Imperial College London

Department of Life Sciences

Seeing the people for the trees: Impacts of conservation on human well-being in Northern Cambodia

Emilie Beauchamp

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Declaration of Originality

This dissertation results entirely from my own work, and includes nothing that is the outcome of work done by or in collaboration with others except where this has been specifically indicated in the text.

Emilie Beauchamp, August 2016

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Abstract

Over recent decades, conservation projects, such as Protected Areas (PAs) and Payment for Environmental Services (PES), have increasingly incorporated poverty alleviation goals or targets towards improving human well-being in addition to biodiversity conservation outcomes. While methods to evaluate biodiversity are widely available, there is less guidance on how to measure the impacts of conservation interventions on human lives. Economic proxies have been popular, yet rarely reflect the multi-faceted incentives of resource users and their responses to conservation interventions.

In this study, I use mixed methods to investigate the effects of conservation interventions on human well-being in Northern Cambodia, using three complementary approaches at different geographical scales. The Northern Plains landscape provides an ideal context for this exercise, because it includes two PAs and three PES initiatives, while also facing increasing development pressures in the form of large-scale agro-industrial development interventions: Economic Land Concessions (ELCs).

I begin by exploring correlates of the spatial placement of ELCs, their outcomes in terms of deforestation rates, and the extent to which these development interventions trade off against conservation goals. The evidence indicates that ELCs not only fail to achieve their intended outcome but are also the main predictor of deforestation in the region, compromising environmental sustainability in the long-run.

I then build on an existing longitudinal dataset from the Northern Plains to provide a medium-term evaluation of the impacts of PAs and PES on the socio-economic status of households in villages within PAs, compared with matched villages outside PAs. I demonstrate that external factors remain the main contributors to the socio-economic status of households across the landscape, with combined PAs and PES slightly reducing the rate of increase in household economic status and agricultural productivity, yet without impeding household development.

The second half of this PhD offers a qualitative exploration of the conceptualisations of human well-being in the study area, to capture the multidimensionality and heterogeneity of well-being in the landscape. I find that individual well-being as well as village solidarity and trust are heavily linked with issues relating to land and resources, and their governance. From this study I developed locally relevant indicators pertaining to perceptions of salient land issues, which allow a more accurate assessment of the subjective dimension of human well-being across a landscape that features competing land uses from PAs and ELCs.

The research findings highlight the complexity of attributing conservation impacts and capturing the direct and indirect consequences of conservation and development policies, and demonstrate how a more nuanced evaluation of conservation impacts on humans can guide future conservation interventions.

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“Counting sounds easy until we actually attempt it, and then we quickly discover that often we cannot recognize what we ought to count. Numbers are no substitute for clear definitions. Not everything that can be counted counts, and not everything that counts can be counted.”

William Bruce Cameron

Table of Contents

List of Figures

List of Tables

List of Acronyms

ADB	Asian Development Bank
APC	Average Predictive Comparison
BACI	Before-After-Control-Interventions
BLUP	Best Linear Unbiased Predictor
BN	Basic Necessities
BNS	Basic Necessities Survey
BPWS	Boeng Per Wildlife Sanctuary
CBD	Convention on Biological Diversity
CF	Community Forest
CI	Conservation International
CPA	Community Protected Area
DiD	Difference-in-Differences
ELC	Economic Land Concessions
FA	Forestry Administration
FAO	Food and Agriculture Organization of the United Nations
GW	Global Witness
ICDP	Integrated Conservation and Development Projects
ICEM	International Centre for Environmental Management
IUCN	International Union for Conservation of Nature
KPWS	Kulen Promtep Wildlife Sanctuary
MAFF	Ministry of Agriculture, Forestry and Fisheries
MEA	Millennium Ecosystem Assessment
MoE	Ministry of Environment
NGO	Non-Governmental Organisations
NSDP	National Strategic Development Plan
NTFP	Non-Timber Forest Product
PA	Protected Area
PES	Payment for Environmental Services
PLUP	Participatory Land Use Plan
PSM	Propensity Score Matching
PVPF	Preah Vihear Protected Forest
RCT	Randomised Control Trial

REDD	Reducing Emissions from Deforestation and forest Degradation
RGC	Royal Government of Cambodia
SLC	Social Land Concessions
SMP	Sansom Mlup Prey
USAID	United States Agency for International Development
VIF	Variable Inflation Factor
WCS	Wildlife Conservation Society
WeD	Well-being in Developing Countries
WWF	World Wide Fund for Nature
ZANB	Zero-Altered Negative Binomial

1. Introduction

1.1 Research statement

Over recent decades, the world has experienced an accelerating rate of environmental change due to anthropogenic pressures such as population growth and climate change, driving biodiversity and ecosystem loss and increasing concerns for future development such as food security (Chevin et al. 2010; Mace 2013). Faced with limited resources in a globalised world, efforts to improve people's lives through economic development often clash with attempts to stop the decline in biodiversity and ecosystem degradation (Ostrom 2007; Sachs et al. 2009). This is especially the case in developing countries, which are expected to support the bulk of development pressures from now until 2050, but which also host most biodiversity-rich areas of the planet (Baudron & Giller 2014; Phalan et al. 2013).

Consequently, the success of conservation interventions in these areas often depends on the multifaceted and sometimes competing interests and motivations that lead local people to sustainably manage natural resources in the first place (Barrett et al. 2005; Wells & McShane 2004; Sunderland et al. 2008). For example, most forest-dependent people live below the poverty line and face a number of challenges, from land encroachment to food insecurity and poor sanitation (Angelsen et al. 2014). Under these circumstances, unless conservation improves human well-being and originates from people's own needs and desires, it will be hard for policy-makers to see biodiversity conservation as a priority.

For these reasons, the link between conservation and human well-being has been increasingly emphasised in international policy and reflected in conservation organisations' mandates and activities (Brundtland & Khalid 1987; MEA 2005; Stiglitz et al. 2009; OECD 2011). For example, the Convention on Biological Diversity's 2020 Aichi targets include clear commitments towards benefiting communities, livelihoods and human well-being (CBD 2010). Today this may seem like stating the obvious, yet it is fair

to remember that conservation and development have historically been seen as opposites (Wells et al. 1992). In fact, many of the early conservation strategies applied in colonial and postcolonial times were as bio-centric as the contemporaneous development strategies were anthropocentric (Barrett & Arcese 1995). 'Fences and fines' protectionist approaches to conservation had little or no regard for local people, and often heightened conflict with local communities (Machlis & Tichnell 1985).

Since the 1980s, new approaches to conservation emphasising the links between environment and poverty alleviation, and the role of communities in resource use and conservation, have led to the development of alternative mechanisms to protect biodiversity while considering human needs (Bossel 1999; Roe et al. 2012). This has been driven by attempts to improve biodiversity outcomes, but also by an ethical principle that conservation should at the very least 'do no harm' to the local populations affected (CBD 1992; IUCN 2003, 2014), and by the recognition that conservation aims are intrinsically linked with the interest or motivation that leads local people to sustainably manage their resources (McShane & Wells 2005; Barrett et al. 2005; Sunderland et al. 2008). As a result, a wide range of conservation interventions now aim at mitigating poverty and improving local livelihoods, and even further, enhancing human well-being (Leisher et al. 2013; Milner-Gulland et al. 2014).

Newer 'win-win' or multifaceted conservation approaches include Integrated Development and Conservation Projects (ICDPs), which promote indirect linkages between the two fields, or more direct market-based instruments such as Payment for Environmental Services (PES) (Ferraro & Kiss 2002; Wegner 2015; Wunder et al. 2008). Several studies have investigated the performance of these different conservation approaches (Brooks et al. 2006; Brooks et al. 2013; Leverington et al. 2010; Muradian et al. 2013). Yet despite an extensive literature exploring the effects of conservation on human livelihoods, studies rarely point to clear-cut arguments about net outcomes and often suffer from a lack of methodological robustness (McKinnon et al. 2016; Oldekop et al.

2016). In fact, while academic and policy circles have readily engaged in the philosophical integration of the social and conservation realms, challenges remain with regards to understanding precisely what works, why, and for whom (Costanza et al. 2016; Milner-Gulland et al. 2014; Moon & Blackman 2014). Although the number of studies assessing social impacts of conservation is increasing rapidly, there has been little change overall in the general evaluation methods used over the last 15 years (de Lange et al. 2015).

The situation is changing due to the recent adoption by conservation scientists of approaches from the economics and development fields, aimed at improving our understanding of the social effects of interventions (Ferraro & Pressey 2015). This includes the increased adoption of counterfactual thinking and more scientifically rigorous evaluation methods, such as quasi-experimental designs- that can help disentangle the attribution of the conservation interventions- versus other external elements occurring at a similar time and space within complex contexts (Andam et al. 2008; Ferraro & Pattanayak 2006). Still, due to the novelty of the appetite for such designs and the difficulty in applying them retrospectively (Ahmadia et al. 2015; Ferraro et al. 2015), very few studies have explored the evolution of social impacts over multiple time periods and at a landscape scale.

There has also been an increasing recognition of the heterogeneity and multidimensionality of social impacts over the last few years, expressed in terms of changes in well-being (Agarwala et al. 2014). The acknowledgement of the importance and complexity of social dynamics proves an invigorating (and challenging) advance in conservation science, and examples from the development field have provided guidance on the application of a human well-being approach in the context of conservation evaluation (Abunge et al. 2013; Britton & Coulthard 2013; Dawson & Martin 2015; Schaaf 2010).

Well-being can be understood in terms of three interacting dimensions: the objective material circumstances of a person; a subjective evaluation by the person of their goals and the processes they engage in to attain them; and a

relational component capturing their ability to achieve these goals through social networks and interactions (Gough & McGregor 2007). The concept of well-being thus provides a useful framework allowing researchers to evaluate trade-offs between aspects of human development, to understand the heterogeneity of intervention impacts on different people within and between communities, and to capture potentially unintended effects from interventions (Daw et al. 2015; Pomeroy et al. 2011).

Guidance around operationalising the seemingly intangible nature of the term well-being exists, with frameworks such as the Well-being in Developing Countries (WeD) approach (Bottrill et al. 2014; Gough & McGregor 2007). Yet only a handful of studies have to date applied the concept in a conservation context (Britton & Coulthard 2013; Rasolofoson et al. 2016).

Using mixed methods to evaluate impacts of conservation projects within a well-being framework can help encapsulate the complexity of the dynamics through which changes in well-being take place with scientific rigor (Agarwala et al. 2014; McGregor et al. 2015). Despite a growing number of case studies adopting mixed methods in evaluation (Burrows & Read 2015), guidance about combining localised qualitative inferences and quantitative measures that can be transferable for national or global policy-making is vague (Gough 2004; Woodhouse et al. 2015); thus the operationalisation of this integration in a comprehensive way remains challenging (Burrows & Read 2015; Dawson 2015).

This study aims to understand the effects of conservation interventions on human well-being in Northern Cambodia, through two complementary and overarching themes: assessing the trade-offs between conservation and development outcomes in complex systems through the application of a pragmatic mixed methods approach; and exploring the multidimensionality and heterogeneity of social effects of conservation through the lens of a human well-being framework (Figure 1.1).

