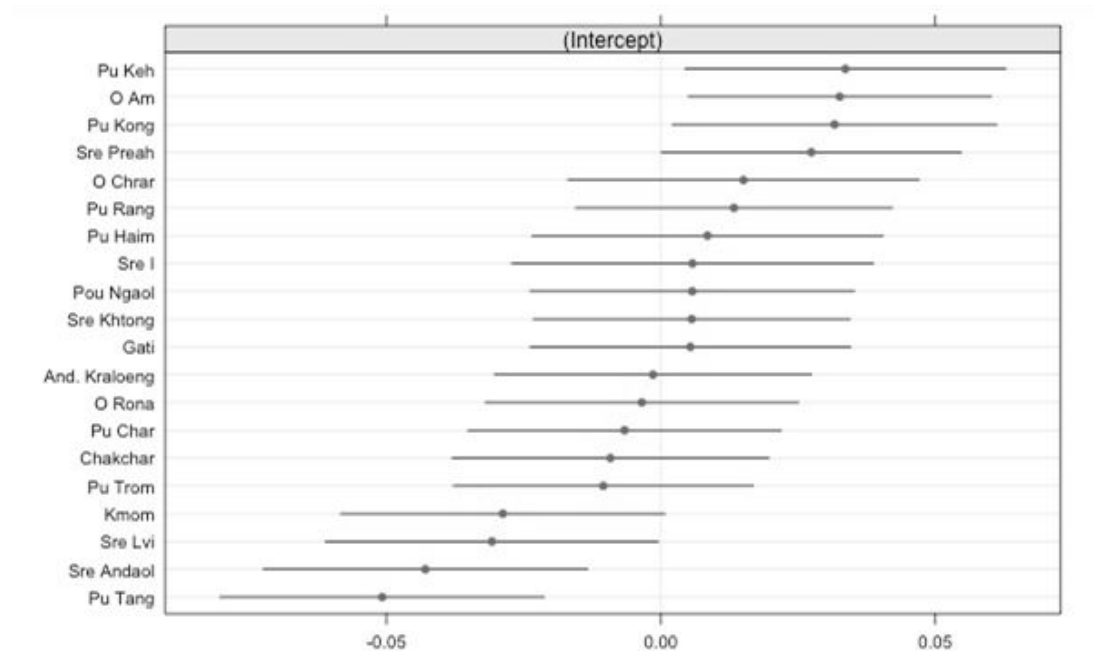


Figure 3.4: BLUPs for the village random effect. The x-axis shows the effect of living in a particular village in terms of the difference to the full household poverty score from the intercept. Error bars show the 95% confidence interval for each village.

Adjusted poverty scores were used to compare household economic well-being between 2007 and 2012. For the 11 items used to create the adjusted poverty scores, these scores ranged from 0.08 to 0.83 in 2007 and from 0 to 1 in 2012 (Figure 3.5). Correcting for the different numbers of households in each of the villages surveyed in both 2007 and 2012 gives average adjusted poverty scores of 0.42 ($SE^* = 0.07$) for 2007 and 0.50 ($SE^* = 0.07$) in 2012. Despite similar means for the two surveys, there is a right-hand skew for households in 2012.

A linear mixed model was constructed to investigate changes in adjusted poverty score in greater detail (Table 3.4). The effect of the survey year dummy variable shows that there was a significant increase of 0.15 in the adjusted household poverty score between the two surveys in 2007 and 2012. This showed that, on average, households have access to or own more of those items classified by their peers as

basic necessities. As such, these results confirm that household economic well-being has improved over the period between the two surveys. However, with the exception of distance to the nearest market, no interaction terms were included in the model. This suggests that there have been no significant improvements in equity, despite overall improvements in economic well-being, as some socio-economic groups maintain their advantage while others remain more economically vulnerable.

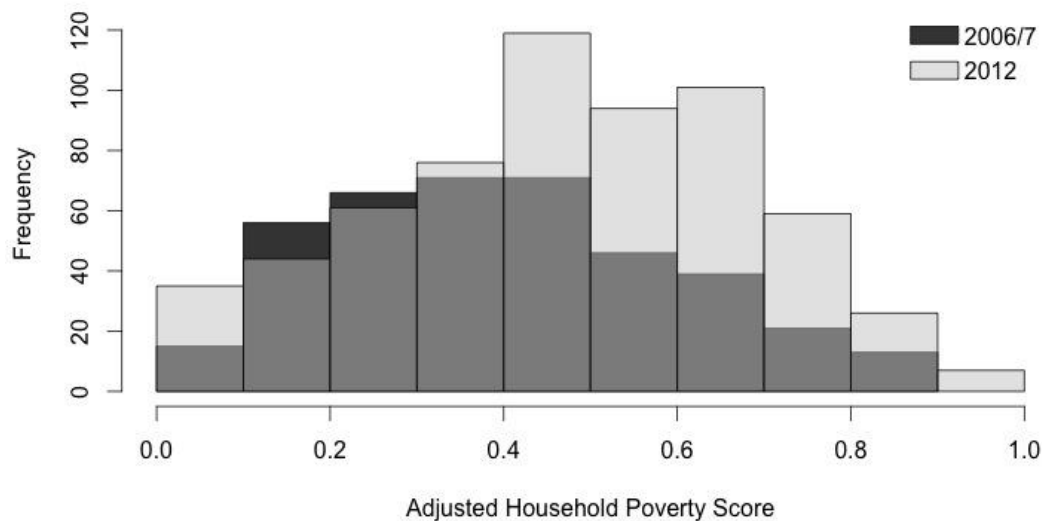


Figure 3.5: Comparison of the distribution of adjusted household poverty scores between the 2007 and 2012 quantitative household livelihood surveys.

Table 3.4: Coefficient estimates for the LMMs with the adjusted household poverty score as the response variables. Standard errors are given in parentheses. $R_m^2 = 0.330$, $R_c^2 = 0.335$.

Variable	Estimate	t value
intercept	0.358 (0.023)	15.542
household size	+0.020 (0.003)	7.145
widow	+0.054 (0.018)	-3.289
landless	-0.064 (0.019)	2.726
owns 51-150 resin trees	+0.033 (0.015)	2.218
owns > 150 resin trees	+0.069 (0.025)	4.644
shop owner	+0.112 (0.024)	-8.804
labour seller	-0.116 (0.013)	3.377
employed	+0.071 (0.021)	7.306
service provider	+0.059 (0.022)	-2.927
survey year (2012)	+0.146 (0.020)	2.672
distance to nearest market:survey year (2007)	-0.001 (0.000)	-2.218
distance to nearest market:survey year (2012)	-0.003 (0.000)	-6.200

One exception to this can be found by comparing the effect of the interaction terms between the distance to the nearest market and the survey year dummy variable on household poverty scores. In 2012, the effect of living further from the nearest market was three times stronger than for 2007. For some of the most remote villages, this increased disadvantage due to distance from market centres is sufficient to offset the gains suggested by the survey year. As such, households in these villages have effectively experienced no improvement in household poverty scores. These results suggest that, whilst overall levels of household economic well-being are improving across the project area, development is occurring at different rates. Households in the most remote villages have yet to experience much or any benefit, while those households living in villages close to market centres are developing more rapidly.

Resource security

Resin tree ownership

In 2007, 216 out of 398 households (54.3%) reported owning resin trees, approximately the same proportion as in 2012, when 301 of the 622 households sampled (48.4%) reported owning resin trees. Applying population weightings for each of the villages sampled in both surveys gives an adjusted proportion of 0.45 ($SE^* = 0.11$) of households owning trees in 2007 and 0.34 ($SE^* = 0.15$) in 2012. Given population growth between the two surveys, this result suggests that, whilst the proportion of households that own resin trees has decreased, the absolute number of resin tree owners may have increased slightly (741 in 2007 to 864 in 2012). Of those households that reported owning trees, the average number owned in villages surveyed in both years was 93 trees in 2007 and 99 trees in 2012 respectively. This suggests that, as both the absolute number of households with resin trees and the average number of resin trees owned has increased between 2007 and 2012, the total number of resin trees being tapped may also have increased. However, the differences found between the two years are within confidence intervals and so it is not possible to say this with any certainty. Similarly, though, there is no evidence of a significant decrease in resin tree numbers.

In order to assess the trends in resin tree ownership in more detail, a generalised linear mixed model, with a resin tree owner dummy variable as the response was constructed (Table 3.5). Five explanatory variables were included in the final model:

household size, indigeneity, landlessness, whether the village sampled was situated in the core zone and a dummy variable for the year of the survey. The variable with the greatest effect was whether a household lived in the core zone, which significantly raised the probability that households would own resin trees. Indigenous households were also significantly more likely to own resin trees. Household size was positively correlated with the probability of owning resin trees and landless households were found to have a reduced probability of tree ownership, although the effects of both of these variables were marginal. A small effect was also found for the survey year dummy, which shows that households experienced a marginal drop in the probability of owning resin trees between the two survey years. This drop does not necessarily indicate a decline in the security of this important resource. The number of resin trees suitable for tapping within a certain area is limited and it is thought that all available trees are tapped (Evans *et al.*, 2003). Hence, as the population grows, it is to be expected that the proportion of households with trees might fall. Provided that the decline in the proportion of resin tree owners was not coupled with a fall in the number of resin trees owned per household, it is considered likely that tree numbers were relatively stable.

Table 3.5: Coefficient estimates for the GLMM with the probability of owning resin trees. The difference in probability was found by a reverse transformation of the logit link function used in the GLMM for households of sample average size. Standard errors are given in parentheses. Significance values: ** = $P < 0.01$; * = $P < 0.001$.**

Variable	Estimate	P
intercept	0.013 (0.065)	***
household size	+0.007 (0.002)	***
indigenous	+0.118 (0.044)	***
landless	-0.023 (0.005)	**
in core zone	+0.418 (0.260)	**
survey year (2012)	-0.020 (0.004)	***

To check this, a linear mixed model was constructed to estimate the number of trees owned by each resin tree owning household, correcting for household socio-economic factors. The only variable that was found to be correlated with the number of resin trees owned was the adjusted household poverty score (Table 3.6), a relationship that has already been observed (Table 3.4). The dummy survey year variable was not included in the final selected model, suggesting that there was no significant change in the number of resin trees owned per household between the two surveys. This stability in the number of trees per household suggests that the observed decline in the

proportion of resin tree owning households is likely to be due to the increase in the number of households in the study area rather than a decline in the absolute number of households involved in tapping. One caveat to this result is that both the marginal and conditional R^2 statistics for the model are low, which may suggest that reporting of resin tree numbers is unreliable.

Table 3.6: Coefficient estimates for LMMs, with the natural logarithm of trees owned by resin tree owning households as the response variable. Standard errors are given in parentheses. $R_m^2 = 0.034$, $R_c^2 = 0.149$.

Variable	Estimate	t value
intercept	3.848 (0.129)	29.753
adjusted poverty score	+0.080 (0.020)	3.914

In 2012, respondents were also asked if they had been affected by companies or outsiders logging their resin trees in the past five years. In total, 23 households (3.7%) from 10 different villages responded that they had lost trees, at an average of 115 each. It is possible that the number of trees reported as lost has been inflated in individual cases, and in some villages it is surprising that so many trees were reported lost by one household but no other households had seemingly been affected. While the number of losses does not appear to be high enough to have significantly affected the average number of trees owned by resin tapping households, the reported losses represent a significant loss of potential income for those households affected and indicate that some logging of resin trees is occurring within the landscape.

Wild Meat Meals

In 2007, the average number of meals that contained meat from any source was 14.2 (68% of meals), of which 4.4 meals (21% of meals) contained wild meat. In 2012, the average number of meat meals was 11.3 (53.7% of meals), of which 3.6 meals (17% of meals) contained wild meat. There are very strong spatial effects associated with the number of wild meat meals consumed. As such it is difficult to explain the differences in consumption patterns without taking account the variation between villages. Correcting for variation between villages, by applying population weights to calculate a weighted average, gives an adjusted population-wide average number of meat meals 12.9 per household (of which 2.9 meals contained wild meat) in 2012. Comparing adjusted values for households in villages sampled by both the 2007 and 2012 surveys shows that the average number of meat meals decreased from 15.8

meals per week in 2007 to 13.5 meals per week in 2012 and wild meat meals eaten decreased from 5.2 to 3.1.

A generalised linear mixed model was constructed in order to understand which socio-economic variables were correlated with the number of wild meat meals consumed in 2012 (Table 3.7). The results of this model reveal a significant effect of household opportunity to hunt or fish on the number of wild meat meals eaten: resin and NTFP collectors spend more time in the forest, service providers spend longer in the village and widows and labour constrained households have less time available to hunt or fish than larger households or those with available labour. The effect of household poverty score also suggests that consumption of wild meat declines with increasing household economic well-being, although households that are in debt eat fewer wild meat meals a week (possibly because they sell any meat that they catch).

Table 3.7: Coefficient estimates for the GLMM with the number of wild meat meals consumed per household in one week in 2012 as the response variable. The difference in the number of wild meat meals eaten was found by a reverse transformation of the logit link function used in the GLMM for an average household (i.e. assuming sample average adjusted poverty score, household size, education level and distance to nearest market). The difference in number of wild meat meals consumed provides an estimate of the effect of belonging to each of the different socio-economic groups included in the model. Standard errors are given in parentheses. Significance values: ** = $P < 0.01$; * = $P < 0.001$.**

Variable	Estimate	P
intercept	1.605 (0.530)	***
adjusted poverty score	-0.665 (0.014)	***
household size	+0.055 (0.018)	**
number of years education	+0.093 (0.014)	***
resin tree owner	+0.422 (0.113)	***
service provider	-0.391 (0.131)	**
NTFP collector	+0.997 (0.128)	***
widow	-0.311 (0.111)	**
in debt	-0.430 (0.070)	***
household labour constrained	-0.398 (0.065)	***
feels resources secure	+0.217 (0.095)	*
distance to nearest market	+0.040 (0.011)	***
in core zone	+1.561 (0.861)	**

The estimates for village level explanatory effects (distance to nearest market and whether the village is inside the core zone) reveal a similar picture, with households in those villages close to all-day markets eating markedly fewer wild meat meals than more remote villages where alternative meat sources are less available. Households living in villages located inside the core zone were found to eat significantly more

meat meals per week than those living outside the core zone, suggesting that conservation activities may be having a positive effect on household protein intake or that there is lower availability of alternative protein sources, such as market-bought fish. Alternatively, this result may be an artefact of lower enforcement effort in more remote villages. Together, these results demonstrate the relative importance of spatial effects on the number of meat meals consumed per household as opposed to those associated with belonging to different socio-economic groups. Overall, a complex pattern emerges, with the number of wild meat meals consumed determined by availability (living within the forest), the time available to households to spend hunting or fishing, the resources available to each household and opportunity to choose alternative meat sources. Consequently, whilst the number of wild meals eaten appears to have declined, it is difficult to attribute this decline to a reduction in stock levels. However, as the total number of meat meals eaten from any source has also decreased slightly, it is possible that there has been a decline in stocks that households have not been able to replace.

Perceived household resource security

The results to the question on whether survey respondents felt secure regarding the resources upon which they rely showed little variation between villages, with the exception of O Chrar, O Rona and Sre Khtong (in which lower than average levels of resource security were reported and which had all been recently affected by concessions or illegal logging) and Pu Trom (in which higher than average security was reported and which has an elephant sanctuary located close by with strong links to the local community and ties to the conservation project). In total, 271 households (44.9% of those that responded to this question) felt secure about their resources. Correcting for population differences between villages gives a marginally different adjusted figure for the whole project area of 47.6%. Of those households that felt secure about their resources, the presence of conservation in the area was cited by 59.8% of respondents (Figure 3.6). For those that did not feel secure about their resources, concessions (56.9%) and illegal logging (33.1%) were cited as the two biggest threats.

A GLMM was constructed to understand which households felt most secure about their resources, with the probability of feeling secure as the response variable (Table

3.8). All of the explanatory variables included in the final model were found to be associated with feeling insecure (i.e. having a lower probability of feeling secure) and were related to those households who rely on natural resources the most. Households who collect NTFPs, have many resin trees or live in the core zone were found to feel the least secure, all of whom are most reliant on natural resources. In many respects this is unsurprising, as those with the most to lose could be expected to be most concerned about the security of the resources upon which they rely, but it does show that there is progress to be made with regard to increasing the security of natural resources at the site.

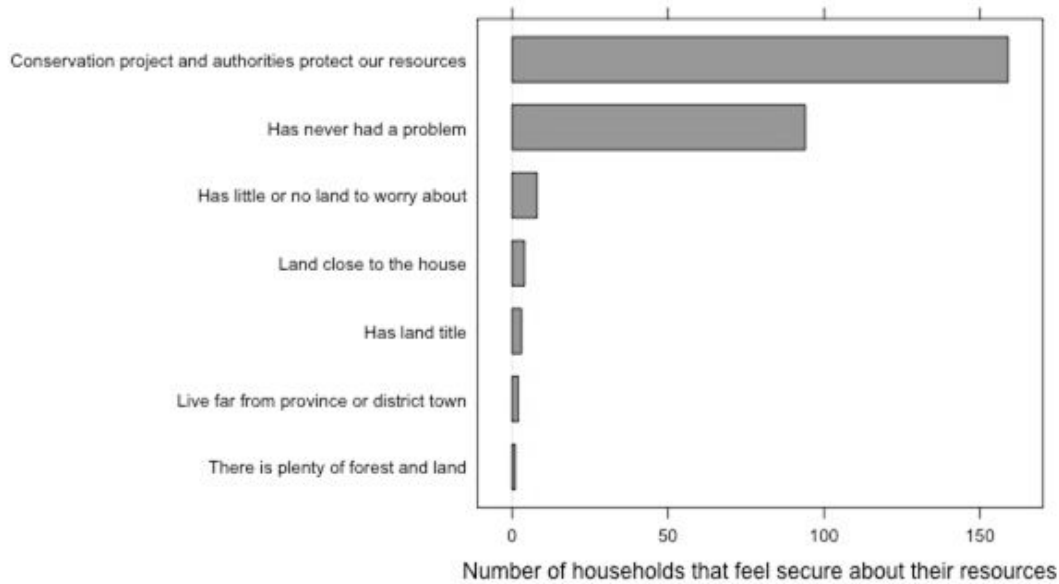


Figure 3.6: Reasons given for why respondent households felt secure about their resources

Table 3.8: Coefficient estimates for the GLMM with the probability of feeling secure about natural resources important for livelihoods. The difference in probability was found by a reverse transformation of the logit link function used in the GLMM for an average household (i.e. assuming sample average number of resin trees per household). Standard errors are given in parentheses. Significance values: * = $P < 0.05$; ** = $P < 0.01$; * = $P < 0.001$.**

Variable	Estimate	P
intercept	0.618 (0.054)	**
NTFP collector	-0.210 (0.045)	***
no. resin trees	-0.001 (0.000)	*
in core zone	-0.145 (0.068)	*

Sufficient farmland to support livelihoods

Household land use

In 2007, the weighted average area of productive land claimed per household for the villages sampled in both periods was 1.8 ha, with 70 households (20.2%) reported to be landless. In 2012, the weighted average area of productive land for the same villages had increased to 2.3 ha per household, with only 32 households (7.2%) landless. Across the full 20 project villages, the weighted average land holding was found to be 2.4 ha per household. Amongst those households with land, the average reported area of land held increased from 2.2 ha to 2.6 ha per household between 2007 and 2012. However, it is likely that these figures do not reflect the true extent of increases in land use (see Chapter 4).

A linear mixed model of the log-transformed area of land claimed per household was constructed for land owning households (Table 3.9). The results of this model show the variable with the greatest explanatory power in both time periods is the adjusted household poverty score, with an increase of 0.1 in household poverty score found to be associated with a 19.1% increase in household land. It is likely that this relationship acts in both directions. Better off households are more able to acquire additional land and have the resources to cultivate it, while acquiring more land is likely to bring in greater earnings and, therefore, increase household economic well-being. A dummy survey year variable was not included in the final model, which suggests that in real terms, despite increases in household economic well-being between the two surveys, there has been no significant increase across the landscape in the area of land held by households. As with the model of the number of resin trees owned, both the marginal and conditional R^2 statistics are low. Given that no other correlation was found, this supports the argument that reporting of areas is unreliable.

Table 3.9: Coefficient estimates for LMM with the log transformed reported area of land claimed per household as the response variable. Standard errors are given in parentheses. $R_m^2 = 0.175$, $R_c^2 = 0.216$.

Variable	Estimate	t value
intercept	-0.439 (0.095)	-4.608
adjusted poverty score	+1.908 (0.162)	11.767

The proportion of households that reported owning more than 5 ha was also virtually unchanged between the two surveys, with 5.5% of households with more than 5 ha in 2007 and 4.8% in 2012. This suggests that the number of households complying with community regulations or legal restrictions on land ownership may be relatively stable, although it is difficult to give too much credence to these figures given that interview respondents are unlikely to admit to rule breaking.

Land alienation

The results of the two household livelihood surveys show that the percentage of landless households decreased between 2007 and 2012 (20.2% and 7.2% respectively). Correcting for variation between villages by applying population weights gives slightly revised figures of 19.8% landless households in 2007 and 8.3% in 2012. These figures suggest that complete land alienation is less of a problem than before. A generalised linear mixed model was constructed to investigate the probability of households being landless in the two surveyed time periods in more detail (Table 3.10). Household poverty score, whether the household owned resin trees and a dummy survey year variable were all included in the final selected model. The relationship between landlessness and poverty score has already been shown, and the model confirms that households with lower poverty scores have a higher probability of being landless than those with higher scores. Resin tree owning households were also considerably less likely to be landless. This is unsurprising, as owning resin trees is closely associated with household well-being. For a household of average poverty score, the probability of being landless fell by 0.15 between the two surveys, suggesting that progress has been made towards reducing the extent of land alienation in the study site. This is particularly heartening given that a programme of participatory land use planning has been the one of the major conservation activities implemented over this period.

Table 3.10: Coefficient estimates for the GLMM with the probability of a household being landless as the response variable. The difference in probability was found by a reverse transformation of the logit link function used in the GLMM for an average household (i.e. assuming sample average household poverty score). Standard errors are given in parentheses. Significance values: ns = $P > 0.05$; * = $P < 0.001$.**

Variable	Estimate	P
intercept	0.214 (0.083)	ns
adjusted poverty score	-0.039 (0.001)	***

resin tree owner	-0.143 (0.024)	***
year (2012)	-0.154 (0.019)	***

In 2012, interview respondents were also asked if they had lost any land to companies in the last 5 years. Ten households (1.6%) from seven villages reported losing land, at an average of 3.3 ha each. As with resin tree losses, the magnitude of these losses is unsubstantiated but suggests that households remain at risk of losing land to companies granted economic land concessions.

3.4. *Discussion*

In general, the overall status of the indicators considered in this chapter is largely encouraging, particularly the improvements in household economic well-being observed generally and for all vulnerable groups. Whilst some groups continue to be at a disadvantage relative to other households, this has not prevented them from experiencing an overall improvement in economic well-being, as has been reported elsewhere in Cambodia (Clements *et al.*, in press). The only caveat to this picture of landscape-wide development is for households located in the most remote parts of the project area, where distance to market centres offset the gains in economic well-being observed elsewhere. It is expected, however, that the economic well-being of these households will be found to have improved at the next iteration of the quantitative livelihood survey, as access to this part of the project area is improving year by year.

Of the two social targets examined, progress has been made in relation to aspects of both of them. For the target to increase natural resource security, the results relating to the three of the main indicators considered suggest, on balance, that the key resources upon which people's livelihoods depend continue to be protected. Whilst the probability of a household owning resin trees has fallen marginally, this can largely be attributed to the increasing number of households living in the study site and the number of resin trees owned by those households that have trees appears to be stable. The number of wild meat meals per week has fallen but it is not clear whether this is associated with increased availability of alternative protein sources or a decline in stock levels. Perceptions of resource security were not recorded in 2007 so a comparison between the two years was not possible. However, nearly half of all households feel secure about their resources, of which the majority attribute this feeling to conservation activities.

For the second target of ensuring sufficient farmland to support household livelihoods, progress was more clear-cut. Most positive was the significant reduction in the percentage of landless households, a group shown to have lower household economic well-being than those with at least some productive land. As one of the main interventions undertaken by the project in this period has been a programme of participatory land use planning and indigenous land titling, in which the indigenous communities of six villages have now been granted communal land title, this trend demonstrates encouraging progress towards the project target (Evans et al., 2012b). This is particularly encouraging given the high rates of landlessness across the country (UNDP, 2011). The average land held per household was less encouraging, as this does not appear to have changed. However, there are issues with using reported areas (as discussed below) and it is thought likely that the area of household land has in fact increased (see Chapter 4).

Of the indicators investigated, most concerning are project-wide population trends and the percentage of households that feel insecure with regard to key natural resources: land, resin trees and forest products. Whilst the majority of the rise in household numbers has been centred on the lowland area close to the Keo Seima district town of O Am, other parts of the project area are experiencing higher than average growth. Immigration is a particular concern, as it is often cited as a reason why households feel insecure regarding their natural resources and is a significant driver of forest loss nationwide (Chan, 2008; McMahon, 2008; Biddulph, 2011). Efforts to curb immigration (mostly centred on the enforcement of protected area boundaries and community land use planning) are on-going but current trends remain a concern. So too does the percentage of households worried about their resources. In this case, the majority of households cited economic land concessions and illegal loggers as the main threats. It is expected that project efforts to protect resources from both of these threats will improve as a result of accreditation of the SPF REDD+ demonstration project and, hence, the percentage of households concerned for their resources is expected to fall. However, the level of perceived insecurity in relation to key natural resources is a concern, as it is throughout the country (Chan, 2008; Grimsditch & Henderson, 2009; Biddulph, 2011).

Data issues

Whilst the picture presented by the results is generally positive, the quality of the data used must be taken into account. Many of the indicators considered were selected in such a way to minimise issues that can arise in areas where education and literacy rates are low and responses highly variable. For instance, one aspect of household livelihoods that is of particular interest is the income households receive from different livelihood activities. Whilst data for this was collected in both the 2007 and 2012 surveys, collection of income data can be subject to multiple issues, particularly if long recall periods are used (Bernard *et al.*, 1984). Consequently, household poverty score was preferred for making comparisons in household economic well-being between the two time periods. However, it was not possible to completely eliminate some of these sources of uncertainty, such as area estimation and short-term recall.

Area reporting is particularly difficult. The majority of plots are irregularly shaped and are often located on steeply sloping ground that makes estimation problematic, even for experienced individuals and despite efforts to improve the quality of area data collection. During the implementation of the 2012 quantitative livelihood survey, trained CENTDOR enumerators paid particular attention towards assisting respondents in answering area questions as accurately as possible. In some cases, area estimation may also have been improved by the manner in which households sell their cassava. Often cassava yields are now sold on the basis of field area and an assessment of quality, not on actual yield, with cassava traders supplying the labour to harvest whatever the field yields (S. Milne, pers. comm.). Fields are measured as part of this process, which may aid some farmers in becoming more aware of their field sizes. These cases are the exception, however, and so area estimation remains an issue. In addition to the difficulties in estimation, there are also concerns that farmers may choose to deliberately misreport areas, particularly if they have cleared forest illegally outside of agreed community boundaries or have exceeded area limits. Analysis presented in Chapter 4, for which household plots were measured with GPS units, found significantly higher household land areas than those reported during the 2012 livelihoods survey in the two villages sampled as part of this analysis. This is a concern, and it shows that more rigorous methods are required to collect data relating to the area under cultivation for each household.

Possibly the largest source of error in the data presented does not come from misreported values but from activities that were not covered by the 2012 survey for reasons of cultural sensitivity and because the CCB manual for REDD+ impact assessments states that illegal activities do not need to be considered when assessing the social impacts of projects (Richards & Panfil, 2011). In landscapes such as SPF, where involvement in small-scale illegal activity is high, this can lead to problems in interpreting the data. For example, if the project is successful in reducing illegal logging or forest clearance (both important targets with respect to REDD+), it is conceivable that household economic well-being indicators will reveal a net decline. Certain vulnerable groups, who may become involved in illegal activities for lack of alternative options, are likely to be disproportionately affected. In this situation, there are potentially complex trade-offs and synergies between conservation objectives. Effective action towards one project target (reduced deforestation or degradation) may seem to penalise progress towards another (increased economic well-being) for some groups (e.g. households involved in illegal logging) but benefit others (e.g. resin tappers). These trade-offs may even occur within the same household (i.e. a household may benefit from improved protection of resin trees but lose out if they are involved in illegal logging or land clearance). Under CCBA guidance, however, negative impacts from illegal activities can be ignored, but it is difficult to attribute reductions in household economic well-being to successful project activities without monitoring involvement in illegal activities. Complementary qualitative monitoring approaches, which can significantly improve understanding of research contexts (Drury *et al.*, 2011), may serve to minimise the confounding effect of economic gains from illegal activities but it cannot be assumed to be eliminated entirely.

Indicator selection

One of the principal objectives of the 2012 quantitative livelihood survey was to test the appropriateness of the indicators selected as part of the social monitoring framework. The monitoring of social impacts resulting from project activities in a context such as SPF, where livelihood strategies are going through a period of significant change as a result of improved access and greater integration with the market economy, is highly complex, which makes it difficult to select indicators that reflect changes that are directly attributable to project activities or threats (as evidenced, for example, by the difficulties in interpreting trends in wild meat

consumption). However, identifying suitable alternative indicators is also difficult. For example, in order to assess progress towards the target of ensuring sufficient farmland to support household livelihoods, an understanding of how much land is needed to be sufficient is first required. This is problematic, since both agricultural productivity and livelihood strategies vary. A household that grows cash crops may require less land than one that grows rice. In this instance, it may be sufficient to ask each household if they are able to feed themselves without difficulty all year round, but subjective questions such as this are vulnerable to bias or strategic responses. Consequently, one of the key pieces of information required to assess progress towards this project goal remains illusive.

This difficulty in selecting alternative indicators or indicators which provide clear evidence of positive or negative trends undermines the suitability of applying the theory of change based approach to impact assessment recommended by the CCBA. Although this approach has advantages in comparison to other more robust approaches, such as the use of matched samples (e.g. Arriagada *et al.*, 2012; Clements & Milner-Gulland, in press) or randomised trials, it can be difficult to accurately assess impacts in contexts that are subject to strong external drivers of change in the absence of a counterfactual. Employing complementary qualitative methods, which would allow the project team to discuss the causes of observed trends with local communities, may reduce the challenge of interpretation. In addition, further refinement of some of the indicators included in the monitoring framework may be required. It is recommended that the causal chains presented within the conceptual model (Figure 3.1) are refined following the completion of the proposed qualitative discussions. In this way, the interpretation of changes in the status of different individual indicators can be improved and placed within the framework of each causal chain. For example, the interpretation of indicators related to the target of improved resource security should be considered in the context of changes to indicators for both the relevant direct and indirect threats identified in the causal chain for this target. If indicators change in the expected direction at each stage along the causal chain, greater confidence can be given to the resulting conclusions.

Chapter 4

A tale of two villages: an investigation of conservation-driven land tenure reform in a Cambodian Protection Forest

4.1. *Introduction*

Sparsely populated, resource rich forest habitats have frequently been subject to exclusionist policies by former colonial or national governments, repeatedly failing to recognise the rights of the people living inside such areas (Colchester, 2004). Biodiversity conservation has a particularly chequered past in this regard, with the protectionist ‘fences and fines’ approach dominating conservation practice throughout much of its history (Adams, 2004). Given the high biodiversity value of many forest habitats and often weak political representation of forest peoples, it is no surprise that this approach has brought conservation practitioners and forest inhabitants into conflict (Brockington & Igoe, 2006). More recently, Government efforts to meet commitments made under the Convention of Biological Diversity (CBD) to set aside areas for the protection of biodiversity have brought further accusations of ‘green grabbing’ (Fairhead *et al.*, 2012).