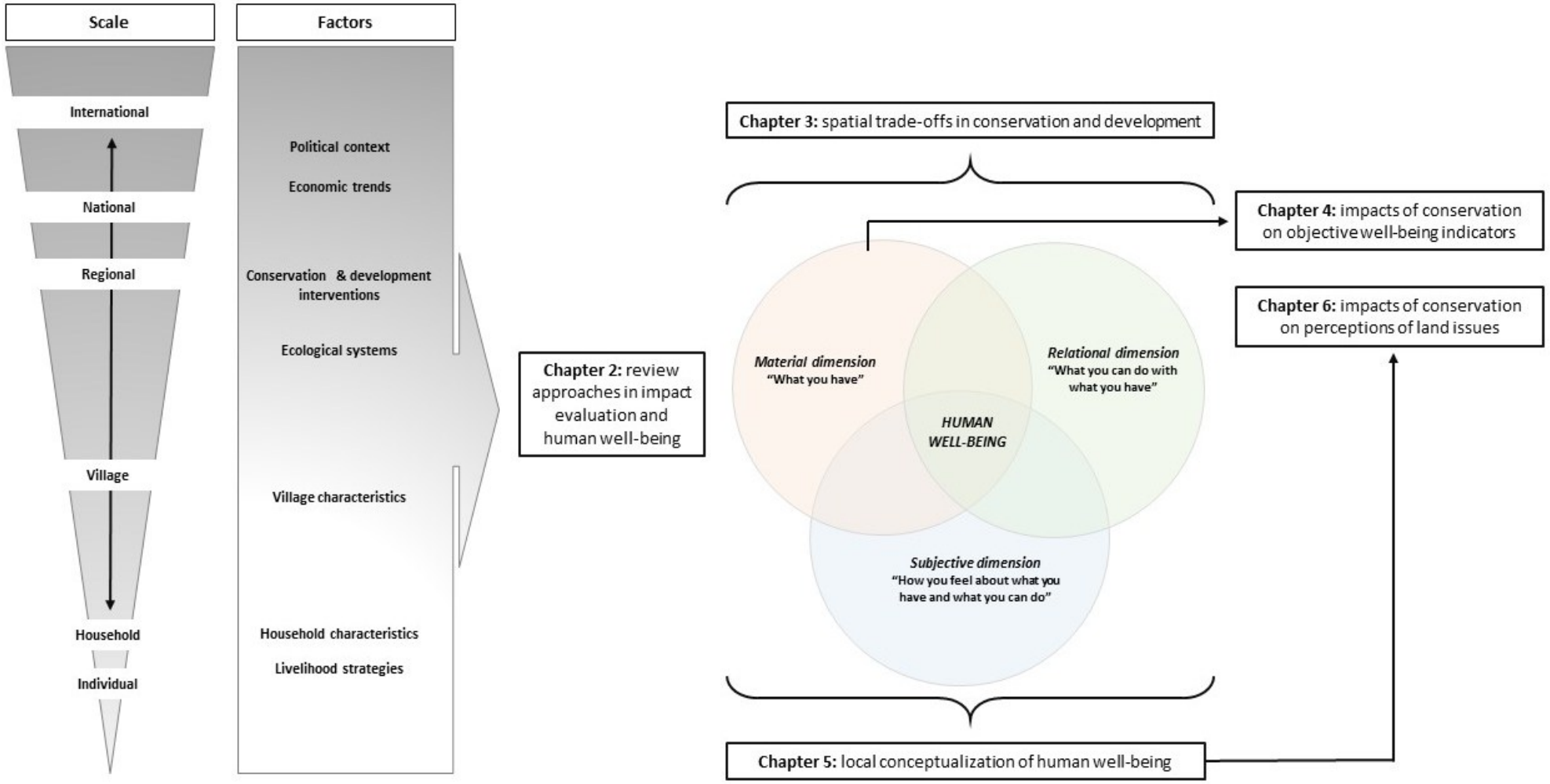

Figure 1.1: Conceptual framework of this thesis, highlighting the use of a well-being approach and mixed methods to assess social impacts of conservation projects in complex landscapes at different scales.

This research focuses on an area of Northern Cambodia as a case study, which includes two PAs actively managed by the Royal Government of Cambodia (RGC) in collaboration with WCS since 2005. Additionally, three PES projects were designed to complement PA management in a number of villages. To understand the impacts of these interventions, a two-stage mixed methods approach was implemented, first using qualitative methods to develop and support a systematic household survey design. The quantitative survey was also based on a quasi-experimental survey designed in 2008, which was repeated in 2011 and as part of this study in 2014. Thus part of this study builds on this historical dataset and on a previous short-term impact evaluation (Clements & E J Milner-Gulland 2015) to provide one of the first multi-period, quasi-experimental, survey-based social impact evaluations of a regional-scale conservation intervention to date.

Cambodia has seen rapid economic progress and globalisation over the past decade and has recorded the fifth highest rate of deforestation worldwide between 2000 and 2012 (Hansen et al. 2013). This is primarily due to land grabbing through the granting of Economic Land Concessions (ELCs) (Davis et al. 2015): interventions politically justified as agricultural intensification development programmes. In this context, the Northern Plains of Cambodia provide a unique opportunity to study the magnitude of the social effects of conservation within a fast-changing landscape featuring competing pressures and trade-offs between development and conservation. While this study aims to contribute to the body of knowledge assessing the influence of ELCs on different dimensions of well-being within a conservation context, this is not a comprehensive analysis of their impacts on the lives of Cambodians. I acknowledge that the political processes at play behind these interventions deserve far more scrutiny in order to be fully understood than the scope of this study allows.

1.2 Aims and objectives

The overall aim of this thesis is to understand the effects of conservation interventions on human well-being, focusing on the integration of qualitative

insights and quantitative evaluation. The research aim is addressed through the following objectives applied to Cambodia as a case study:

1. To explore the spatial trade-offs between development and conservation interventions at a regional scale.

2. To evaluate factors influencing medium-term trends in socio-economic outcomes, comparing villages with different levels of influence from the conservation intervention and ELCs in Northern Cambodia.

3. To investigate local conceptualisations of human well-being and their implications for the design and evaluation of conservation policy.

4. To assess perceptions of locally prioritised aspects of human well-being related to land issues, in villages differentially affected by conservation and ELCs.

1.3 Thesis outline

Subsequent to this introductory chapter, the thesis has the following structure:

Chapter 2 constitutes a review of the evolution of conservation approaches over recent decades, of applied methods in evaluation, and of related epistemological paradigms. I then focus on recent developments in social impact evaluation methods applied to the field of conservation. I finish by discussing the background and justifying the use of the human well-being conceptual framework used in this study.

Chapter 3 sets the contextual background in which the study takes place. I provide an overview of Cambodia's socio-political history before describing the Northern Plains study site, as well as the details of the survey design.

Chapter 4 examines the spatial trade-offs between conservation and development policy goals by assessing the factors that influence the

placement of ELCs as agro-industrial development policies. More specifically, I investigate whether the location of ELCs respond to expected socio-environmental factors related to their intended policy outcome and their effect on long-term environmental sustainability in the region.

This chapter is in second review at Land Use Policy as:
Beauchamp, E., Clements, T., Milner-Gulland, E.J. Exploring trade-offs between development and conservation outcomes in Northern Cambodia.

Chapter 5 takes Clements & Milner-Gulland's (2015) evaluation of short-term impacts of conservation interventions on three observable outcomes (socio-economic status, agricultural productivity, and food security) to the medium term. I use a 6-year dataset of a longitudinal panel of households to clarify the mechanisms through which social effects take place and how this translates into the development pathways adopted by households living inside PAs compared to households outside PAs.

This chapter is under revision at World Development as:
Beauchamp, E., Clements, T., Milner-Gulland, E.J. Assessing medium-term impacts of conservation interventions on local livelihoods in Northern Cambodia.

Chapter 6 offers a qualitative exploration of the conceptualisations of human well-being in the study area to capture the multidimensionality and heterogeneity of perceptions in the landscape. I find that individual well-being as well as village solidarity and trust are heavily linked to issues related to land and its governance, and are being strongly affected by the competing land use interventions at play in the landscape.

This chapter is under revision at Conservation and Society as:
Beauchamp, E., Woodhouse, E., Clements, T., Milner-Gulland, E.J. "Living a good life": Conceptualisations of well-being in a conservation context in Cambodia.

Chapter 7 builds on Chapter 6's findings to investigate how competing pressures from PAs and ELCs affect five key land issues reflecting well-being conceptualisation priorities in the communities studied. I use ordinal regressions to assess factors influencing local perceptions of land issues and investigate whether conservation interventions can improve perceived tenure security against external development pressures.

Chapter 8 provides a synthesis of the research findings, reflections on the methodological approaches for assessing social impacts in conservation, and key implications for conservation management, as well as directions for future research.

This research was performed under the umbrella of the wider project "Measuring complex outcomes of environment and development interventions" undertaken between September 2013 and March 2016, which was a partnership between the Wildlife Conservation Society (WCS), Imperial College London (ICL), and University College London (UCL), and was funded by the UK Economic and Social Research Council and the UK Department for International Development.

This thesis is the result of my original and independent research. Nonetheless, I hereby acknowledge two areas where my work builds on initially collaborative efforts. Firstly, this thesis builds on previous research to evaluate the impacts of conservation projects in Northern Cambodia (Clements & Milner-Gulland 2014). I have, however, adapted the original survey design to address my novel objectives and modified the indicators used to reflect recent changes that have occurred in the Northern Plains landscape between 2011 and 2014. Details of these changes are described in Chapter 3. Secondly, this thesis

applies a conceptual well-being framework that has been co-developed with the ESRC-DFID project team. I have actively participated in the decision-making around the adapted well-being framework used in this thesis and I provide justification for its use in this thesis in Chapter 2. I independently designed all the survey instruments and methodologies used in this thesis.

1.3.1 Other collaborative outputs related to this study include:

Peer-reviewed paper

Woodhouse, E., Homewood, K. M., **Beauchamp, E**., Clements, T., McCabe, J. T., Wilkie, D., & Milner-Gulland, E. J. (2015). Guiding principles for evaluating the impacts of conservation interventions on human well-being. Phil. Trans. R. Soc. B, 370(1681), 20150103.

Book chapter

Woodhouse, E., Homewood, K. M., **Beauchamp, E.**, Clements, T., McCabe, J. T., Wilkie, D., & Milner-Gulland, E. J. (in press). “Chapter 5: Understanding human well-being for conservation: a locally driven, mixed methods approach”. Bunnefeld, N., Emily Nicholson, E., Milner-Gulland, E.J. (Eds.). Decision-making in Conservation & Natural Resource Management: Uniting Top-Down and Bottom-Up Approaches. Cambridge University Press.

Report **(contributing author)**:

Woodhouse, E., De Lange, E., Milner-Gulland, EJ. 2016. "Evaluating the impacts of conservation interventions on human well-being: guidance for practitioners”. International Institute for Environment and Development, London.

1.4 My scientific approach

Recent calls to integrate self-reflections in applied research fields such as development and conservation science have recommended including a

declaration of self-ethnography and explicit, more personal statements about the hard choices researchers have had to make when faced with the realities of practical research (McShane et al., 2011). The following section presents reflections on my personal scientific approach underlying this thesis, including a self-ethnography establishing my background as a researcher (Mosse 2005). This exercise has been deemed increasingly important in clarifying the purpose and identifying potential biases in the application of scientific expertise (Holm et al. 2013; Pasgaard 2015).

Prior to this thesis, I have had the chance to work on a number of projects operating at the nexus of environmental and developmental issues, across the private, governmental, and third sectors. My previous studies are grounded in development economics and throughout years working in Costa Rica, Barbados, India, and Cameroon, it became evident that no development programme can be sustainable if it doesn't account for adequate natural resource management. For this reason, I wished to expand my knowledge of approaches to conservation, especially in terms of what works and for whom. Can conservation interventions aiming - in theory - primarily at saving nature adequately account for human needs? Having never worked in biological conservation before, I saw the opportunity to do my PhD as part of the wider ESRC-DFID funded project on "Measuring complex outcomes of environment and development interventions" as a chance to answer this question for myself, and to support the work of the Wildlife Conservation Society (WCS) and further contribute to conservation and development policy in Cambodia.

Being part of a larger project allowed me to cover considerable trans-disciplinary issues through our synergetic efforts. However, it did set certain boundaries to the exercises to be completed during this thesis. For one, the medium-term evaluation of WCS's PES programmes in Northern Cambodia was one deliverable. The application of a shared and collectively designed, transferable, multidimensional well-being framework to further assess the PES programmes was a second one. With the financial, logistical, and time constraints of conducting this research as a PhD thesis, I have found that such

trans-disciplinary work often only gets ‘scratches the surface’ of certain topics, as expanding your horizons laterally only provides so much space and time for deepening each individual topic covered. I have done my best to be transparent about the limitations of my knowledge both before and now, and I humbly acknowledge that much more work needs to be done to properly present a unified narrative when presenting trans-disciplinary research. In this sense, this thesis is testament to the difficulty of bridging natural and social sciences in terms of language used, prioritised methods, and even thesis presentation and content.

This work is also a result of adopting a very pragmatic approach to science, recognising that the thesis primarily exists because it is useful to inform and hopefully influence the behaviour of end users who can act upon my findings. In terms of thesis structure, each chapter has been written to stand alone, to hold its logic and argument within itself, rather than follow the monograph approach typical to social sciences. This ‘research paper’ style is a practical solution to a thesis that covers many different subjects, literatures, and methodologies, but also aims to facilitate the future sharing of the findings of this thesis.

Additional limitations include that despite my experience in social surveys, my overall background brings me far short of the sorts of skills and understanding required to carry out a thorough anthropological and ethnological study. To do so would have required spending much longer on participant observation in order to build up a more holistic narrative account of local perceptions (Newing et al. 2011). While I am aware that mental health is an important factor in well-being, I have also made no attempt at conducting psychology-oriented assessments. I feel that attempting to do so without appropriate professional training would have been detrimental to both the research and the participants.

I cannot state I consciously entered this PhD under a specific philosophy of science or worldview. In retrospect, my approach to science can be tagged as pragmatic positivist (Feilzer 2009; Moon & Blackman 2014), yet with the

relativist perspective of aiming to understand the difference between human beings and their environment, with a respect for democratic approaches to their opinions and values (Johnson & Onwuegbuzie 2004). I largely adopt an 'action research' outlook, based on a belief that the primary aim of research is to support management actions. For example, I am aware that the heavier representation of quantitative methods in this thesis is a result of responding to the need identified by WCS to report on its programme evaluation. Thus, the knowledge I acquired is inevitably tinted with my own perceptions and I acknowledge that it is difficult to remain objective whilst providing insights into a particular conservation activity that I believe is important.

I was aware of my own position as a Western researcher and the related biases this introduces in research, and I have worked to reduce these prejudices throughout this study. For example, I based myself in Cambodia for the majority of my PhD and I learned Khmer. This allowed me to better understand the granularities of expressions of well-being and personal opinions discussed in my interviews. This, as well as the relatively extensive period of time (considering my other tasks) spent in the three communities where I based my work on well-being conceptualisations, helped bridge the cultural gap of the white foreign researcher and international workers parachuting into villages for snapshot assessments. I was able to communicate directly with villagers and participate in local life with fewer repercussions as time went by. Overall, I believe this pragmatic approach to research has been an appropriate way of answering my personal and research questions and of providing a novel contribution to science and policy.

2. Theoretical background

2.1 Introduction

In this chapter, I start by discussing the trends in conservation approaches and practices over recent decades. I then look at the evolution of evaluation practices, focusing on the recent developments related to evaluating the social impacts of conservation interventions. More specifically, I describe two areas of methodological novelty this study applies to achieve its objectives: the application of quantitative methods to capture attribution and complexity of intervention effects; and the promotion of mixed methods to better understand the effects on the multiple dimensions of human well-being. I then review literature and frameworks addressing the concept of human well-being, and proceed to elaborate on the approach used in this study.

2.2 Evolution of conservation practices

2.2.1 From "fences and fines" to win-win approaches

Many of the early conservation strategies applied in colonial and postcolonial times were as bio-centric as the contemporaneous development strategies were anthropocentric (Barrett & Arcese 1995). From the 1950s to the 1980s, biodiversity conservation efforts concentrated on establishing networks of parks and reserves to protect such sites (Bell 1987; Prendergast et al. 1999). In fact, conservation was typified by the "fences and fines" approach emphasising interventions with little or no regard for local people, and often heightened conflict with local communities (Machlis & Tichnell 1985).

By the 1980s, many case studies yielded criticism, indicating that conservation interventions had failed in their goals of preserving biological diversity in the tropics (Leader-Williams & Albon 1988). Parks and protected areas were found to be rapidly becoming "islands" as the wild lands around them converted to alternative, often incompatible, uses. Additionally, the conservation community started to acknowledge that communities next to or within protected areas

frequently bore substantial costs to their livelihoods – as a result of loss of access – while receiving little in return (Wells et al. 1992)

Consequent consensus emerged that new approaches in conservation management were needed, ones that integrated the needs of local people (McNeely et al. 1990). Simultaneously, the international policy discourse and related global conventions emphasised the link between environment and poverty alleviation and promoted a 'win-win approach' to describe the simultaneous achievement of positive outcomes for both agendas (Bauch et al. 2014; Brown 2004; Scherl 2004). The 1980 International Union for Conservation of Nature (IUCN)'s World Conservation Strategy reflects this shift by emphasizing the linkage between protected area management and local communities' economic activities (IUCN 1991), but it was at the Earth Summit in Rio de Janeiro in 1992 that the addition of development in conservation was sealed (Christensen 2004).

The logic and rhetoric of win–win thinking encompasses a number of popular conservation approaches and programs, including debt-for-nature swaps, extractive reserves, community-based conservation, and integrated conservation and development projects (McShane et al. 2011). Starting in the mid-1980s, the concept of Integrated Conservation and Development Projects (ICDPs) gained rapid momentum at the time (Garnett et al. 2007; Marcus 2001). First introduced through the World Wide Fund for Nature (WWF)'s Wildlands and Human Needs Program in 1985, ICDPs have now been defined as "an approach that aims to meet social development priorities and conservation goals" (Worah 2000).

By the early 2000s, despite the popularity of ICDPs and decades of experience, evidence on their effectiveness was at best not convincing (Brooks et al. 2006; Wells & McShane 2004). Indeed most studies point to ICDP failures rather than successes (Agrawal & Gibson 1999; Bauch et al. 2014; Berkes 2004; Hughes & Flintan 2001; Kelman 2013 McShane et al. 2011;). Several criticisms lay at the heart of ICDPs, including that the projects

give the wrong and too few incentives for local people to participate in conservation (Barrett & Arcese 1995; Ferraro & Kiss 2002).

A wealth of literature reviewing ICDPs has now documented the difficulties of integrating conservation and development at the site level, the reality that integration is still the exception, and that synergies do not emerge naturally (Adams et al. 2004; Paudel et al. 2005). Research recognised that people's motivations are not finite (Ferraro 2001) and that interventions based on flawed assumptions about people's behaviours, needs and aspirations are likely to fail in achieving both conservation and development objectives (Brown 2003). A main criticism of ICDPs lies in their concept, inasmuch as ICDPs fail to conserve biodiversity by virtue of their too complicated and indirect linkages between conservation and development. But foremost, the optimistic approach hides realistic trade-offs between conservation and development, hence failing to achieve either's targets (Brown 2004; Salafsky 2011); Scherl 2004.

2.2.2 Market-based conservation approaches

Following the disillusion of the 'win-win' approach in the early 2000s, a new international conservation discourse evolved towards neoliberal and market-oriented approaches, theoretically allowing further decentralisation and empowerment of local communities (Blom et al. 2010; Milne & Adams 2012). Neoliberalism in conservation is diversely manifested, but frequently involves the displacement of the state as conservation actor by private sector and non-governmental organisations (NGOs), and the adoption of market-based approaches rather than regulation as a means of achieving conservation goals (Brockington & Duffy 2010; Büscher 2008). Most prominent amongst this are Payments for Environmental Services (PES), and, more specifically, initiatives for reducing emissions from deforestation and forest degradation and other land use changes (REDD+) (Mahanty et al. 2013).

PES have been defined as a voluntary, conditional agreement between at least one "seller" and one "buyer" over a well-defined environmental service — or a land use presumed to produce that service (Wunder 2007). Direct strategies

such as PES are purported to be more effective than indirect strategies such as ICDPs at delivering conservation and development, and more cost-efficient (Engel et al. 2008; Ferraro & Simpson 2002; Muradian et al. 2010; Wunder 2007).

Critics of the PES approach highlight that ecosystems should be more than just valued for their uses or for people's sake (Kosoy & Corbera 2010; McCauley 2006; Redford & Adams 2009; Robertson 2006). In other words, creating environmental services markets is a step towards the commodification of nature by setting an exchange value for the use value of ecosystems, leading to “selling out on nature” (Gomez-Baggethun & Ruiz-Perez 2011; McAfee & Shapiro 2010). In fact, market incentives can result in changes in attitudes, “crowding out” altruistic motivations (Frey 1993), as the effects of moral sentiments and material interests on behaviour do not usually interact in complex ways (Bowles & Hwang 2008). Moreover, PES do not foster the creation of social capital (García-Amado et al. 2011). In fact they provide the potential for communities to fall into unfair agreements due to asymmetrical power relations in the context of weak institutions, and fail to reinforce the intrinsic understanding and conservation motivation of local communities (Milne & Adams 2012).

2.2.3 Human-centred conservation

The evolution of conservation approaches bears witness to a gradual yet constant move towards more human-centred conservation approaches, with PES addressing issues of motivation and incentives for creating more sustainable human behaviours. Today, a wide mix of mechanisms are used to achieve conservation objectives, which have grown to include a range of values that can be maintained in protected wild and cultural landscapes (Stolton & Dudley 2010). Among others, there is now consensus among international policy circles that conservation should at very least ‘do no harm’ to the local populations affected by interventions (CBD 1992; IUCN World Parks Congress 2003, 2014), and a range of conservation interventions now

aim at mitigating poverty, improving local livelihoods, and even further, enhancing human well-being (Leisher et al. 2013; Milner-Gulland et al. 2014).

Some studies point to the success of PES projects where programmes are slowly implemented by local organisations and allow a good understanding and are supported by local people (Clements et al. 2010; García-Amado et al. 2011). It is argued that expansion of PES can occur if schemes can demonstrate clear additionality (i.e. incremental conservation effects vis-a-vis predefined baselines), if PES recipients' livelihood dynamics are better understood, and if efficiency goals are balanced with considerations of fairness (Engel et al. 2008; Wunder 2007). PES are arguably well suited to contexts in which there is reasonable land tenure rights, and with emerging, not-yet realised threats (Pagiola et al. 2005; Zilberman & Mccarthy 2008). In fact, it seems that social factors, such as the institutional and socio-political settings of projects, are the main factors in enabling or blocking conservation success across mechanisms used.

In recent years studies have increasingly recognised that engaging with the human dimensions of conservation is necessary to produce robust and effective conservation policies, actions and outcomes (Bennett et al. 2017; Sandbrook et al. 2013). It is now recognised that conservation policy, while aiming for the preservation of natural resources, primarily stems from social processes (Mascia et al. 2003).

2.2.4 Effectiveness of conservation efforts

Recent decades have seen conservation practices undergo a pronounced expansion, geographically and conceptually. Yet despite the constant search for more efficient and holistic approaches to conserve the world's biodiversity and the people reliant on it, recent indicators of the state of biodiversity globally show constant declines, with no significant recent reductions in rate (Wardle et al. 2011). Additionally, indicators of pressures on biodiversity such as including resource consumption, overexploitation, and climate change impacts

showed increases (Butchart et al. 2010). Have the past decades of conversation effort failed? Not entirely.

Overarching studies have found that that despite inadequate funding and management processes, protected area management was successful at reducing deforestation, contributing to biodiversity conservation and community well-being (Andam et al. 2008; Ferraro et al. 2013; Leverington et al. 2010). Additionally, systematic literature reviews of conservation projects have showed that permitted use of natural resources, market access, and greater community involvement in the conservation project are all important factors for successful outcomes (Lele et al. 2010), and that community managed forests present lower and less variable annual deforestation rates than protected forests (Brooks et al. 2006).

Similar reviews conclude that decentralization of resource management such as community managed forests present lower deforestation rates then protected forests (Porter-Bolland et al. 2012) and provide more positive socio-economic and environmental outcomes for communities, due to locally-based conflict resolution. Furthermore, Leisher et al. (2013) found evidence across different types of conservation projects that some mechanisms effectively contribute to alleviating poverty, such as ecotourism and PES. Finally, there have been rigorous case studies providing empirical evidence that conservation projects can contribute to both biodiversity conservation and rural livelihoods, through PES mechanisms (Baral et al. 2007; Clements & E. J. Milner-Gulland 2015; Ingram et al. 2014).

There is therefore evidence showing that conservation efforts can successfully achieve the goals of preserving nature while doing no harm to local populations. While this is encouraging, it is questionable whether these studies constitute a representative sample of the status of conservation globally. This is primarily because of the general lack of data gathered during conservation projects (Sheil 2001). A main point of contention in the ongoing discourse over the efficiency of conservation interventions is the lack of ecological and social

monitoring and applied research activities within projects (Kremen et al. 1994; Tallis et al. 2008). Secondly, when data is available there is often a lack of rigor in the methodologies used to evaluate the impacts of conservation, especially when it comes to the social side of impacts. The field of conservation is generally behind in testing intervention against null hypotheses and following evidence-based policy implementation, and few studies use appropriate impact evaluation methodologies (Andam et al. 2008; Ferraro & Pattanayak 2006; Sutherland et al. 2004). Lastly, it is worth acknowledging that the publishing culture in conservation primarily documents success stories rather than lessons learned from failures (Hobbs 2009; Knight 2009).

The lack of clear evidence from rigorous impact evaluations remains one of the reasons for the lack of consensus on ICDP effectiveness still today (Bauch et al. 2014; Hughes & Flintan 2001). In a recent systematic review of 136 community-based conservation evaluations, 80% of the studies included were rated as poor quality on the basis of conflict of interest (i.e. lack of independence), data validity and other problems, arguably throwing the results of an otherwise meticulous statistical analysis into serious doubt (Brooks et al. 2013). Similarly, lack of evidence from sustainable livelihood projects led to the passing in 2012 of a resolution at the IUCN World Conservation Congress which called for a critical review of the benefits to biodiversity of alternative livelihood projects (Roe et al. 2014).