From the 1980s onwards, however, there has been increased recognition of the customary rights of indigenous peoples (IPs), with both international and national legislation slowly moving to reflect this. This has been reflected within conservation, with article 8(j) of the CBD, decision 7.23 of the 2005 CBD Conference of the Parties and the CBD's 2010 Aichi target 18 all requiring signatories to respect the rights and practices of indigenous and local communities. Beyond international agreements, there has been increasing acceptance within conservation organisations that the rights of local communities must be considered, which has resulted in a movement towards the principle of ‘doing no harm’ as a minimum requirement (Adams *et al.*, 2004).

This change of approach is well reflected in the increasing trend towards the adoption and recognition of various forms of indigenous or community conserved areas (ICCAs). As of 2008, it was estimated that ICCAs encompassed over 400 million ha in 28 of the world's 30 most forested states, a significant increase on similar

calculations from 2002 (Sunderlin *et al.*, 2008). This represents a significant step forward in the recognition of customary tenure rights, although rights-related issues are often not the primary impetus behind the adoption of ICCAs (Berkes, 2009). One argument in support of ICCAs lies in their perceived effectiveness in providing greater protection benefits in comparison with more traditional forms of conservation management. Whilst there is no guarantee that ICCAs result in positive biodiversity outcomes, there is some evidence that points in this direction (for a review see Shahabuddin & Rao, 2010). Furthermore, as payments for environmental services schemes become increasingly widespread, clarification of disputed or informal tenure arrangements becomes ever more necessary to ensure that payments are effective and customary rights holders do not lose out (Engel *et al.*, 2008; Milne & Niessen, 2009; Larson, 2011).

In part, the success of rights-based approaches is dependent on the manner in which they are implemented. The rise of ICCAs was preceded by greater interest in participatory approaches to conservation (Agrawal & Gibson, 1999; Berkes, 2004) and in this regard participatory land use planning approaches have gained considerable support. Such approaches are thought to be an improvement on top-down land use planning methods, ensuring that the process is more inclusive, makes greater use of local knowledge, reduces the risk of future disputes and supports local level institutional development (McCall & Minang, 2005; Cronkleton *et al.*, 2010). Concerns have been raised, however, regarding the effect of participatory land use planning approaches on local land use and the degree to which land access ultimately reflects power arrangements within a village. In an investigation of pilot participatory land use planning projects in Laos, Lestrelin *et al.* (2011) found evidence to suggest that, despite village participation, the process resulted in maintenance of the status quo, with the extent of individual households' access to land dependent on their power to negotiate with village elites. Despite participatory land use planning approaches being widely applied in multiple contexts and for different purposes, published case studies are rare and outcomes are often left unevaluated (Bourgoin, 2012). Where case studies have been published, there is a distinct lack of analyses looking at how different groups within villages have been affected by and comply with the institutional changes brought about by participatory tenure reform instruments.

In this chapter, I seek to redress this gap. I evaluate the implementation of indigenous land titling, a product of a participatory land use planning process, in two villages in the Cambodian uplands, investigating at the household level how land use has evolved following the initiation of this process. I do this in the context of a dynamic but varying socio-economic landscape that is driving significant land use and demographic change. In this way, it is possible to compare the performance of tenure reform in two villages that have been exposed to different levels of social and economic change.

An analysis of household land use change and compliance with both the legally binding zonation of community lands and community-agreed rules governing land use within community titled areas is presented. The land holdings of individual households had been measured at the beginning of the titling process in each village. These were re-measured for a sample of households in each village and compared with the size, location and use of the holdings to that recorded as part of the process. These data were used to evaluate the extent to which the indigenous customary lands and the agreed conservation areas of the two communities have been successfully protected from land conversion from forest to agriculture. The extent of individual household land use change since the start of the land tenure reform process was analysed, in the context of rapidly changing social and economic circumstances (in particular, immigration of poor landless households). Within this analysis, I investigate the effects of different socio-economic characteristics thought to affect land use decision-making, including ethnicity, available household labour, livelihood options, wealth and residency, on the behavioural response of households to land tenure reform. Household understanding of the tenure reform process and perception of tenure security in each of the study villages were also examined. This provides a valuable case study from which to draw lessons, not only for the implementation of land tenure reform for Cambodia's minority IPs, but for participatory approaches to land use planning more widely.

4.2. Indigenous land tenure reform in Cambodia

Cambodia is home to several minority indigenous peoples. Although customs and practices vary between groups, Cambodia's minority IPs have typically operated under a traditional system of collective customary land tenure with a strong spiritual

connection to the surrounding landscape, particularly forests (Baird, 2000; ADB, 2002; Baird & Dearden, 2003; Fox *et al.*, 2008; Simbolon, 2009). Traditional livelihood systems were largely based on small-scale swidden agriculture, with only a small proportion of communal lands cultivated at any single point in time. In recent years, however, there has been a shift in many communities away from traditional agricultural practices, with increasing reliance on the production of commercial and tree crops (Fox *et al.*, 2008).

Largely unaffected by the private property regime of French colonial rule, Cambodia's IPs came under increasing pressure to integrate into Khmer society after independence, culminating in forced integration and mass resettlements during the Khmer Rouge period (1975-1979). Following Vietnamese invasion in 1979, Cambodia's minority groups were allowed to return to their ancestral lands, although many did not return until the 1990s. After the 1991 peace accord, a series of laws aimed at reforming land ownership was enacted, most notably the 2001 Land Law. From the perspective of indigenous communities, the 2001 Land law is particularly important as it provides the legal basis to secure customary land rights as well as safeguarding these rights until such a time as the legal title is granted. Once title is granted, these lands are classified as state private lands, meaning that they remain the property of the state but have no public interest (Oberndorf, 2005). As such, communities do not hold the right to dispose of their land. In order to apply for indigenous communal tenure (ICT), a community must first register as an indigenous community (IC) and be recognised as such by the Ministry of the Interior. Progress towards ICT has been slow, with only eight villages having received title at the time of writing (a further 190 are planned; Milne, 2013).

Despite legal reform recognising the rights of IPs and rural smallholder framers, land disputes, alienation and large-scale land grabbing are frequent and widespread. While large-scale land acquisitions are by no means a recent phenomenon in Cambodia, the situation has been greatly exacerbated in recent years. The human rights NGO ADHOC reports that 2,657,470 ha (approximately 17% of the total land area of the country) had been granted as economic land concessions (ELCs; areas of up to 10,000 ha granted to industrial companies for intensive agriculture), as of December 2012 (ADHOC, 2013). Not only has this had extreme implications for Cambodian

smallholder farmers but also for conservation. In 2012 alone, ELCs covering 381,121 ha were granted, of which over 70% are within existing protected areas. Given the high degree of overlap between Cambodia's indigenous peoples and the country's protected area network, efforts to secure the customary rights of IPs may also serve as added protection from ELCs for protected areas.

4.3. *Land tenure reform in the two villages*

The research presented in this chapter was undertaken in two villages, Andong Kraloeng and O Rona, in Monduliri Province, northeastern Cambodia (Figure 4.1). Both villages are located within Seima Protection Forest (SPF; Chapter 2). The predominant minority indigenous group in the area are the Bunong, who belong the Mon-Khmer language family (Bourdier, 2009). During the Khmer Rouge period, the area was almost totally abandoned, as households living there were forcibly resettled in the lowland north of Monduliri Province, with the majority of families returning in the 1990s and early 2000s. The resulting loss of knowledge regarding customary land use led PA authorities to initiate a programme of working with indigenous communities to map their customary use areas and to plan future land use. This programme, which was piloted in Andong Kraloeng in 2003 and later expanded to include other villages, involved a series of consultations with local communities, following procedures based on the government's manual for participatory land use planning (Rock, 2001).

Andong Kraloeng is a Bunong village, consisting of six smaller sub-village settlements, located within the densely forested core zone of SPF on the main road between Phnom Penh and the provincial capital, Sen Monorom. Despite being situated along the main road, it has been little affected by immigration from other provinces. In 2011, a sub-decree was passed recognising the rights of the Andong Kraloeng IC, making them the third IC nationally to be granted rights over their customary land (UNOHCHR, 2011). The second study village, O Rona, is located at the edge of SPF and the adjacent Snoul Wildlife Sanctuary, managed by the Ministry of Environment (MoE), and consists of five smaller sub-village settlements. Historically, the village was an indigenous Bunong community but in recent years it has been heavily affected by an influx of immigrant Khmer families seeking land. As the village is situated close to both the district capital and the border with Vietnam, it

is considerably more integrated into the market economy than Andong Kraloeng. This has affected traditional livelihoods, with a greater reliance on commercial agriculture readily apparent amongst Bunong households. It also presents a greater threat to community lands from speculators and immigrants; at the time that the land tenure reform process was initiated in 2005, there were 35 claims to land inside the traditional village boundary from households living in other villages.

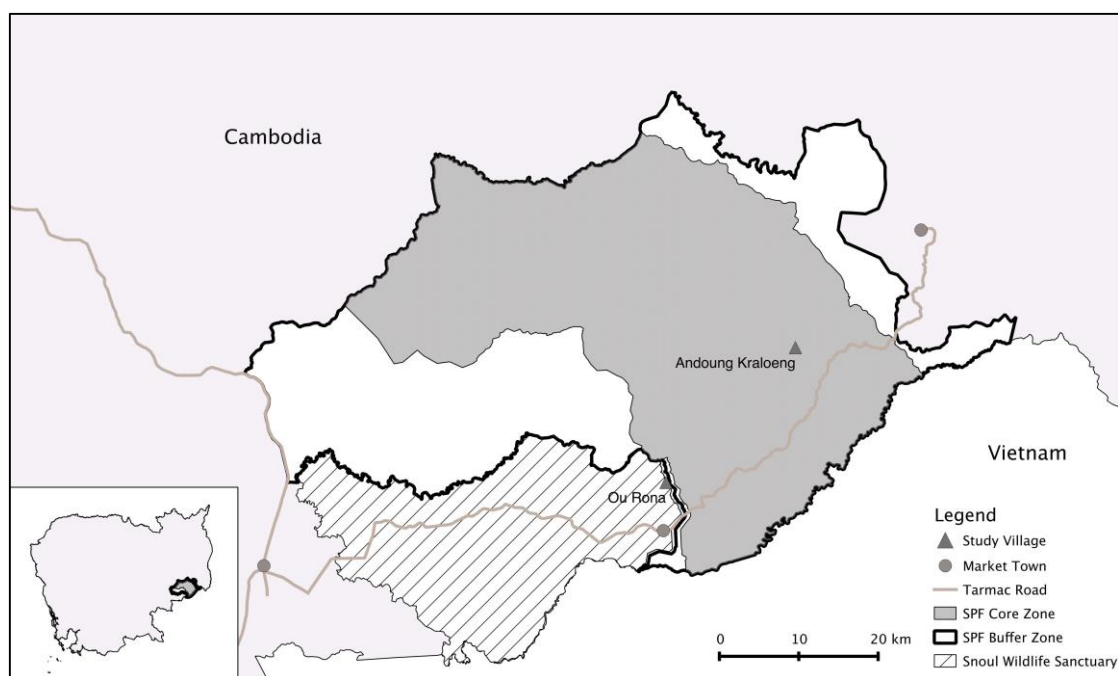


Figure 4.1: Map of Seima Protection Forest (2,927 km²), showing the location of the two study villages.

At the start of the ICT process in both villages, a provisional Indigenous Community was set up. Under Cambodian law, formal recognition by the Ministry of the Interior of a community's status as an indigenous community is a legal pre-requisite for applications for ICT. For each IC, PA authorities facilitated the selection of a management committee, with committee members drawn mainly from traditional village elders. Every indigenous household living in the village at that time elected to join. Following this, the former extent of customary use was investigated using a variety of sources (including historical topographical maps, aerial surveys, forest inventories and local knowledge) and all land holdings within the provisional village area were mapped by PA authorities. On completion, a series of areas was created delineating different land uses (Table 4.1). These included areas designated for current and future agriculture, as well as community forest in which the only form of

resource use permitted is the collection of non-timber forest products (NTFPs). These zones are managed by the IC committee.

Table 4.1: Details of the participatory land use planning process in the two study villages. Land inside areas designated for agriculture is a mix of cultivated land and forest that, as yet, has not been cleared.

	Andong Kraloeng	O Rona
land use designations:		
residential/agriculture	1,323 ha	1,477 ha
NTFP forest	23,584 ha	2,274 ha
spirit forest	43 ha	44 ha
burial forest	27 ha	-
total village area	25,003 ha	3,795 ha
IC formed/land mapped	2003	2005
ICT application	2008	2009
ICT zones redrawn	2010	Dec 2012
ICT granted	2011	2013
Population (heads):		
start of PLUP process	390 (2004)	573 (2006)
June/July 2012	563	1041
number of households:		
start of PLUP process	89 (2003)	121 (2006)
June/July 2012	124	229

In addition to the creation of the different land use areas, the ICT process supported the agreement of a series of rules governing household land use, made enforceable by traditional village sanctions, to assist in the management of village land. These regulations, which were largely drawn up from informal traditional practices, were designed to allow the IC to plan for future growth but also to protect traditional livelihoods. As such, limits were put on the area of paddy land and tree crops allowed for each household. A village constitution, which details the formal composition of the committee, the goals of the IC and criteria for IC membership, was also drawn up.

The main difference between the procedure followed in O Rona and that of Andong Kraloeng was the number of Khmer migrant families living in the village at the time of the ICT process. Under the 2001 Land Law, households are entitled to claim ownership of occupied land provided their claim had been uncontested for at least five years prior to the promulgation of the law. Land claimed after 2001 is not eligible for private ownership and under law remains state property. Although the ICT process in O Rona included every household living in the village, Khmer families were only

permitted to retain the land they already occupied. Any expansion of their land within those areas identified for future agricultural use would be illegal under the 2001 Land Law. This created a two-tiered system within the village, with Khmer immigrant households granted fewer rights than their returnee Bunong neighbours. This was not an issue in Andong Kraloeng as there were no Khmer households in the village at the time of the ICT process. In both villages, the rules governing land use within the village area apply only to Bunong households and to the Khmer households present during the ICT process, as recent settlers are not permitted to claim any land within community titled areas. Newly formed households of married children of IC members automatically become members of the IC, with the accompanying land use rights and responsibility to abide by community regulations.

4.4. *Methods*

Fieldwork for the research was carried out in both villages between May and July 2012, and consisted of a series of focus group discussions, household structured interviews and land use mapping.

Focus group discussions

The aim of the focus group discussions was to gain a better understanding of land use practices and to investigate local perceptions regarding land issues. Each focus group consisted of 8-15 participants and lasted approximately two hours. In each village, one focus group was held with members of the IC committee responsible for the management of community area. In O Rona, three additional focus group discussions were held, which separated participants who had been present at the time of the initial planning exercise and those who had not, as there is a strong distinction in rights between newly arrived and resident households. In Andong Kraloeng, immigration rates are low and the population relatively homogeneous, so this was not deemed necessary.

Household interviews and land use mapping

Structured household interviews and land use mapping were conducted for 114 households, with 44 sampled in Andong Kraloeng and 70 in O Rona (approximately one third of the households in each of the study villages), stratifying proportionally by sub-village settlement and randomly sampling within each stratum. No households

living outside either of the villages were sampled. This approach provided a cross-sectional sample and was selected to ensure that both newly arrived immigrants and newly formed households (e.g. through marriage) were included in the study. As the original land use mapping process included every plot of land within each community zone, a cross-sectional survey design provided sufficient matches between the two time periods to allow for simple panel analyses.

The purpose of the structured interviews was to collect socio-economic and land use data for each household, as well as gathering information on perceptions of land issues and knowledge of the ICT process. Where possible, all interviews were conducted with the head of each household and lasted for approximately 45 minutes. Following the completion of each interview, all land parcels held by the respondent household were measured by walking the parcel edge and recording the path taken on GPS. Observations were made regarding the crops grown, the likely age of those crops and adjoining land uses and owners to triangulate information given during interviews.

Land use mapping check

A set of 100 random points was sampled across each village area, and the owner of the land at each point identified, in order to check whether information about sensitive plots was being withheld during the interviews. Given that a significant proportion of households hold land illegally, it was considered likely that participants might opt to withhold sensitive plots. As sampling within each village was incomplete and did not cover land claimed by outside interests, uncertainties existed regarding whether the team had been shown all plots used by the households sampled. Recent land cover analysis (WCS, 2013) and satellite imagery were used to identify areas under cultivation. Random points were generated within un-visited areas of cultivated land for each settlement using ArcMap version 10.0. Local guides or members of the village ICT committees assisted in identifying the landowner at each point. The names collated were then cross-checked against the list of households already interviewed to ascertain whether any plots had been withheld. This provided a measure of the number of withheld plots for each village. In cases where plots had been withheld, the household head was re-interviewed and the plot mapped. Interviewers were careful at this stage to stress that they were clarifying the details

given during the original interview and to avoid any inference that the respondent had deliberately misled the research team.

Spatial compliance analysis

Land use compliance was measured against two sets of criteria: with the law and with IC regulations governing land use within community boundaries. Plots measured in 2012 as part of this research were compared with those of each household as measured during the previous ICT process and with the various boundaries created through the ICT process. In certain cases, records were incomplete, which had the effect of reducing the overall sample size for the compliance analyses to 105 households. These spatial comparisons were carried out using Quantum GIS version 1.8.0. A margin of error of 0.05 ha or 5%, depending on which was greater, was used to allow for differences in digital and physical boundaries.

For Andong Kraloeng, these analyses were made more complicated as boundaries were changed in 2010. This created a situation where plots that had previously been compliant were made non-compliant and vice versa. In the former case, plots were considered to be compliant for the purposes of this analysis, despite the boundary changes. In the latter case, plots were considered non-compliant if they were outside community agricultural areas when initially cleared, but compliant if they were within community agricultural areas when cleared. For both cases, it was necessary to use reported plot age, triangulated against observations made during plot measurement, to check whether the plot had been cleared at the time the boundaries were changed. For O Rona, the boundaries had not been changed at the time of the survey so this was not an issue. In both villages, however, it was necessary to correct for whether or not each household was a member of the IC. In Andong Kraloeng, all non-members of the IC were excluded from holding land within the community area, but at the beginning of the ICT process all households were members of the IC. In O Rona, non-IC households that were present in the village at the beginning of the ICT process were allowed to keep the land they owned at that time but any further expansion was prohibited, while households that had moved to the village afterwards were excluded from claiming any land.

In addition to analysing land use compliance with the law, compliance with five regulations governing land use within IC managed areas was also checked. These

were regulations banning: 1) buying, selling or renting land, 2) clearance of spirit or burial forest, 3) exceeding 2 ha of land for tree crops (such as cashew or rubber) per household, 4) exceeding 1 ha of land for cultivation of paddy rice per household and 5) exceeding 5 ha of land under any form of cultivation per household. In each case, if these regulations had been broken prior to the rules being drawn up, then the household was considered compliant provided that there were no new infractions. For example, if a household cultivated 7 ha of land prior to the start of the ICT process, they were allowed to keep all 7 ha. If, however, they subsequently cleared more land within the community area, they were judged to be non-compliant with the 5 ha area limit. For the purposes of this analysis, only land within the community titled areas was considered, as the IC regulations only govern land use within these areas.

Statistical modelling

Linear and generalised linear mixed models (LMMs; GLMMs) were selected using backwards step-wise selection methods based on the small sample size corrected Akaike Information Criterion (AICc; Akaike, 1974; Burnham & Anderson, 2002)¹. Models with the lowest AICc were selected except in cases where a more parsimonious model was found with a $\Delta AICc$ value of less than two. The variable settlement, which referred to each sub-village settlement surveyed, was included as the only random effect in all models (see Appendix B; Table B.2 for a list of the explanatory variables considered for each model).

In order to model the area of household land claimed illegally, a hurdle modelling approach was used to account for the high number of zero values (Mullahy, 1986). Compliance with the 2001 Land Law was modelled first using a simple binary variable. Subsequent modelling of correlates of illegal land area claimed was carried out only for those households with some illegal land. All area variables were transformed using natural logarithms. In cases where area variables contained zero values, a constant equal to half the lowest non-zero value was first added to all data points. The exception to this was for the model of total area claimed per household. For this model, three zero value data points were removed and the sensitivity of the

¹ All statistical analysis was carried out using R version 2.15.1, on RStudio version 0.97.314. Within R, the lme4 package version 0.999375-36 was used to analyse all models.

coefficients tested. Removing these data points did not have a significant effect on the model estimates and greatly aided interpretation of the results.

In each case, once the final model had been selected, visual validation was conducted to check for residual normality, heteroskedasticity and possible correlations between fixed effects and the residuals. Over-dispersion in binomial logistic regression models was checked by comparing the sum of squared Pearson residuals with the approximate residual degrees of freedom. No issues were found in any checks. Marginal and conditional R^2 statistics for LMMs were calculated following Nakagawa & Schielzeth (2013).

4.5. *Results*

Land Use Change in the Two Villages

Andong Kraloeng

In Andong Kraloeng, 44 households were interviewed, of which 43 currently claim land (for plan of mapped fields see Appendix B; Figure B.1). The area claimed by these households totalled 133 ha, with 119 ha in cultivation. This represents a significant expansion in the average area of land under cultivation per household, from 1.0 ha in 2004 to 2.7 ha in 2012 (Table 4.2). Extrapolating this land use for the entire village population gives a total area under cultivation of 334 ha, which remains a small fraction of the 1398 ha granted to the IC for agricultural and residential purposes, and shows that there remains considerable scope for agricultural expansion.

A shift away from traditional indigenous land use systems was observed. Such systems tend to be highly diverse, with many different crops commonly grown in small amounts around the edge of the same parcel of land (Baird & Dearden, 2003), but the discussion here is limited to changes in the dominant crop in each field. The most dramatic change observed is the transition to commercial agriculture. In 2004, the average area under some form of cash crop cultivation (principally cashew) was 0.6 ha per household, or 60% of the land under cultivation. Much of this land, however, was also used to grow non-cash crop upland rice intercropped with the main cash crop. For instance, 0.5 ha per household, equivalent to half of all land use within the village, was used for cashew plantations with rice grown underneath or between

young trees. On average, 85% of cultivated land had rice as the dominant or intercropped crop. By 2012, the average area of cash crops had risen to 2.5 ha per household, or 93% of the area cultivated, making the increase in cash crops greater than the observed increase in overall land use. The majority of this increase is accounted for by the emergence of cassava, a crop that was unrecorded in 2004. In 2012, the average cultivated area of cassava was 1.8 ha per household (67% of the cultivated area), with 1.4 ha per household intercropped with cashew. In contrast, the importance of rice had dropped, with only 0.2 ha (7% of the cultivated area) per household cultivated with rice as the dominant or intercropped crop.

Table 4.2: Mean area [ha] given to different land uses per household for the two villages at the time fields were mapped by PA authorities as part of the ICT process and in 2012. The percentage of average household area given to each land use is shown in parentheses. As intercropping is common practice, percentages do not sum to 100.

Land use	Andong Kraloeng		O Rona	
	2004	2012	2006	2004
all cultivation	1.0	2.7	3.1	4.8
cash crop (cassava, cashew and rubber)	0.6 (62)	2.5 (93)	2.9 (94)	4.2 (88)
tree crop	0.7 (68)	1.4 (50)	2.8 (90)	1.9 (40)
rice	0.9 (85)	0.2 (7)	0.8 (26)	0.6 (13)
cassava	0.0 (0)	1.8 (67)	0.1 (3)	3.0 (63)

Not only does this show an increasing reliance on producing cash crops, but it also shows a breakdown of traditional rotational farming. As of 2012, cashew (a tree crop) was present in approximately 50% of cultivated land, much of which was formerly used for growing rice. As cashew is considered to have a 20 year productive life span, land that would formerly be returned to fallow, and therefore collective ownership, is now being retained as individually held land (albeit within communal title) through the planting of cashew.

O Rona

The average land holdings in 2012 for the 70 households sampled in O Rona was 4.8 ha (for plan of mapped fields see Appendix B; Figure B.2), significantly more than in Andong Kraloeng. This represents an increase of 1.7 ha (or 55%) per household from 2006, when fields were mapped as part of the ICT process. As with Andong Kraloeng, these figures demonstrate a rapid expansion in the land being cultivated. There was a significant difference observed in the area of land claimed between households that

were part of the IC and those that were not. For households that were sampled in both 2006 and 2012, members of the IC claimed on average 6.3 ha in 2012 (up from 4.2 ha in 2006), whereas non-IC members claimed only 3.5 ha in 2012 (up from 2.5 ha in 2006). This, however, represents a similar rate of growth for both types of household.

Commercial agriculture was already widely practiced in 2006 in O Rona, with some form of cash crops grown on 94% of agricultural land. In 2012, the proportion of agricultural land involved in commercial cropping was essentially unchanged (88% of cultivated lands), although the absolute area was much increased. The main observed difference between the two time periods was the change in intercropping practices between commercial and subsistence crops. In 2006, 59% of agricultural land (1.8 ha per household) had a commercial crop as the dominant crop but was intercropped with rice. This had fallen to just 5% of cultivated land (0.2 ha per household) by 2012. Overall, the area per household on which rice was grown had contracted slightly from 0.8 to 0.6 ha per household. In contrast, though, the area on which it was grown as the dominant or sole crop had increased from 0.2 to 0.6 ha per household, largely through new areas suitable for paddy farming being cleared. This shows an increasing delineation between areas assigned to growing cash crops and to subsistence rice cultivation.

As with Andong Kraloeng, the most dramatic shift in O Rona has been the uptake of cassava, which was first introduced in 2005. Less than 0.1 ha per household was being grown in 2006 but this had increased to over 3 ha per household by 2012. This, in part, is driving the changes observed in rice growing practices, as cassava is often sold to traders by the field. Households, often those short of labour, agree a sale price set by the area of their field and quality of the cassava, as opposed to harvesting and processing the cassava themselves. Consequently, it makes sense for households to have separate plots for different crops, even within the same field.

The emergence of cassava has also changed the area given to tree crops. In 2006, the average household had 2.8 ha of tree crops, largely intercropped with rice, but by 2012 this had dropped to 1.9 ha and was intercropped with cassava instead. This demonstrates a trend reported during household interviews that some farmers have chosen to replace areas previously planted with tree crops with cassava. Overall, however, the reduction in area planted with tree crops does not indicate a return to

traditional rotational cultivation as cassava is being grown year after year, despite fears of declining yields.

Household land holdings

The selected model for the total log transformed area of land claimed by each household in 2012 included three significant explanatory variables (Table 4.3): the age of the head of the household, whether or not they had arrived after the ICT process was initiated and an adjusted poverty score based on the basic necessity survey methodology (Davies, 1997; see Appendix B for an explanation of how this score was calculated). This meant that neither the household's livelihood options nor available labour had a significant effect on land holdings.

Table 4.3: Parameter estimates for the household land holdings LMM, with $\ln(\text{area})$ as the response variable. One random effect was included in the model: settlement. The full list of variables modelled, plus their explanations, are given in Appendix B; Table B.2. Standard errors are given in parentheses. $R_m^2 = 0.382$, $R_c^2 = 0.410$.

Variable	Estimate	t value
intercept	-2.365 (0.528)	-4.478
age	+0.016 (0.006)	2.459
poverty score	+4.166 (0.667)	6.828
immigrant	-1.025 (0.194)	-3.132

There was a positive effect of age on household land holdings, predicting an increase of 1.6% in the area claimed for every year increase in the age of the household head. A much stronger correlation was found for the adjusted poverty score. In this case, a 0.1 increase in adjusted poverty score was found to result in an increase of 52% in the total area claimed. This results in a predicted 272% difference in the total area of land claimed between the best off and poorest families. Immigrant households, however, were found to have smaller land holdings, with the model estimates predicting that households that arrived after the ICT process had started had 103% less land on average.

Household compliance

Compliance with the 2001 Land Law

Overall, there were high levels of non-compliance in both study villages, although distinct differences in behaviour between the two were observed. In Andong Kraloeng,

26% of cultivated land had been cleared outside agreed boundaries, whereas the figure for O Rona was 47%. Similarly, while 52% of sampled households in Andong Kraloeng were found to have some illegal land, this figure was 79% in O Rona. Comparing the performance of the indigenous communities within each village reduces this difference slightly, with 49% of IC member households non-compliant in Andong Kraloeng and 67% in O Rona.

In order to investigate compliance further, a GLMM, with a binary household compliance variable as the response, was constructed to look at whether or not a household claimed any illegal land (for a model summary table see Appendix B; Table B.3). Only two explanatory variables considered for selection were included in the final model; whether the household was part of the village IC and the natural log transformed area claimed by each household. The difference in compliance between the two villages was accounted for by the inclusion of the settlement lived in by each household as a random effect in this model.

As the interpretation of logistic regression coefficients is not intuitive for log transformed variables with constants added to account for zero values, the effect of the area claimed by each household on the probability of compliance with the 2001 Land Law is plotted for both IC and non-IC member households (Figure 4.2). Among non-IC member households, only those with very little land are likely to comply with the law. This result is, perhaps, unsurprising, as non-IC members have little right to land within either village. As the majority of sampled non-IC member households live in O Rona, this result strongly reflects the two-tiered system that was created there. In fact, the three non-member households that have not claimed land illegally hold no land at all and provide labour for other households. None of the 20 sampled non-IC member households that were present in the village in 2006 was found to be compliant with the law in 2012.

Comparing the curves for IC and non-IC households reveals a strong positive effect of being an IC member on compliance. This effect diminishes rapidly, however, as the area of household land holdings increases. The predicted probability of being compliant with the law for an IC member claiming the average area of land is just over 0.2, illustrating the very low levels of compliance for families with average or greater land holdings (Figure 4.2).

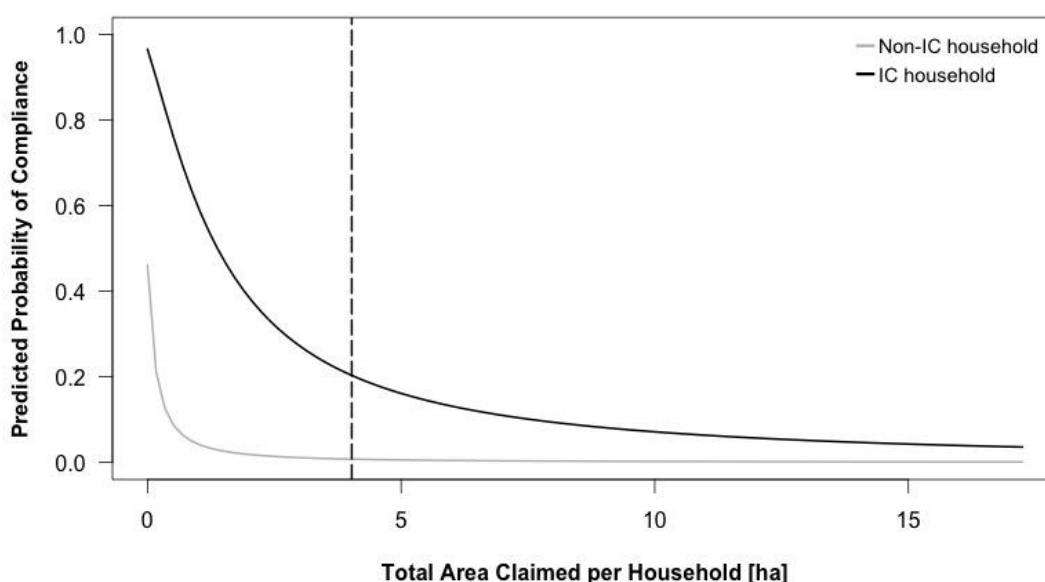


Figure 4.2: Predicted probabilities of compliance with the 2001 Land Law for non-IC and IC households. The vertical dashed line shows the average area claimed per household for the whole sample.