Taking stock of conservation effectiveness to date highlights that while evidence to date is encouraging, that evidence still falls short of acceptable in terms of both quantity and quality. Digging into the published literature evaluating the social impacts of conservation further shows that methods employed to date are ill-suited to exploring the full scope of consequences and opportunities conservation bears on human lives.

2.3 Evaluating social impacts of conservation

Methods to evaluate biodiversity targets of conservation interventions are widely available (Ferraro & Pattanayak 2006), and there is ready

acknowledgment in the literature that robust empirical evaluation is required in order to better understand which approaches can work for biodiversity. Yet extension of these approaches to the social impacts of conservation are still limited (Fisher et al. 2013). The effect of conservation interventions on human lives has long been a topic of contentious debate (Wells et al. 1992; Brockington & Wilkie 2015), continuing to this day as new methods for assessing impacts evolve (Baylis et al. 2015; Woodhouse et al. 2015). Despite years of experience, the social impacts of protected areas are poorly understood largely because previous evaluations have tended to focus on one or very few outcomes, and few have had the requisite data to assess causal effects (i.e. longitudinal data for protected and control sites) (Gurney et al. 2014).

The social impacts of conservation interventions are hard to assess since the processes that cause environmental change are often very complex, and potentially affect multiple aspects of human well-being (McGregor et al. 2007; Milner-Gulland et al. 2014). Additionally, conservation projects rarely operate in exclusive landscapes yet interventions can often have disconnected, if not conflicting, objectives and approaches (Pender et al. 2004; Scheidel et al. 2013).

Among the abundance of literature that has aimed at assessing the social effects of conservation over recent decades (Brockington & Wilkie 2015), studies rarely provide clear-cut and transferable arguments about net outcomes, and often suffer from a lack of methodological robustness (Oldekop et al. 2016; McKinnon et al. 2016).

The redundant issue remains that there is still a scarcity of robust evidence for assessing the effects of conservation interventions (Baylis et al. 2015; Ferraro & Pressey 2015). Pullin et al (2013)'s systematic review of evidence for impacts of protected areas on human well-being reports that the existing quantitative studies on PA impacts are highly susceptible to bias and generally unreliable. Without a suitable research strategy, credible conclusions about

the effects of conservation interventions cannot be drawn from empirical studies (Pressey et al. 2015). The situation is changing as conservation scientists adopt more scientifically rigorous evaluation designs, and conservation funders and practitioners give greater scrutiny to the impacts of their investments (Ferraro & Pressey 2015).

For many, the call for more 'rigorous' impact evaluations is taken to prioritise studies tackling the selection bias aspect of attribution. This attitude prefers the use of randomised control trial (RCT) techniques. However, this position has received an increasing amount of criticism (White 2013). Not only have RCT techniques been deemed reductionist and lacking in context, but they are also inapplicable to conservation and development projects where selection biases are inherent (Camfield & Duvendack 2014; Harrison 2011). Until recently, there have been few RCT studies conducted in international development (Duflo & Kremer 2005; Miguel & Kremer 2004). Along with these considerations, the quality of evidence has also improved over the last decade with the increased application of mixed methods, or the integration of quantitative and qualitative methods, in research on poverty and well-being emanating from the field of development (Bernard 2006; Burrows & Read 2015; Camfield & Duvendack 2014; Dawson 2015; Shaffer 2013). Yet similar improvements are yet to become the norm in a conservation context (de Lange et al. 2015).

The rest of this chapter will review evaluation practices as a discipline to highlight current methodological challenges in the impact evaluations addressed in this study, namely the attribution of impacts to interventions in a fast-changing context over a long time-period, and capturing the non-material impacts of interventions on multi-dimensional human well-being. I will then describe how applying mixed methods to operationalise well-being research can give novel insights into contextualised evaluation methodologies and the situation of conservation in Cambodia.

2.3.1 Review of quantitative social evaluation methodologies

Identifying the precise effects of a policy is a complex and challenging task. This issue is particularly salient in an uncertain economic climate, where governments are under great pressure to promote programmes that can recharge growth and reduce poverty (Khandker et al. 2009). The recent surge in impact evaluation studies represents a response to the growing demands of policy makers and practitioners to be better informed about the impact of conservation policies and to better target their activities (Waldron et al. 2013). Impact evaluations must be clearly differentiated from evaluations in general: whereas traditional evaluations address questions about the design or implementation of an intervention, impact evaluations are structured around attribution questions, namely, whether the change in outcomes is caused by the intervention (Ferraro 2007). The main goal of an impact evaluation is therefore to measure the difference in an outcome, in a way that attributes the difference to the focal program and only that program (Lensink 2014a).

Initially adapted from the medical field, such quantitative evaluation methods focus on comparing the treated units against control units for which outcomes are, in theory, affected by the same factors as the treatment group, other than the assignment of the intervention (Mupepele et al. 2016; Pullin & Knight 2001). It also requires the assumption that outcomes of one individual are not affected by the treatment assignment of any other individuals (Rosenbaum & Rubin 1985). Analogous to drug testing, randomised control trials (RCTs) techniques have been adapted to the field of development studies to determine treatment and control groups by randomised assignment of the intervention, providing a meaningful methodology for conducting valid impact evaluations – in certain conditions (Banerjee & Duflo 2009; Banerjee et al. 2010).

Despite their original status as the ‘gold standard’ of impact evaluations, in practice, the conditions for ideal RCTs almost never hold because conservation and development interventions are most likely to be implemented with a specific bias towards locations with high biodiversity potential (Joppa & Pfaff 2010). Notwithstanding the discussion about the types of indicators used,

impact evaluations in conservation require additional quasi-experimental design considerations to control for remaining selection biases and differential treatment effects (Lensink 2014a).

Moving from experimental to quasi-experimental techniques means finding alternative ways to produce relevant counterfactuals to the treatment units. These include quantitative evaluations of conservation interventions involving statistical matching and before-after-control-interventions (BACI) survey designs, which allow researchers to measure “what would have happened in the absence of the intervention” (Bowler et al. 2012; Ferraro & Pressey 2015; Margoluis et al. 2009). These methods also aim to better capture the attribution of interventions in a complex environment and to enable disaggregated impacts to be captured (Andam et al. 2010; Clements & E J Milner-Gulland 2015; Gurney et al. 2015).

Recent studies using quasi-experimental methods in impact evaluation have provided new and promising insights on the effect of different types of conservation interventions. Studies from Bolivia (Hanauer & Canavire-Bacarreza 2015), Cambodia (Clements & E J Milner-Gulland 2015; Clements et al. 2014), Costa Rica (Ferraro & Hanauer 2014; Robalino & Villalobos 2014), Indonesia (Gurney et al. 2014), Madagascar (Rasolofoson et al. 2016) and Thailand (Andam et al. 2010) point to conservation interventions having either no differential impact on local communities or making positive contributions to poverty mitigation, when compared to counterfactuals.

More importantly, these studies have underlined the importance of not only exploring whether or not conservation interventions improve or exacerbate local populations' situations, but also of understanding the mechanisms through which the effects take place (Brockington & Wilkie 2015; Ferraro & Hanauer 2015).

2.3.2 Challenges in current social impact evaluations

Due to the novelty of the appetite for applying quasi-experimental designs to evaluate conservation intervention impacts and the difficulty in applying these approaches retrospectively, few studies have been able to provide a medium to long-term perspective on these issues (Ahmadia et al. 2015; Kapos et al. 2008). Yet this is a critical exercise, as many of the desired goals of conservation projects are likely to vary in spatial and temporal scale, but short-term success may not predict longer-term benefit. Alternatively, even in the absence of short-term success, the impacts of improved community participation may still lead to important longer-term benefits (Blomley et al. 2008; Brunner et al. 2005).

Investigations of the depth, magnitude and distribution of the social effects of conservation must therefore take a long-term perspective over multiple time periods in order to identify differentiated impacts as well as potential unintended consequences and spatial spillover effects to untargeted areas (Miteva et al. 2012; Pressey et al. 2015; Pullin et al. 2013). Working from the household to the landscape scale is necessary to identify both the interactions between the social impacts of interventions on different sub-groups within communities, and how these interacting effects vary geographically across multiple treatment and counterfactual sites (Agarwala et al. 2014; Pomeroy et al. 2011).

However, undertaking large-scale survey-based evaluations over medium timescales presents a number of challenges. Social change takes time to transform into new livelihood habits. This can take years to unfold, and unintended feedbacks can occur over these long timescales. Despite the strength of currently deemed ‘gold standard’ impact evaluations for attributing change to interventions (Pattanayak 2009), quasi-experimental designs assume linearity in changes and focus on averages. These are inadequate reflections of the realities of rural transitions, as mechanisms of change and development pathways are dynamic, heterogeneous and unpredictable. Additionally, transitions have often been shaped by unpredictable and

uncontrollable events coming into play and interfering with a project's theory of change. In reality, the attribution assumption is hardly ever met over long periods of time. In fact, attributing impacts to interventions can be largely inflated if results are not further controlled for other factors that have come up over the years.

Lastly, most quasi-experimental designs focus on observable indicators – or the material, observable dimensions of human well-being such as standard economic measures of development (McKinnon et al. 2016; Vira & Kontoleon 2010). This fails to capture well-being outcomes considered relevant by local people, such as tenure security, education, ability to insure against shocks, or political power (Agrawal & Redford 2006; Gough & McGregor 2007; Sen 2001).

2.4 Towards more holistic and pragmatic evaluations of conservation

While remaining methodologically robust, impact evaluations also need to become more holistic. Interventions aim to achieve implicit or explicit sets of goals, such as improvements in biodiversity and livelihoods, through an idea of how effects will take place – or a theory of change (Devereux & Roelen 2015). In reality, the implementation of these interventions translates into changes in the social dynamics and in the development pathways of rural communities (Suich et al. 2015). Recognising and qualifying the multidimensional nature of these different pathways and the causal linkages between resource use and livelihoods in context-specific assessments is necessary to achieve the intended goals (Porro et al. 2015).

This comes hand in hand with a call for the adoption of mixed methods in impact assessments, to reflect the complex nature of how social changes occur through these mechanisms (Khagram & Thomas 2010). In other words, quantitative surveys are desirable to confidently identify whether interventions have an impact, answering the 'what' and 'how much' questions, while qualitative research is needed to answer the 'why', 'how' , and 'for whom' questions (Copestake & Remnant 2015; Devereux & Roelen 2015). Despite

acknowledgements of the need for complementarily producing quantitative and qualitative evidence (Ravallion 2007), there remains a tendency to underestimate the fundamental importance of descriptive inference.

In recent years, calls for the application of mixed methods and for more holistic social indicators to evaluate adequately the socio-ecological context in which conservation interventions are based have reached a crescendo (Berkes 2004; Gardner et al. 2009; Garnett et al. 2007).

2.4.1 Embracing the mixed methods research paradigm

Mixed methods research has developed rapidly in recent years, championed as a third approach bridging the traditional paradigms of qualitative and quantitative research (Tashakkori & Teddlie 1998). Mixed methods research as a paradigm, also referred to as Q-squared (Kanbur 2003), has emerged as an alternative against the dichotomy of positivism in quantitative research, which emphasises objectivity and detachment of the observer in the scientific method (Nagel 1989), and the constructivism of qualitative research, which in turn rejects the desirability and feasibility of context-free scientific inquiries and embraces subjectivity in research as a preferred philosophy (Erlandson et al. 1993; Morgan 2007). Johnson & Onwuegbuzie (2004) define mixed methods as “the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study”.

These paradigms are important when considering what justifies the methods used to answer a specific research question. Mixed research makes use of the pragmatic method and system of philosophy, overriding the overwhelming concerns and dogmatism linked with using either positivist or constructivist beliefs (Reichardt & Rallis 1994). In this sense, mixed methods support the development and triangulation of knowledge from both deductive and inductive reasoning (Kanbur & Shaffer 2007). It is also an attempt to legitimise the use of multiple approaches in answering research questions, rather than restricting or constraining researchers’ choices (Feilzer 2009).

A key feature of mixed methods research is its methodological pluralism or eclecticism. The majority of mixed method research designs can be developed from the two major types of mixed methods research: mixed model (mixing qualitative and quantitative approaches within or across the stages of the research process) and mixed method (the inclusion of a quantitative phase and a qualitative phase in an overall research study) (Johnson & Onwuegbuzie 2004). For example, an across-stage mixed-model design can use different methods across the stages of the research process, whereas a within-stage mixed-model design would use both quantitative methods, such as a rating scale, and qualitative methods, such as open-ended questions.

However, using mixed methods has further epistemological and ontological implications beyond the simple application of both qualitative and quantitative methods in a single piece of work. Failure to understand and recognise the principles and assumptions that are embedded in the research methods used can compromise the integrity and validity of their research design and results (Moon & Blackman 2014). Thus a tenet of mixed methods research is that researchers should mindfully create designs that effectively answer their research questions; this stands in contrast to the common approach in traditional quantitative research whereby students are given a menu of designs from which to select (Mertens 2003).

Following a pragmatic mixed method approach to impact evaluation demands the following: clear definition of the steps undertaken throughout the research process with a specific focus on defining the research purpose based on the intervention logic, not by the methods available; clarifying when and why qualitative and quantitative methods have been used and integrated into the research design to generate evidence; and finally, legitimising the research outputs by analysing its validity in order to position it results within the relevant discourse (Ton 2012; White 2013).

While traditionally natural science disciplines have been associated with being more quantitative and social science more qualitative, it is good to remember that research paradigms are not inherent traits of a discipline (Moon & Blackman 2014; Morgan 2007). The original focus on biological sciences in conservation as observed in original 'fences and fines' approaches may have lent an overwhelmingly positivist approach to early social impact evaluations, yet it has become clear that in order to understand the social dynamics of conservation, more nuanced mixed methods assessments must be produced to capture how and for whom conservation works.

The dynamic, complex, and inter-disciplinary nature of conservation projects dictate the need for more thoughtful integration and use of both qualitative and quantitative methods using the mixed methods paradigm to adequately capture mechanisms through which impacts take place (Copestake 2014).

Additionally, novel approaches are needed to explore the holistic and non-material trade-offs that conservation interventions can trigger when it comes to local people's livelihoods, motivations and strategies under changing circumstances (Berkes 2004; Sandker et al. 2009; Souto et al. 2014). This is especially important when conservation interventions such as PES come into play, as their success in achieving conservation goals depends on understanding the incentives of local communities. Over the past few years, conservation literature has also started to incorporate the social concept of human well-being as a key consideration in designing successful conservation policies and measuring intervention impacts (Agarwala et al. 2014; OECD 2011).

2.4.2 Exploring non-material definitions of development

The concept of well-being is embedded in the capability approach to development, which arose in response to the inadequacy of economic proxies to measure development and the need for more holistic indicators of growth and quality of life (Ravallion 2003). The capability concept was first coined by Amartya Sen in 1979 while discussing inequality (Sen 1980), yet it was in the

1990s that Sen and Nussbaum provided a clear argument setting the approach as a more relevant concept to capture and measure a nation's quality of life than regular economic measures (Nussbaum & Sen 1993). Capability, defined as person's ability to do valuable acts or reach valuable states of being, is a more appropriate concept to capture the heterogeneity and subjectivity of the diverse aspects of development and human well-being, moving away from traditional approaches typically focusing on resources or utility (Nussbaum 2003).

Sen's further work on *Development as Freedoms,* arguing that capabilities provide the best basis for thinking about the goals of development, played a significant role in moving the economics and development studies paradigms away from the exaggerated emphasis on growth and towards issues of personal well-being, agency and freedom (Sen 2001). The capability approach provided an evaluative space for investigating human well-being, accommodating concerns about the ability to live well across all spheres of life, either material, mental, or other substantive freedoms. Guidelines to developing a specific list of 'basic capabilities' was not provided by Sen. In fact, early critics of the capability approach argued that the lack of prescriptive factors defining capabilities made it incommensurable and unhelpful in cross-geographic assessments (Saith 2001).

Early works to operationalise an assessment of well-being includes Nussbaum's adoption of a more universalist view of well-being which considers certain 'basic human capabilities' as being core to human life, with a degree of overlapping consensus between different societies, thus serving as a basis for cross-cultural comparison (Nussbaum 1995). Nussbaum's narrative specifically frames basic human capabilities as entitlements similar to human rights (2001), and is grounded in social justice theory, with the aim of facilitating the adoption of a capability approach in public policy institutions (Nussbaum 2004; Robeyns 2005). The list of original indicators was nonetheless conceptually general to leave room for negotiation, including

entitlements such as life, bodily health, senses, imagination and thought, emotions, and control over one's environment.

The primary divergence between different streams of capabilities research lay in the intended goal of the work: while Nussbaum's perspective steers the capability approach towards social justice and institutionalism, Sen's capability work targets applied work on poverty and destitution in developing countries (Clark 2005).

2.4.3 Acknowledging the multi-dimensionality and heterogeneity of well-being

The capability approach influenced a number of studies aimed at capturing empirically the many different aspects of human poverty and well-being in development literature in the 2000s (Alkire 2002; Saith 2001). For example, Narayan et al's (2000) 'Voices of the Poor' research, undertaken under the World Bank's commission, reviewed participatory poverty studies conducted in the1990s. It conducted a series of new studies across 23 countries, in which the poor discuss their perceptions of a good life and bad life and highlight components that people commonly invoke as constituting well-being. Five constituents of well-being emerged: material assets, health, good social relations, security, and freedom of choice and action.

An important initiative is the University of Bath's Well-being in Developing Countries (WeD) research (Gough & McGregor 2007). It developed three approaches to empirically study well-being, which includes the Global Person Generated Index (Martin et al. 2010; Camfield & Ruta 2007). Under the WeD's project, well-being is defined as "a state of being with others, which arises where human needs are met, where one can act meaningfully to pursue one's goals, and where one can enjoy a satisfactory quality of life''. This well-being perspective has the potential to provide comprehensive, locally relevant understandings of social impacts, and to elucidate the multi-faceted incentives of resource users and responses to interventions (Woodhouse et al. 2015). In fact, the aim is to understand human well-being not as jobs, or livelihoods, but

as a social and cultural way of life and as a process (Britton & Coulthard 2013; White 2010).

Other noteworthy developments have emerged from international policy-focused perspectives, for example work on indicators for measuring Quality of Life (Costanza et al. 2007). Further top-down exercises have also been essential in moving the overall paradigm of development towards a more multi-dimensional and heterogeneous view of well-being, such as the Organisation for Economic Co-operation and Development (OECD)'s "How's Life" in 2011 and its "Better Life Index" initiatives, which attempt to bring together internationally comparable measures of well-being in line with the recommendations of the Commission on the Measurement of Economic Performance and Social Progress (Stiglitz et al. 2009). This has supported the emergence of consensus in academic and international policy circles over two main principles for conceptualising human well-being.

First, human well-being is a multidimensional concept (Gough & McGregor 2007; MEA 2005; White 2010). Well-being can be understood in terms of three interacting dimensions: the observable material circumstances of a person; a subjective evaluation by the person of their goals and the processes they engage in to attain them; and a relational component capturing their ability to achieve these goals through social networks and interactions (Figure 2.1) (Gough & McGregor 2007). Several frameworks now see well-being as encompassing five primary domains across these three dimensions (MEA 2005; Narayan et al. 2000; Woodhouse, Homewood, Beauchamp, Clements, McCabe, et al. 2015). Human well-being is not only multidimensional in terms of domains but also in terms of the degree to which it is shared, or collective, rather than individual (Gough & McGregor 2007; Woodhouse et al. 2015).

Second, conceptualisations of human well-being are heterogeneous (Agarwala et al. 2014; Dawson & Martin 2015). Well-being is a social construction, and hence needs to be understood from the 'eye of the beholder' and defined by the individuals and communities where well-being is to be

assessed (Gough 2004; Schaaf 2010). Heterogeneity can occur along with geographical variations, but also along socio-economic lines, including but not limited to gender, religion, wealth status, age, ethnicity, and livelihood type (Agarwal 2001). The idea of 'communities of interest' (Ziller 2004) suggests that the interests or concerns which pattern social life and interactions of groups of people can be more relevant than physical location (Hoggett 1997). Heterogeneity also applies on a temporal scale, as personal interests and well-being priorities change along different life stages (Britton & Coulthard 2013; Fisher et al. 2013)

Several frameworks have emerged to describe and categorise the links between well-being and the environment (Fisher et al. 2014; MEA 2005; Roe & Biodiversity 2010; Yang et al. 2013). This notably includes the Millennium Ecosystem Assessment (MEA), which links ecosystem services to five main constituents of well-being. Yet despite the term's popularity, well-being is rarely defined or carefully examined in an empirical context by those concerned with conservation, with only a handful of studies diving into explorations of local perceptions of well-being (Abunge et al. 2013; Britton & Coulthard 2013; Dawson & Martin 2015; Schaaf 2010). Consequently, few studies have used a well-being approach to evaluate the impacts of conservation projects by developing multi-dimensional, locally relevant indicators obtained through consultation with local communities (Fry et al. 2015). There is hence a need for further integration of the concept of human well-being into evaluations of the social outcome of conservation interventions.

2.5 Operationalising a well-being approach through mixed methods in conservation

The well-being framework used in this thesis and as part of the wider ESRC-DFID project adopts an integration of the WeD's approach to well-being, considered to be a successful empirically-tested evaluative approach, and Narayan's five empirically-defined well-being constituents that have been further used by the Millennium Ecosystem Assessment (MEA) and other environmental studies (see Figure 2.1). Despite the variety of prescriptive

approaches, I favoured this hybrid, non-prescriptive framework which allows flexibility in capturing the multi-dimensionality and heterogeneity of locally subjective well-being conceptualisations. The framework further allows responses to be channelled through five components of well-being that have been well established in the field of environmental and conservation science. The hybrid yet clearly defined framework is logically cohesive (McGregor 2004; Robeyns 2005) given the across-stage mixed methods used to explore and analyse well-being, and respects the epistemological goals of Sen's original conceptual definition. This was chosen to maximise the external validity and uptake of resulting evidence in conservation, development and ecosystem-based international policy circles.

The well-being approach used in this thesis provides a holistic and potentially powerful framework for incorporating goals for different well-being domains into decision-making, which can help to build political support and mobilise funding for conservation (Bottrill et al. 2014) . The concept of well-being can also allow researchers to acknowledge and evaluate trade-offs between more diverse and subjective aspects of human development and the protection of nature; this acknowledgement is essential for the success of conservation management and policy decisions (Daw et al. 2015).

2.5.1 Pragmatic justification of methods used

This study was performed under the umbrella of the wider project "Measuring complex outcomes of environment and development interventions", which aimed to contribute to the advancement and operationalisation of the following guiding principles for evaluating the impacts of conservation on human well-being (Woodhouse et al. 2015).

The purpose of this thesis within the wider project is the application of novel mixed methods to provide a contextualised assessment of the impacts of complex conservation and development interventions on human well-being in Northern Cambodia. When considering the pragmatic question 'For whom is a pragmatic solution useful?', the end users are both the local population across

the study site, and WCS as the intervention manager and intermediary (Mertens 2003). Within this framework, I consider my role as a scientist to lie between that of a science arbiter, who aims to answer specific questions that have been posed by the decision-makers, and that of an honest broker seeking to clarify the scope of choices available for the policies (Pielke 2007). For example, the objective of evaluating the medium-term socio-economic impacts of conservation projects in the Northern Plains stems from WCS's desire to evaluate their programme. Yet through the inclusion of a well-being approach to evaluation I seek to expand the scope of future avenues for work for WCS, clarifying how a more holistic approach to social impact could improve conservation policies.

A high-quality impact evaluation must answer a broad range of evaluation questions of a more process nature, to inform both the design and the implementation of the program being evaluated (White 2013). This work's overarching aim to understand the effects of conservation on human well-being imposes epistemological ramifications on the choice of methods used to create valid knowledge towards this goal. While a well-being approach requires a qualitative, constructivist approach to explore local conceptualisations of well-being, a quantitative approach is required to statistically infer generalisable statements across the landscape scale that can be useful for policy-making across the Northern Plains (Rorty 1991). The aim of the thesis further justifies the use of multiple geographical focuses, as social and environmental processes occur over different scales. Consequently, the study of society and environmental relations can be improved by varying the scalar configurations of interactions (Diepart & Dupuis 2014).

This thesis uses survey-based instruments through which respondents' statements are recorded describing observable states of affairs, for example daily rice consumption and number of individuals in a household, and non-observable states of affairs, such as perceptions of security in current and future land tenure. Such observation statements as the basis of facts upon which knowledge is derived hold a level of human bias, for example the

fallibility of recalling and averaging the right numbers (Chalmers 2013). Steps towards improving the reliability of the statements recorded throughout this work and are further detailed in the next chapter describing the data collections. The use of both quantitative and qualitative methods to triangulate observation statements as a significant factual basis for scientific knowledge proved essential.