The second part of the compliance hurdle analysis comprised a linear model with the log-transformed area of illegal land held by non-compliant households as the response. Three explanatory variables were included in the final model (Table 4.4): the total land holdings of each household, whether households were members of the IC and whether the household head was Bunong. This final variable was possible because several Khmer men had married Bunong women and moved into their wives' home villages. Under the rules drawn up by each IC, these households automatically became IC members even though the head of the household was Khmer. The results of this model again show a strong correlation between compliance and the total area of land claimed by each household. In this case, an increase in the total area of 1% resulted in a 1.1% increase in the area of illegal land held per household, suggesting that households hold legal and illegal land in roughly equal proportions.

Table 4.4: Parameter estimates for the illegal household land holdings, with $\ln(\text{illegal area})$ as the response variable. P values significant at the 95% confidence level are shown in bold. The full list of variables modelled, plus their explanations, are given in Appendix B; Table B.2. Standard errors are given in parentheses. $R^2 = 0.613$. Significance values: * = $P < 0.05$; * = $P < 0.001$.**

Variable	Estimate	P
intercept	-0.359 (0.156)	*
$\ln(\text{area})$	1.084 (0.107)	***
IC member	-0.500 (0.246)	*
indigenous	-0.521 (0.245)	*

More informative, from the perspective of evaluating the outcomes of the ICT process, are the effect estimates for being an IC member at the time the ICT process was initiated and for the household head identifying themselves as indigenous. The effects of these two variables are comparable, with an approximate 65% reduction in the predicted area of illegal land held in both cases. This suggests that, even among those households that had held land illegally, there is a positive effect on compliance from being a member of an IC. The second of these two results suggests that, holding the effect of being an IC member constant, households with indigenous heads hold less illegal land than those with heads from non-indigenous backgrounds.

Compliance with Community Regulations

The second aspect of household compliance considered was whether households complied with the set of five regulations that were drawn up as part of the original agreements in each village and which govern land use within community titled areas. Overall, IC regulations experienced a higher rate of compliance than observed for the 2001 Land Law. In Andong Kraloeng, 77% of households were found to be compliant with all five IC regulations considered. In O Rona, the figure was lower, with 52% of households compliant.

In Andong Kraloeng, three of the rules were obeyed by every household sampled: those prohibiting the buying and selling of land, clearing land in spirit and burial forest and exceeding 1 ha of paddy land (Table 4.5). The regulation with the lowest level of compliance was the limit on tree crop area, with all households who were not totally compliant breaking this rule. This reflects the changes in the traditional rotational cultivation system observed earlier. In O Rona, only the ban on clearance of burial or spirit forest was completely observed (Table 4.5). In contrast to Andong Kraloeng, nearly 50% of households were found to be breaking total area restrictions within the community titled area. In part, this was due to non-IC member households claiming land that they had not possessed in 2006. At 68%, the compliance rate for IC members was still lower than in Andong Kraloeng, but higher than for the village overall.

A mixed model approach to analysing IC regulation compliance was deemed unnecessary in this case, as no difference in compliance was attributed to different

settlements. Instead, a generalised linear model (GLM) was produced, with three explanatory variables included in the final selected model: the log-transformed total household land holdings, whether the household was an IC member and whether the household held some illegal land (Figure 4.3; for coefficient estimates see Appendix B; Table B.4).

Table 4.5: Percentage of respondent households that were found to have complied with the five community land use regulations. Only land inside the community agricultural areas was considered.

Regulation	Andong Kraloeng	O Rona
max 5 ha total area	92	56
max 1 ha paddy land	100	94
max 2 ha tree crop cultivation	77	81
spirit/burial forest	100	100
no buying/selling land	100	92
all regulations	77	52

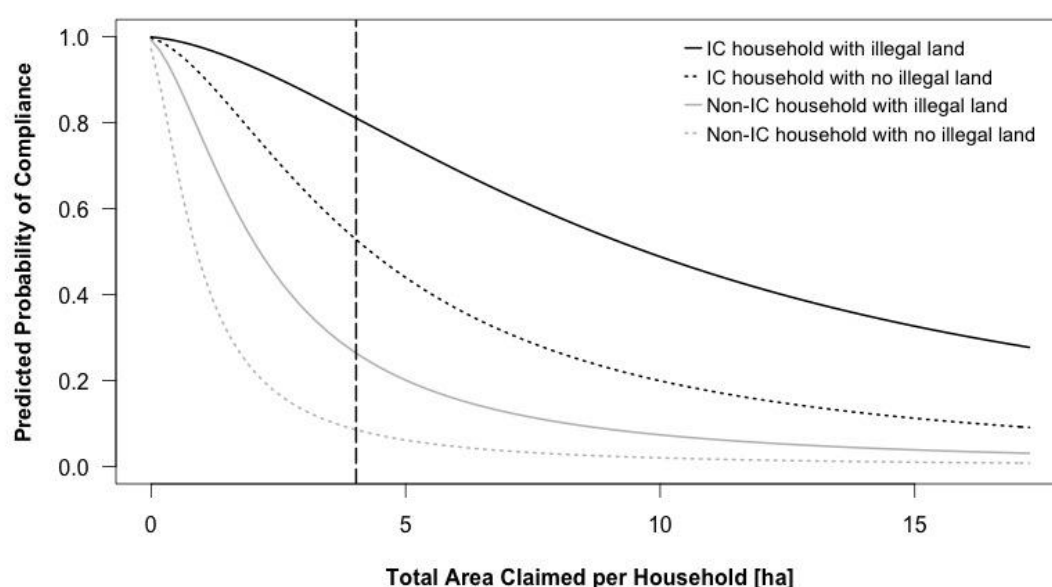


Figure 4.3 Predicted probabilities of compliance with IC regulations. The vertical dashed line shows the average area claimed per household for the whole sample.

Increased household land holdings are associated with a significant reduction in the probability of compliance with the set of five IC regulations. This effect is most striking for non-IC members (Figure 4.3). It is also clear from comparing the curves for non-IC and IC member households that once again there is a strong positive effect on compliance associated with a household belonging to the village IC. Again, this is expected given the two-tier system in place in O Rona, in which non-IC members

were afforded little right to land. Crucially, non-member households are not represented on the committee that manages community land. It is unsurprising, therefore, that households do not comply with regulations on which they have no say. Interestingly, the correlation between compliance with IC rules and compliance with the 2001 Land Law was negative. Comparing the curves in Figure 3 for households with and without illegal land for both IC members and non-IC members separately, it is evident that households with illegal land have a greater probability of being compliant with the regulations governing land use in community areas over the full range of total land holdings. This implies that households may seek to circumvent IC regulations by clearing land outside of community areas, rather than breaking the regulations within the titled area.

Perceptions of ICT

In addition to differences in land use, understanding and perceptions of the ICT process differed significantly between the two villages. In Andong Kraloeng, 90% of IC respondents displayed some understanding of the land use plan (this figure was only 46% of IC respondents in O Rona). There was also a much greater level of understanding in Andong Kraloeng that the responsibility for monitoring and sanctioning households who were non-compliant with the land use plans was split between the committee and the protected area authorities. Whilst 44% of IC respondents in Andong Kraloeng mentioned the committee when asked who enforced the land use plans, the figure in O Rona was only 17%.

With respect to how the land use plans were perceived, community members in Andong Kraloeng were more likely to view the land use plans positively and to feel secure about their land tenure. In O Rona, IC members frequently queried the validity of IC regulations and restrictions on area, citing the failure of committee members (i.e. those charged with managing community resources) and other community leaders to observe them. The average land holdings for such leaders in O Rona was 8.6 ha, well above the limit of 5 ha set down in IC rules. Conversely, community leaders in Andong Kraloeng claimed an average of just 2.9 ha, which is below the village average. IC members in O Rona also felt less secure regarding their land tenure. Only 6% of respondent reported that they felt secure in their tenure, with most respondents

worried about economic land concessions or powerful immigrants taking their land (in comparison 72% of IC respondents in Andong Kraloeng felt secure).

4.6. *Discussion*

This research reveals households in two villages responding to land tenure reform and drivers of land use change in different ways. In Andong Kraloeng, compliance with both the legal land use plans that were created as part of the tenure reform process and the community regulations that govern land use in community areas was relatively high. In O Rona, a village that has been strongly exposed to market forces and immigration, compliance rates were much lower, with extensive illegal land clearance within conservation areas and illegal settlement of Khmer migrants observed. The reasons behind these differences are complex and multi-faceted, yet they provide valuable lessons for further implementation of ICT in Cambodia, and participatory land use planning approaches more widely.

The most significant difference between the two villages is the degree to which they have been exposed to outside interests. Milne (2013) reports that over 500 ‘outsiders’, ranging from smallholder farmers to influential politicians, claim land inside the provisional community area in O Rona. This is in addition to the families that have moved into the village unopposed. As a direct result of losing land to these outside interests, the boundaries of the O Rona ICT have been substantially redrawn from those that were included in the original ICT application. That application contained plans for 1477 ha to be granted for communal agriculture and residential use, while only 648 ha has been included within the redrawn boundaries. The remaining 829 ha has been lost to outside interests or non-IC households in the period between the original application and receipt of ICT. Furthermore, the entire proposed western NTFP forest area, which initially covered an area of 446 ha, has either already been deforested or has been included as part of the 648 ha designated for community agricultural use to compensate for the losses in this area.

It is debatable how much individual households have been involved in the sale of community land to outsiders. Private access to land designated for indigenous community title claims is often achieved through the use of intimidation, misinformation and stealth (Fox *et al.*, 2008; Milne, 2013). Under the 2001 Land Law,

communities are not granted disposal rights, which makes it illegal to sell land within ICTs, but this has not stopped sales. Although little evidence of direct sales of land parcels was found, a recent study of tenure policy changes introduced to O Rona after the research presented here was completed reports frequent selling of plots by Bunong to migrant Khmer families or outside land speculators (Milne, 2013). Such sales are considered shameful and, hence, frequently carried out in private (Fox *et al.*, 2008). As such, reported compliance with the ban on buying and selling land in O Rona may under-estimate actual sales. However, a comparison of land mapped for IC households matched between the two time periods (and for whom the head of the household has remained the same) shows that 74% of the land mapped in 2006 has been retained. Given that households are expected to have given some of this land as wedding gifts when their children married, it is possible that the selling of land that is in use by IC households has been overstated (although this does not preclude the selling of previously unclaimed community land).

Whilst the extent to which IC households have been involved in the sale of land to outside interests is unclear, it is evident that the influx of external claims on community land has had a negative impact on IC households. In interviews, IC members frequently expressed frustration at their inability to exclude outsiders and the loss of community land. For example, one woman said that “before people used to try to stop the immigrants, but now we fear outsiders because they are rich and powerful.” It is clear to them that their claim on the land, although recognised under law, is insecure, thereby eroding one of the main benefits of the provision of tenure. This in turn was used as a justification for clearing outside of designated community areas. As one man put it, “we have to clear outside the community boundaries because there is no more land available”. Despite these pressures, however, the ICT process appears to have been partially successful in conservation terms, as IC members were less likely to claim illegal land and when they did claim illegal land, they claimed 65% less land than non-IC members.

In Andong Kraloeng, the IC has made a concerted effort to prevent large scale migration into the village, making access to land for outside interests significantly more difficult (albeit the village is under less pressure than O Rona). In part, this can be attributed to the village situation at the time land use planning was initiated. Unlike

in O Rona, where the two-tier system was necessitated in response to already high levels of in-migration from non-indigenous households, Andong Kraloeng had very few migrant households settle in the village prior to ICT. Of the 44 households sampled in this research, only five were non-IC households. This has contributed to a stronger sense of community identity and ownership of customary lands, as well as greater belief in their right to exclude outside interests from their land. Consequently, villagers report having turned away numerous migrant households since receiving ICT. As such, those conditions most commonly associated with positive outcomes for tenure reform have been achieved and compliance (particularly in regard to IC rules) has benefited (Ostrom, 1990).

Despite the generally positive situation for Andong Kraloeng, there appears to have been a breakdown of the traditional rotational cultivation system in response to the emergence of cash crops over the past decade. This does not necessarily represent a failing of the ICT process as no system can be expected to remain static over time, particularly in the face of rapidly changing socio-economic conditions. It does, however, underscore the importance of allowing for possible changes as part of the planning process and of ensuring that the institutions that are created to manage community areas have the capacity to be able to respond to those changes. As agriculture becomes more commercialised in Andong Kraloeng, it remains to be seen whether social institutions within the village can adapt, particularly if it brings influential households into conflict with IC regulations. The results of the household analyses support this, with those households with greater land holdings (i.e. older, more affluent and more established households) more likely to be non-compliant with community boundaries and regulations and also found to hold more illegal land if non-compliant.

The results regarding the perceptions of IC members of the IC committees in each village suggest that the social processes and institutions that support the management of community land may play an important role in maintaining compliance with the defined community boundaries and regulations. In Andong Kraloeng, committee leadership is strong, with committee members seen to be compliant with community regulations and legal boundaries, and ordinary community members display a greater awareness of the committee's role in managing community land. In O Rona, where

the overall perception the IC committee is poor, the ICT process is largely considered to be an externally imposed intervention, and not supported.

This has important implications for how ICT and participatory land use planning approaches are implemented elsewhere. In other villages in SPF, for example, improved road access to more remote villages, and the increasing threat of land alienation caused by economic land concessions, has led to the acceleration of the ICT process. Whilst this has been forced by the changing conditions to which these villages are exposed, the FA and WCS must be careful to ensure that the necessary support is given to local social institutions, which are critical to the successful implementation and sustainability of IC managed lands. With its origins in the recognised need to support and empower local voices, this lesson is also particularly relevant to the implementation of participatory land use planning approaches more broadly.

Similarly important is the need to ensure on-going compliance monitoring, both within community areas and the wider protected area, and to provide external support for this where required. The considerable loss of community lands in O Rona, and the perceived inability of IC members to prevent it, demonstrates that simply supporting a community through the legal processes required to apply for tenure is not sufficient. External political support may be necessary to assist communities in excluding outside interests from illegal land grabs. Without this, the security that the establishment of tenure should introduce may not materialise, leading to some of the issues observed in O Rona.

It may also be necessary to provide stronger enforcement of community boundaries. Unenforced boundaries will fail to induce sufficient incentive for local institutional development and effective management of community resources. In Andong Kraloeng, where the threat of external land grabbing is low and available land is far from scarce, 26% of cultivated land has still been cleared illegally. While it is possible that this is due to a lack of understanding of the rules that govern land use or of where the boundaries of each area lie, it is more likely that these areas have been cleared despite an understanding that to do so would be illegal. Effective policing of such infractions is likely to increase the incentive for committees to manage land use within community areas more effectively. This is supported by the result of the

community regulation compliance model, which suggested that households may offset their non-compliance with community rules (to which they may feel more social pressure to comply) through land use outside of community boundaries. As such, protected area authorities should support community monitoring and exclusion of outside interests within community boundaries, whilst ensuring adequate enforcement of community expansion beyond those boundaries.

Conclusion

In this chapter, I have shown how two contrasting villages have coped with implementing tenure reform. In one village, the evidence presented provides support for the proposition that tenure reform in protected areas conducted with the participation indigenous communities can be consistent with positive outcomes for biodiversity conservation (in this case, retention of protected forest cover), whilst providing communities with the rights to customary lands. In the other village, these positive effects have been largely negated by severe disruption from outside interests, powerful market forces and a failure in leadership on the part of those local institutions created to manage communal lands. In such cases, it is in the interests of both communities and those seeking to further conservation for local people to be provided with the institutional support necessary to protect and manage their resources effectively.

Chapter 5

Applying the carrot and stick in a Cambodian commons: an experimental games approach to the investigation of conservation incentives

5.1. *Introduction*

The institutional arrangements that govern individual behaviour can have substantial consequences for the management of natural resources (Ostrom *et al.*, 1990). In situations where property rights are undefined or unenforced, extraction of resources is limited by the ability of users to exploit them, their preferences to do so and the institutions that govern extraction. Understanding behaviour under different institutions is central, therefore, to the development of policies aimed at managing resource extraction.

A common approach regarding open access environments is to predict extraction based on the theory of rational self-interest, as characterised in Hardin's 'tragedy of the commons' (Hardin, 1968). Although this model accurately predicts behaviour in many instances, it has been consistently shown to underestimate cooperative behaviour under certain conditions (Gintis, 2000). Other studies have shown that social norms, defined loosely as the standards or shared beliefs within a group regarding how an individual ought to behave, can have a significant impact on cooperative behaviour (Sethi & Somanathan, 1996; Ostrom, 2000; Biel & Thøgersen, 2007), with the extent to which norms affect behaviour heavily dependent on individual preferences. Experiments investigating the cooperative behaviour of individuals have found evidence to suggest that only a minority of subjects free ride, with most being willing to cooperate if others reciprocate (Fischbacher *et al.*, 2001; Rustagi *et al.*, 2010). These results suggest that, although some individuals conform to the model of rational self-interest, they are unlikely to form the majority. Adding this to the results of studies of social norms provides strong evidence to suggest that when individuals are faced with a social dilemma there are many more determinants of behaviour than assumed by the simplistic model of rational self-interest.

In addition to personal behavioural preferences, the institutional conditions under which individuals make decisions are also a significant determinant of behaviour. For example, a study of 15 ‘small-scale’ societies found that the behaviour measured across different experimental games varied depending on the conditions present in each setting (Henrich *et al.*, 2005). Such experimental games are a common tool in behavioural economics and have been applied to investigating the effects of different institutions on behaviour, including resource extraction (e.g. Ostrom *et al.*, 1994). Games can be used to examine the role of socio-economic variables in decision-making and have the potential to enable the investigation of behaviour under conditions that mimic the effects of different policies (Cardenas & Ostrom, 2004). The results of such studies are varied and wide ranging but show that developing appropriate institutions and governance systems is central to effective management of resources (Vollan & Ostrom, 2010).

In this chapter, I present the results of a series of experimental games to investigate how certain institutional arrangements affect extraction from a common pool resource (CPR). I focus on the individual behaviour of smallholder farmers in a CPR setting subject to combined institutional conditions. In so doing, I follow a similar experimental design to that described in Travers *et al.* (2011), which enables the comparison of the relative effects of different conservation interventions by considering multiple treatments within the same experiment. These include external enforcement and reward payment regimes similar to those found under the mechanism of payments for environmental services (PES). Such payments are being increasingly widely used in the context of protected area management, in conjunction with more traditional enforcement activities, with conservation organisations providing payments both collectively and directly to individuals in return for engaging in, or desisting from, particular activities (for examples of how both payment structures have been applied in northern Cambodia see Clements *et al.*, 2010).

The effect of enforcement of exogenous rules on behaviour has been the focus of a number of experimental studies in the lab (e.g. Beckenkamp & Ostmann, 1999) and in the field (e.g. Cardenas *et al.*, 2000; Cardenas, 2004; Velez *et al.*, 2006; Vollan, 2008; Reichhuber *et al.*, 2009), although the results are often contradictory. There is

evidence to suggest that under certain conditions existing pro-social behaviour can be undermined ("crowded out") by rule enforcement, most notably when the probability of detection is low, penalties for non-compliance are weak or intrinsic social cohesion high (Ostmann, 1998; Cardenas *et al.*, 2000; Vollan, 2008). Further evidence suggests that even when cooperation is not reduced by enforcement, crowding out can occur once enforcement has been removed (Reeson & Tisdell, 2008). Elsewhere, it has been shown that exogenously imposed rules have the potential to reduce extraction and increase the efficiency with which subjects negotiate game environments, even when detection probabilities are low (Reichhuber *et al.*, 2009; Travers *et al.*, 2011). This variation in the observed effect of exogenous regulation has also been found within studies. For example in a study in rural Colombian villages, Velez *et al.* (2006) found that the effect of exogenous resource controls varied significantly between groups depending on the background of the participants. As such, it would appear that while external enforcement institutions can be effective at reducing extraction from a CPR, it is difficult to predict the outcome of such institutions prior to implementation.

In many conservation settings, those responsible for implementing rule enforcement have little control over the size of penalties but may influence the probability that non-compliance will be detected, for instance through greater investment in patrolling. Hence, it is important to understand the effect that increasing the probability of detecting rule breaking will have on compliance. In the lab, studies have shown that subjects respond more to changes in the severity of sanctions than they do to the probability of detection (Ostmann, 1998; Beckenkamp & Ostmann, 1999). Currently, in the context of field based experimental games, there has been little work focused on this question. This chapter seeks to address that omission by considering two exogenous enforcement regimes: one mimicking the conditions often found in developing country conservation settings in which the probability of detection is low and one mimicking a situation in which conservation managers have invested in enforcement and increased the probability of detection.

On the other side of the incentives scale, there is evidence that rewards can be highly effective at inducing cooperation when the allocation of rewards is decided externally, without cost to the recipients (Vollan, 2008; Travers *et al.*, 2011; Narloch *et al.*, 2012). As with sanctions, there is a risk that exogenously awarded rewards may undermine

existing norms and serve to crowd out inherent cooperation (Frey & Jegen, 2001). In a survey of attitudes regarding the site of a proposed noxious facility in Switzerland, Frey and Oberholzer-Gee (1997) found that the offer of incentives as compensation crowded out feelings of civic duty, resulting in lower levels of support. Conversely, appropriation was reduced by an exogenous reward system in a CPR game amongst pastoralists in Namibia and South Africa (Vollan, 2008). This effect was unchanged even if a minority of the group voted in support of rewards when given the option of voting for the different institutions within the game. In another study, Travers *et al.* (2011) investigated collectively conditional rewards, whereby the reward was conditional on aggregate group extraction falling within certain thresholds. It was demonstrated that the level of conditionality (i.e. the group extraction threshold on which rewards were conditional) was important in determining the effectiveness of the rewards, with higher conditionality leading to more restraint in extraction. In situations where participants have been allowed to choose between enforcement and rewarding institutions, rewards have been found to be preferred (e.g. Vollan, 2008; Sutter *et al.*, 2010).

In this chapter, I examine the effect of two exogenous penalty and reward payment regimes, as both stand alone and interacting interventions, on individual behaviour. While the effect on extraction from a CPR of both enforcement and reward payment regimes has been considered previously, here I investigate behaviour when both conditions are present. This allows the study of potential interactions between the disincentives created through enforcement and the positive incentives offered through reward payments. This has particular relevance for conservation policy-making, as the potentially conflicting interactions from different but simultaneously applied interventions are rarely considered, despite their ubiquitous use in actual conservation interventions (for example PES schemes within protected areas; Clements *et al.* 2010).

5.2. A common pool resource game

The CPR game used in this research was framed around the extraction of fish from a communal pond (see Appendix C for the game script used). The harvesting of fish was selected because fish is an important household resource and familiar to all participants. Two other options were piloted (a generic, unitless resource and bamboo) but feedback from the pilot suggested participants were better able to

understand the dilemma when it was presented in terms of harvesting fish. Participants were split into groups of 10, ($n = 10$), and instructed that they would make a series of decisions regarding the number of fish to harvest individually from a communal pond. Each individual, $j \in \{1, \dots, n\}$, could harvest x fish to a maximum of 10, $x \in \{0, \dots, 10\}$, each round, $t \in \{1, \dots, 5\}$. In contrast to some other studies that used non-linear payoff structures to model returns from extraction of a CPR (e.g. Ostrom *et al.*, 1992; Cardenas, 2000), a linear payoff structure was used because initial piloting had shown that participants had difficulty understanding the complexities of non-linear payoff structures. For each fish that an individual harvested from the pond, they received 100 Riel with nobody else in the group benefitting. Each fish left in the pond at the end of every round earned 12 Riel for all group members. This was explained as the future benefit to the group of having fish in the pond. This created a Pareto optimum at which no fish were harvested and a unique Nash equilibrium at which every participant chose to harvest the full quota available to them (10 fish). In total, 10 different experimental treatments were considered. For certain treatments, participants could be subject to enforcement penalties for each fish above a set threshold, e , with a probability of detection, λ , or reward payments, p (see Table 5.1 for parameters used in each treatment). The individual payoff π_j as described by these rules is given by the following equation (see Appendix C for specific payoff equations for each treatment):

$$\pi_j = 100x_j + 12(100 - \sum_{i=1}^n x_i) - \lambda e + p \quad \text{Eq. 5.1}$$

Table 5.1: Treatment options for the CPR game. All treatments were played by 80 participants with the exception of the private treatment, which was played by 360 participants. Treatment parameters are given for the payoff equation (Equation 5.1).

Treatment	Policy instrument	e	λ	p
private	-	-	-	-
peer-pressure	business as usual	-	-	-
weak enforcement	law enforcement	125	0.1	-
strong enforcement	law enforcement	125	0.4	-
individual payments	PES	-	-	250
individual payments & weak enforcement	PES with law enforcement	125	0.1	250
individual payments & strong enforcement	PES with law enforcement	125	0.4	250
collective payments	PES	-	-	250
collective payments & weak enforcement	PES with law enforcement	125	0.1	250
collective payments & strong enforcement	PES with law enforcement	125	0.4	250

Private treatment

The private treatment was played in anonymous conditions, such that no individual was aware of who else was in their group. After each round, participants were privately told their own payoff, plus the total group extraction. Illiterate participants were assisted in this. No communication between participants was allowed and participants were made to sit apart. As such, this treatment provided a measure of the internalised preferences of each participant in the absence of external controls on behaviour.

Communication & peer-pressure treatment

In this treatment, participants were separated into two groups of 10 individuals. Before individual decisions were taken, the group discussed the level of individual extraction they thought acceptable, with any outcomes of the discussion non-binding. They were then asked whether they had reached a group decision on the number of fish that each person should take and, if so, that decision was recorded. Once individual decisions had been made and the payoffs calculated, each participant read out how much they had chosen to extract and their payoff. As such, the treatment conditions allowed for individuals to experience shame, which has been shown to increase pro-social behaviour in a social dilemma (Lopez *et al.*, 2012). Participants were not permitted to lie to other group members at this stage. In this way, all participants were made aware of the decisions and earnings of other group members. This treatment served as a control for all further treatments, which were structured in a similar manner in known groups of 10 individuals with group decision-making and payoff reporting.

External enforcement treatments

In the external enforcement treatments, participants were subject to an imposed rule enforced by an external agent. In this case, the rule was structured such that any individual “caught” harvesting more than two fish per round would incur a penalty. The threshold of two fish was set so that a small harvest was still seen as legitimate, as past experience had shown that participants can struggle to understand the payoffs if they are not allowed to harvest anything. This reflects conditions in many conservation scenarios, in which only a certain level of appropriation is permissible.

The penalty was set at 125 Riel, 1.25 times the value of a harvested fish, for each fish individuals harvested above the threshold of two. This was set to mimic the enforcement regime for illegal harvest of natural resources in the study site, where penalties are rarely enforced beyond confiscation of illegal harvests and tools. Once individual decisions had been made and decisions and earnings read out, each individual was asked to roll a ten-sided die, the outcome of which would determine whether or not they were monitored that round. If they were monitored and were found to have harvested more than the threshold, then they received the proportional penalty of 125 Riel per fish. Two treatments were used: for the weak enforcement treatment, the probability of being monitored was set at 0.1 and for the stronger treatment the probability of being monitored was four times greater at 0.4. For example, if an individual chose to harvest four fish during the weak enforcement treatments and rolled a 2 on the die, they would not be monitored and their non-compliance would go unpunished. If they behaved in the same way during the strong enforcement treatments, they would be monitored and would be fined 250 Riel (125 Riel for each fish harvested above the threshold of two).

Individual payments treatments

For the individual payments treatments, participants were offered reward payments if they kept their harvest to two fish or fewer. Compliant participants were eligible to receive a bonus payment of 250 Riel, equivalent to 2.5 times the value of a single fish. The bonus was set in this way so that the individual opportunity cost of not harvesting at or close to the Nash equilibrium was not met by the bonus. This was intended to mimic the level of potential incentive payments in the study site, which are unlikely to cover the full opportunity cost incurred by foregoing extraction. In this case, it was assumed that monitoring would be perfect. For the two treatments that combined the individual payments treatment with the two external enforcement treatments, participants could receive a payment for keeping extraction below the threshold but also faced the possibility of a penalty for over-extraction.

Collective payments treatment

In the collective payments treatments, participants were again offered incentive payments but this time the payments were conditional on aggregate group behaviour.

If the total group extraction was equal to or less than 20 fish, every individual would receive a bonus payment of 250 Riel. If the total harvest was greater than this threshold, none of the participants would receive a payment, irrespective of their individual harvest. This treatment modelled incentive schemes where participants are contracted on a collective basis rather than individually. Again, it was assumed that monitoring was perfect. For the two treatments that combined the collective payments treatment with the two external enforcement treatments, participants could receive a payment if the group kept extraction below the threshold but also faced the possibility of a penalty for over-extraction.

5.3. Theoretical prediction and hypotheses

In this section, the behaviour predicted by the standard model of rational self-interest is presented, as well as *a priori* hypotheses regarding the expected behaviour under different treatments of the CPR game that follow from the background literature presented in Section 5.1.

Standard theory prediction

Under the standard *Homo economicus* model of rational, selfish behaviour, participants of the CPR game described in Section 5.2 should remain unaffected by the different treatments. For the control peer-pressure and private treatments, in which there were no reward payments or penalties, the Nash Equilibrium is for all individuals to extract 10 fish, the maximum possible. For the enforcement treatments, the marginal expected penalty for extraction is lower than the marginal return (even under the higher probability of detection), and therefore does not alter predicted behaviour. Likewise, the theoretical prediction for the payment treatments remains unchanged, as the payment received for extracting below the threshold is lower than the individual return of extracting the full allowance.

Hypotheses

H5.1: probability of detection in rule enforcement

H5.1.1 As the probability of detection is increased, the expected penalty for non-compliance increases also. As discussed above, under institutional conditions that allow for the enforcement of rules with penalties, the behaviour of risk neutral

individuals conforming to the model of rational self-interest would be expected to be unaffected by changes to the probability of detection, provided that the expected penalty remained less than the marginal return of non-compliance. As such, for the experimental conditions described above, it is expected that, under enforcement conditions only, there will be no significant difference in extraction from the pond between the two enforcement treatments.

H5.1.2 Previous studies have found evidence to suggest that crowding out of intrinsic motivation is likely to occur when weak exogenous rule enforcement conditions are imposed (e.g. Cardenas *et al.*, 2000). However, only weak evidence of such an effect was found by Travers *et al.* (2011) under similar conditions as those studied here. Therefore, it is expected that no crowding out will be observed under enforcement conditions only, compared to the extraction based on intrinsic motivations observed in the control.

H5.2: individual vs collective payment structure

H5.2.1 Both payment structures tested are expected to result in significant reductions in extraction in comparison with that observed for the control treatment. Given that the experimental design of this research closely matches that of Travers *et al.* (2011), which found no significant difference between two individual and collective payment structures in the effect on extraction from a common pool resource, the individual and collective treatments are expected to perform similarly in reducing extraction.

H5.2.2 It is also predicted, following the results of Travers *et al.* (2011), that the collective payment treatment will have secondary benefits, such as carry over effects into subsequent treatments, which are not observed under the individual payments treatment.