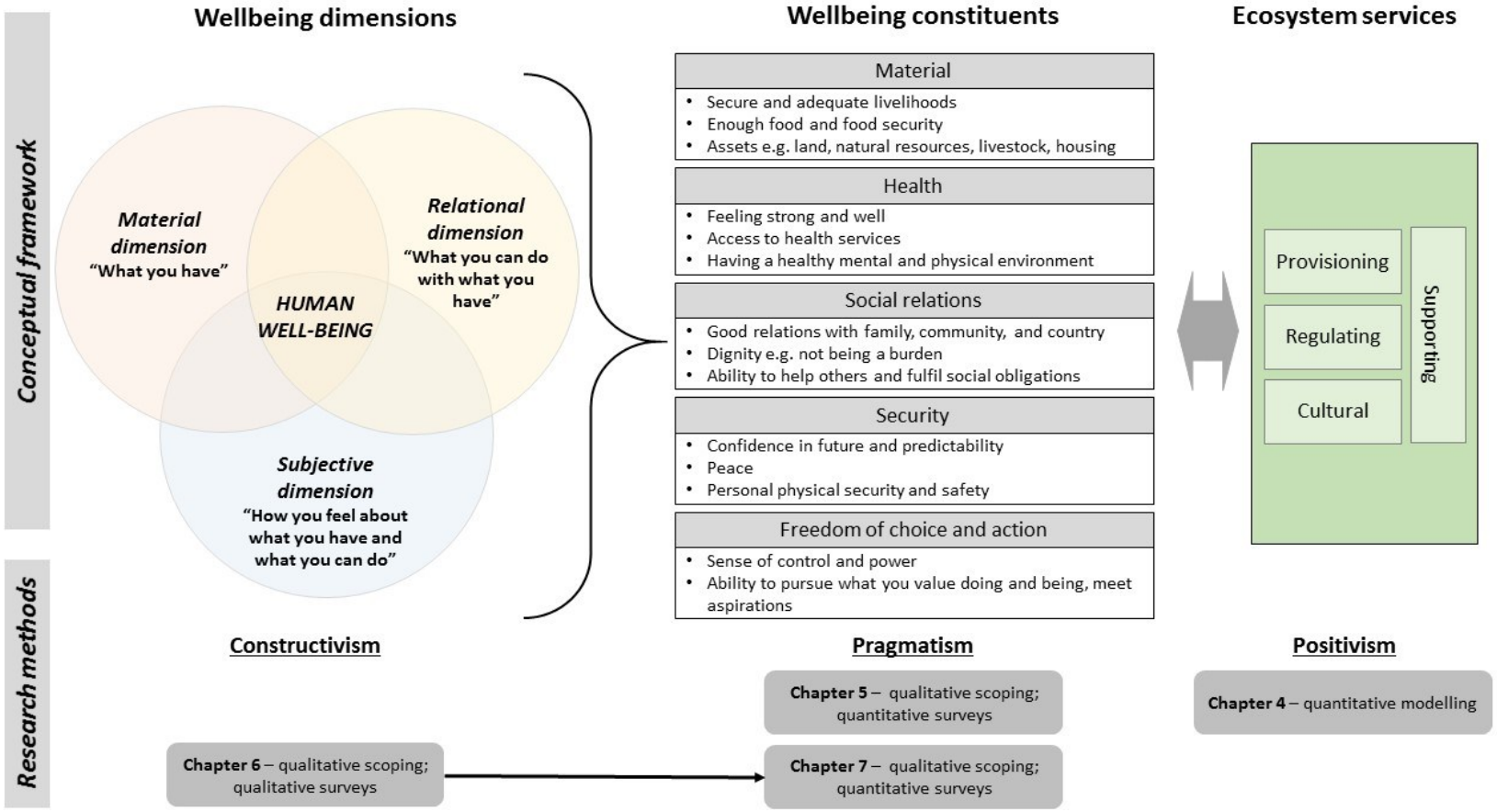

Figure 2.1: Framework for researching human well-being used in this study, based upon McGregor & Sumner (2010), and drawing upon the World Bank's 'Voices of the Poor' research and the Millennium Ecosystem Assessment (Narayan et al. 2000; MEA 2005)**. Well-being encompasses five primary domains, which can each be seen through the lens of the three dimensions. This study uses a mixed method paradigm, applying both within and across the research process.**

3. Cambodia and the Northern Plains landscape

In this third chapter, I provide an overview of the social, political and economic context of Cambodia. More specifically, I expand on the recent development interventions, in terms of Economic Land Concessions (ELCs), and of conservation management present in the country, before focusing on the Northern Plains landscape. Finally, I provide further detail about the historical datasets on which this study builds and on the data collection process for this study.

3.1 Recent Khmer political history

Cambodia is primarily known to the world for two historical periods. First, Cambodia was the epicenter of the Khmer Empire, once the axis of what is considered by some historians as the greatest empire of Southeast Asia between the 10th and 13th century (Chandler 2007). Testament to its grandeur, the temple complex of Angkor Wat was declared a World Heritage Site in 1992 and is now Cambodia's primary tourist destination (Winter 2007). Second, the country is known for the genocide that took place under Pol Pot's Khmer Rouge regime between 1975 and 1979, which led to the death of a third of the Cambodian population at the time and spurred a civil war that lasted for over two decades (Chandler 1998). In fact, it was only in 1998 that the prolonged armed conflicts were successfully resolved by the Cambodian government's so-called 'win-win' policy, which dismantled the Khmer Rouge's last stronghold without bloodshed and integrated the separatists into the mainstream society (Gottesman 2004; Sokkhoeurn 2010).

The turbulent nature of Cambodia's development can be traced back to Angkorian times (Chandler 2007), yet today's changes are particularly entrenched in the last half century. It is a period that has been dominated by societal disruptions including civil war, social displacements and political strife (Gottesman 2004; Sophal 1995). In fact, the Khmer Rouge's decimation of Cambodia's population was accompanied by the destruction of its economy,

infrastructure, social structure, government and religion (Chandler 1998; Clayton 1998).

Cambodia has been in transition since the 1980s, when reconstruction post-Khmer Rouge began under the scrutiny and choreography of international interveners (Hughes 2003). These changes meant that Cambodia went from command economy to free-market economy, from war to peace, from authoritarian rule to democracy. Yet the ensuing economic liberalization included no safety nets for the poor, and thus failed to trickle down to rural areas (Kent 2006). Consensus emerging from the literature today recognises that corruption and elite capture have been the norm throughout Cambodian history (Chandler 1998; 2007), and to this day attempts at participatory democracy are overshadowed by patronage structures, semi-authoritarianism and the exercise of patriarchal power (Blunt & Turner 2005; Curley 2013; Öjendal & Sedara 2006).

3.1.1 Twenty-first century Cambodia

In the 21st century, Cambodia is a low-income country stretching over 181,035 square kilometres, with a population of 15.6 million and a GDP per capita of $3700 (World Bank 2016). Due to its relatively recent history of war and conflict, development assistance has played and still plays a major role in the development of the country since its placement under a UN protectorate from 1991 to 1993 (Chanboreth & Hach 2008). Cambodia passed its first constitution in 1993 after democratic elections that saw Hun Sen, with his Cambodian People's Party, become the first Prime Minister of the Royal Government of Cambodia (RGC)'s first legislature. Since 2003, the Rectangular Strategy, and its 2008 revision Rectangular Strategy Phase II, represents the RGC's overarching long-term socio-economic policy agenda. A panoply of policy documents has been created to deliver the Rectangular Strategy, the most important of which are the series of five-year National Strategic Development Plans (NSDP). Its latest version, the NSDP 2014, is still regarded as the government's intended roadmap for implementing policies (RGC 2004; NSDP 2014).

In parallel, Cambodia has also seen rapid economic progress, registering annual GDP growth of almost 10% per year between 1998 and 2008, along with an average annual population growth rate of 1.7% between 2000 and 2013 (World Bank 2011; World Bank 2013). But despite its economic growth and heavy overseas development aid, Cambodia still only ranks 138th on the Human Development Index, with an estimated 20% of its population living under the poverty line (CIA 2013). Twenty-nine percent of its population live in urban areas, the remaining 71% living in rural areas and depending primarily on agriculture for their livelihoods (NIS 2014).

Cambodia's recent history has left indelible marks on its population despite international efforts at nation building. Despite the fast recovering fertility rates (Heuveline & Poch 2007), the widespread and selective killings greatly affected Cambodia's population structure, leaving 34% of the current population aged under 15 in the 2009 census (NIS 2009). The Khmer Rouge's genocide targeted primarily the urban, educated elite (Chandler 1998; Hughes 2003), and basic education during the Khmer Rouge was centred on 'political education' and agricultural skills rather than academic subjects. While the education sector has been a major focus since 1991, UNESCO (2009) reports adult literacy rates between 2002 and 2008 at 73.9% and adult functional literacy rates, measured as a person who can read, write and calculate, at 37.1%. Less than half the population attends high school (UNESCO 2009). Lingering effects of malnutrition, disabilities from land mines, and mental health issues such as post-traumatic stress disorder are notable negative effects of the genocide on the Cambodian population, among many others documented (de Jong et al. 2003; Mollica et al. 1997).

Culturally, modern Cambodia has seen a regeneration of the Khmer Theravada Buddhism traditions which had been in place since the 13th century yet had been abolished, as were other religions, during the Khmer Rouge (Harris 2010; Kent 2006; Marston & Guthrie 2004). The revival of religion in the country has been associated with peace-making in communities (Kent &

Chandler 2008), however the credibility and moral authority of the new Buddhist authorities within the new power and moral order has been called into question due to their links with the political elite (Jacobsen & Stuart-Fox 2013). Though important research on Cambodian culture, religion and morality has been published over the past decade, there are still relatively few works documenting recent changes and the socio-cultural impacts of the Khmer Rouge (Kent & Chandler 2008; Hughes & Un 2011).

3.2 Modern rural transitions in Cambodia

Cambodia has been governed by the same, relatively fixed, elite since the removal of the Khmer Rouge from power in early 1979, with Hun Sen and his Cambodian People's Party still in power. Thus Cambodia remains a "hybrid of largely rhetorical and symbolic acquiescence to democratic norms built on the foundations of a patrimonial and highly predatory state structure" (Cock 2010). The result has been increasing elitism and growing co-optation and monopolization of local political economies in rural areas by profit-hungry urbanites and officials. Yet faced with greater international scrutiny after the establishment of the current government in 1992 (Ear 2013), the current political elite has turned to legal instruments in order to continue their expropriation of resources (Cock 2010; Hughes 2008; Hughes & Un 2011; Milne 2015).

One of the clearest instances of this is through land speculation, which can be observed through a closer look at the recent conservation and development trends at play in Cambodia (Diepart & Dupuis 2014). In fact, both conservation and development are stated as priorities of the Royal Government of Cambodia (RGC)'s long-term 'Rectangular Strategy' for development and the related National Strategic Development Plans (NSDP 2014). While the interface and trade-offs between development and conservation interventions can be observed in several developing countries, Cambodia presents an interesting case study due to recent accelerating land use change triggered by a series of recent environmental and development laws and by the patrimonial natural of its political system.

3.2.1 Environmental trends in Cambodia

Cambodia is located in the Indo-Burma hotspot (Myers et al. 2000) and is of global importance to conservation, some of its landscapes being the largest remaining areas of habitat for several endangered species (Clements & E J Milner-Gulland 2015). Forests covered about 55% of the country in 2010, and represent a substantial source of its natural wealth and contribution to local livelihoods (USAID 2012). In 1993, King Norodom Sihanouk introduced a royal decree designating 23 protected areas, covering about 3.3 million hectares (18.3% of Cambodia's total area) (ICEM 2003). Due to continuing political unrest until 1998 and weak enforcement, most of Cambodia's protected area networks have remained 'paper parks' without the involvement of conservation NGOs (Clements et al. 2010).

Most Cambodian PAs contain human settlements dating from before the boundaries were drawn and the level of enforcement over PA rules is generally low (Clements et al. 2010). This results in unclear property and user rights for the communities living in PA, where resource use rules under Cambodian law allow local uses such as non-timber forest product (NTFP) collection, although forest clearance, commercial logging, and hunting or trade of threatened species are illegal. The creation of new settlements within PAs is forbidden, and the number of households allowed to migrate to PA villages is limited. Villages are, however, permitted by PA authorities to expand agriculture to a limited extent within agreed land-use plans.

In the 2000s, RGC's commitment to decentralise the political system and natural resource management also spurred the development of Community Forests and Community Protected Areas, supported by NGOs (ICEM 2003). In legislature, commitments to biodiversity conversation in Cambodia have been sustained in recent years. In 2010, RGC's NSDP stated objectives to have the country's forest cover at 59% of its total area by 2013, increasing reforestation from 11,000 ha in 2008 to 73,000 ha in 2013, and going from 124 community forests in 2008 to 450 in 2013.