H5.3: combined payments and penalties

It has been shown that the phenomenon of crowding out is more likely in situations in which pro-social behaviour would otherwise be strongest (Vollan, 2008). As such, it is expected that combining the payment-based treatments, which are expected to promote pro-social behaviour, with the two enforcement institutions will result in

crowding out and increased levels of extraction in comparison with the payment structures operating in isolation.

5.4. *Methodology*

The CPR game was conducted in 13 villages between March and April 2012. Each village was categorised *a priori* into one of three village types using two key variables for guidance: distance to the nearest all-day market and the proportion of Bunong households in the village (for values of selection variables for each village see Appendix C; Table C.1). These variables are thought to influence a range of village characteristics, including poverty, livelihood strategies and village cohesion. Access to each village plays an important role in governing livelihood decisions as it has a strong effect on the sale price of different commodities and the cost of transporting goods to market. In reality, access is a combination of distance and the quality of road, but road quality is particularly difficult to measure as it varies annually and throughout each year. While many of Cambodia's minority indigenous peoples have become integrated into Khmer society, often to the point where they identify themselves as Khmer, the Bunong have maintained many of their customary practices, including their own language. The proportion of Bunong households in a village, therefore, provides a useful proxy measure of the level of integration with Khmer society.

For each village type, 120 villagers were selected to participate in the games. Households were selected at random from a list kept by the village chief. The head of each household was then contacted by the village chief and invited to participate in the games. If they were unavailable or chose not to play, another adult was invited from the same household. It was made clear to all selected households that they were not required to participate, and a member of the research team was present to ensure that no household was coerced. A reserve list of randomly selected households was produced to ensure that 20 individuals agreed to play each session in case households were unavailable or chose not to participate. As there were fewer than six villages in two of the three village types, the number of participants was higher for some villages than for others. Sample sizes were approximately proportional to population size. Participants were all aged over 18 and where possible only one person per household participated. In certain cases, this was not possible due to the small size of some of the

study villages and, in those cases, members of the same household played on the same day but never interacted in the game. The experiments were held in the local school for the majority of study villages. In some villages, however, there was no school or the school was not available. In such cases, appropriate houses were identified with sufficient space for participants to sit in groups or separate for the private treatment.

The CPR game followed a similar experimental design to that described in Travers *et al.* (2011). It was conducted over 18 separate days, with 360 participants (20 per day). Each participant played three different treatments: the private treatment plus two others. The order in which the treatments were played was changed for each session to control for possible ordering and earnings effects. To avoid individuals' decisions being governed by repeatedly playing with the same people, group composition was controlled to minimise the number of participants who played each treatment in the same group. All treatments were repeated for a total of five rounds. Payments for all rounds were made after the game had finished to avoid payoff effects influencing behaviour. Each individual was given a payoff sheet on which the payoffs earned in previous treatments were written and was paid privately, with the majority of earnings totalling between four and six US dollars. Daily farm wages in the study area are usually five dollars so the game payments were roughly equivalent to paid labour. All sections of the experiment were run by a team of four: the lead author, two Khmer research assistants and a Bunong translator to assist participants with lower Khmer skills.

After an explanation of the game, two practice rounds were played following the same format as the private treatment. Participants marked decisions by circling the number of fish they wanted to harvest (see Appendix C for individual decision sheet). Individual earnings and total group extraction were written on all sheets after each round. Once the practice rounds were completed, participants were asked five multiple-choice questions to test their understanding of the main principles of the dilemma. On completion of this test, the answers were explained to help those participants that still had problems with understanding. Individual scores from these tests were checked in the regression analysis described below but were found not to be significantly correlated with game behaviour. During the experiment, the private treatment was played in a single room and all other treatments were played in separate

rooms such that it was not possible for different groups to hear what was happening in groups other than their own.

5.5. *Results*

Generalised linear mixed effects models (GLMMs; Zuur *et al.*, 2009) were constructed to analyse the results of the game². The logit link function was used due to the binomial error structure of the number of fish taken by an individual, with Laplace approximation used to estimate the model parameters (Bolker *et al.*, 2009). Model selection for fixed effects was carried out by comparing Akaike information criterion values (AIC; Akaike, 1974). The final model was selected using step-wise selection and comparing Δ AIC values. Following Burnham and Anderson (2002), if the difference in AIC values between models was less than two, the most parsimonious model was selected. If the Δ AIC values were greater than two, the model with the lower AIC value was selected. The random effect structure, including variables for village, day number, group and individual, was investigated using likelihood ratio tests (Bolker *et al.*, 2009). Once both the random and fixed effect structures had been selected, visual validation was conducted to check for residual normality, heteroskedasticity and for possible correlations between fixed effects and the residuals. Each model was also checked for over-dispersion by comparing the sum of squared Pearson residuals with the approximate residual degrees of freedom.

The results of the CPR game are best compared against the baseline created by the control peer-pressure treatment. In this treatment, the mean individual extraction was 4.9 fish per round. This closely matches the results of Travers *et al.* (2011). As expected, the majority of treatments performed better than the control at reducing extraction from the CPR (Table 5.2; Appendix C, Figures C1-C3). Whilst some treatments achieved an equilibrium state with average harvest remaining effectively constant over the five rounds, extraction in other treatments had not reached equilibrium at the end of the game.

² All models were analysed using R version 2.12.0 (R Core Development, 2010) in the open source software package RStudio version 0.96.228 (RStudio, 2012). Within R, the lme4 package version 0.999375-36 (Bates & Maechler, 2012) was used to code the GLMMs.

Table 5.2: Descriptive statistics for key explanatory variables. Sample standard errors are shown in parentheses.

Variable	Statistic
male participants	45%
Bunong participants	62.9%
mean age	37.5 (13.4)
mean years in education	2.6 (3.2)
mean number of fish taken during each treatment:	
practice rounds	4.5 (2.1) fish
private	5.5 (3.0) fish
peer-pressure	4.9 (2.8) fish
weak enforcement	4.5 (2.9) fish
strong enforcement	5.9 (2.8) fish
individual payments	2.2 (1.9) fish
individual payments & weak enforcement	3.8 (2.8) fish
individual payments & strong enforcement	3.1 (2.7) fish
collective payments	2.1 (2.2) fish
collective payments & weak enforcement	2.9 (2.4) fish
collective payments & strong enforcement	2.6 (1.6) fish
discussion periods ending in decision	97.1%

The effect of treatment and socio-demographics on individual extraction

The model for the individual number of fish harvested each round shows a mixed picture, with the private and both enforcement treatments having no significant effect on individual extraction compared to the peer pressure control treatment (Table 5.3, column 2; difference in fish = -0.1 and 0.4 for the weak and strong enforcement treatments respectively). This matches the prediction made under hypothesis H5.1.1 that increasing the probability of detection, without the expected penalty being higher than the marginal gain in harvesting extra fish, would not result in a significant change in extraction behaviour. Conversely, all treatments that included individual or collective payments resulted in reductions in extraction. For the two payment structures in the absence of enforcement, there was no significant difference between their effects on extraction; with the mean reduction in individual extraction estimated to be 2.6 fish (SE = ± 0.4) for individual payments and 2.2 fish (SE = ± 0.4) for the collective payments (Wald test, $P = 0.447$). This supports the prediction made in hypothesis H5.2.1 that no significant difference would be observed in extraction under the two payment structures.

Table 5.3: Parameter estimates for the selected CPR game generalised linear mixed models, with the number of fish harvested by an individual in a single round as the response variable. The difference in the number of fish taken was found by calculating the expected number of fish taken for each variable and comparing this with the number expected for the intercept. Standard errors in terms of number of fish are shown in parentheses. A comparison of the effect of each treatment for round 1 and round 4 is given in Supplementary Materials Table C.4. The full list of variables modelled, plus their explanations, are given in Supplementary Materials Table C.2. Significance values: ns = not significant; (*) = $P < 0.1$; * = $P < 0.05$; ** = $P < 0.01$; * = $P < 0.001$. Reference level treatment indicated by ref.**

Explanatory variables	Peer pressure treatment as ref		Individual payments & strong enforcement as ref	
	Estimate	P	Estimate	P
intercept	3.938 (0.724)	*	2.815 (0.634)	**
treatment:				
peer pressure	ref	-	+1.123 (0.806)	ns
private	-0.105 (0.643)	ns	+1.018 (0.641)	(*)
weak enforcement	-0.097 (0.838)	ns	+1.026 (0.839)	*
strong enforcement	+0.383 (0.852)	ns	+1.506 (0.810)	ns
individual payments	-2.567 (0.434)	***	-1.444 (0.457)	**
collective payments	-2.243 (0.514)	***	-1.121 (0.549)	(*)
individual payments & weak enforcement	-1.927 (0.575)	***	-0.804 (0.608)	ns
individual payments & strong enforcement	-1.123 (0.709)	(*)	ref	-
collective payments & weak enforcement	-1.774 (0.641)	**	-0.651 (0.602)	ns
collective payments & strong enforcement	-2.252 (0.534)	***	-1.129 (0.508)	*
education	+0.056 (0.022)	**	+0.048 (0.019)	**
decision	-0.750 (0.185)	***	-0.614 (0.147)	***
practice	+0.191 (0.038)	***	+0.163 (0.033)	***
round:				
round 2	+0.855 (0.081)	***	+0.755 (0.074)	***
round 3	+0.577 (0.080)	***	+0.503 (0.072)	***
round 4	+1.009 (0.081)	***	+0.898 (0.076)	***
round 5	+0.835 (0.081)	***	+0.736 (0.075)	***
random effect:				
individual	SD = 0.484		SD = 0.484	
group	SD = 0.561		SD = 0.561	
session	SD = 0.591		SD = 0.591	

The picture becomes more complicated when the treatments integrating payments with enforcement regimes are considered. For the treatments with individual payments, enforcement appeared to undermine the incentives for extraction reduction, with both levels of enforcement producing a weaker effect on extraction than the payments on their own. This crowding out was more severe for the stronger

enforcement regime (1.1 fewer fish extracted than in the control, compared to 2.6 fewer for individual payments alone) than the weaker one (1.9 fewer fish). For the collective payment treatments, no undermining effect was observed for either of the two enforcement regimes (1.8 fewer fish than the control with weak enforcement and 2.3 fewer fish with strong enforcement, rather than 2.2 fewer with just collective payments).

Running the model again with the individual payment with strong enforcement as the reference level provides a clearer picture of the relative performance of the different payment treatments (Table 5.3, column 3). This shows that adding strong enforcement to individual payments significantly increased individual extraction relative to the individual payments treatment (1.4 fewer fish under individual payments alone than payments with strong enforcement), collective payments treatment (1.1 fewer fish) and collective payments with strong enforcement treatment (1.1 fewer fish). On this basis, it appears that although there was no difference between the performance of individual and collective payments under zero enforcement, performance for individual payments was crowded out slightly under weak enforcement and significantly under stronger enforcement regimes. Under no combination was there any meaningful increase in compliance under integrated treatments relative to the two payment treatments. This matches the effect expected under hypothesis H5.3, with exogenous enforcement crowding out the strong pro-social behaviour observed when payments were offered with no enforcement. However, the lack of an effect when rule enforcement was added to collective payments is contrary to predictions and suggests that further thought is required to understand why crowding out occurs under some conditions and not others.

In addition to the treatment played, a number of individual demographic and livelihood variables were tested, of which only one was included in the final selected model. This was the number of years of education that each participant had received. Despite the fact that a logistic regression was used in the analysis, the effect of education was linear over the range of years spent in education observed for the sample. As such, each additional year in education was found to result in a small increase in the number of fish taken (diff. in fish = 0.06). None of the other variables

tested were included in the final model, meaning that no effect was found for participant age, gender, ethnicity or any of the livelihood variables considered.

Two other variables were found to have a significant effect on individual extraction. Group decision-making (i.e. when a group made a collective decision during the discussion period) resulted in a reduction of 0.8 fish per group member when a decision was recorded, mirroring a similar result to that found in Travers *et al.* (2011). This shows the strong impact that collective decision-making can have on individual harvesting decisions. Finally, the mean individual extraction from the two practice rounds was also found to be significantly and approximately linearly correlated with extraction during the game itself. This suggests that behaviour within the game was governed not only by the conditions of each treatment but also by inherent preferences. Participants, who took more than others during the practice, also took more in the other treatments they played, irrespective of the difference in conditions.

Three random effects were also included in the selected model: individual, group and session. The variation explained by each random effect was roughly comparable (Table 5.3). This indicates the importance not just of individual decision-making but also of group interaction, with both the groups in which participants played individual treatments and the group of 20 participants selected to play the CPR game for a single day session included in the model. This matches a similar result in Hayo and Vollan (2012), who found that adding a group dummy variable to their analysis of CPR extraction in Southern African rangelands improved the explanatory power of their model.

One variable that was found to be important by Travers *et al.* (2011), but was not included in the selected model here, was the previous treatment played. Previously, it was found that individual extraction was significantly reduced after participants had played treatments that promoted a degree of self-organisation within each group. Under the conditions presented by the set of treatments considered here, this would suggest that the three collective payment treatments would reduce extraction in subsequent treatments played. The difference between the AIC of a model containing a variable for the previous treatment played and the selected model was 6.3, which suggests that the previous treatment played has no effect on extraction. A closer look at the parameter estimates of each individual treatment confirms that only one

treatment had any meaningful effect on extraction in future treatments; the simple collective payments treatment (diff. in fish = -2.1, $p = 0.004$). This is comparable with the effect size found in the previous study, and supports hypothesis H5.2.2 that although performance under the two payment structures was not significantly different, collective payments offer secondary benefits that are not observed for individual payments. The fact that no effect was recorded for the combined collective treatments suggests that, although overall performance was not reduced, integrating enforcement with an payment-based intervention can crowd out at least one of the positive effects of self-organising.

5.6. *Discussion*

This chapter builds upon existing research that investigates how different institutional arrangements affect individual extraction behaviour in a CPR scenario. By investigating behaviour under more complex and realistic institutional conditions, in which both payments and penalties are applied simultaneously and separately, it has been possible to examine how individuals respond to such conditions, particularly whether penalties can crowd out the pro-social behaviour observed under reward payment treatments.

The fact that little difference was found in performance when the two payment types (collective and individual) were considered in isolation may have implications for the structuring of payments in the study site and more widely. Collective payments are thought to offer potential advantages over individual contracts, such as reduced transaction costs (Wunder, 2007), and to encourage cooperation through peer monitoring and peer pressure to comply. Structuring payments collectively can also generate secondary benefits because of the institutions created to manage them (Clements *et al.*, 2010). Collective payments are, however, potentially less appealing to recipients where social cohesion is low, as the ability to control the extraction of others in their group is likely to be weak. Should individuals within the group ignore the incentive, their behaviour has the potential to impact upon compliant individuals. This may in turn lead to the non-compliance of individuals who would have cooperated if contracted individually, as they are faced with incurring the opportunity cost of foregoing extraction with little hope of receiving the compensatory payment.

The more simplistic individual payments are less vulnerable to the concerns raised for collective payments and, consequently, offer the potential for improved performance in situations where social cohesion is low. This reflects the results of Narloch *et al.* (2012), who found that individual payments improved contributions in a public goods game but that collective payments were ineffective. In that study, groups were unable to make agreements or discuss behaviour, which is likely to limit social cohesion. However, the set-up in this research led to similar results from both individual and collective payments, although the transactions costs of setting up individual incentive agreements are likely to be higher than those for collective payments in the Eastern Plains Landscape. A preference for collective over individual payments in this system is further supported by the carry-over effects observed for collective payments. The lower extraction recorded for treatments following collective payments suggests that participants were able to maintain the same level of cooperation even after the offer of a payment had been removed. Although the mechanism for this carry over effect is currently unclear, Travers *et al.* (2011) observed the same effect in treatments thought to promote self-organisation amongst game participants. This supports the notion that structuring payments collectively has the potential to empower recipients and, hence, may lead to a more sustainable solution than if payments were simply contracted on an individual basis.

The role of enforcement and crowding out

Neither of the two external enforcement treatments achieved a significant reduction in extraction over the control. This follows theoretical predictions, as the incentives in both treatments were insufficient to move the Nash Equilibrium away from each individual extracting the maximum possible. Both treatments resulted in lower social efficiencies than found for the control, with the stronger treatment lowest due to the higher penalty rate. Even though participants would have been aware that these treatments were resulting in lower individual payoffs, the penalties were insufficient to reduce extraction. This corresponds to the findings of a number of other studies (e.g. Ostmann, 1998; Cardenas *et al.*, 2000). There was, however, no evidence that the enforcement treatments in isolation led to crowding out of the baseline cooperation measured in the control, despite the generally strong social cohesion of the subject

pool. This is at apparent odds with the findings of Volla (2008) that crowding out occurs when people have strong social cohesion and are subject to external penalties.

The effect of enforcement on the cooperation achieved under the two payment structures is more informative. It is rare for incentive schemes in conservation to operate in isolation, without some form of enforcement (often imposed by an external agent). As such, it is important to understand how these different policy instruments interact. None of the treatments that combined enforcement with payments improved on the performance of payments alone. In many ways, this is unsurprising as both the collective and individual payment treatments lowered mean extraction to approximately two fish per round for each individual, the same as the threshold for receiving a payment. Given that the enforcement regimes used the same threshold, improvements in performance would have been expected to be restricted only to those individuals who took more than the threshold.

In the case of the weaker enforcement regime, adding complexity to the institutional conditions experienced by the participants appears to have weakened the response to the incentives created by the two payment structures, as both saw a slight decline in their effectiveness. This is an example of how externally imposed rules have the potential to crowd out cooperation achieved under other conditions. Other authors (e.g. Cardenas *et al.*, 2000) have suggested that this crowding out effect is caused by externally imposed rules promoting individualistic behaviour, thereby undermining cooperative behaviour. This was supported by the way in which participants responded to the enforcement mechanism during the game, with several participants commenting during the discussion periods that extraction decisions should be up to the individual because of the risk of being penalised.

For the individual payment treatment, the crowding out effect was strongest when combined with the stronger enforcement regime. In some sense this is counter to expectations, as increasing the probability of detection reduces the expected payoff of breaking the rule limiting extraction. One possible explanation for this result is that the high probability of monitoring acted to highlight the importance of the enforcement mechanism in participants' minds and, hence, further promote individualistic behaviour. Participants understood that group members who took more than the threshold of two fish did so at their own risk, thus reducing the incentive for

group decision-making and individual compliance. The response to the strong enforcement regime when coupled with collective payments was very different. In this case, several participants were observed using the presence of penalties in the treatment as a means to encourage non-compliers to cooperate. By so doing, they were using an externally imposed institution to promote behaviour in the group's best interest, an action for which there was little incentive in the case of the individual payments.

This apparent difference in how the two payment structures interacted with the enforcement regimes demonstrates the potential for individuals to respond very differently to seemingly similar sets of incentives. In the case of individual payments, increasing the probability of rule breaking detection strengthened the crowding out effect, and increased extraction, but the same mechanism served to strengthen group decision-making for collective payments. This finding builds on the work of Vollaard (2008), as it shows that crowding out can occur when both supportive and controlling institutions are present, but only under certain conditions.

Policy implications

Whilst many previous studies have investigated the effect of both positive and negative sets of incentives on extraction behaviour in the commons, the results presented here have built up a more complex picture by comparing the effects of multiple simultaneous interventions, including several that integrate seemingly opposing sets of incentives. These results can help guide policy decision-making.

One of the principal dilemmas facing conservation organisations is how to provide incentives to change illegal behaviour. Typically, this has been attempted through the implementation of various enforcement measures but there are a number of barriers to successful implementation of such measures. These include, amongst others, weak local institutions (Barrett *et al.*, 2001), poor support for natural resource laws from national governments and logistical and financial constraints. More positive measures can be employed but this raises questions about the value and form of possible incentives. Some authors have argued that it is necessary to compensate the full opportunity costs of foregoing the illegal behaviour but this approach has clear issues associated with it. In particular, the opportunity costs of many illegal activities, such

as the clearance of forest for commercial agriculture, may be prohibitively high. The results of the payment treatments are encouraging in this respect, as all treatments, including those integrated with enforcement regimes, resulted in significant reductions in individual extraction, and yet only covered 31% of the individual opportunity cost of not harvesting the full 10 fish. This suggests that, contrary to the model of selfish rationality, individuals will alter their behaviour even when the pure financial incentives are insufficient to suggest that they would do so.

The results of the integrated payment and enforcement treatments are of greater policy relevance. These demonstrate that focussing solely on the effects of positive incentives may overestimate the impact of such policies by failing to take account of the possible crowding out effect of also providing negative incentives by externally imposed enforcement of rules. There is also evidence here to suggest that these risks can be minimised by adopting a collective payment structure rather than an individual structure. This would also offer the advantage of promoting a greater degree of self-organisation amongst resource users and lowering transaction costs. In the context of payments for environmental services, collective payments may therefore provide a more effective solution for encouraging reductions in individual resource use.

Finally, in this chapter, I have considered a series of exogenous conservation interventions that might be employed to encourage pro-conservation behaviour in the study area. In the context of Seima Protection Forest, the results presented suggest that certain policy options could be used to reduce extraction from the reserve. Both the individual and collective payment treatments brought considerable reductions in comparison to the baseline behaviour. Conversely, increasing investment in patrolling may not bring about any significant benefits or could even be counter-productive if combined with individual payment schemes designed to encourage resource conservation. Consequently, it is recommended that careful consideration be given to possible unwanted effects, such as crowding out, during the design phase of future payments schemes proposed for the site.

Chapter 6

Investigating incentive based approaches to biodiversity conservation through scenarios

6.1. *Introduction*

It has long been understood that local communities shoulder a disproportionate share of the costs of biodiversity conservation, whilst benefits accrue largely at national or global scales (Wells, 1992; Balmford & Whitten, 2003). The establishment of protected areas (PAs), for example, is often driven by values surrounding the importance of endangered species or habitats, which may not be shared by those most affected by conservation activities (Roe & Elliott, 2006). Conversely, PAs have often been associated with displacement, food insecurity and the loss of livelihoods (Ghimire & Pimbert 1997; Adams *et al.*, 2004; Colchester, 2004; Brockington & Igoe, 2006; Cernea & Schmidt-Soltau, 2006), with significant negative impacts for local people. Recognition of this inequality and the resentment it can create has helped to give rise to a raft of incentive based approaches to conservation. Notable examples include integrated conservation and developments projects (ICDPs; Wells & Brandon, 1993; Barrett & Arcese, 1995), community based natural resource management (CBNRM; Kellert *et al.*, 2000; Singleton, 2000) and payments for ecosystem services (PES; Ferraro & Kiss, 2002; Wunder, 2007; Engel *et al.*, 2008). While the motivation behind these different approaches may vary, the principle that local people are incentivised to cooperate with conservation efforts is common to all. However, despite the long period of interest in incentives and their increasing use in conservation, questions remain about how best they might be structured. For instance, should incentives be collective or targeted at individuals? Are direct payments preferable to in-kind support? How do the effects of using payments compare with those of alternative top-down approaches, such as law enforcement? These are all questions that should be answered prior to the implementation of conservation policies, and yet their answers are not clear-cut.

For contexts in which the use of resources is restricted or illegal, such as within protected areas, the appropriateness of using incentives as a means to encourage pro-

conservation behaviour has been questioned. Concerns have been raised regarding both the additionality and validity of providing incentives to discourage a behaviour that is already illegal (Börner & Wunder, 2008). However, where resources are lacking for effective protected area management, incentive schemes may still be a legitimate means of changing behaviour (Clements, 2010; Petheram & Campbell, 2010). In such cases, it may not be necessary or appropriate to cover full opportunity costs, as incentives can augment existing preferences to obey the law. In this context, it has been suggested that in-kind support, such as the setting up of a community fund for infrastructural development or livelihood enhancement (e.g. agri-environmental or alternative livelihood schemes) to increase the profitability of existing land uses, is preferable to direct payments (Wunder, 2005; Asquith *et al.*, 2008). There is a corresponding risk, however, that such an approach could weaken the conditionality attached to the provision of incentives, as such support could be difficult to withdraw (Sommerville *et al.*, 2010), and would also vary in the extent to which different resource users benefit (Lee & Mahanty, 2009).

Assessing the future response of those targeted by conservation programmes is not an easy task, particularly for contexts, such as those commonly found in developing countries, in which institutions are weak (Barrett *et al.*, 2001) and property rights ill-defined (Geist & Lambin, 2002). Consequently, decision-making under different economic incentives is often conceptualised in terms of maximising utility (Barrett & Arcese, 1998; Damania *et al.* 2005). However, this approach is problematic. Whilst decision-makers are commonly modelled as rational actors, who seek only to maximise their own benefit, empirical evidence suggests that most decision-making is influenced by other-regarding preferences (Gintis, 2000). For environments where property rights are uncertain, such as for many common property resources, predictions of behaviour become particularly complex. Similarly, the opportunity costs borne through cooperating with conservation initiatives not only incorporate tangible financial costs, such as those of lost earnings through restricted access of resources, but may also include other elements (such as foregone recognition of tenure), which are harder to quantify. Issues such as these, coupled with a paucity of data relating to potentially unknown factors that influence decision-making, can make predicting behaviour more challenging. Similarly, testing approaches in real life is

also difficult, as pilots can be prohibitively expensive and experimental approaches, such as randomised controlled trials, even more so (Agrawal, 2014).

One way to overcome the difficulties in predicting behaviour is to turn to methods, such as scenario-based interviewing, which allow for the investigation of decision-making under a range of credible futures prior to the implementation of an intervention. While predicting future behaviour is problematic, placing limits on the length of time and changes considered can act to reduce the complexity and produce meaningful results (Gordon, 1992). Scenarios presented in the form of qualitative narratives (e.g. Cinner, 2009) have the advantage that they can be easily understood and, therefore, allow for the exploratory examination of behaviour in contexts where respondents may struggle to place values on complex hypothetical situations (as in contingent valuation). Discussing the future in this way provides valuable insight into not only *how* people are likely to respond to the scenarios presented, but also the reasons *why* they might respond that way.

Such approaches may also serve to help minimise the risks presented by heterogeneity amongst the target populations for conservation policies, or by exogenous changes such as external market fluctuations. Accounting for such complexity is one of the principal challenges facing conservation; something that integrated conservation and development projects are often said to have failed to do (McShane & Newby, 2004; Blom *et al.*, 2010; Waylen *et al.*, 2012). In part, this is because conservation often operates within highly complex socio-ecological systems in which relationships between society and natural systems are dynamic and multi-scale (Berkes, 2004). Even at the site level, heterogeneity within target populations may be high (Chan *et al.*, 2007; Waylen *et al.*, 2013). Scenario approaches enable the response to conservation policies by different agents to be tested and, hence, the extent of homogeneity of response to be estimated for a target group.

In this chapter, scenario interviews are used to examine the potential outcomes of different approaches to changing incentives within Seima Protection Forest. This is done through an analysis of the stated responses of smallholder farmers from several villages within the project area to seven future scenarios, which include exogenous changes to the sale price of cassava (the dominant agricultural commodity in the area) and different intervention options aimed at reducing deforestation at the site

(increased enforcement effort, communal and individual conditional payments and a village fund for infrastructural development). For each scenario, interview respondents were asked how their land use and livelihood practices might change and, hence, the responses given provide an indication of the expected variation in farmer reactions to the intervention options under consideration for the study site. Within this methodological framework, the predicted effectiveness of each option for incentivising pro-conservation behaviour (in this case, reduced forest clearance) is investigated and compared against the response to exogenous changes in the price of cassava. By analysing responses at the household level but within three distinct livelihood zones, the effect of economic well-being, livelihood strategy and socio-demographic variables on the responses given to each scenario are examined. In this way, I seek to identify whether, in the context of this case study, opportunities exist to target interventions towards those households or livelihood zones most likely to respond positively.

6.2. *The Seima Protection Forest REDD+ Demonstration Project*

Proposals for the REDD+ project at Seima Protection Forest are well advanced and focus on the core protection zone, with 20 participating villages located within or in close proximity to this zone. Household livelihoods within the project area are based on subsistence agriculture and the collection of forest products (Evans *et al.*, 2003). Increasingly, however, farmers are turning towards the production of cash crops, such as cassava and cashew, and encroaching further into the protected area (Chapter 4). Immigration of households seeking land from neighbouring provinces has helped to drive expansion of agricultural land and fuel encroachment (Chapter 3; Chapter 4; Milne, 2013). Whilst these two processes are helping to drive deforestation within the proposed REDD+ project area, the rate and extent of change vary between villages.

A programme of participatory tenure reform is currently underway or complete in 15 of the project villages (A. Diment, pers. comm.). Under this scheme, communal land title is granted to each officially recognised indigenous community, with land inside village boundaries divided into different use areas. Land use inside the communal title is governed by a set of rules designed to protect customary practices and ensure long-term sustainable use of communal land. Clearance of forest is only permitted inside designated community areas. Hence, clearance outside the titled area is illegal and

subject to enforcement by PA authorities, whilst clearance inside community areas is governed by village institutions. Clearance rates are high both inside and outside titled areas (see Chapter 4), and detection probabilities are low. At the point of writing, six indigenous communities living within the boundaries of the protected area have received official communal land titles. With the exception of the initial pilot village, assistance for land use planning and land titling has been prioritised in villages near the district capital because land and forest resources were judged to be under the greatest threat, as they are located close to good quality roads and, therefore, subject to both high immigration and increasing commercialisation of agriculture. This has added to the institutional complexity across the study site, as different villages are now at various points along the tenure reform process.

The area is characterised into three livelihood zones in which different livelihood activities dominate: a cash crop zone, a lowland paddy zone and an upland zone. These zones have repeatedly been referred to in project documentation and reflect the major inter-community heterogeneity with respect to bio-physical characteristics, institutional framing, opportunity costs of stopping deforestation and economic well-being. As such, the majority of variation in clearance behaviour due to the conditions in which decisions are made is expected to be represented by these zones. The cash crop zone is centred around the district capital of Keo Seima and is characterised by easy road access and mature cash crop markets. This area is also currently experiencing the highest rate of land conversion (WCS, 2013). The lowland paddy zone is located in the most remote part of the protected area. Access to this area is difficult (particularly during the wet season) and the dominant livelihood strategy is centred on the cultivation of paddy rice, supported by liquid resin collection from native dipterocarp trees. The upland zone is also located further from market centres, although access is largely better than for the paddy zone. In this zone, households cultivate a greater diversity of crops and have recently made the transition towards commercial production.

Variation in economic well-being between the three livelihood zones has previously been assessed using a participatory poverty index, which was calculated following the basic necessity survey method (see Chapter 3 for an explanation of this method). Across the 622 households sampled, the household poverty score ranged from 0.10 to

0.82, with a mean of 0.44 (SE = 0.13). After correcting for other household demographic and socio-economic variables, a significant difference was found between the mean poverty score of households from villages in each of the three livelihood zones. As expected, communities in the cash crop zone had the highest mean household poverty score (0.10 higher than the mean score for villages in the paddy zone ($p < 0.001$) and 0.04 higher than the mean score for villages in the upland zone ($p = 0.054$)), indicating that these households are on average better off than households from villages in the other two zones. The livelihood zone with the lowest mean household poverty score was the lowland paddy zone (mean score for villages was 0.06 lower than the mean score for villages in the upland zone ($p = 0.016$)), which again was as expected as this is the most remote zone with fewer income generating livelihood opportunities available to the people who live there. Within each zone, there was little difference in heterogeneity at the household level. The standard errors for household poverty scores in all three zones are comparable, with the least variation in the upland zone and the most in the cash crop zone ($SE_{\text{cash}} = 0.14$, $SE_{\text{paddy}} = 0.14$, $SE_{\text{upland}} = 0.12$).

6.3. *Methods*

All households surveyed as part of this research had previously participated in the basic necessity survey. As such, it was possible to stratify each household by two variables: poverty score and livelihood zone. Sampling for the scenario interviews was spread equally across poverty score terciles, which were derived for the whole survey area, and the three livelihood zones, such that an equal proportion of households from the three poverty score terciles were interviewed for each zone. In total, 49 households were interviewed: four households to pilot the method and another five households for each poverty score tercile in each livelihood zone. In cases where the household head was not present in the village at the time that the survey was carried out, a replacement household was selected randomly from a list of all households within the village. Rather than sample households from each of the 20 REDD+ villages, two or three villages were selected for each livelihood zone in such a way as to cover the full range of conditions found in villages within each zone.

Interviews were semi-structured, with respondents presented with a baseline business as usual scenario and a further six scenarios in which one aspect of future conditions

was changed. Each scenario was presented one by one and the respondent asked to qualitatively explain how they would react over the next five years with regards to their agricultural and other livelihood activities. Follow-up questions were asked to ensure that the respondent had fully understood the scenario, to explore responses in greater detail and to triangulate between responses to different scenarios. As land-use is a potentially sensitive issue in Cambodian protected areas, respondents were assured that all data collected would be confidential. A subsample of responses from two villages was validated by comparing landholdings reported during the scenario interviews with those reported in Chapter 4, with all responses comparing favourably.

Interview responses to the six future scenarios were compared against those to the baseline business as usual scenario. Responses were then coded into different categories depending on their likely impact on forest cover. In certain cases, in which direct changes in clearance behaviour were not described, coding was based on existing understanding and knowledge of land use practices within the study area. For example, where respondents intended to buy land already in use, this was coded as a resultant increase in forest clearance based on existing understanding of clearance processes in sampled villages. In this case, it is reportedly common practice for individuals to clear forest specifically for sale or to sell land within village boundaries but subsequently clear additional forest to compensate for the loss (Milne, 2013). In both instances, the act of buying land fuels additional indirect clearance. Where the conditions presented within a scenario were contingent on the behaviour of others, interview respondents were asked to describe their response to the scenario based on whether others in their group cleared. Responses were then coded as conditional or unconditional depending on whether they were contingent on the behaviour of others or not.

There follows a description of the conditions presented by each scenario. *A priori* hypotheses are included for each of the six scenarios in which the conditions were different to those of the business as usual baseline scenario and are based on prior understanding of behaviour within the study villages and existing literature.

Baseline business as usual scenario

In this scenario, it was explained that current conditions would stay constant over the next five years. All average prices would remain at a stable level, although there

would be some small variation between each year. Law enforcement effort would remain constant but, in cases where indigenous land title had yet to be granted, tenure reforms would progress as currently planned.

Performance payments

In these three scenarios, respondents were offered the option of receiving an annual payment of \$200 in return for agreeing not to clear any additional land, including inside areas designated for use under communal land title. Payments were set at \$200 as this was felt to be representative of the likely sum offered in the future as part of the REDD+ project (T. Evans, pers. comm.). In the first of these scenarios, payments were to be made on an individual basis and were dependent solely on the compliance of the household interviewed. In the second scenario, payments would be made based on the behaviour of groups of ten individual households from within the same neighbourhood as the respondent household. Each household would receive \$200 if all households in the group chose not to clear any additional land, otherwise they would receive nothing. In the third of these scenarios, the money would be paid into a village level development fund to support infrastructural development or other development projects identified by the community instead of the \$200 being paid to each individual household. These payments would again be dependent on the collective behaviour of groups of ten households from the same neighbourhood.

Hypothesis H6.1: the offer of conditional payments will reduce the number of households who predict that they will expand their agricultural land relative to a) the business as usual baseline, and b) the increased enforcement effort scenario.

Hypothesis H6.2: the offer of conditional payments will more strongly reduce the number of households who predict that they will expand their agricultural land when payments are conditional on group-level compliance than when they are conditional solely on individual compliance, but the type of collective payment offered will not make a difference to land expansion.

Increase in enforcement effort

In this scenario, respondents were told that enforcement effort within the study site would be doubled, such that it would be twice as likely that illegal land clearance would be detected. The likelihood of prosecution once caught was unaffected. This

additional enforcement activity would be restricted to conservation areas, i.e. clearance inside titled areas designated for communal agricultural use would not be subject to increased law enforcement as these areas are subject to community management.

Hypothesis H6.3: doubling the probability of detection will decrease the number of households who predict that they will expand their agricultural land relative to the business as usual baseline.

Increase and decrease in cassava price

For these two scenarios, respondents were asked to imagine that the price of cassava halved or doubled over the next five years, with some small yearly variation. Cassava has quickly become the dominant commercial crop grown in most areas of the study site and many farmers report that the price at which they are able to sell this crop is of particular importance in determining future land use (H. Travers, pers. obs.). However, the cassava market in the project area is imperfect and prices can be volatile. These two scenarios were included to explore the effect that a consistent increase or decrease in average cassava prices would have on future smallholder land use and to compare the effect of such changes against those resulting from conservation interventions.

Hypothesis H6.4: doubling the price of cassava will increase the number of households who predict that they will expand their agricultural land relative to the business as usual baseline.

Hypothesis H6.5: halving the price of cassava will decrease the number of households who predict that they will expand their agricultural land relative to the business as usual baseline.

Statistical analysis

A series of generalised linear mixed effects models were constructed to analyse the probability of pro-conservation behaviour under the different scenarios considered. Two response variables were considered. The first of these was a dichotomous variable describing whether or not a household would follow pro-conservation behaviour under the conditions presented by each scenario. In this context, pro-

conservation behaviour was defined as reducing clearance relative to the baseline business as usual scenario, but including those who did not clear forest in either the treatment or baseline scenario. The second response variable, a subset of the first, was a dichotomous variable describing whether or not a household stated it would reduce its clearance relative to the baseline scenario (i.e. excluding those who did not clear in the baseline scenario). For both response variables, models were considered for conditional (those dependent on reciprocation) and unconditional (those independent of reciprocation) responses. Model selection was carried out using backwards stepwise selection on the basis of corrected Akaike information criterion (AICc; Akaike, 1979) values. Following Burnham and Andersen (2002), the most parsimonious candidate models with a ΔAICc value of less than two were selected, otherwise the model with the lowest AICc was selected. In each model, an individual random effect was included to account for multiple responses by each individual. Inclusion of a village random effect was tested using likelihood ratio tests and rejected for all models (Bolker *et al.*, 2009). Explanatory variables included livelihood zone, poverty score and demographic variables, such as age, sex and ethnicity (see Appendix D for details).

6.4. *Results*

Under the baseline business as usual scenario, 82% of respondents declared that they would continue to increase their agricultural land over the next five years, while the remaining 18% stated that they had no intention of expanding their land. This shows the high level of smallholder farmer involvement in forest clearance in the study site. The stated reactions of each household to the scenarios presented were coded relative to those under the baseline scenario (Figure 6.1). This showed significant variation in the reported responses to each scenario, ranging from a large increase in the rate of forest clearance under increased cassava prices to a potentially large decrease under collective payments or a village development fund. Overall, however, a high proportion of respondents reported that their behaviour would be unaffected by the conditions presented to them in a given scenario. This proportion was particularly high for both the enforcement and individual payment scenarios, for which only 11% of respondents reported that they would change their proposed clearance behaviour relative to business as usual. The results of the logistic mixed effects models of pro-

conservation behaviour and reduced clearance under different scenarios confirm many of the observational results above (Table 6.1). The scenario presented was a significant determinant of stated behaviour in both models.

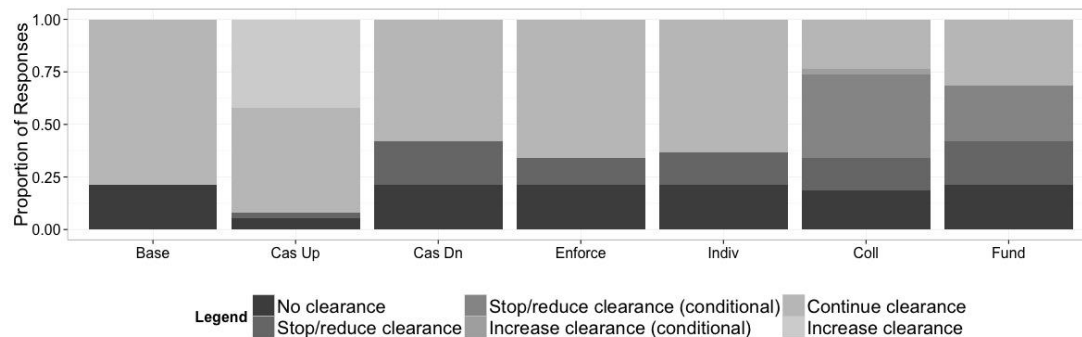


Figure 6.1 Proportion of coded responses for the business as usual baseline scenario and each of the six future scenarios. Conditional behaviour refers to behaviour that is contingent on reciprocation.

Options for benefit sharing

With respect to the different options considered for benefit sharing, the two collective payment scenarios performed significantly better than individually contracted payments, provided that others in the group reciprocated. The probability of behaving in a pro-conservation manner increased relative to the baseline scenario by 0.53 for the collective payments scenario and 0.35 for the village fund scenario, but only by 0.03 for the individual payment scenario (Table 6.1, column 1). When only unconditional responses were considered, all of the benefit sharing scenarios considered had only a negligible effect on response relative to the business as usual baseline, even though the clearance rate reduced significantly under the village fund scenario (Table 6.1, column 2). With respect to reductions in forest clearance, collective payments significantly out-performed individual payments. With payment into a village fund as the reference, the probability that a household would reduce clearance under individual payments was 0.58 lower than for collective payments (Table 6.1, column 3). The probability that individual payments would reduce household agricultural expansion was only 0.05. As such, there is mixed support for hypothesis H6.1a but strong support for hypothesis H6.2.

Table 6.1: Parameter estimates for the pro-conservation and clearance reduction models considering conditional and unconditional responses. The difference in the probability of acting in a pro-conservation manner or reducing clearance relative to the baseline scenario was found by calculating the expected probability for each variable and comparing this with the probability expected for the intercept. The full list of variables modelled, plus their explanations, are given in Appendix D; Table D.1. Significance values: ns = not significant; (*) = $P < 0.1$; * = $P < 0.05$; ** = $P < 0.01$; * = $P < 0.001$. Reference level treatment indicated by ref.**

Variable	Pro-Conservation Model		Clearance Reduction Model	
	conditional	unconditional	conditional	unconditional
intercept	0.007 (0.010) ***	0.001 (0.003) ***	0.435 (0.121) ns	0.041 (0.040) ***
scenario:				
baseline	ref	ref		
cassava up	-0.006 (0.002) *	-0.001 (0.000) *	-0.430 (0.011) ***	-0.040 (0.004) **
cassava down	0.067 (0.072) **	0.021 (0.029) ***	-0.327 (0.071) ***	0.011 (0.050) ns
enforcement	0.026 (0.035) *	0.006 (0.010) *	-0.389 (0.040) ***	-0.023 (0.020) ns
individual	0.026 (0.035) *	0.006 (0.010) *	-0.389 (0.040) ***	-0.023 (0.020) ns
collective	0.532 (0.186) ***	0.004 (0.007) *	+0.191 (0.114) ns	-0.023 (0.020) ns
fund	0.353 (0.192) ***	0.016 (0.023) ***	ref	ref
zone:				
cash	0.535 (0.180) ***	0.584 (0.252) ***		
upland	0.019 (0.025) (*)	0.008 (0.022) (*)		
paddy	ref	ref		
random effect:				
individual (SD)	1.387	2.213	2.054	2.906
AICc	253.8	210.8	234.1	182.0
N	315	315	270	270

As with pro-conservation behaviour, the probability that households would reduce clearance relative to the baseline scenario was significantly higher for both collective reward scenarios if conditional behaviour was considered than when only unconditional behaviour was considered (Table 6.1, columns 3 and 4). As such, these results show that the offer of collective payments to individual households or to a village development fund had the potential to be the most effective benefit sharing option with respect to reducing forest clearance but, crucially, a high proportion of respondents stated that their decision to stop or reduce clearance was conditional on the cooperation of others. Within this group the extent of their cooperation was roughly evenly split into two categories: those households who would only *stop* clearing provided that most or all others in their group reciprocated and those who would only *continue* to clear if most or all others in their group did likewise. Consequently, whilst both scenarios offer a potentially significant reduction in clearance, there is a risk that compliance with the conditions of the payments would be undermined: first by the minority of respondents who rejected the payment outright and subsequently by those respondents who would only cooperate if everyone else in the group did so.

Responses to the individual payments treatment were similarly nuanced. While the majority of respondents rejected the offer of \$200 in return for not clearing, the reasons for doing so varied. For many, the equation was simple: the \$200 payment offered was insufficient to compensate them for the opportunity costs they would experience by halting agricultural expansion. Another commonly voiced reason was that if respondents did not clear any more land, the land currently in use would gradually lose fertility and at present they had insufficient land to rotate cultivation. In these cases, some respondents reported that they would be happy to agree to the conditions of the payment once they had secured sufficient land. In other cases, however, respondents rejected the conditions of the payment even though the projected earnings of the land they proposed to clear (based on current earnings from the land they held already) were lower than the payment offered. For these households, the reasons for clearing related less to the potential income that they could generate from the land but rather to securing land for their family for the future. Concerns were frequently raised that unless they cleared the five hectares allowed under community rules as part of the communal land titling process, the land was more vulnerable to

seizure from outside interests, a significant issue across the country. A similar concern related to whether there would be sufficient land available for their children when they married (i.e. whether the allowance made under communal titling for future expansion of the village was sufficient) and that it was better to clear the land now to secure their children's future. In these cases, the opportunity cost of not clearing related less to the potential annual income that could be generated from the land than to perceived failures in the long-term management of the land titling process.

Enforcement vs. benefit sharing

One of the decisions facing PA authorities in Seima is how best to invest REDD+ revenues to reduce forest clearance. To this end, investment in the most effective benefit sharing option, collective payments, was compared with additional enforcement effort. The results of the pro-conservation model show that doubling the detection rate for people who clear forest illegally resulted in a negligible effect on response (0.03 increase in the probability of acting in a pro-conservation manner relative to the baseline; Table 6.1, column 1). The probability that a household would reduce agricultural expansion as result of increased enforcement effort was estimated to be 0.04. This provides only very weak support for hypothesis H6.3 that doubling the rate of detection would reduce the number of households expanding their agricultural lands relative to the business as usual baseline. In this regard, the enforcement scenario performed poorly in comparison to collective payments (probability of reducing clearance 0.39 lower than for collective payments; Table 6.1, column 3). As such, assuming that cooperation is reciprocated amongst groups under the collective payment scenario, increasing enforcement effort was found to be a poor alternative to benefit sharing, which provides strong support for hypothesis H6.1b.

One of the reasons behind the lack of effectiveness of the enforcement scenario lies in the recent land tenure reforms that have been implemented throughout the study area. In all but one of the villages sampled, indigenous communal land title has been granted or is in the process of being applied for. Consequently, land has been identified for future expansion of agricultural activities in each village. As such, any infraction within this land is not subject to law enforcement by protected area staff, but governed by community land use rules drawn up by the overseeing village committee. Interview respondents were, therefore, able to claim that they would be

unaffected by increased law enforcement effort as none of their proposed expansion would encroach conservation areas.

Conservation interventions vs. exogenous price changes

Another issue facing managers at the study site is the rapid commercialisation of agriculture. While this has resulted in significantly increased household incomes in the areas that have benefited from it (Chapter 3), the rate of change threatens to swamp interventions aimed at controlling the expansion of agricultural land. Respondents were presented with only one change from business as usual in each scenario in order to keep the exercise simple for the respondents (i.e. no scenario contained both price changes and a new conservation intervention). Despite this, it is informative to compare responses under the exogenous price changes scenarios and the most effective conservation intervention, collective payments.

Whilst the two scenarios that presented exogenous changes related to the sale price of cassava resulted in negligible differences to the probability of acting in a pro-conservation manner relative to the business as usual baseline (-0.01 for the cassava up scenario and 0.07 for the cassava down scenario; Table 6.1, column 1), the picture this paints is slightly misleading. For the scenario in which the sale price doubled, over 40% of respondents reported that they would increase their intended clearance relative to the business as usual baseline, which is comparable to the 58% of respondents that said they would reduce clearance under the collective payments scenario assuming others reciprocated. A chi-squared test of responses to the cassava up scenario shows that a significant proportion of the population would increase clearance relative to business as usual if the price of cassava doubled (chi-squared test, $df = 1$, $p = 1.5e-6$), providing strong support for hypothesis H6.4. Not only does this illustrate the significant impact that this one crop has on the landscape, but it also highlights the risk of the positive effects of investment in benefit sharing being undermined by exogenous changes in the study villages. There are also implications for any potential livelihood intervention aimed at improving the profitability of the cassava crop as a way of reducing the need to deforest, as there is a distinct risk that this would perversely increase the incentive to clear land. It is also worth noting that the scenario in which the cassava price halved had the highest proportion of all scenarios of respondents unconditionally stopping or reducing their proposed

agricultural expansion, which supports hypothesis H6.5. As such, an exogenous price reduction resulted in greater reductions in clearance than both the enforcement and individual payment scenarios. Conditional responses to the collective payments still led to significantly higher reduction in clearance than that resulting in price reductions, however. The majority of respondents reported that their income would suffer under cassava price reductions, as alternative livelihood options available to them are less profitable.

Heterogeneity of Response

Understanding how the response to different scenarios varies with changing conditions and household characteristics may help to identify opportunities for targeting interventions in specific areas or at different groups. Separating scenario interview responses by livelihood zone revealed significant differences between the responses of households in each zone, with households in the cash crop zone reporting very different behaviour to the other two zones (Figure 6.2, row 1). The greatest difference resulted from over 50% of the respondents in this zone reporting that they would not clear or buy any further land under business as usual conditions, either because they felt that they already had sufficient land, there was no land available to be cleared or they did not want to clear land illegally.

As expected from the observational results, the logistic mixed effects regression found pro-conservation behaviour to be significantly affected by livelihood zone, with the probability that households from the cash crop zone would act in a pro-conservation manner predicted to be 0.54 higher than households in the remote paddy zone (Table 6.1, column 1). Unlike the conservation interventions considered, this effect was maintained when only unconditional behaviour was considered (0.58 increase in probability; Table 6.1, column 2). This result comes from households stating that they had no plans to expand their fields even under the baseline scenario and so would behave in a pro-conservation manner no matter which intervention was put into place. From the perspective of understanding which interventions would be the most effective at reducing clearance and where those interventions should be targeted to have the greatest impact, this is not particularly helpful. However, livelihood zone was not included as an explanatory variable in the selected model for the two models that considered whether households would actively reduce clearance relative to the

baseline scenario. This suggests that, even though pro-conservation behaviour is predicted to be higher in the cash crop zone, there is no zonal effect on the effectiveness of different interventions with respect to active reductions in forest clearance.

In contrast to separating responses by livelihood zone, very little difference was apparent between the response of households from different basic necessity survey terciles (Figure 6.2, row 2). Household poverty score and other demographic variables also did not feature in the selected models explaining clearance behaviour. This suggests that differences between the conditions in the three livelihood zones may be a more important factor influencing decision-making than individual household heterogeneity.

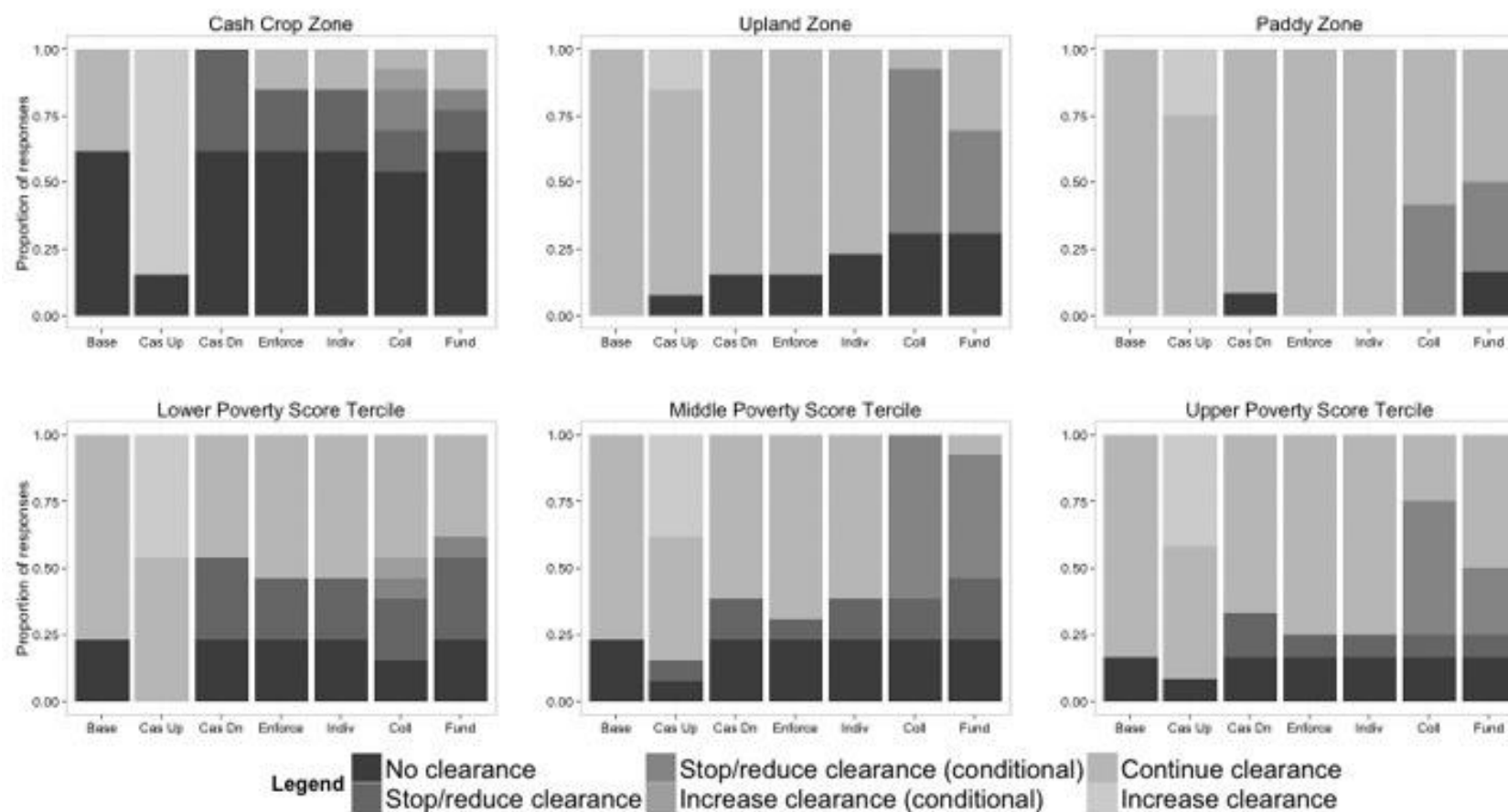


Figure 6.2: Proportion of coded responses for the business as usual baseline scenario and each of the six future scenarios stratified by livelihood zone (row 1) and household poverty score terciles (row 2). Conditional behaviour refers to responses that are contingent on reciprocation.

6.5. *Discussion*

Intervention effectiveness

The results of the scenario interviews show that investment of REDD+ revenues can dramatically reduce the number of smallholder households involved in agricultural expansion, and in turn reduce clearance of biodiversity rich forest. Both of the collective benefit sharing options (collective payments and payments into a village fund) resulted in significant reported reductions in agricultural expansion. The caveat to this result, however, is that these reductions were only observed if conditional behaviour was included in the analysis. This finding is similar to several previous studies of collective action which have found that within a population, whilst a minority will either chose to cooperate or not in most situations, the majority are classified as ‘conditional cooperators’, who will only cooperate provided that other people reciprocate (Fischbacher *et al.*, 2001; Rustagi *et al.*, 2010). This suggests that compliance with the terms of a conditional payment would be dependent on facilitating a strong sense of collective action within each village, possibly by maximising opportunities for dialogue within the community by undertaking a genuinely participatory approach to designing the benefit sharing system.

The results also demonstrate the risk of investing in activities that may prove ineffective at changing the incentives for households to reduce expansion. Neither doubling current levels of law enforcement, nor offering payments to individual households had any meaningful effect on pro-conservation behaviour and both performed poorly in comparison to the two collective benefit sharing scenarios at reducing overall clearance. With respect to enforcement, the results of the scenario interviews confirm previous studies, which suggest that the effectiveness of law enforcement in Cambodia is weak in situations where expected penalties are low (Claridge *et al.*, 2005). This is unsurprising in a country such as Cambodia, where the “rule of law” generally is weak and corruption levels high (Kheang, 2006). It is possible, however, that the effectiveness of increasing law enforcement effort may have been underestimated, as respondents were able to claim that they planned all future clearance inside community boundaries. As already shown by the results presented in Chapter 4, compliance with community boundaries is far from perfect even amongst households with less than 5 ha (i.e. those households with less than

their allocation for land within community titled areas). Hence, respondents may have been over-reporting their intention to clear in titled areas. With respect to individual incentive payments, these have been found to be more effective than collective payments in some other contexts (e.g. Narloch *et al.*, 2012). From this previous work it might easily be assumed that individual payments are a viable or superior alternative to collective payments for Seima, yet this has been shown not to be the case in this instance. This result highlights the value of using approaches, such as scenario interviews, to investigate possible responses to newly introduced policies prior to their implementation in different contexts.

Finally, the results of the two scenarios in which the price of cassava was changed offer some perspective on the risk of assuming the continuation of business as usual conditions when planning conservation interventions. Until 2005, cassava made up a negligible proportion of total cultivated area in the study site. Since that time, the area of land under cassava cultivation has increased exponentially and many households now only grow cassava (see Chapter 4). The unforeseen introduction of a new cash crop has, in just a short space of time, had a dramatic influence on both the landscape and people's livelihoods. This is a salutary lesson in how quickly the context in which conservation interventions are implemented can change. In this research, the choice of scenario was restricted by possible futures that interview respondents could conceive of sufficiently in order to be able to predict their behaviour, which precluded unfamiliar changes. However, from the observed effects of increasing the price of cassava it is evident that exogenous changes may bring about differences in future clearance rates that are comparable to those achieved by planned interventions. Similarly, planned changes to the profitability of cassava, for example through proposed agricultural intensification (Milne *et al.*, 2012), could result in perverse effects as has been found in other contexts (Angelsen & Kaimowitz, 1999; Damania *et al.*, 2005)

Intervention interaction with communal land titling

One of the challenges facing the developers of the REDD+ demonstration project in Seima is the design of benefit sharing with respect to existing activities, such as the conservation-led indigenous communal land titling process. In the majority of villages within the study area, community managed agricultural areas have either been

approved or applied for. These areas are designated for agricultural purposes and yet, in many villages, the main land cover within these areas is still forest. Clearance within these areas will, therefore, count against the REDD+ project and reduce revenues. In the benefit sharing options considered in this research, benefits were made conditional on households ceasing all clearance, irrespective of where that clearance might take place. This has the advantage of disincentivising all clearance but carries with it the risk that some households will feel it necessary to expand their land anyway because they have insufficient land to provide for themselves. An alternative option, in which payments are only contingent on not clearing outside of the indigenous communal land title, would allow households to clear up to 5 ha within titled areas, essentially writing off the forest within these areas, but would provide clear incentives for title boundaries to be respected³. This option would also improve integration with law enforcement activities, which focus only on clearance outside of the community areas.

This ties in strongly with the differences in responses for households from different livelihood zones. In the cash crop zone, tenure reform has progressed the furthest, with the majority of villages having now received communal title. Villages in this zone have also experienced the greatest level of encroachment on their land and, as such, there is now little legal land available in these villages. Much of the clearance and agricultural expansion in this area is now, therefore, illegal. These conditions are likely to reduce the available options for households that are unwilling to break the law and may not be able to afford the high land prices that result from the scarcity of available land. It is, however, doubtful that clearance rates in this zone would be lower in reality, as much of the clearance experienced is due to migrants moving to the study area. For the remaining two zones, the majority of villages have only recently had boundaries agreed as part of their application for communal tenure, particularly in the case of the paddy zone. Commonly expressed sentiments were the need to clear to protect community land from outside interests and the right of each household to cultivate up to five hectares of land. This is reflected both in the low

³ Subsequent to the completion of this chapter, a Verified Carbon Standard audit of the REDD+ project required that areas under communal management, including all ICT areas, be withdrawn from project boundaries, as suggested here.

number of responses that indicated an unconditional reduction in clearance in response to the different scenarios and by the 100% of respondents in these two zones reported their intention to expand their land holdings under the baseline scenario. Fears regarding their security of tenure are driving households to clear more land than they might otherwise. As such, it may be better to make benefits conditional only on clearance outside community areas, which would allow households to secure their titled land from possible land grabbing in the future. If payments are made conditional on halting all clearance, they may be perceived as being unfair, even if they are voluntary.

Despite some obvious differences in responses between the three livelihood zones, no significant difference was found with respect to the effectiveness of different interventions to reduce agricultural expansion. Similarly, no effect on response was found for different household characteristics, including household poverty score. This consistent response across different zones and households suggests that, in this instance, few opportunities exist for targeting interventions in specific places or at specific groups. Whilst this simplifies implementation, as the same level of benefits can be offered to every household across the landscape, these results suggest that there will be some households that, initially at least, will choose not to cooperate with the REDD+ project and will continue to clear no matter what conservation intervention is implemented. The key, however, will be to mobilise conditional cooperators to support the conservation intervention.

Chapter 7

Discussion

7.1. *Benefit sharing for REDD+*

“Power tends to corrupt, and absolute power corrupts absolutely”

Baron Acton (1834–1902)

One of the principal narrative strands relating to the implementation of REDD+ regards the opportunities for the delivery of co-benefits for both biodiversity and local livelihoods alongside the primary goal of reducing carbon emissions (Brown *et al.*, 2008; Stickler *et al.*, 2009), such that successful projects could result in win-win-wins. This is not an easy task and the history of conservation is littered with poorly conceived policy initiatives that have failed to balance the need for trade-offs between seemingly conflicting objectives (Blom *et al.*, 2010, McShane *et al.*, 2011). In this study, I have focussed on analysing the possible future effects of different interventions under consideration at one REDD+ site in order to understand which of these would have the greatest impact on resource use if implemented. This process has generated results that will directly feed into the design of conservation activities at that site, yet there are wider lessons to be learnt.

The most widely applicable lesson regards the structure of performance payments as part of a benefit sharing system, and the institutions that are created or adapted to manage them at the local level. The results of Chapters 5 and 6 both suggest that collective payments are preferable to individual payments either outright (Chapter 6) or because of associated added benefits, such as carry over effects or positive interactions with enforcement (Chapter 5). Responses to the scenario interviews in Chapter 6 also suggested that collective payments were most effective when disbursed as cash rather than contributions to a village-level development fund. These predictive results are supported by the findings of recent work undertaken in protected areas in the Northern Plains Landscape of Cambodia, which investigated the effectiveness of pilot incentive schemes similar in structure to those considered here (Clements *et al.*, 2010; Clements, 2012; Clements & Milner-Gulland, in press).