Yet despite these policy objectives, Cambodia recorded the world's fifth highest national deforestation rate between 2000 and 2012, with a 7% loss of its official forest cover during that period (Hansen et al. 2013). In fact, recent evidence suggests that behind the government's embrace of ambitious conservation policy goals, its current timber extraction regime works through the use and abuse of legal mechanisms to profit Cambodian political elite's interest (Baird 2014b; Le Billon 2007; Milne 2015). This patrimonial pattern has shaped Cambodia's modern land policy parameters, including weak property rights, lack of political transparency, and the struggle to establish effective governance and institutions to enforce local resource rights (Hill & Menon 2013; Jacobsen & Stuart-Fox 2013).

The 2001 Land Law initiated a process of codifying land claims by local people, indigenous communities and the private sector, marking a move towards a formal land registration system and official land titles (RGC 2001). While this introduction could be beneficial in supporting tenure security for local communities (Markussen 2008), its weak enforcement and co-option by the elite opened the door for the monetization of land titles and the widespread granting of ELCs as large areas of state public land were reclassified as state private, consequently weakening informal possession rights in poor rural communities (Hap 2010; Neef & Oldenburg 2013). The intensification of granting Economic Land Concessions (ELCs) in recent years is testament to what Biddulph (2010) has tagged "Geographies of Evasion": the weak outcomes from development intervention policies due to their evasive focus on geographies located away from the main problems which they were stated to address.

3.2.2 Rising development concerns: deforestation and ELCs

While Cambodia had already started granting land to private companies for investment in plantations and large-scale agriculture in the 1990s, ELCs as a process for agro-industrial development became formalised through the 2001 Cambodia Land Law and the subsequent Sub-decree n°146 (RGC 2001; RGC 2005). According to RGC's strategic policy documents, ELCs respond to the

national impetus for economic development by boosting agricultural production and generating work for local communities (Arias et al. 2012; MAFF 2015; Phelps et al. 2013).

State law requires ELCs to be located in state-owned private land, which is considered to be ‘free’ or ‘non-use’ land; in contrast with state-owned public land under which PAs are designed (MAFF 2015; NSDP 2014; RGC 2005). The 2001 Land Law and the 2005 sub-decree n°146 on ELCs stipulate the criteria that proposed ELC projects are evaluated against (Article 5). As well as the need to generate state revenues and to increase agricultural production, ELCs must also: create local employment to diversify livelihoods in rural areas; promote living standards of the people and avoid or minimise adverse social impacts; and perpetuate environmental protection and natural resources management (Article 5). Sub-decree n°146’s Article 4 also contains commitments to the inclusion of comprehensive environmental protection provisions within concession management. This includes the completion of an environmental and social impact assessment and the development of a sustainable land use plan, which has to be put to public consultation and needs final approval from provincial authorities (MAFF 2015; RGC 2005).

In 2008, a review of the Protected Areas Law created the possibility for ELCs to be conceded within Cambodia’s Protected Areas network. The granting of ELCs also increased apace, along with rising foreign direct investments in agriculture (Arias et al. 2012; LICADHO 2014; Ullenberg 2009). By 2013, several local and international NGOs claimed that over two million hectares, covering almost half of Cambodia's total arable land, had been granted as ELCs (LICADHO 2014; Neef et al. 2013; Peeters 2015). In recent years, communities, local and international organisations have increasingly raised concerns about the impacts of the widespread granting of ELCs and the lack of adherence to the established legal criteria in the granting process (BICP 2012; GW 2009; 2012; LICADHO 2005; 2014). Issues have arisen specifically around unfair eviction from land, human rights abuses, rapid deforestation rates, and ELCs being granted over high value forests and protected areas

(Bues 2011; Hor et al. 2014; Sperfeldt et al. 2012; Subedi 2012; Subedi 2014; Ullenberg 2009; Vrieze & Naren 2012).

Partly in response to external pressures and with looming national elections, the RGC introduced a moratorium on the granting of new ELCs and a systematic review of all ELCs in May 2012 (Bolin 2013; LICADHO 2014; RGC 2012). However, recent reports indicated that ELCs have continued to be allocated since the ban in 2012, with at least 16 new concessions totalling over 80,000 hectares granted by the end of 2013 (LICADHO 2014). Amongst these, 35,000 hectares of land have been granted within the protected area network since the moratorium (LICADHO 2014). Additionally, field reports have shown that most ELCs, once cleared of forest, remain largely unexploited for agriculture, hence not contributing to agricultural productivity in Cambodia (CEA 2009; GW 2009; GW 2012).

Due to a continuing lack of transparency in the granting of ELCs, the mechanism has been implicated as primarily serving the interests of elite wealth accumulation through land grabbing for high value timber logging, rather than the intended provision of development and agricultural goods (Neef & Touch 2012; Biddulph 2010; Vrieze & Naren 2012; Un & So 2011). The context of historically weak institutions and accelerating land use change under development pressures makes Cambodia a unique site for the study of the impacts of conservation on human well-being.

3.3 Study landscape: the Northern Plains

The Northern Plains of Cambodia is a landscape located in the province of Preah Vihear along the border with Thailand and Lao (see Figure 3.1). The Northern Plains encompasses a mixture of forest, grasslands, and freshwater wetlands and one of the largest remaining areas of deciduous Dipterocarp forest, and is thus considered an area of high biodiversity interest (Myers et al. 2000; O'Kelly et al. 2012). This landscape represents an ideal location to focus this research, due to the existence of conservation interventions with well-

designed and ongoing impact monitoring, including PAs and additional PES projects, as well as a number of ELCs, in some cases overlapping with PAs.

Households across the landscape are subsistence farmers whose livelihoods revolve around small-scale rice farming, with additional non-timber forest product harvesting and fishing around villages. Collecting liquid resin from Dipterocarp trees has also traditionally been an important livelihood in Northern Plains' communities (Clements et al. 2014; Rainey et al. 2010). Resource use rules within the protected area under Cambodian law allow local uses such as NTFP collection, although forest clearance, commercial logging, and hunting or trade in threatened species are illegal. Villages are, however, permitted by PA authorities to expand agriculture to a limited extent within agreed land-use plans.

3.3.1 Conservation management

The Northern Plains landscape contains two Protected Areas: the Preah Vihear Protected Forest (PVPF) in the north east of the province, which is managed by the Forestry Administration (FA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF); and Kulen Promtep Wildlife Sanctuary (KPWS) to the east, which is managed by the Ministry of Environment (MoE). While PVPF was declared in 2002, KPWS was established in 1993 as part of Cambodia's first protected area network.

Since 2005, international non-governmental organisation Wildlife Conservation Society (WCS) has assisted the MoE and FA's conservation efforts in both PAs (Clements & E J Milner-Gulland 2015). More specifically, the WCS has supported the Royal Government of Cambodia's agencies in implementing three types of Payment for Environmental Services (PES) schemes within the two PAs: a premium payment scheme for eco-friendly rice (Ibis Rice), an ecotourism programme, and a bird nest protection programme. The three PES schemes were designed in response to a high level of threat where conservation opportunity costs, at least for conversion of forest lands, were also moderately high (Clements et al. 2010).

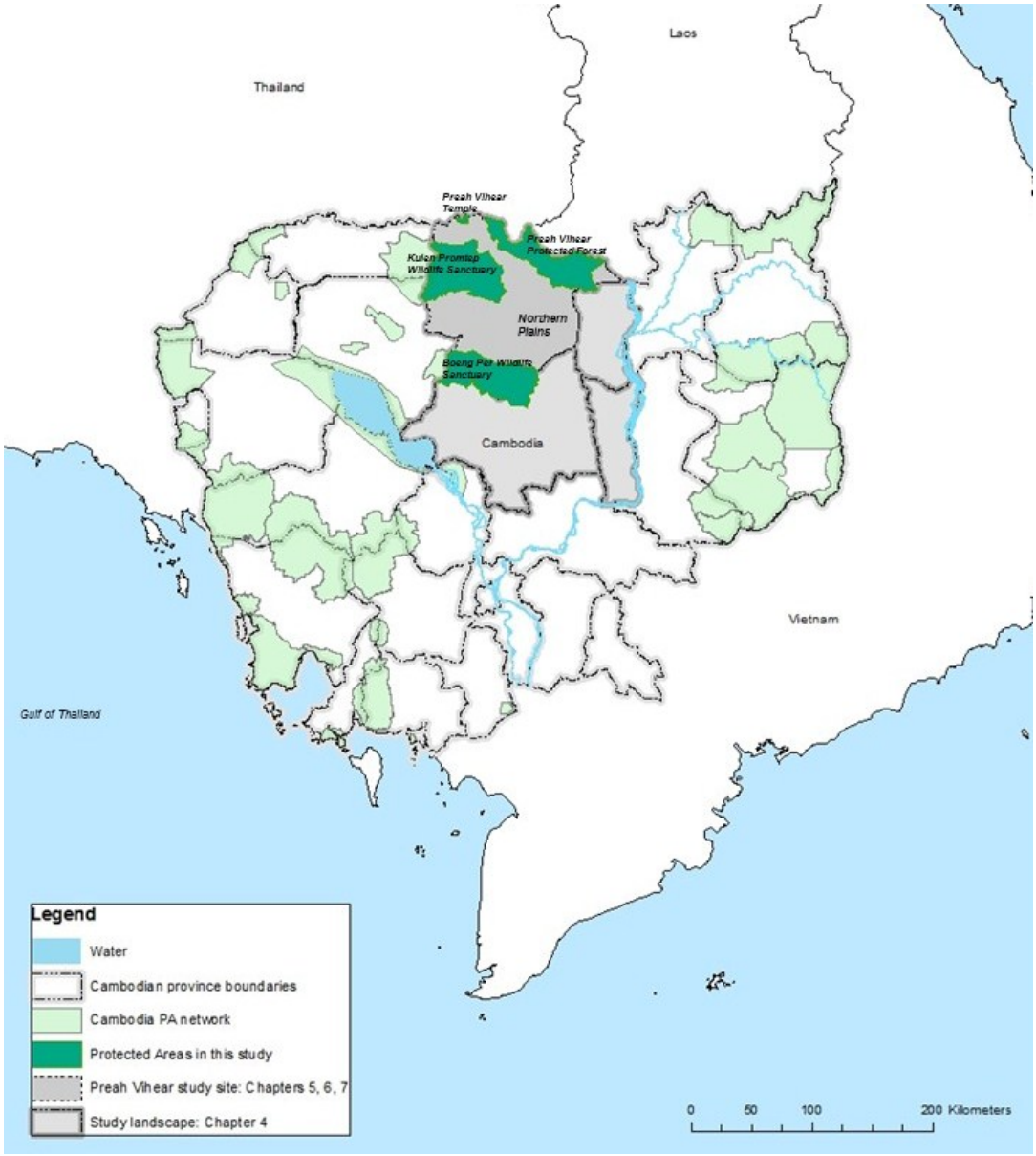

Figure 3.1: Map of the study areas

A core effort of WCS since 2005 has been to assist communities in developing Participatory Land use Plans (PLUPs) for PA villages, in order to gain official status and formalise the customary tenure rights in place in the wake of the weak implementation of the 2001 Land Law (Clements et al. 2014). The PLUPs clearly delineate the areas around villages that farmers are permitted to clear for growing rice or other produce versus those kept under strict PA management rule, thus limiting the conversion of habitat to rice fields (WCS 2009).

Ecotourism projects have been established in three villages to date; the most prominent one of which started in 2005 in Tmatboey, followed by the second project established in Dongplat in 2008, and the last in 2010 in Prey Veng (Clements et al. 2010; Clements 2012). The three sites contain the presence of high profile target species, such as the Giant Ibis, to attract international bird watchers. The ecotourism programme aims to conserve the globally threatened wildlife by establishing local village-level tourism that directly links the revenues received from tourists to the preservation of the species' habitat.

The Ibis Rice scheme started in the four core villages of Tmatboey, Dongplat, Prey Veng and Narong in 2008. This programme was designed as a more viable option for large-scale replication across the Northern Plains, compared to the restricted number of ecotourism opportunities possible. The scheme has now been expanded to 11 villages. Under this agri-environment payment programme, farmers who keep to local land-use planning rules and the no hunting rules of the PA are allowed to sell their rice at a higher rate than the traders' price through to the third-party marketing organisation Sansom Mlup Prey (SMP) through a village-level committee responsible for the management of the land-use plan. The PLUPs thus provide the basis for the monitoring of the Ibis Rice project (Travers et al. 2014).

Last, the bird nest protection programme, which started in 2003 and is now implemented across over 24 villages, provides small direct payments (up to 5 USD/day) to local villagers who report and protect the nest of a specific endangered bird species during nesting period (Clements et al. 2013). The endangered bird species found in the Northern Plains are particularly vulnerable to human disturbance and particularly the collection of nests for eggs and chicks by local people for consumption and trade (Clements et al. 2013). This programme was designed to rapidly locate, monitor and protect nesting sites around villages, providing a small direct payment to individuals who would report and successful protect the nests until the chicks fledge as an alternative incentive.