These are useful results that can help guide policy setting for REDD+ projects, yet there are also implications for how such payments are managed. One of the reasons payments were preferred to contributions was a widely held scepticism that a village fund, managed by the indigenous community committee in each village, would be free from corruption or invested in projects that would benefit everyone. This echoes the results of Chapter 4, which showed that members of the management committee in O Rona were amongst the worst offenders with respect to non-compliance with community land use regulations and were regarded poorly by other members of the indigenous community. This issue cuts deeper than simple elite capture of resources, a phenomenon commonly encountered by community style interventions (Mansuri & Rao, 2004; Platteau, 2004). In Seima, the Bunong have strong traditional institutions, which are tied to their animist belief system and interactions with the natural environment (UNDP, 2010). It is convenient for conservation interventions that require management at the local level, such as land use planning or village development funds, to link into these institutions, as it is commonly perceived to afford them added legitimacy (Agrawal & Gibson, 1999; Berkes, 2004). Yet, this approach fundamentally alters the role of traditional village authorities, which can dramatically change the way in which they are perceived (as seen in O Rona; Chapter 4). Consequently, there is a risk that the implementation of conservation interventions can act to undermine traditional authority and erode cultural well-being (Jones *et al.*, 2008); impacts that may go unnoticed, as they are particularly difficult to quantify or measure (Milner-Gulland *et al.*, 2014). Conversely, collective benefits have, in some instances, been found to strengthen local institutions (e.g. Clements *et al.*, 2010).

Another lesson regards the extent to which interventions should be targeted at specific groups. Part of the value of approaches such as economic games (Chapter 5) and scenario interviews (Chapter 6) lies not only in being able to assess the relative effectiveness of different policy options but also in identifying sections of a population that may be particularly responsive to interventions. However, beyond the headline results of which intervention might bring about the greatest behavioural change, the results of Chapters 5 and 6 showed that there was a great deal of consistency observed in responses between groups for each approach. While there is significant diversity across the study site with respect to livelihood opportunities, economic well-being, ethnicity and culture, the two approaches found little evidence

to suggest that response to the different benefit sharing options considered would vary across the population. This was found to be true even in situations where overall behaviour differed, such as the difference in pro-conservation behaviour observed between different livelihood zones in Chapter 6. This is encouraging because it suggests that, in this instance, an egalitarian approach to benefit sharing, in which the same benefits are offered to every household, is appropriate. This is important, as it runs counter to the commonly heard suggestion that approaches that improve equity outcomes, which can add legitimacy to conservation efforts (Skutsch *et al.*, 2011), sacrifice efficiency (Alix-Garcia *et al.*, 2008; Proctor *et al.*, 2009; Pascual *et al.*, 2010). However, the results of Chapter 3 show that, while overall household economic well-being increased from 2007 to 2012, certain groups remain disadvantaged. Consequently, there is an argument for focussing benefit sharing on vulnerable groups, or at the very least ensuring that such groups do not lose out.

Finally, since the increased interest in conserving forest resources generated by the emergence of REDD+, there have been fears of a revival of green-grabbing, and a recentralisation of forest management (Phelps *et al.*, 2010). These fears have been supported by the emergence of evidence that the rate of decentralisation of forest management has slowed significantly in recent years (RRI, 2014). Yet, in Seima, where indigenous communities are receiving title over their customary lands (as described in Chapter 4), titled areas are being removed from the REDD+ project because the project applicant (the Cambodian government) does not have full management rights to that land. This has created a bizarre situation in which project proponents have followed widely held recommendations to secure legal recognition of the customary rights of local people and obtained free, prior, informed consent from all villages identified as having land or extracting resources from within the project boundary, yet those areas have now been excluded from the project. As such, any incentives created to reduce clearance by local people must focus on illegal expansion beyond titled areas. It may be that this would be a more effective approach than providing incentives to reduce clearance inside titled areas (as discussed in Chapter 6), but it reopens the debate about the equity of benefit sharing because households living in participating villages, in effect, have no more right to exploit resources within project boundaries or receive benefits from the project than immigrant households moving to the area from other provinces.

7.2. Experimental games vs. scenario interviews

Two of the approaches used in this study, experimental games (Chapter 5) and scenario interviews (Chapter 6), evaluated the potential effectiveness of interventions under consideration at the study site. While the application of neither of these approaches to investigating the likely effects of conservation interventions is entirely novel, no other study has applied both approaches to the investigation of policy effectiveness in the same contextual setting. It is instructive, therefore, to look at how each of these two approaches performs in comparison with the other, and consider whether the combined results allow for greater confidence regarding the external validity of the individual approaches and conclusions.

Combined, the two approaches offer considerable complementarity. One advantage of the qualitative approach taken during the scenario interviews is the ability to follow lines of enquiry as they develop during the interviews. The experimental setting of the CPR game allows for fewer opportunities to query the thought behind individual decisions. Although each participant was interviewed at the end of every experimental session, they often found it difficult to remember how they felt during each round or explain their motivations behind each decision. The scenario interviews, therefore, offer greater scope for interrogating the reasons why responses to the different interventions vary. Scenario interviews also allow for greater complexity to be included in the policy context considered, as descriptive narratives are often easier to understand than the stylised conditions of experimental games. For this study, this meant that land clearance, which was considered too complex to be understandable in the context of the CPR game, could be investigated using scenario interviews. On the other hand, the results of the CPR game allow for direct comparisons in the magnitude of response to different policy options, rather than simply the number of households that would alter their behaviour. Combined, therefore, the two approaches provide a framework to investigate future policy effectiveness in both a quantitative and qualitative manner.

However, both of these two approaches have had criticisms levelled at them regarding the external validity of the results obtained through their application. While experimental games have been increasingly applied to understanding behaviour within a commons or other social dilemma, there have been surprisingly few studies that have

investigated external validity in an empirically rigorous manner (Levitt & List, 2007; Martin, 2013). Following the taxonomy of experiments devised by Harrison and List (2004), framed experiments are considered to have greater validity than artefactual experiments and field experiments greater validity than lab experiments. Framed field experiments, such as described in Chapter 5, are therefore expected to offer greater validity than experiments involving volunteers in a lab setting. Yet, the limited evidence that exists in regard to experimental external validity is mixed. For example, in one of the most controlled comparisons between real life and experimental behaviour made to date, Voors et al. (2012) found no meaningful correlation between behaviour in a context-free public goods game and response to a real life development intervention in the same subject pool of individuals in Sierra Leone. Yet, in a comparison between behaviour in a framed CPR game and three real life incentive payment schemes, Martin (2013) found that those individuals who were characterised as co-operators or conditional co-operators in the CPR game in Cambodia were less likely to clear land illegally (and, thus, break the terms of the PES agreements) than those individuals characterised as free-riders from their behaviour during the game. As such, doubts remain as to whether or not the results of experimental games should be used to guide policy decision-making.

For scenario interviews, the major concern relates to the hypothetical nature of the approach and the potential for disparity between stated and observed behaviour. Participants in an experimental game are placed in a real social dilemma, no matter how stylised, in which the decisions they make will affect the size of payoff they receive at the end of the experiment; an approach that is considered critical to the validity of the results (Croson, 2005). Yet, this control is lacking for scenario interviews. The potential for disparity between observed behaviour and that stated in an interview setting has been particularly investigated for contingent valuation (e.g. Neill *et al.*, 1994; Brown *et al.*, 1996; Loomis *et al.*, 1996; Foster *et al.*, 1997), a method used to estimate an individual's willingness to pay or accept different futures from their stated preferences, with stated willingness to pay found to be higher than observed willingness to pay in the majority of studies (Venkatachalam, 2004). Again, this potential for misleading results may cast doubt on the suitability of using responses to hypothetical scenarios to help guide policy making.

Given these questions regarding the validity of the two approaches, it is worthwhile comparing the results presented in Chapters 5 and 6. For the three common policy options considered, the results of the two approaches are closely matched for increased enforcement effort and collective payments and produce different results for individual payments. Of the matched results, increased enforcement effort was found to be ineffective for both approaches while collective payments were found to significantly reduce resource use, even though the size of the payment offered should have been insufficient to offset forgone income from extraction. It is particularly encouraging that the results of both approaches identify collective payments as being the most effective at changing behaviour from that predicted under business as usual conditions. Triangulated in this way, the fact that the two sets of results compare so strongly lends confidence to the validity of the conclusions drawn.

However, before this triangulation of results can be accepted, it is also important to consider the differences in the findings for individual incentive payments, which were found to be largely ineffective using scenario interviews but significantly reduced resource appropriation in the CPR game. Specifically, how might the differences in approach used explain the apparent disparity between strong agreement for collective payments and disagreement for individual payments? For collective payments, the principal mechanism by which cooperation is elicited is through peer-pressure and fear of disapproval or hope of approval. In the CPR game, this effect was directly realised through disclosure of individual decisions to the rest of the group. During the scenario interviews, while respondents were not directly subject to peer-pressure, they were made aware of the implications of their decisions during questioning. For individual payments, while there was no direct peer-pressure to act in any particular way, participants in the CPR game were able to discuss their options with the rest of their group and still faced public disclosure of their decisions. But respondents of the scenario interviews made their decisions individually with neither assistance nor disclosure. In this respect, the game participants were able to draw upon greater collective decision-making than respondents to the scenario interviews. As group based decision-making has been shown previously to lead to more advantageous results for individuals (Kocher & Sutter, 2004), this could explain why the results of the two approaches match for collective payments but differ for individual payments. However, further evidence would be required to support this explanation.

Overall, then, the results of the two approaches offer significant complementarity but, while there is some commonality in findings, there was insufficient agreement to be able to triangulate results as a proof of the external validity of these methods.

7.3. *Complexity in conservation policy research*

“In the land of the blind, the one-eyed man is King”

Desiderius Erasmus (1466 – 1536)

One of the major challenges facing conservation policy makers is predicting the likely impact of new interventions implemented within complex institutional settings (Hirsch *et al.*, 2010; Game *et al.*, in press). The institutional context in which resource use decisions are taken has a significant impact on outcomes, yet it is rare for the effect of interactions between interventions, which add greatly to contextual complexity, to be investigated. In this study, I have shown that this is an omission that should be corrected in the future.

As discussed above, the interaction between the creation of land use boundaries under indigenous communal titling and the effects of performance payments made conditional on clearance reductions (presented in Chapter 6) have implications that go beyond the effect on resource use. Similarly, the results of Chapter 4 underlined the important interaction between the indigenous land titling process and law enforcement efforts. In both of the villages studied in Chapter 4, there was significant illegal household land clearance outside of titled areas, although the extent and proportion of households involved were both significantly greater in O Rona. In O Rona, the land titling process was also being undermined by the high level of immigration and illegal land grabbing within community titled areas. These results highlight a failure by protected area authorities, and the wider Cambodian legal system, on the one hand to protect the legal rights of Seima’s indigenous communities and on the other to prosecute those individuals guilty of illegally clearing protected forest. The effectiveness of indigenous land titling, and participatory land use planning approaches more generally, in reducing uncontrolled land clearance stems from two principal tenets: security of tenure and defined boundaries clearly delineating areas where clearance is permitted and where it is not. The results of Chapter 3 show that, although many households attribute natural resource security to the conservation

programme, over 50% of households do not feel secure about their resources. If security of tenure cannot be assured because communities are not provided with assistance in protecting their land and encroachment of protected forest is allowed to go unchecked, it becomes significantly more difficult to predict whether participatory land use policies will be successful.

The results of the experimental games presented in Chapter 5 provide further support for the need to consider interactions between interventions carefully, by illustrating the potentially nuanced effects such interactions can have on resource user behaviour. While it has previously been shown that weak enforcement of resource restrictions can undermine existing norms, such that extraction increases relative to that experienced in the absence of enforcement (Cardenas *et al.*, 2000; Vollan, 2008), this undermining effect has not previously been observed to reduce the performance of positive incentives such as payments. The fact that this crowding out effect was only observed when payments were offered to individuals, but not groups, further demonstrates the potential pitfalls of considering interventions in isolation.

Given the potential for interactions between conservation interventions to add contextual complexity or have unexpected effects on behaviour, coupled with the general confounding effect that institutional complexity can have on policy setting, there is cause to consider the trade-off in research between the desire for increased contextual relevance and the risk of parochialism. In part this represents a trade-off between the desire of researchers to be able to draw wide-reaching lessons from their work and the requirements of practitioners, who want results to be directly applicable to the context in which they are working. Several of the results presented in this study are potentially limited to the institutional context found in Seima Protection Forest, or even specific villages. For instance, the results of Chapter 4 show that the difference in the conditions found in the two villages had a significant impact on household compliance, and hence the success of indigenous land titling in reducing illegal clearance. Whilst it is still possible to tease out lessons that apply more widely, there is a risk that in so doing those lessons may not apply to other contexts. For example, one of the main results of this study is to show that collective payments are more effective at reducing resource use than individual payments, but in another context Narloch *et al.* (2012) found that individual payments were more effective. Given the

difficulties in applying lessons learned from behavioural research to other contextual settings and the potential benefits of in-depth studies, which are better able to take account of the multi-faceted nature of local context (Drury *et al.*, 2011), I would argue that the charge of parochialism seems a small price to pay for gaining a more precise understanding of behaviour, albeit within a more restricted context.

7.4. *Opportunities for future research*

The results presented in this thesis have for the most part focussed on conservation-driven institutional change to reduce resource extraction, particularly that of smallholder land clearance. And yet, the mechanisms by which the interventions considered affect the decision-making processes that lead smallholders to clear remain poorly understood. In Seima, the decision regarding whether or not to clear additional land is influenced by a wide variety of factors, including but not limited to labour availability (both within and outside the household), tenure concerns and the perceived profitability of agricultural land use and alternative livelihood options, as well as the institutional settings in which the decision is taken. It is doubtful, however, that these decisions are made completely rationally, but that individuals instead rely on simple heuristics to help guide them (Simon, 1972). Increased understanding of how land use decisions are taken at the household level, and the factors that are considered, would give greater confidence in the results presented here regarding the relative effectiveness of different policy options, and would also allow for further refinement of the options considered.

One of the leading approaches with respect to understanding underlying decision-making processes is agent-based modelling, a computational modelling technique which allows researchers to study a heterogeneous set of evolving, autonomous decision-making entities (agents) that interact with their environment and other decision-makers (Janssen, 2005). In allowing agents to interact in this way, agent-based models provide a potentially powerful tool for examining behaviour and, consequently, have been used in a wide array of disciplines in the social and environmental sciences (Matthews *et al.*, 2007). In particular, the development of multi-agent systems, which combine agent-based and cellular models, has heralded new opportunities to investigate the underlying processes of land use change within complex socio-ecological systems (Wooldridge, 2002).

One of the key choices facing researchers using agent-based models is how to define the interaction between agents and with the environment (Janssen, 2005). A commonly applied approach is to follow the theory of bounded rationality (Simon, 1972), which sets out the idea that people often rely on simple heuristics rather than optimisations as the basis of decision-making. Similarly, agents often make decisions on the basis of imperfect information and preferences can change as new information becomes available through interactions with other agents and the environment (Heckbert *et al.*, 2010). Defining rules for agent interactions and strategies can, therefore, be particularly challenging in complex socio-ecological systems, in which individual decision-making can produce significant externalities for other stakeholders. It is for this reason that multi-agent systems are increasingly combined with empirical methods to define agent behaviour within the particular system of interest. Robinson *et al.* (2007) list five methods of empirical methods that have been used in conjunction with agent-based models; sample surveys (Berger & Schreinemachers, 2006), participant observation (Huigen, 2004), field and laboratory experiments (Castillo & Saysel, 2005; Evans *et al.*, 2006), companion modelling (Castella *et al.*, 2005; Barnaud *et al.*, 2008) and GIS and remotely sensed data analysis (Deadman *et al.*, 2004). These methods differ significantly in their approach, scale and ability to supply data on social and biophysical processes but can all be used to provide information relating to macro-level phenomena and micro-level processes. At the macro-level, this information is most widely used for comparison with model results as a means of validation, whereas micro-level information is collected with the intention of informing model coding.

The empirical approaches used in this study - household surveys (Chapter 3), GIS analysis of land use change (Chapter 4), experimental games (Chapter 5) and scenario interviews (Chapter 6), have the potential to inform the development of an agent-based model of smallholder land clearance. Despite the examples listed above of experimental games being combined with agent-based models, efforts in this direction have so far been limited and have not made use of the advances made in recent years in taking games out of the lab into the field. In so doing, future research could advance the field of land use multi-agent systems by modelling real world agents and their environment and directly parameterising agent characteristics using the behavioural preferences elicited through the use of experimental games and scenarios.

The creation of such a model would enable the investigation of the decision-making processes underlying smallholder land clearance, with the associated potential for the refinement of conservation interventions that this offers.

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Appendix A

Supplementary material for Chapter 3

Table A.1: Items included in the household poverty score, with the weighting used for each item, percentage of households that reported owning or having access to each item and whether each item was included in calculating the reduced poverty score used for comparison between 2006/7 and 2012.

Basic necessity survey item	Weights	Own/have access to	Reduced score
three meals per day	100.0%	79.4%	no
VCD player	63.7%	30.1%	no
mosquito net for all household members	99.5%	84.7%	no
able to attend all weddings invited to	95.8%	64.6%	no
car battery (more than 40 A)	86.8%	29.7%	yes
two draft animals	89.1%	25.7%	yes
120L water jar	98.2%	54.2%	yes
access to electricity (public supply or generator)	95.2%	12.4%	no
thick blanket for all household members	91.6%	21.1%	no
long knife	98.6%	92.1%	no
motorised tiller (<i>koyun</i>)	78.1%	12.2%	no
axe	98.7%	90.5%	no
hand pump well at home	95.7%	12.9%	no
home toilet	93.7%	9.2%	yes
wooden wardrobe	78.1%	10.3%	no
access to car taxi service	85.4%	19.3%	no
motorbike	98.9%	81.7%	yes
zinc/fibro/tile roof	99.8%	84.7%	yes
wooden walls	99.7%	69.0%	yes
television	81.0%	30.1%	yes
mobile phone	90.2%	72.0%	yes
homestead land at least 0.5ha	96.3%	26.0%	yes
at least 3 ha chamkar	99.7%	38.9%	yes
water supply to home	98.9%	0.3%	no
able to send children to school to grade 9	96.3%	11.7%	no
ability to attend all traditional ceremonies	98.6%	72.2%	no
two sets of clothes for every household member	95.3%	28.0%	no
synthetic tent for sleeping in the forest	93.6%	41.2%	no
hammock with mosquito net	96.6%	35.5%	no
ox cart	75.1%	20.4%	no
strimmer	84.6%	29.7%	no
kettle	93.4%	86.5%	no

Table A.2: Variables used in statistical modelling in Chapter 3.

Variable	Data type	Variable type	Description
poverty_score	continuous	response/explanatory	poverty score of respondent household
adj_score	continuous	response/explanatory	reduced poverty score of respondent household
resin	binary	response/explanatory	whether or not the respondent household owned any resin trees
trees	categorical	response/explanatory	quantity of resin trees owned (0-50, 51-150,>150)
log_area	continuous	response/explanatory	ln(total area of land claimed by respondent household)
ntfp_collect	binary	response/explanatory	whether or not the respondent household collected non-liquid resin NTFPs
wild_meals	count	response	number of meals eaten in previous week containing wild meat
widow	binary	explanatory	whether or not the respondent household was widow headed
dependent	binary	explanatory	whether or not the respondent household consisted totally of dependents (<15s or >65s)
landless	binary	explanatory	whether or not the respondent household owned any productive land
age	continuous	explanatory	age of household head
yrs_village	continuous	explanatory	number of years respondent had lived in village
gender	categorical	explanatory	gender of respondent
indigenous	binary	explanatory	whether or not the the head of the respondent household was an IP
AME	continuous	explanatory	household adult male equivalence calculated using Barba and Cabrera (2008)
hh_size	continuous	explanatory	total number of members in respondent household
education	continuous	explanatory	number of years spent in education by the household head
km	continuous	explanatory	distance to nearest all day market [km]
position	binary	explanatory	whether or not the respondent household held a formal position of authority
labour	binary	explanatory	whether or not the respondent household was involved in wage labour
shop	binary	explanatory	whether or not the respondent household operated a shop
employed	binary	explanatory	whether or not a member of respondent's household was employed
service	binary	explanatory	whether or not the respondent's household operated a village service
debt	binary	explanatory	whether or not the respondent household was in debt
hh_labour	binary	explanatory	whether or not the respondent household felt they had sufficient labour within the household
labour_avail	binary	explanatory	whether or not the respondent household felt their was sufficient labour available
security	binary	explanatory	whether or not the respondent household felt their natural resources were secure
core	binary	explanatory	whether or not the village was located in the core zone
year	categorical	explanatory	year of survey
village	categorical	random	village in which respondent household lived

Appendix B

Supplementary material for Chapter 4

Calculation of adjusted household poverty score

The basic necessity survey provides a locally defined poverty index, which can be used to score households sampled in the area of the survey (Davies, 1997). In Chapter 4, the results of the large scale socio-economic survey described in Chapter 3, which was undertaken in Seima Protection Forest (SPF) at the time of the measurement of land use in the two villages and contained a basic necessity component, were used.

The basic necessity component of this survey consisted of a series of 40 household items, assets and services. Respondent households were asked whether or not they owned the items on the list or, in the case of services, whether they had access to those services. For example one of the questions on the list asked whether the respondent household had access to a car-taxi service to and from the district capital or nearest market town. Respondents were also asked whether or not they believed that each item on the list was a basic necessity, which was defined to them (following the adapted definition used by Clements *et al.* (in press)) as the “*minimum requirement for living that all households of the community should have and no-one should not have.*”

The list was created at a one-day workshop, held at the SPF headquarters of the Forestry Administration in April 2012, and to which representatives of different livelihood zones within SPF and different wealth bands were invited. These representatives were selected by FA or WCS staff, who were able to identify suitable candidates for participation. Over the course of the one-day workshop, participants were introduced to the concept of basic necessities and compiled the list of items. The list was proportionally populated with (i) items that everyone thought were basic necessities and that everyone would have (or would have access to) (ii) items that everyone thought were basic necessities, and around half of all people would have, but would get as they became richer and services improved (iii) items that everyone thought were basic necessities, but only some people would have, but might get as they became richer and services improved (iv) items <50% of people thought were

basic necessities. The list was populated in this way to ensure that there was a good level of differentiation between households, that respondents were made to think whether or not each item really met the definition of a basic necessity and that the same list of items could be used again in the future after incomes were anticipated to rise.

Once the survey instrument had been compiled, it was piloted in three villages to ensure that the items fell roughly in proportion to the different categories identified. No items were changed following the pilot and the survey was conducted in a further 17 villages across the SPF locality, covering a total of 622 households. A household poverty score was calculated for each household using only those items that over 50% of sampled households thought were basic necessities (in this case 31 items). Scores were weighted by the proportion of the sample that thought each item met the definition of a basic necessity and these scores were summed over the full list of 31 items for each household to produce a household poverty score. For example, if 95% of the sample thought that a sharp knife was a basic necessity, the score for owning a sharp knife would be 0.95.

In this analysis, asset data was collected for a smaller list of assets and then used these assets to calculate an adjusted poverty score based on the coefficient estimates of a LMM, with household poverty score as the response variable. This model was run for the sample of 622 households that participated in the full basic necessity survey (Table B.1). For the purposes of this analysis, the original household poverty scores were recalculated after removing those items that corresponded to the items that data were collected on. Model selection was undertaken using the method described in the main text. From this, it was possible to calculate adjusted poverty scores for each household sampled in the land use survey, based on the asset data collected.

Table B.1: Parameter estimates for the selected adjusted household poverty score GLMM, with a the recalculated poverty score as the response. One random effect was included in the selected model: village (SD= 0.532). Standard errors are shown in parentheses.

Variable	Estimate	t values
intercept	4.460 (2.192)	2.035
roof_type2	-1.791 (0.536)	-3.341
roof_type 3	-1.296 (0.437)	-2.968
roof_type 4	-0.334 (0.613)	-0.545
walls_type 1	3.121 (2.183)	1.430
walls_type 2	4.040 (2.513)	1.608
walls_type 3	3.092 (2.282)	1.355
walls_type 4	4.543 (2.644)	1.719
walls_type 5	3.476 (2.162)	1.608
owns_2cattle	0.162 (0.024)	6.665
owns_moto	0.724 (0.244)	2.969
owns_mobile	0.978 (0.226)	4.323
owns_dvdplayer	1.338 (0.209)	6.400
owns_strimmer	0.643 (0.219)	2.928
owns_wardrobe	0.805 (0.370)	2.176

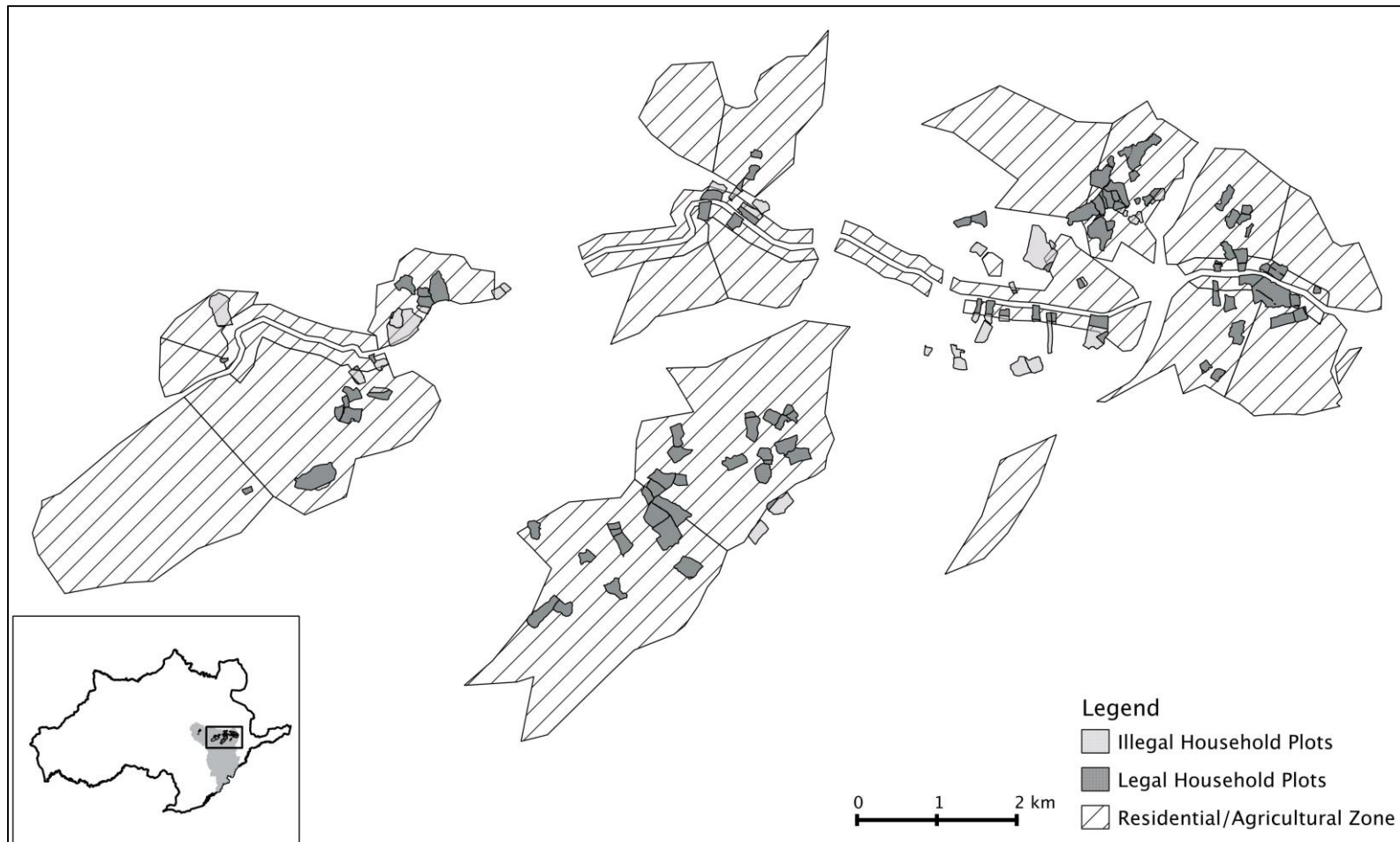


Figure B.1: Map of household land use in Andong Kraloeng for the 43 households sampled. The area surrounding the residential and agricultural zones is community NTFP forest in which all clearance is illegal.

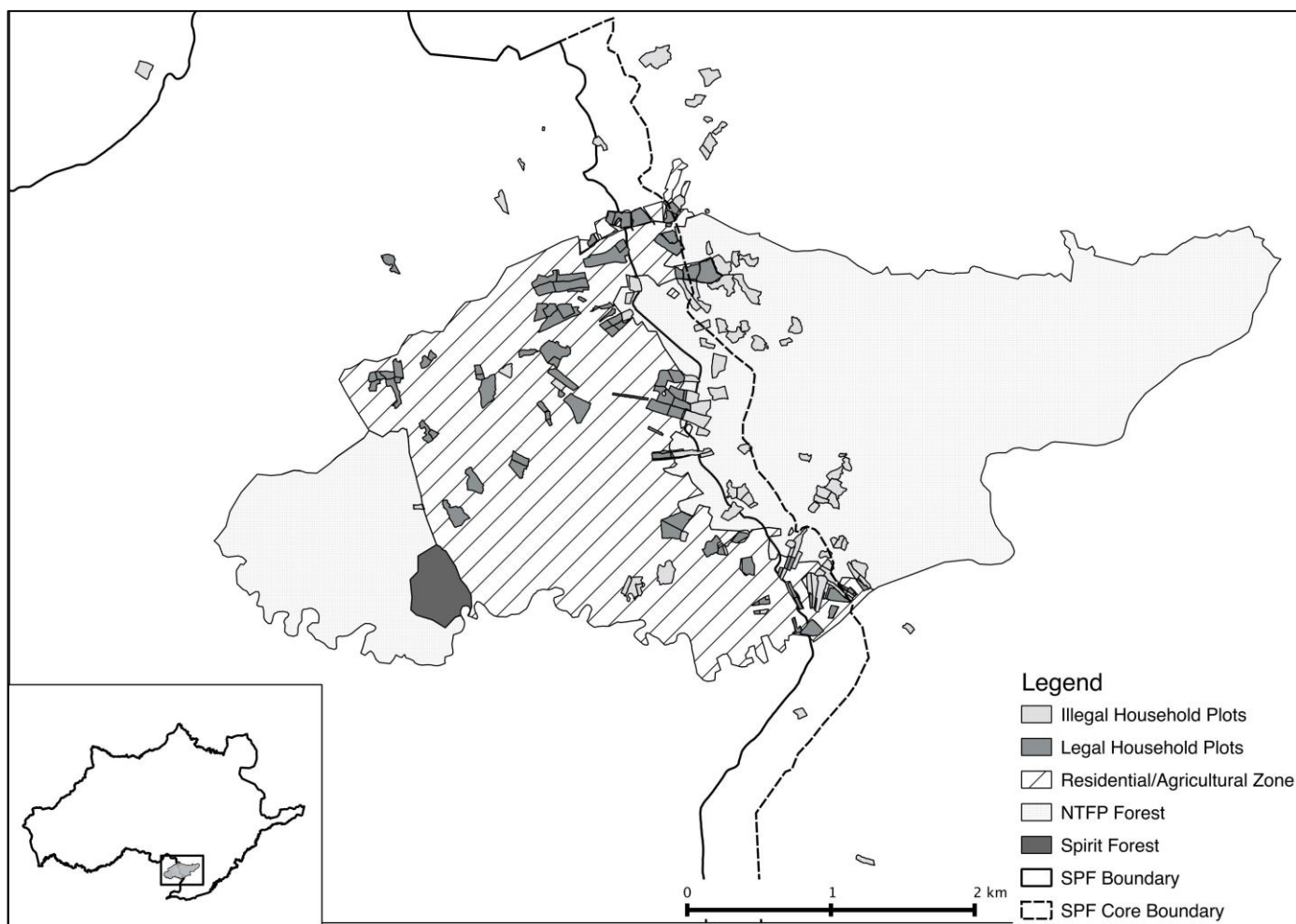


Figure B.2: Map of household land use in O Rona for the 70 households sampled. The area outside of the village boundary is all under protection (either as part of SPF or SWS) and, hence, clearance is restricted.

Table B.2: Variables used in statistical modelling.

Variable	Data type	Variable type	Description
log_area	continuous	response	ln(total area of land claimed by respondent household)
log_ill_area	continuous	response	ln(total area of illegal land claimed by respondent household)
law_compliance	binary	response	whether or not the respondent household was compliant with the 2001 Land Law
reg_compliance	binary	response	whether or not the respondent household was compliant with the five community regulations considered
age	continuous	explanatory	age of respondent
yrs_village	continuous	explanatory	number of years respondent had lived in village
gender	categorical	explanatory	gender of respondent
indigenous	binary	explanatory	whether the head of the respondent household was an IP
AME	continuous	explanatory	household adult male equivalence with recommended daily allowances taken from Barba and Cabrera (2008)
hh_size	continuous	explanatory	total number of members in respondent household
immigrant	binary	explanatory	whether or not the respondent household lived in the village at the time of ICT
community	binary	explanatory	whether or not the respondent household is a member of the village IC
position	binary	explanatory	whether or not the respondent held a formal position of authority
labour	binary	explanatory	whether or not the respondent was involved in wage labour
shop	binary	explanatory	whether or not the respondent household operated a shop
employed	binary	explanatory	whether or not a member of respondent's household was employed
service	binary	explanatory	whether or not the respondent's household operated a village service
poverty_score	continuous	explanatory	adjusted household poverty score of respondent household
settlement	categorical	random	sub-village settlement in which respondent household lived

Table B.3: Parameter estimates for the selected legal compliance GLMM, with a binary compliance variable as the response. P values significant at the 95% confidence level are shown in bold. One random effect was included in the selected model: settlement. The full list of variables modelled, plus their explanations, are given in Appendix B; Table B.2.

Variable	Estimate	SE	P Values
intercept	-2.953	1.224	0.016
community	3.502	1.411	0.013
ln(area + 0.125)	-1.345	0.432	0.002

Table B.4: Parameter estimates for the selected community regulation compliance GLMM, with a binary compliance variable as the response. P values significant at the 95% confidence level are shown in bold. One random effect was included in the selected model: settlement. The full list of variables modelled, plus their explanations, are given in Appendix B; Table B.2.

Variable	Estimate	SE	P Values
intercept	1.375	0.677	0.042
community	2.479	0.762	0.001
ln(area + 0.125)	-1.685	0.432	<< 0.000
law_comp	-1.342	0.651	0.039

References

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Appendix C

Supplementary material for Chapter 5

Table C.1: Key village type selection criteria by village. Household data from Pollard & Evans (2009). O Am household data (*) from the national commune database (NCDD, 2008). Bunong % refers to the percentage of Bunong households within each village. Type gives the *a priori* characterisation of each village.

Village	No. HHs	Bunong %	Km to market	Type	Sample size
Chakchar	124	87%	60	1	n = 20
Gati	54	94%	22	1	n = 20
Kmoum	62	100%	55	1	n = 20
O Charar	27	93%	18	1	n = 20
Rokathmei	51	92%	40	1	n = 20
Sre Andoal	50	100%	48	1	n = 20
Andong Kralleng	107	95%	25	2	n = 20
Pu Char	66	92%	14	2	n = 20
Pu Haim	252	90%	19	2	n = 20
Sre Levi	28	100%	10	2	n = 20
Sre Preah	112	66%	12	2	n = 40
O Am	733*	0%	0	3	n = 80
O Rona	160	46%	8	3	n = 40

CPR game script

[Introductions]

Before I begin to explain what we are going to do today I would like to make a few general comments. I will then explain the basic principles of the games that we are going to play. After I have finished this explanation I will take you through four simple examples and then we will play some practice games to help you to understand the process.

We will be playing games for cash. Any money that you receive in the games is yours to keep and take home. This will be given to you at the end of the day. How much money you receive is dependent on how you play the games, and how other people who are playing with you play. The money for these games has been supplied to undertake scientific research. If at any time you find that this is something that you do not wish to participate in for any reason, you are of course free to leave whether we have started the game or not. If you choose to leave after you have played some of the games, you will be paid the money that you have earned.

It is important that when you are sitting in the group like this you do not discuss the game or how you think you should play the game. Please feel free to talk amongst yourselves but do not discuss the games themselves. This can spoil the game for everyone. If it happens we may not be able to play the game with you today.

[If this is the second or third day of the games within the village add the following:

“You are going to play a very different game than the games played before. If you have heard comments about other games from people who have played games on previous days, whatever they have mentioned might not apply today. If you follow their advice you may end up earning less money than you could do so please just listen to my explanation and play the game how you think best.”]

We will be playing three games today. We will then individually ask you some questions about your thoughts on the day. We should be finished by about 5pm. If you think you will not be able to stay that long please let us know now.

Each game follows the same basic principles which I will explain now. It is important that you listen as closely as possible as you will need to understand how the games work if you are to receive any money. We will run through a number of different examples for you to help you understand how the games are played. If you have any questions about how to play the games once they have been explained please put your hand up and we will try to answer them.

I am now going to explain the game.

Explanation

In all the games we are going to play you will be in groups of 10 other people from this village. In some games you will know who is in your group and in other games you won't. In each game there are 100 fish in a communal pond from which the people in your group can harvest. You will be asked to individually decide on the number of fish that you want to harvest. You can decide to harvest a maximum of 10 fish and a minimum of 0. For each fish that you harvest you will receive 100 KHR. However, harvesting from the pond reduces the availability of fish for the village. The number of fish left at the end of the season is an indication of the future value of the fish to your group. At the end of each season the number of unharvested fish will be counted. Everyone in your group will receive 12 KHR for every fish remaining. So, to summarise, if a fish is unharvested everyone in your group benefits but if a fish is harvested only the person who harvested it receives any benefit.

[Show poster to show value of fish to individual and fish in the village]

We will play each game for 5 seasons. The number of fish in the communal pond will be the same for every season that we play no matter how the group behaved in previous seasons.

You will be asked to signal your choice by circling the number of fish that you want to harvest on the sheet of paper that you have in front of you. Please have a look at this sheet of paper now. As you can see there is a row for each season. Each season has an option for you to select a harvest of 0 to 10 fish. So if you want to harvest four fish, circle four pictures. If you decide to harvest eight fish, circle eight pictures. If you decide not to harvest, circle the zero. *[Holds up example]* The top row on your sheet has been filled out for you as an example to show how to select your choice. In this case you can see that a harvest of four fish has been selected. Once you have made your choice for the season we will collect your paper so that we can calculate the total harvest for the group. We will then tell you the total harvest for that season and tell you your individual winnings for that season.

After we have played 5 seasons the game will end.

[Play two practice rounds as per the control]

You should all now have a completed practice round sheet. As you can see we have filled out the two boxes at the end of the row. The number in the first box is the total number of fish taken out of the pond by your group. So this is the number of fish circled by each member of your group all added up together. The second number is the money that you receive from the round. Now remember that this is a practice round so the money in that box won't go towards your earnings at the end of the day. We calculate this number by giving you 100 KHR for each of the fish you have circled. We then give you 12 KHR for each of fish left unharvested after every member of the group has selected their individual harvest.

I will now take you through four simple examples to show you the range of behaviour possible:

Example 1: All members take 0 fish – payoff = 1200 KHR

Example 2: All members take 10 fish – payoff = 1000 KHR

Example 3: 9 take 10 fish/1 takes 0 fish – payoff = 1120/120 KHR

Example 4: 1 takes 10 fish/9 take 0 fish – payoff = 2080/1080 KHR

Before we start to play the game for real I would just like to ask you some simple questions to make sure that you understand how the game works and how to use the payoff and answer sheets. Please circle the correct answer on this question sheet for each question. For all questions, assume that the other people in the group take the same number of fish no matter what you choose to do.

[Hand out question sheets. Go through each question, making sure that people look at their own sheet only. Once everyone has answered all the questions, collect the sheets and mark down a score on each. Then go through the answers]

1. Do you earn more if you harvest 3 or 8 fish?
2. Do you earn more if you harvest 7 or 2 fish?
3. Do you earn more if the group total is 55 or 85?
4. Do you earn more if the group total is 22 or 62?
5. If the group total is 67, do other people earn more if you harvest 8 or 4 fish?

We should now be ready to play the first game. If anyone still has any questions, please ask now. Remember if you feel that this is not something that you wish to take part in you are free to leave at any time and any money that you have earned up to the point you leave will be given to you.

Control

[Prepare the room for the control treatment. Arrange the desks in straight lines facing the front of the room. Place a results sheet and desk number at each seat, making sure to write the desk number on the results sheet. Invite the participants to sit down]

Ok, we are now ready to play the [game number] game. Let's quickly run over the details. You will be asked to decide how many fish you want to harvest each season from the communal pond. You can decide to harvest a maximum of 10 fish and a minimum of 0. For each fish that you decide to harvest you will receive 100 KHR. This is the same for every member of your group. Everyone in the group benefits from having fish remaining unharvested at the end of the season so that you will each receive 12 KHR for each fish left in the communal pond.

This game is played in private, which means that you will not know who is in your group. It is very important that you do not talk to each other during this game as this will spoil the game for everybody. We will ask you to decide how many fish you want to harvest for and to mark your decision on the sheet in front of you. We will then calculate the total harvest for the group and your individual payoffs. Nobody else will be told how much you have chosen to harvest or how much you have received. We will play the game for 5 seasons which will probably last for about an hour.

We are now ready to start the game. From now on all the decisions that you make **will** count towards the game. Please now decide how many fish you would like to harvest in the first season and mark your decision on your sheet.

[Check that people only look at their own sheet. Help anyone who is having trouble. Once everyone has marked their decision collect all the sheets and total the group clearance. Then calculate each individual's earnings and write both on each sheet. Return the sheets to the respective participants]

As you can see, we have filled out the two boxes from that round. Remember the top box shows you the amount cleared by the rest of your group and the lower box gives you your earnings from that round.

[Repeat until all 5 seasons have been played making sure to say which number season is currently being played when asking players to make their decision. Collect the results sheets at the end of the game]

Peer-pressure

[Prepare the rooms for the single group treatments. Arrange all desks in a circle facing each other. Place a results sheet on each desk and ask participants to sit in ascending numerical order. Make sure that the correct number is on each sheet]

Ok, we are now ready to play the [game number] game. Let's quickly run over the details. You will be asked to decide how many fish you want to harvest each season from the communal forest. You can decide to harvest a maximum of 10 fish and a minimum of 0. For each fish you decide to harvest you will receive 100 KHR. This is the same for every member of your group. Everyone in the group benefits from having fish remaining unharvested at the end of the season so that you will each receive 12 KHR for each fish left in the pond.

In this game you will know who is in your group and the number of days you choose to harvest will **not** be private. Before each round you will be given a few minutes in which you are free to discuss your decision and the decisions of the other players with the rest of your group. You can also make agreements about how many fish you think each individual should be allowed to harvest although these agreements **are not binding**. Once this period is over we will ask you to individually decide how many fish you want to harvest and to mark your decision on the sheet in front of you as before. We will then calculate the total harvest for your group and your individual payoffs. Once we have handed back your sheets we will ask each of you individually to tell the other members of the group how much you chose to harvest.

We will repeat this game for 5 seasons. After each season you have a few minutes to talk about the game with the other members of the group before beginning the next season. Once all 5 seasons have been played, the game will end.

Ok, now we are ready to start the game. Please discuss amongst yourselves how many fish you think each person should be allowed to harvest.

[Allow group discussion for as long as the participants choose to talk. Once the discussion has stopped, ask the group whether or not they have reached a group decision. Accept any uncontested answer and ask what decision has been reached. If there is a disagreement about whether a decision has been reached, allow the participants the opportunity to resolve the disagreement. If they resolve the

disagreement, ask what decision has been reached. If it is unresolved, note down the values discussed]

Now you have finished your discussion, please decide how many fish you would like to harvest in the first season and mark your decision on your sheet. Remember that the group decision is not binding and you can choose any harvest from 0 to 10 fish.

[Check that people only look at their own sheet. Help anyone who is having trouble. Once everyone has marked their decision collect all the sheets and total the group clearance. Then calculate each individual's earnings and write both on each sheet. Return the sheets to the respective participants]

As you can see, we have filled out the two boxes from that round. Remember the top box shows you the amount cleared by the rest of your group and the lower box gives you your earnings from that round.

[Help each individual to read out their earnings for that season. Repeat until all 5 seasons have been played making sure to say which number season is currently being played when asking players to make their decision. Select a different player each time to begin declaring their decision for the season. Collect the results sheets and feedback sheets at the end of the game.]

Weak enforcement

[Prepare the rooms for the single group treatments. Arrange all desks in a circle facing each other. Place a results sheet on each desk and ask participants to sit in ascending numerical order. Make sure that the correct number is on each sheet]

Ok, we are now ready to play the [game number] game. Let's quickly run over the details. You will be asked to decide how many fish you want to harvest each season from the communal pond. You can decide to harvest a maximum of 10 fish and a minimum of 0. For each fish that you decide to harvest you will receive 100 KHR. This is the same for every member of your group. Everyone in the group benefits from having fish remaining unharvested at the end of the season so that you will each receive 12 KHR for each fish left in the communal pond.

In this game you will know who is in your group and the number of days you choose to harvest will **not** be private. Before each round you will be given a few minutes in which you are free to discuss your decision and the decisions of the other players with the rest of your group. You can also make agreements about how much fish you think each individual should be allowed to harvest although these agreements **are not binding**. Once this period is over we will ask you to individually decide how many fish you want to harvest and to mark your decision on the sheet in front of you as before. We will then calculate the total harvest for your group and your individual payoffs. Once we have handed back your sheets we will ask each of you individually to tell the other members of the group how much you chose to harvest.

For this game, an external authority has made a rule that you are not allowed to extract more than two fish from the pond in any single season. If you choose to fish, there is a chance that your decision will be penalised. At the end of each season we will roll a ten-sided dice, which will determine who in the group is monitored. There

will be a 1 in 10 chance that the external authority will monitor you. If you are monitored and you have decided to do any fishing in the season you will be fined 125 KHR for each fish that you harvest over the permitted threshold of two fish. This means that if, for example, you are monitored and have chosen to harvest four fish, you will be fined 250 KHR (125 KHR for the two fish you harvested above the threshold of two).

We will repeat this game for 5 seasons. After each season you have a few minutes to talk about the game with the other members of the group before beginning the next season. Once all 5 seasons have been played, the game will end.

Ok, now we are ready to start the game. Please discuss amongst yourselves how many fish you think each person should be allowed to harvest.

[Allow group discussion for as long as the participants choose to talk. Once the discussion has stopped, ask the group whether or not they have reached a group decision. Accept any uncontested answer and ask what decision has been reached. If there is a disagreement about whether a decision has been reached, allow the participants the opportunity to resolve the disagreement. If they resolve the disagreement, ask what decision has been reached. If it is unresolved, note down the values discussed]

Now you have finished your discussion, please decide how many fish you would like to harvest in the first season and mark your decision on your sheet. Remember that the group decision is not binding and you can choose any harvest from 0 to 10 fish and that if you harvest more than the two fish you are allowed to, you may be fined.

[Check that people only look at their own sheet. Help anyone who is having trouble. Once everyone has marked their decision collect all the sheets and total the group clearance. Then calculate each individual's earnings and write both on each sheet. Return the sheets to the respective participants]

As you can see, we have filled out the two boxes from that round. Remember the top box shows you the amount cleared by the rest of your group and the lower box gives you your earnings from that round.

[Help each individual to read out their earnings for that season. Ask each participant to roll the die. If they roll a 1, they will be monitored and fined 125 KHR for each fish they harvest above two. Correct their payoff and announce the new amount to the rest of the group. Repeat until all 5 seasons have been played making sure to say which number season is currently being played when asking players to make their decision. Select a different player each time to begin declaring their decision for the season. Collect the results sheets at the end of the game]

Strong enforcement

[Prepare the rooms for the single group treatments. Arrange all desks in a circle facing each other. Place a results sheet on each desk and ask participants to sit in ascending numerical order. Make sure that the correct number is on each sheet]

Ok, we are now ready to play the [game number] game. Let's quickly run over the details. You will be asked to decide how many fish you want to harvest each season from the communal pond. You can decide to harvest a maximum of 10 fish and a minimum of 0. For each fish that you decide to harvest you will receive 100 KHR. This is the same for every member of your group. Everyone in the group benefits from having fish remaining unharvested at the end of the season so that you will each receive 12 KHR for each fish left in the communal pond.

In this game you will know who is in your group and the number of days you choose to harvest will **not** be private. Before each round you will be given a few minutes in which you are free to discuss your decision and the decisions of the other players with the rest of your group. You can also make agreements about how much fish you think each individual should be allowed to harvest although these agreements **are not binding**. Once this period is over we will ask you to individually decide how many fish you want to harvest and to mark your decision on the sheet in front of you as before. We will then calculate the total harvest for your group and your individual payoffs. Once we have handed back your sheets we will ask each of you individually to tell the other members of the group how much you chose to harvest.

For this game, an external authority has made a rule that you are not allowed to extract more than two fish from the pond in any single season. If you choose to fish, there is a chance that your decision will be penalised. At the end of each season we will roll a ten-sided dice, which will determine who in the group is monitored. There will be a 4 in 10 chance that the external authority will monitor you. If you are monitored and you have decided to do any fishing in the season you will be fined 125 KHR for each fish that you harvest over the permitted threshold of two fish. This means that if, for example, you are monitored and have chosen to harvest four fish, you will be fined 250 KHR (125 KHR for the two fish you harvested above the threshold of two).

We will repeat this game for 5 seasons. After each season you have a few minutes to talk about the game with the other members of the group before beginning the next season. Once all 5 seasons have been played, the game will end.

Ok, now we are ready to start the game. Please discuss amongst yourselves how many fish you think each person should be allowed to harvest.

[Allow group discussion for as long as the participants choose to talk. Once the discussion has stopped, ask the group whether or not they have reached a group decision. Accept any uncontested answer and ask what decision has been reached. If there is a disagreement about whether a decision has been reached, allow the participants the opportunity to resolve the disagreement. If they resolve the disagreement, ask what decision has been reached. If it is unresolved, note down the values discussed]

Now you have finished your discussion, please decide how many fish you would like to harvest in the first season and mark your decision on your sheet. Remember that the group decision is not binding and you can choose any harvest from 0 to 10 fish and that if you harvest more than the two fish you are allowed to, you may be fined.

[Check that people only look at their own sheet. Help anyone who is having trouble. Once everyone has marked their decision collect all the sheets and total the group clearance. Then calculate each individual's earnings and write both on each sheet. Return the sheets to the respective participants]

As you can see, we have filled out the two boxes from that round. Remember the top box shows you the amount cleared by the rest of your group and the lower box gives you your earnings from that round.

[Help each individual to read out their earnings for that season. Ask each participant to roll the die. If they roll a 1, 2, 3 or 4 they will be monitored and fined 125 KHR for each fish they harvest above two. Correct their payoff and announce the new amount to the rest of the group. Repeat until all 5 seasons have been played making sure to say which number season is currently being played when asking players to make their decision. Select a different player each time to begin declaring their decision for the season. Collect the results sheets at the end of the game]

Individual payments

[Prepare the rooms for the single group treatments. Arrange all desks in a circle facing each other. Place a results sheet on each desk and ask participants to sit in ascending numerical order. Make sure that the correct number is on each sheet]

Ok, we are now ready to play the [game number] game. Let's quickly run over the details. You will be asked to decide how many fish you want to harvest each season from the communal pond. You can decide to harvest a maximum of 10 fish and a minimum of 0. For each fish that you decide to harvest you will receive 100 KHR. This is the same for every member of your group. Everyone in the group benefits from having fish remaining unharvested at the end of the season so that you will each receive 12 KHR for each fish left in the communal pond.

In this game you will know who is in your group and the number of days you choose to harvest will **not** be private. Before each round you will be given a few minutes in which you are free to discuss your decision and the decisions of the other players with the rest of your group. You can also make agreements about how much fish you think each individual should be allowed to harvest although these agreements **are not binding**. Once this period is over we will ask you to individually decide how many fish you want to harvest and to mark your decision on the sheet in front of you as before. We will then calculate the total harvest for your group and your individual payoffs. Once we have handed back your sheets we will ask each of you individually to tell the other members of the group how much you chose to harvest.

In addition, for this game there is an opportunity to earn a bonus payment from an external organisation. These payments are designed to reduce the number of fish that the group harvests. If you choose to harvest two fish or fewer each season, you will be rewarded by a bonus payment of 250 KHR. This is irrespective of how other people in your group behave. If you harvest more than two fish, you will not be eligible for the bonus.

We will repeat this game for 5 seasons. After each season you have a few minutes to talk about the game with the other members of the group before beginning the next season. Once all 5 seasons have been played, the game will end.

Ok, now we are ready to start the game. Please discuss amongst yourselves how many fish you think each person should be allowed to harvest.

[Allow group discussion for as long as the participants choose to talk. Once the discussion has stopped, ask the group whether or not they have reached a group decision. Accept any uncontested answer and ask what decision has been reached. If there is a disagreement about whether a decision has been reached, allow the participants the opportunity to resolve the disagreement. If they resolve the disagreement, ask what decision has been reached. If it is unresolved, note down the values discussed]

Now you have finished your discussion, please decide how many fish you would like to harvest in the first season and mark your decision on your sheet. Remember that the group decision is not binding and you can choose any harvest from 0 to 10 fish. Remember also that in this game if you choose to harvest two fish or fewer you will be rewarded with a bonus payment of 250 KHR.

[Check that people only look at their own sheet. Help anyone who is having trouble. Once everyone has marked their decision collect all the sheets and total the group clearance. Then calculate each individual's earnings and write both on each sheet. Return the sheets to the respective participants]

As you can see, we have filled out the two boxes from that round. Remember the top box shows you the amount cleared by the rest of your group and the lower box gives you your earnings from that round.

[Help each individual to read out their earnings for that season. Repeat until all 5 seasons have been played making sure to say which number season is currently being played when asking players to make their decision. Select a different player each time to begin declaring their decision for the season. Collect the results sheets at the end of the game.]

Individual payments with weak enforcement

[Prepare the rooms for the single group treatments. Arrange all desks in a circle facing each other. Place a results sheet on each desk and ask participants to sit in ascending numerical order. Make sure that the correct number is on each sheet]

Ok, we are now ready to play the [game number] game. Let's quickly run over the details. You will be asked to decide how many fish you want to harvest each season from the communal pond. You can decide to harvest a maximum of 10 fish and a minimum of 0. For each fish that you decide to harvest you will receive 100 KHR. This is the same for every member of your group. Everyone in the group benefits from having fish remaining unharvested at the end of the season so that you will each receive 12 KHR for each fish left in the communal pond.

In this game you will know who is in your group and the number of days you choose to harvest will **not** be private. Before each round you will be given a few minutes in which you are free to discuss your decision and the decisions of the other players with the rest of your group. You can also make agreements about how much fish you think each individual should be allowed to harvest although these agreements **are not binding**. Once this period is over we will ask you to individually decide how many fish you want to harvest and to mark your decision on the sheet in front of you as before. We will then calculate the total harvest for your group and your individual payoffs. Once we have handed back your sheets we will ask each of you individually to tell the other members of the group how much you chose to harvest.

For this game, an external authority has made a rule that you are not allowed to extract more than two fish from the pond in any single season. If you choose to fish, there is a chance that your decision will be penalised. At the end of each season we will roll a ten-sided dice, which will determine who in the group is monitored. There will be a 1 in 10 chance that the external authority will monitor you. If you are monitored and you have decided to do any fishing in the season you will be fined 125 KHR for each fish that you harvest over the permitted threshold of two fish. This means that if, for example, you are monitored and have chosen to harvest four fish, you will be fined 250 KHR (125 KHR for the two fish you harvested above the threshold of two).

In addition, for this game there is an opportunity to earn a bonus payment from an external organisation. These payments are designed to reduce the number of fish that the group harvests. If you choose to harvest two fish or fewer each season, you will be rewarded by a bonus payment of 250 KHR. This is irrespective of how other people in your group behave. If you harvest more than two fish, you will not be eligible for the bonus.

We will repeat this game for 5 seasons. After each season you have a few minutes to talk about the game with the other members of the group before beginning the next season. Once all 5 seasons have been played, the game will end.

Ok, now we are ready to start the game. Please discuss amongst yourselves how many fish you think each person should be allowed to harvest.

[Allow group discussion for as long as the participants choose to talk. Once the discussion has stopped, ask the group whether or not they have reached a group decision. Accept any uncontested answer and ask what decision has been reached. If there is a disagreement about whether a decision has been reached, allow the participants the opportunity to resolve the disagreement. If they resolve the disagreement, ask what decision has been reached. If it is unresolved, note down the values discussed]

Now you have finished your discussion, please decide how many fish you would like to harvest in the first season and mark your decision on your sheet. Remember that the group decision is not binding and you can choose any harvest from 0 to 10 fish. Remember also that in this game if you choose to harvest two fish or fewer you will be rewarded with a bonus payment of 250 KHR and that if you harvest more than the two fish you are allowed to, you may be fined.

[Check that people only look at their own sheet. Help anyone who is having trouble. Once everyone has marked their decision collect all the sheets and total the group clearance. Then calculate each individual's earnings and write both on each sheet. Return the sheets to the respective participants]

As you can see, we have filled out the two boxes from that round. Remember the top box shows you the amount cleared by the rest of your group and the lower box gives you your earnings from that round.

[Help each individual to read out their earnings for that season. Ask each participant to roll the die. If they roll a 1 they will be monitored and fined 125 KHR for each fish they harvest above two. Correct their payoff and announce the new amount to the rest of the group. Repeat until all 5 seasons have been played making sure to say which number season is currently being played when asking players to make their decision. Select a different player each time to begin declaring their decision for the season. Collect the results sheets at the end of the game.]

Individual payments with strong enforcement

[Prepare the rooms for the single group treatments. Arrange all desks in a circle facing each other. Place a results sheet on each desk and ask participants to sit in ascending numerical order. Make sure that the correct number is on each sheet]

Ok, we are now ready to play the [game number] game. Let's quickly run over the details. You will be asked to decide how many fish you want to harvest each season from the communal pond. You can decide to harvest a maximum of 10 fish and a minimum of 0. For each fish that you decide to harvest you will receive 100 KHR. This is the same for every member of your group. Everyone in the group benefits from having fish remaining unharvested at the end of the season so that you will each receive 12 KHR for each fish left in the communal pond.

In this game you will know who is in your group and the number of days you choose to harvest will **not** be private. Before each round you will be given a few minutes in which you are free to discuss your decision and the decisions of the other players with the rest of your group. You can also make agreements about how much fish you think each individual should be allowed to harvest although these agreements **are not binding**. Once this period is over we will ask you to individually decide how many fish you want to harvest and to mark your decision on the sheet in front of you as before. We will then calculate the total harvest for your group and your individual payoffs. Once we have handed back your sheets we will ask each of you individually to tell the other members of the group how much you chose to harvest.

For this game, an external authority has made a rule that you are not allowed to extract more than two fish from the pond in any single season. If you choose to fish, there is a chance that your decision will be penalised. At the end of each season we will roll a ten-sided dice, which will determine who in the group is monitored. There will be a 4 in 10 chance that the external authority will monitor you. If you are monitored and you have decided to do any fishing in the season you will be fined 125 KHR for each fish that you harvest over the permitted threshold of two fish. This means that if, for example, you are monitored and have chosen to harvest four fish, you will be fined 250 KHR (125 KHR for the two fish you harvested above the

threshold of two).

In addition, for this game there is an opportunity to earn a bonus payment from an external organisation. These payments are designed to reduce the number of fish that the group harvests. If you choose to harvest two fish or fewer each season, you will be rewarded by a bonus payment of 250 KHR. This is irrespective of how other people in your group behave. If you harvest more than two fish, you will not be eligible for the bonus.

We will repeat this game for 5 seasons. After each season you have a few minutes to talk about the game with the other members of the group before beginning the next season. Once all 5 seasons have been played, the game will end.

Ok, now we are ready to start the game. Please discuss amongst yourselves how many fish you think each person should be allowed to harvest.

[Allow group discussion for as long as the participants choose to talk. Once the discussion has stopped, ask the group whether or not they have reached a group decision. Accept any uncontested answer and ask what decision has been reached. If there is a disagreement about whether a decision has been reached, allow the participants the opportunity to resolve the disagreement. If they resolve the disagreement, ask what decision has been reached. If it is unresolved, note down the values discussed]

Now you have finished your discussion, please decide how many fish you would like to harvest in the first season and mark your decision on your sheet. Remember that the group decision is not binding and you can choose any harvest from 0 to 10 fish. Remember also that in this game if you choose to harvest two fish or fewer you will be rewarded with a bonus payment of 250 KHR and that if you harvest more than the two fish you are allowed to, you may be fined.

[Check that people only look at their own sheet. Help anyone who is having trouble. Once everyone has marked their decision collect all the sheets and total the group clearance. Then calculate each individual's earnings and write both on each sheet. Return the sheets to the respective participants]

As you can see, we have filled out the two boxes from that round. Remember the top box shows you the amount cleared by the rest of your group and the lower box gives you your earnings from that round.

[Help each individual to read out their earnings for that season. Ask each participant to roll the die. If they roll a 1, 2, 3 or 4 they will be monitored and fined 125 KHR for each fish they harvest above two. Correct their payoff and announce the new amount to the rest of the group. Repeat until all 5 seasons have been played making sure to say which number season is currently being played when asking players to make their decision. Select a different player each time to begin declaring their decision for the season. Collect the results sheets at the end of the game.]

Collective payments

[Prepare the rooms for the single group treatments. Arrange all desks in a circle facing each other. Place a results sheet on each desk and ask participants to sit in ascending numerical order. Make sure that the correct number is on each sheet]

Ok, we are now ready to play the [game number] game. Let's quickly run over the details. You will be asked to decide how many fish you want to harvest each season from the communal pond. You can decide to harvest a maximum of 10 fish and a minimum of 0. For each fish that you decide to harvest you will receive 100 KHR. This is the same for every member of your group. Everyone in the group benefits from having fish remaining unharvested at the end of the season so that you will each receive 12 KHR for each fish left in the communal pond.

In this game you will know who is in your group and the number of days you choose to harvest will **not** be private. Before each round you will be given a few minutes in which you are free to discuss your decision and the decisions of the other players with the rest of your group. You can also make agreements about how much fish you think each individual should be allowed to harvest although these agreements **are not binding**. Once this period is over we will ask you to individually decide how many fish you want to harvest and to mark your decision on the sheet in front of you as before. We will then calculate the total harvest for your group and your individual payoffs. Once we have handed back your sheets we will ask each of you individually to tell the other members of the group how much you chose to harvest.

For this game, an external authority has made a rule that you are not allowed to extract more than two fish from the pond in any single season. If you choose to fish, there is a chance that your decision will be penalised. At the end of each season we will roll a ten-sided dice, which will determine who in the group is monitored. There will be a 1 in 10 chance that the external authority will monitor you. If you are monitored and you have decided to do any fishing in the season you will be fined 125 KHR for each fish that you harvest over the permitted threshold of two fish. This means that if, for example, you are monitored and have chosen to harvest four fish, you will be fined 250 KHR (125 KHR for the two fish you harvested above the threshold of two).

In addition, for this game there is an opportunity to earn a bonus payment from an external organisation. These payments are designed to reduce the number of fish that the group harvests. Whether you receive the bonus is dependent on the total group harvest. If at the end of the season the total harvest is equal or less than 20 fish, everyone in the group will receive a bonus payment of 250 KHR. If the total group harvest is more than 20 fish then nobody will receive a bonus payment. So for example if you only harvest a single fish but the total group harvest is 27 fish then you will not receive a bonus payment, but if you were to harvest four fish and total group harvest was 18, say, then you would receive a bonus.

We will repeat this game for 5 seasons. After each season you have a few minutes to talk about the game with the other members of the group before beginning the next season. Once all 5 seasons have been played, the game will end.

Ok, now we are ready to start the game. Please discuss amongst yourselves how many fish you think each person should be allowed to harvest.

[Allow group discussion for as long as the participants choose to talk. Once the discussion has stopped, ask the group whether or not they have reached a group decision. Accept any uncontested answer and ask what decision has been reached. If there is a disagreement about whether a decision has been reached, allow the participants the opportunity to resolve the disagreement. If they resolve the disagreement, ask what decision has been reached. If it is unresolved, note down the values discussed]

Now you have finished your discussion, please decide how many fish you would like to harvest in the first season and mark your decision on your sheet. Remember that the group decision is not binding and you can choose any harvest from 0 to 10 fish. Remember also that in this game if the total group harvest is 20 fish or fewer everyone in the group will be rewarded with a bonus payment of 250 KHR.

[Check that people only look at their own sheet. Help anyone who is having trouble. Once everyone has marked their decision collect all the sheets and total the group clearance. Then calculate each individual's earnings and write both on each sheet. Return the sheets to the respective participants]

As you can see, we have filled out the two boxes from that round. Remember the top box shows you the amount cleared by the rest of your group and the lower box gives you your earnings from that round.

[Help each individual to read out their earnings for that season. Repeat until all 5 seasons have been played making sure to say which number season is currently being played when asking players to make their decision. Select a different player each time to begin declaring their decision for the season. Collect the results sheets at the end of the game.]

Collective payments with weak enforcement

[Prepare the rooms for the single group treatments. Arrange all desks in a circle facing each other. Place a results sheet on each desk and ask participants to sit in ascending numerical order. Make sure that the correct number is on each sheet]

Ok, we are now ready to play the [game number] game. Let's quickly run over the details. You will be asked to decide how many fish you want to harvest each season from the communal pond. You can decide to harvest a maximum of 10 fish and a minimum of 0. For each fish that you decide to harvest you will receive 100 KHR. This is the same for every member of your group. Everyone in the group benefits from having fish remaining unharvested at the end of the season so that you will each receive 12 KHR for each fish left in the communal pond.

In this game you will know who is in your group and the number of days you choose to harvest will **not** be private. Before each round you will be given a few minutes in which you are free to discuss your decision and the decisions of the other players with the rest of your group. You can also make agreements about how much fish you think each individual should be allowed to harvest although these agreements **are not**

binding. Once this period is over we will ask you to individually decide how many fish you want to harvest and to mark your decision on the sheet in front of you as before. We will then calculate the total harvest for your group and your individual payoffs. Once we have handed back your sheets we will ask each of you individually to tell the other members of the group how much you chose to harvest.

For this game, an external authority has made a rule that you are not allowed to extract more than two fish from the pond in any single season. If you choose to fish, there is a chance that your decision will be penalised. At the end of each season we will roll a ten-sided dice, which will determine who in the group is monitored. There will be a 4 in 10 chance that the external authority will monitor you. If you are monitored and you have decided to do any fishing in the season you will be fined 125 KHR for each fish that you harvest over the permitted threshold of two fish. This means that if, for example, you are monitored and have chosen to harvest four fish, you will be fined 250 KHR (125 KHR for the two fish you harvested above the threshold of two).

In addition, for this game there is an opportunity to earn a bonus payment from an external organisation. These payments are designed to reduce the number of fish that the group harvests. Whether you receive the bonus is dependent on the total group harvest. If at the end of the season the total harvest is equal or less than 20 fish, everyone in the group will receive a bonus payment of 250 KHR. If the total group harvest is more than 20 fish then nobody will receive a bonus payment. So for example if you only harvest a single fish but the total group harvest is 27 fish then you will not receive a bonus payment, but if you were to harvest four fish and total group harvest was 18, say, then you would receive a bonus.

We will repeat this game for 5 seasons. After each season you have a few minutes to talk about the game with the other members of the group before beginning the next season. Once all 5 seasons have been played, the game will end.

Ok, now we are ready to start the game. Please discuss amongst yourselves how many fish you think each person should be allowed to harvest.

[Allow group discussion for as long as the participants choose to talk. Once the discussion has stopped, ask the group whether or not they have reached a group decision. Accept any uncontested answer and ask what decision has been reached. If there is a disagreement about whether a decision has been reached, allow the participants the opportunity to resolve the disagreement. If they resolve the disagreement, ask what decision has been reached. If it is unresolved, note down the values discussed]

Now you have finished your discussion, please decide how many fish you would like to harvest in the first season and mark your decision on your sheet. Remember that the group decision is not binding and you can choose any harvest from 0 to 10 fish. Remember also that in this game if the total group harvest is 20 fish or fewer everyone in the group will be rewarded with a bonus payment of 250 KHR and that if you harvest more than the two fish you are allowed to, you may be fined.

[Check that people only look at their own sheet. Help anyone who is having trouble. Once everyone has marked their decision collect all the sheets and total the group

clearance. Then calculate each individual's earnings and write both on each sheet. Return the sheets to the respective participants]

As you can see, we have filled out the two boxes from that round. Remember the top box shows you the amount cleared by the rest of your group and the lower box gives you your earnings from that round.

[Help each individual to read out their earnings for that season. Ask each participant to roll the die. If they roll a 1 they will be monitored and fined 125 KHR for each fish they harvest above two. Correct their payoff and announce the new amount to the rest of the group. Repeat until all 5 seasons have been played making sure to say which number season is currently being played when asking players to make their decision. Select a different player each time to begin declaring their decision for the season. Collect the results sheets at the end of the game.]

Collective payments with strong enforcement

[Prepare the rooms for the single group treatments. Arrange all desks in a circle facing each other. Place a results sheet on each desk and ask participants to sit in ascending numerical order. Make sure that the correct number is on each sheet]

Ok, we are now ready to play the [game number] game. Let's quickly run over the details. You will be asked to decide how many fish you want to harvest each season from the communal pond. You can decide to harvest a maximum of 10 fish and a minimum of 0. For each fish that you decide to harvest you will receive 100 KHR. This is the same for every member of your group. Everyone in the group benefits from having fish remaining unharvested at the end of the season so that you will each receive 12 KHR for each fish left in the communal pond.

In this game you will know who is in your group and the number of days you choose to harvest will **not** be private. Before each round you will be given a few minutes in which you are free to discuss your decision and the decisions of the other players with the rest of your group. You can also make agreements about how much fish you think each individual should be allowed to harvest although these agreements **are not binding**. Once this period is over we will ask you to individually decide how many fish you want to harvest and to mark your decision on the sheet in front of you as before. We will then calculate the total harvest for your group and your individual payoffs. Once we have handed back your sheets we will ask each of you individually to tell the other members of the group how much you chose to harvest.

In addition, for this game there is an opportunity to earn a bonus payment from an external organisation. These payments are designed to reduce the number of fish that the group harvests. Whether you receive the bonus is dependent on the total group harvest. If at the end of the season the total harvest is equal or less than 20 fish, everyone in the group will receive a bonus payment of 250 KHR. If the total group harvest is more than 20 fish then nobody will receive a bonus payment. So for example if you only harvest a single fish but the total group harvest is 27 fish then you will not receive a bonus payment, but if you were to harvest four fish and total group harvest was 18, say, then you would receive a bonus.

We will repeat this game for 5 seasons. After each season you have a few minutes to talk about the game with the other members of the group before beginning the next season. Once all 5 seasons have been played, the game will end.

Ok, now we are ready to start the game. Please discuss amongst yourselves how many fish you think each person should be allowed to harvest.

[Allow group discussion for as long as the participants choose to talk. Once the discussion has stopped, ask the group whether or not they have reached a group decision. Accept any uncontested answer and ask what decision has been reached. If there is a disagreement about whether a decision has been reached, allow the participants the opportunity to resolve the disagreement. If they resolve the disagreement, ask what decision has been reached. If it is unresolved, note down the values discussed]












Now you have finished your discussion, please decide how many fish you would like to harvest in the first season and mark your decision on your sheet. Remember that the group decision is not binding and you can choose any harvest from 0 to 10 fish. Remember also that in this game if the total group harvest is 20 fish or fewer everyone in the group will be rewarded with a bonus payment of 250 KHR and that if you harvest more than the two fish you are allowed to, you may be fined.












[Check that people only look at their own sheet. Help anyone who is having trouble. Once everyone has marked their decision collect all the sheets and total the group clearance. Then calculate each individual's earnings and write both on each sheet. Return the sheets to the respective participants]












As you can see, we have filled out the two boxes from that round. Remember the top box shows you the amount cleared by the rest of your group and the lower box gives you your earnings from that round.












[Help each individual to read out their earnings for that season. Ask each participant to roll the die. If they roll a 1, 2, 3 or 4 they will be monitored and fined 125 KHR for each fish they harvest above two. Correct their payoff and announce the new amount to the rest of the group. Repeat until all 5 seasons have been played making sure to say which number season is currently being played when asking players to make their decision. Select a different player each time to begin declaring their decision for the season. Collect the results sheets at the end of the game.]












Decision sheet












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	1	2	3	4	5	6	7	8	9	10		<div></div>

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	1	2	3	4	5	6	7	8	9	10		<div></div>

CPR treatment payoff equations

Enforcement treatments ($\lambda = 0.1$ or 0.4):

$$\pi_j = \begin{cases} 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) & \text{if } x_j \leq 2 \\ 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) - 125\lambda & \text{otherwise} \end{cases}$$

Individual payment treatment:

$$\pi_j = \begin{cases} 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) + 250 & \text{if } x_j \leq 2 \\ 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) & \text{otherwise} \end{cases}$$

Individual payment plus enforcement treatments ($\lambda = 0.1$ or 0.4):

$$\pi_j = \begin{cases} 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) + 250 & \text{if } x_j \leq 2 \\ 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) - 125\lambda & \text{otherwise} \end{cases}$$

Collective payments treatment:

$$\pi_j = \begin{cases} 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) + 250 & \text{if } \sum_{i=1}^n x_i \leq 20 \\ 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) & \text{otherwise} \end{cases}$$

Collective payment plus enforcement treatments ($\lambda = 0.1$ or 0.4):

$$\pi_j = \begin{cases} 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) + 250 & \text{if } \sum_{i=1}^n x_i \leq 20, x_j \leq 2 \\ 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) + 250 - 125\lambda & \text{if } \sum_{i=1}^n x_i \leq 20, x_j > 2 \\ 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) & \text{if } \sum_{i=1}^n x_i > 20, x_j \leq 2 \\ 100x_j + 12 \left(100 - \sum_{i=1}^n x_i \right) - 125\lambda & \text{if } \sum_{i=1}^n x_i > 20, x_j > 2 \end{cases}$$

Table C.2: Variables used in statistical modelling of the CPR game.

Variable	Data type	Variable type	Description
fish	bounded proportional	response	number of fish taken by one subject
treatment	categorical	explanatory	experimental treatment played
previous	categorical	explanatory	experimental treatment played previously
age	continuous	explanatory	age of subject
yrs_village	continuous	explanatory	number of years subject had lived in village
education	continuous	explanatory	number of years in education
literacy	binary	explanatory	whether or not subject was literate
gender	categorical	explanatory	gender of subject
head	binary	explanatory	whether or not the subject was the head of family
ethnicity	categorical	explanatory	ethnicity of subject
dependency	continuous	explanatory	dependency ratio of household
gender_hhh	categorical	explanatory	gender of household head
understanding	bounded proportional	explanatory	number of correct answers to understanding questions
numeracy	categorical	explanatory	scored ability to correctly identify and order series of numbers
position	binary	explanatory	whether or not the subject held a formal position of authority
decision	binary	explanatory	whether or not a group decision was made
livelihood	continuous	explanatory	number of livelihood activities followed by household
round	categorical	explanatory	number of the round played
game	categorical	explanatory	when in the day the observation was recorded
day	categorical	explanatory	which day in the village the observation was recorded
village	categorical	random effect	village in which the observation was recorded
session	categorical	random effect	day on which the observation was recorded
group	categorical	random effect	group from which the observation was recorded
individual	categorical	random effect	subject from which the observation was recorded

Table C.3: Parameter estimates for the selected CPR game GLMM, with the number of fish harvested in a round as the response variable. The difference in the number of fish taken was found by calculating the expected number of fish taken for each variable and comparing this with the number expected for the intercept. P values significant at the 95% confidence level are shown in bold. Three random effects were included in the model: individual (SD = 0.484), group (SD = 0.561) and session number (SD = 0.591). The full list of variables modelled, plus their explanations, are given in Supplementary Materials Table C.2.

Variable	Estimate	SE	No. of fish	Diff in no. fish	P values
intercept	-0.431	0.296	3.938	-	0.145
private	-0.044	0.265	3.833	-0.105	0.868
weak enforcement	-0.041	0.343	3.841	-0.097	0.905
strong enforcement	0.158	0.343	4.321	+0.383	0.644
individual payments	-1.408	0.326	1.371	-2.567	<< 0.001
collective payments	-1.158	0.329	1.695	-2.243	0.001
ind. w. weak enf.	-0.948	0.326	2.011	-1.927	0.004
ind. w. strong enf.	-0.506	0.329	2.815	-1.123	0.124
coll. w. weak enf.	-0.855	0.345	2.164	-1.774	0.013
coll. w. strong enf.	-1.164	0.341	1.686	-2.252	< 0.001
education	0.024	0.009	3.994	+0.056	0.009
decision	-0.328	0.084	3.188	-0.750	<< 0.001
practice	0.079	0.016	4.129	+0.191	<< 0.001
round 2	0.349	0.032	4.793	+0.855	<< 0.001
round 3	0.237	0.032	4.515	+0.577	<< 0.001
round 4	0.410	0.032	4.947	+1.009	<< 0.001
round 5	0.340	0.032	4.773	+0.835	<< 0.001

Table C.4: Comparison of the predicted difference in the number of fish taken by an individual for different treatments between round 1 (Table 5.2) and round 4 (the treatment for which the estimated effect is most different from round 1).

Treatment	Difference in fish taken in round 1	Difference in fish taken in round 4
intercept (peer pressure)	-	-
private	-0.11	-0.11
weak enforcement	-0.10	-0.10
strong enforcement	+0.38	0.40
individual payments	-2.57	-3.02
collective payments	-2.24	-2.60
ind. w. weak enf.	-1.93	-2.20
ind. w. strong enf.	-1.12	-1.23
coll. w. weak enf.	-1.77	-2.01
coll. w. strong enf.	-2.25	-2.61

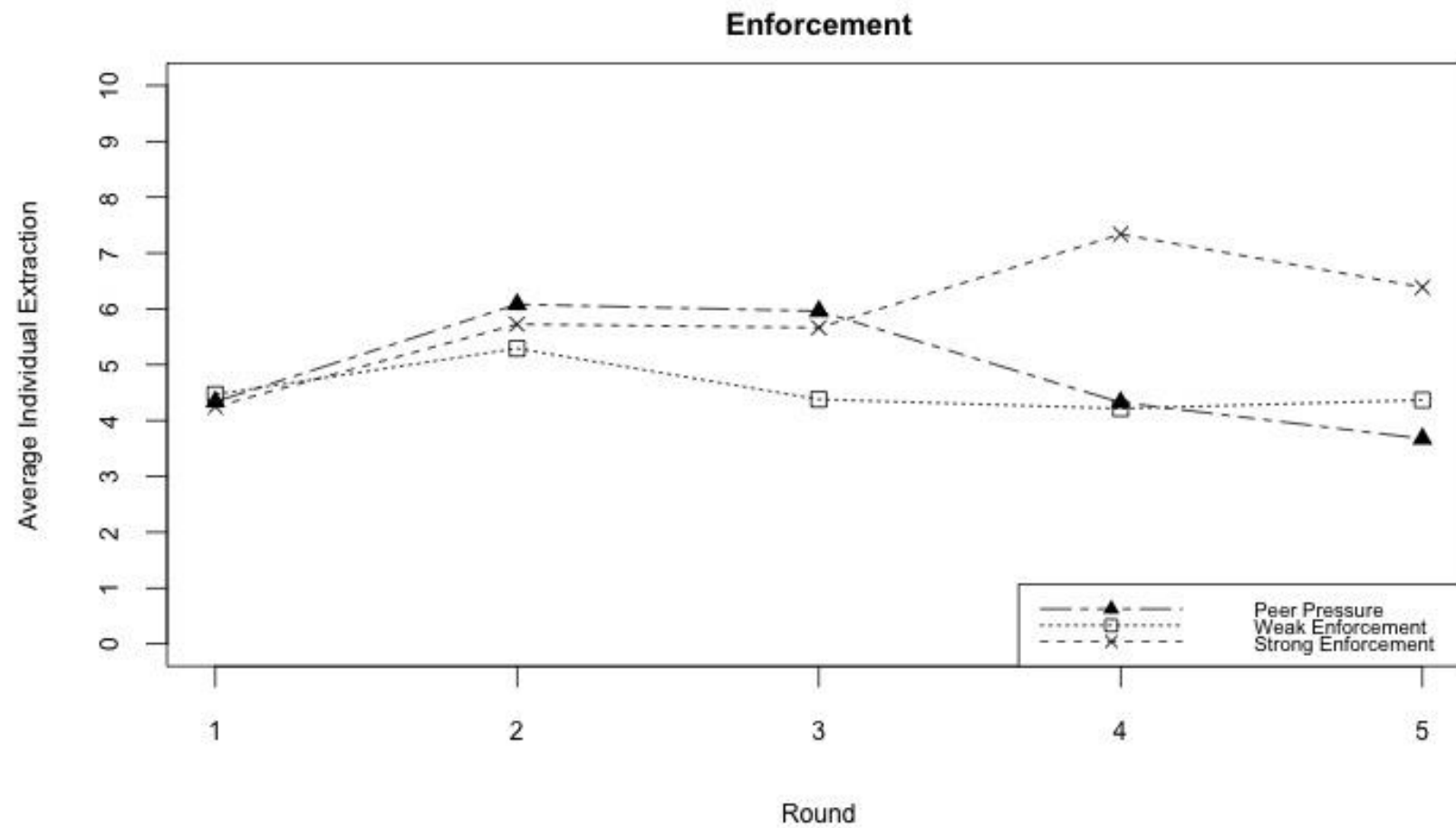


Figure C.1: Average individual extraction per round during the enforcement treatments of the CPR game

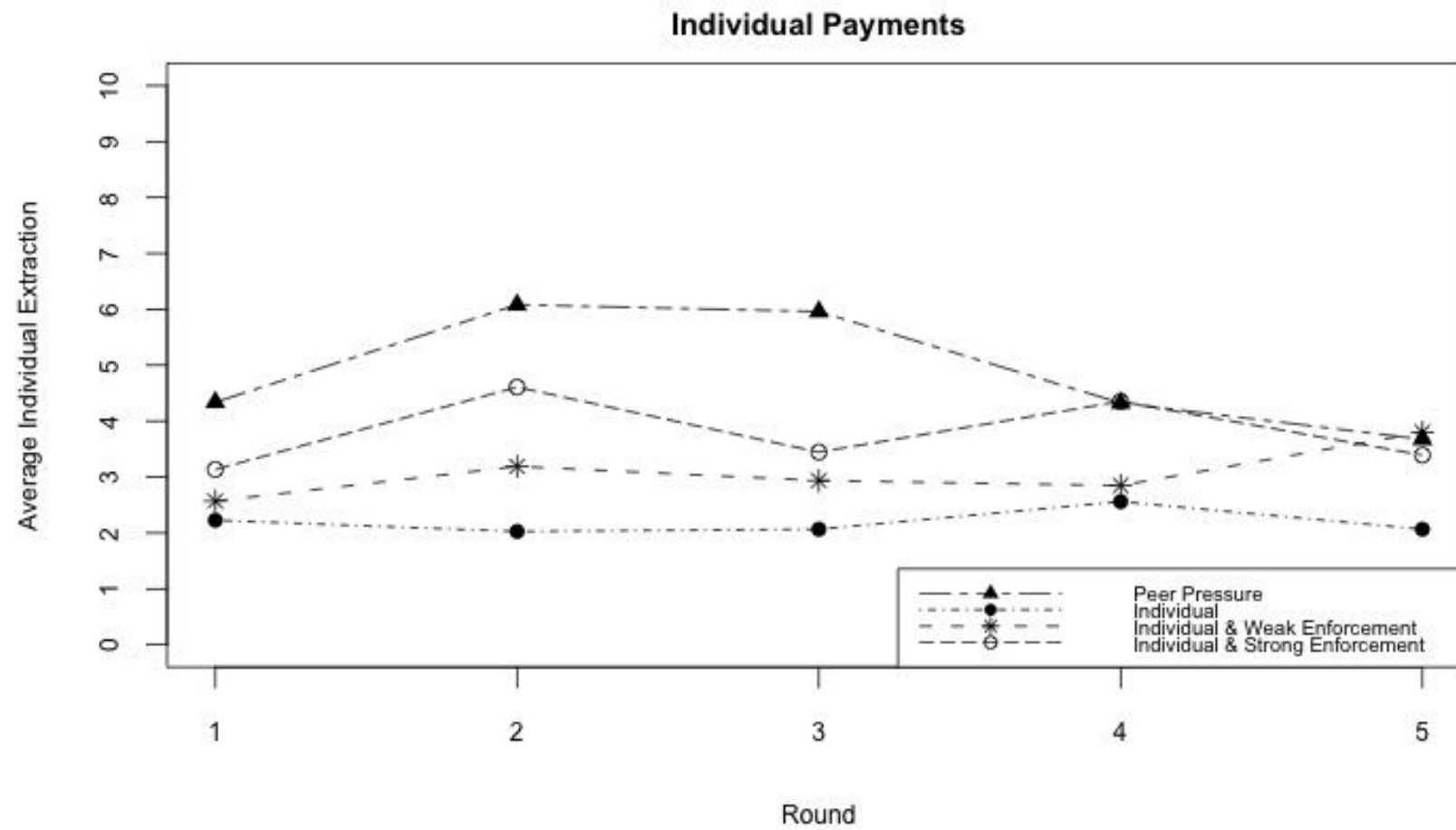


Figure C.2: Average individual extraction per round during the individual payments treatments of the CPR game.

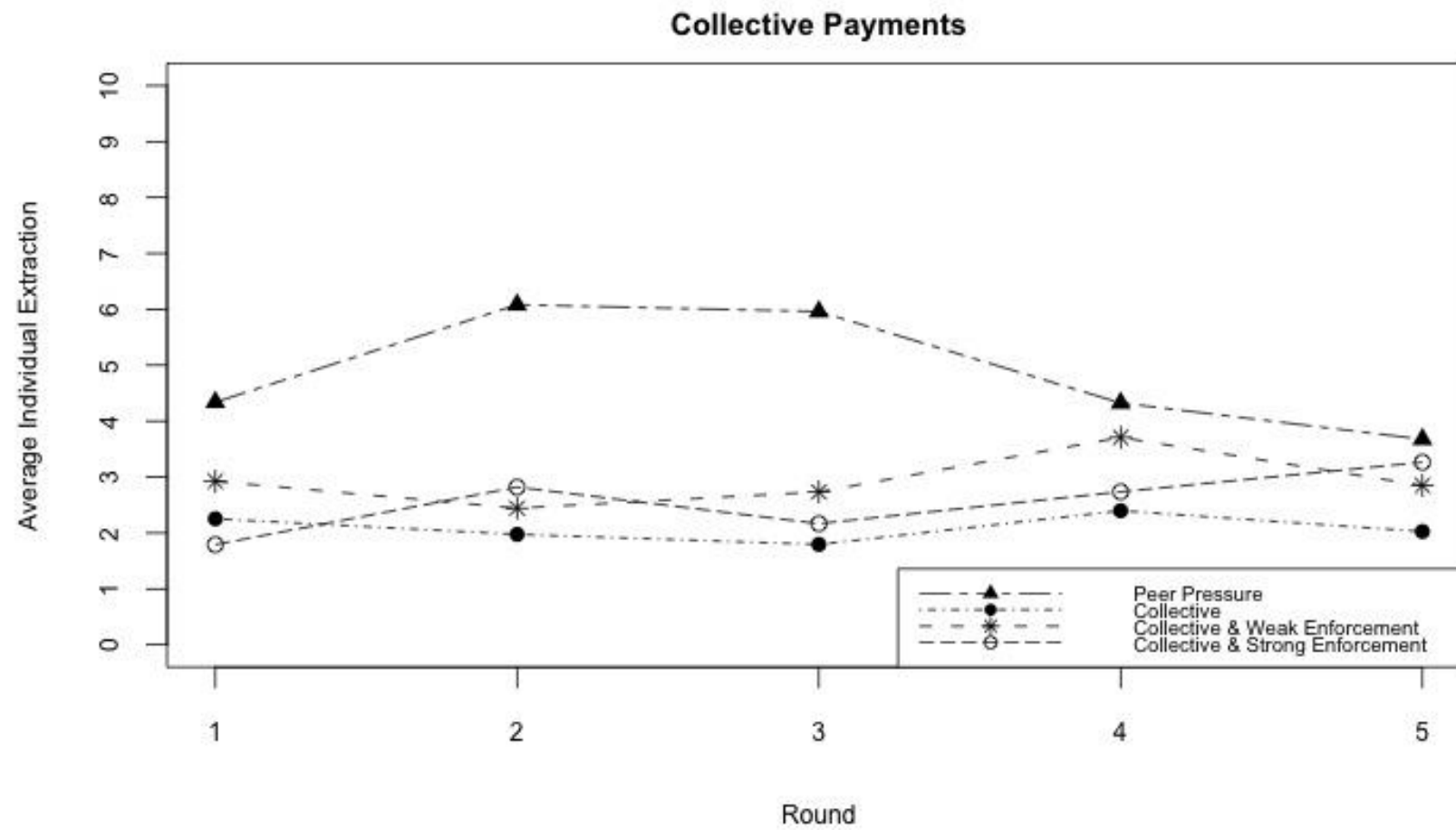


Figure C.3: Average individual extraction per round during the collective payments treatments of the CPR game.

Appendix D

Supplementary material for Chapter 6

Scenarios script

Interview Introduction

[Introduce research team]

I would like you to think about the future and what you would do if different things changed. I will present different possible futures to you and I would like you to imagine how you and your household would respond to the conditions in those scenarios. Each scenario will cover a period of five years and only one condition will be different to now.

For example, I might present you with a scenario of the future in which the price of cassava has increased to double its current value but everything else was the same as it is now. I would then want you to think about how that would affect you and the rest of your household. For instance if the price of cassava was double what you are paid now, could you afford to hire more labour? Would you want to change the area of land that you own by, for example, clearing or buying more land, or even selling your land? Would you change the proportion of your land on which you grow cassava? Would you change the proportion of your labour that you devote to farming as opposed to other activities, such as resin collection? How do you think it would change your relationship with other families in the village?

Or maybe you would not do anything different to what you do currently. If that was the case, would there be anything stopping you from making changes? For example, would it be possible for you to hire more labour than there is available to you now? Is it possible to buy/sell or clear more land?

So what I am asking you to do is to think about how you might react to changes in the future.

Scenarios

Cassava Price Increase

I want you to imagine that as, with our example, the price at which you can sell your cassava doubles. This means that the cassava trader pays you twice as much as they pay you this year. Imagine that this change continues for five years - how do you think this will affect you? Remember in this future, everything else will remain as it is now.

Cassava Price Decrease

I want you to imagine that the price at which you can sell your cassava halves. This means that the cassava trader pays you half as much as they pay you this year. Imagine that this change continues for five years - how do you think this will affect you? Remember in this future, everything else will remain as it is now.

Law Enforcement Effort Increase

I want you to imagine that the protected area authorities, the Forestry Administration, increase the number of law enforcement patrols targeting forest clearance and fields located within the protected area. This extra effort means that the patrols are four times more likely to catch illegal land clearance. Imagine that this change continues for five years - how do you think this will affect you? Remember in this future, everything else will remain as it is now.

Individual Payments to Reduce Forest Clearance

Now, I want you to imagine that the protected area authorities are offering another type of payments to your village for people not to clear forest. This payment will be worth \$200 to everyone who receives it and if you receive it you will be given money directly. Imagine you will receive a payment if you do not clear forest around your fields or the village land. This payment is only dependent on your own behaviour. That means that if you do not clear forest you will receive the payment. Imagine that this change continues for five years - how do you think this will affect you? Remember in this future, everything else will remain as it is now.

Communal Payments to Reduce Forest Clearance

Now, I want you to imagine that the protected area authorities are offering payments to your village for people not to clear forest. This payment will be worth \$200 to everyone who receives it and if you receive it you will be given money directly. Imagine you and the other members of your *krom* will receive a payment if there is no forest clearance around your fields or the village land. This payment is dependent on the behaviour of everybody, not just you. That means that if other people from your *krom* clear but you do not, you will not receive the payment. Similarly, if other people from your *krom* did not clear but you did, that would mean that nobody would receive the payment. Only if nobody in your *krom*, including you, did not clear would everybody receive the payment. Imagine that this change continues for five years - how do you think this will affect you? Remember in this future, everything else will remain as it is now.

Payment to a Village Fund

Finally, I want you to imagine that protected area authorities are again offering payments to your village for people not to clear forest. This time the payments will be made into a village fund to pay for improved village infrastructure, such as roads, drainage, schools or health clinics. The money paid into this fund will be dependent on the village on there being no forest clearance by anyone in the village. If people choose to clear forest, there will be less money paid into the village fund and it will take longer to pay for improvements to village infrastructure. Imagine that this change continues for five years - how do you think this will affect you? Remember in this future, everything else will remain as it is now.

Table D.1: Variables used in statistical modelling in Chapter 6.

Variable	Data type	Variable type	Description
pro	binary	response	whether or not respondent acted in a pro-conservation manner
reduced	binary	response	whether or not the respondent reduced clearance relative to baseline
scenario	categorical	explanatory	scenario for which behaviour was predicted
age	continuous	explanatory	age of respondent
log_area	continuous	explanatory	natural logarithm of area of productive land held by household
yrs_village	continuous	explanatory	number of years respondent had lived in village
education	continuous	explanatory	number of years in education
gender	categorical	explanatory	gender of respondent
indigenous	binary	explanatory	whether or not the respondent belonged to IP
hh_size	continuous	explanatory	number of members of household
labour	binary	explanatory	whether or not the respondent household was involved in wage labour
shop	binary	explanatory	whether or not the respondent household operated a shop
employed	binary	explanatory	whether or not a member of respondent's household was employed
service	binary	explanatory	whether or not the respondent's household operated a village service
poverty_score	continuous	explanatory	household poverty score
livelihood_zone	categorical	explanatory	livelihood zone in which village was situated
individual	categorical	random effect	subject from which the observation was recorded