Implementing PES in the context of weak institutions can be difficult (Wunder 2007), thus both the ecotourism and Ibis Rice projects worked towards strengthening local village institutions and land rights, for example by developing Participatory Land Use Plans (PLUPs) against which compliance is measured (Clements et al. 2010; Clements et al. 2014). In each PLUP village, a locally elected Community Protected Area (CPA) committee manages the compliance to rules for participating households and oversees that these rules are respected around the village. For example, Ibis Rice payments to individual farmers are linked to CPA monitoring of their compliance with the land-use plan and no-hunting rules, with external verification by WCS.

3.4 Survey design of this study

One of the strengths of this research is the existence of historical datasets from WCS, providing an appropriate baseline for measuring change due to interventions, and which are of sufficient sample size for statistical inferences to be drawn (Clements 2012; Clements et al. 2014; Evans et al. 2003). WCS's datasets in Preah Vihear include two longitudinal assessments upon which the survey design for this study, and more specifically Chapter 5's analysis, builds.

The original survey design of Clements & Milner-Gulland (2014) uses covariate matching to compare the effect of PAs on socio-economic status at the village level, based on four key factors characterizing village-level poverty prior to the initiation of the PAs in 2005: forest cover within 5 km of the village; village size; and distances to roads and markets. Among the 211 villages in Preah Vihear province, 11 villages in PAs were selected for analysis. Within these 11 PA villages, four villages have been the focus of higher levels of conservation activity, specifically the PES schemes, by WCS since 2008: Tmatboey, Dongplat, Narong and Prey Veng.

Ten villages were originally identified as potential control villages through propensity score matching (PSM). Due to time and resource constraints, five

of these ten villages that were located at least 20 km away from the PA border, to control for spillover effects, were selected as controls for the 2008-2011 impact evaluation. The baseline assessment included 709 households across 16 villages in 2008. Households were initially selected through random stratified sampling. A wealth-ranking exercise with village chiefs was done, during which the village household list was divided between either above or below average wealth status in the village. Random selection was done subsequently within the two categories in each village. The 2011 assessment surveyed 931 households using the same method and increasing the selection of participating households to account for population growth. It covered the longitudinal panel of households as well as an additional sample to account for the increasing number of participants in the PES projects. Since the 2011 assessment, sites both inside and outside PAs have been affected by ELCs, thus adding a layer of complexity to the landscape.

The survey design used to collect data for this thesis was primarily inherited from the initial design for the short-term evaluations of the socio-economic impacts of conservation programmes in the Northern Plains. Four villages, which were part of the original control villages identified through PSM but that were not surveyed in 2008 and 2011, were added to the survey in 2014 in order to capture the trade-offs between conservation and development outcomes at play in the study area. The four villages were selected as they had been affected by ELCs. The 2014 survey thus counts 1129 households across 20 villages (Figure 3.2**Error! Reference source not found.**).

Several geographical scales are considered across this study: Chapter 4 takes a regional approach to capture large-scale spatial trends; Chapter 5 measures the social impacts of conservation activities across the 16 longitudinal villages surveyed in 2008, 2011 and 2014; Chapter 6 explores the well-being determinants and narratives of conservation and development change of three villages; and Chapter 7 assesses perspectives on land issues across the 20 villages surveyed in 2014. Additionally, both Chapter 5 and Chapter 7 adopt a hierarchical structure in their analysis to enable the assessment of the different

levels of conservation activities at play. These two chapters first present their analysis at their respective landscape scale, followed by an analysis of the subset of four core PES villages to explore the potential additionality of impacts of the three PES projects.

3.4.1 Data collection methods

The overarching aim of this thesis and the conceptual framework applied demands the use of multiple mixed methods to adequately answer all the research objectives outlined. To this end, several qualitative and quantitative survey questionnaires were used across two data collection periods, along with informal participant observations, to improve the reliability of the statements recorded. Other steps to reduce bias during the implementation of the research included careful breakdown of complicated concepts in survey questionnaires, the training of students that were independent to WCS to implement the surveys, and learning Khmer in order to be able to independently observe and participate in conversations.

The spatial data used in Chapter 4 was owned by WCS and otherwise acquired through collaborations with external organisations such as Conservation International. A first field trip primarily concerned with participant observation and scoping of the study site was done in February 2013. During this period, I accustomed myself with the Cambodian culture and started learning Khmer. The first field data collection period was carried out between October 2013 and May 2014, where I visited three villages for on average one month each. During this time, I used qualitative research methods including informal discussions, focus groups, semi-structured interviews for villagers, and key informant interviews to gather information on local conceptualisations of well-being.

The flexible nature of the methods allowed me to capture unexpected findings and provided details on local nuances used to express the multi-dimensional quality of well-being (Woodhouse et al. 2015). For example, open-ended questions such as “What does having a good life means to you?”, and “How

satisfied are you with the current level of your well-being?" encouraged people to discuss their personal opinions without prescriptive boundaries for answers. Two gendered focus groups were held in each village. The first is an institutional context exercise adapted for understanding primary actors and institutions at play in the villages (Martin & Sherington 1997), which highlighted differences in institutional arrangements between the villages studied and provided a means of triangulating the classification of each of the study villages into their respective profiles. The second is an originally-developed exercise that provided a platform to discuss local ideas about well-being and understand how key dimensions and subjective well-being vary between different groups within and between villages.

This qualitative research period also allowed for validation of the content of the forthcoming household survey questionnaires. More specifically, I used participant observations to legitimise the list of Basic Necessity Survey items and services used to create a localised index of socio-economic status (Chapter 5). From these personal observations and the observation statements recorded, I developed hypotheses on the macro and micro factors that have influenced livelihoods and well-being in the landscape since 2008, supported by and evolving from the findings of the short-term evaluation produced in 2011. These hypotheses, along with literature reviews, form the evidence base for the selection of *a priori* variables used in the quantitative models in Chapters 4, 5 and 7.

The second data collection took place between July and December 2014. For the purpose of this data collection, I hired and trained a team of eight assistants who were independent of WCS, most of which were students at the National University of Agriculture in Phnom Penh. Changes were made to the survey questionnaire in order to test new hypotheses developed during the qualitative research period. For example, new variables were added to the original design, such as the presence of solar panels as an item in the Basic Necessity Survey, and a new section was created to quantitatively assess the different dimensions of well-being that had been stated as priorities by the villagers

(Appendix A). While the three socio-economic response variables analysed in Chapter 5 are unchanged in order to test medium-term social impacts since 2008, I derived and validated the factors and interactions chosen as independent variables in the statistical analysis from the first phase of my research in 2014.

All research protocols were approved by Imperial College Research Ethics Committee before the start of the research. Prior to each interview and focus group, the purpose of the research and content of the interview were explained. Participants were informed they were not obliged to participate, that they could stop the interview at any point, and that all their answers would be kept anonymous. Due to low levels of literacy, participants gave their verbal consent to continue. To avoid strategic bias in responses, our research group was clearly introduced as independent researchers.

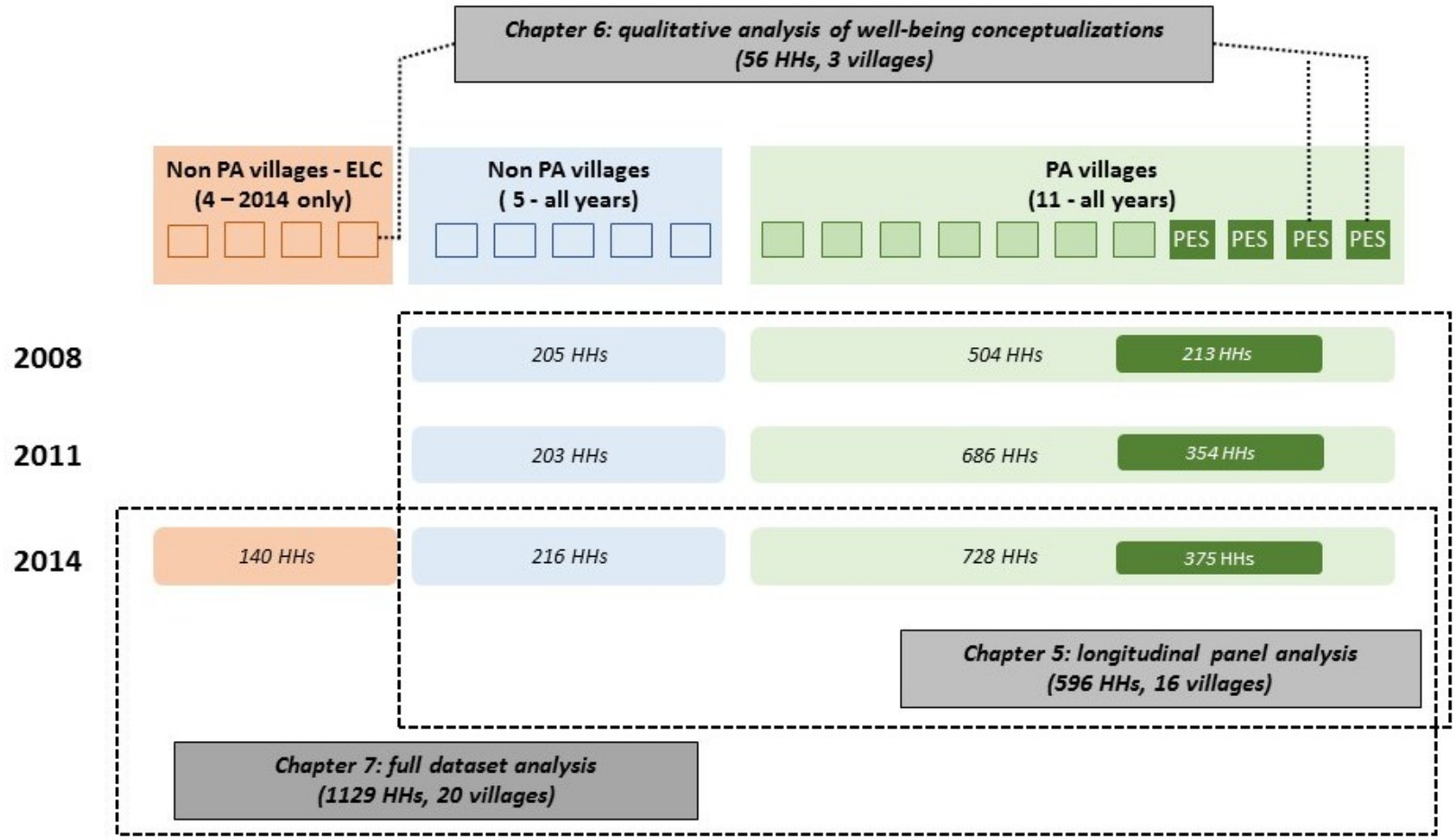

Figure 3.2: Diagram illustrating the survey design of the historical dataset and household (HH) surveys used in the frame of this thesis.

4. Exploring trade-offs between development and conservation outcomes in Northern Cambodia

4.1 Introduction

Land as a global resource has become the focus of intensified demands from a variety of users over recent decades (Lambin & Meyfroidt 2011). In an industrialising and globalised world, reconciling land use policies to achieve aspirations for economic development, food production and biodiversity protection is a tricky task (Tscharntke et al. 2012). Several studies now emphasise that trade-offs between different land uses are inevitable to meet both development and conservation agendas (Halpern et al. 2013; McShane et al. 2011). This is especially the case for developing countries, which are expected to support the bulk of development pressures from now until 2050, but which also host most biodiversity-rich areas of the planet (Balmford et al. 2002; Baudron & Giller 2014; Phalan et al. 2013). Notwithstanding the challenge of designing adequate development policies, governments must also devise appropriately matching conservation strategies.

Land use change and deforestation follow complex dynamics, with agriculture as a central feature. More than half of the new agricultural land across the tropics was carved out from intact forests between 1980 and 2000 (Gibbs et al. 2010). This trend continued into the new millennium, with conversion of forests to agricultural plantations being considered the main cause of forest loss since 2000 (DeFries et al. 2010; Gibbs et al. 2010; Stibig et al. 2014). Over the past decade agricultural intensification has been adopted by several countries across the tropics as a policy for reducing pressure on forests from extensive farming (Green et al. 2005; Phelps et al. 2013). Proponents argued the strategy can satisfy agricultural demand and growth in the face of rising population (Angelsen 2010; Phalan et al. 2011; Shively & Pagiola 2004; Ziegler et al. 2012). In theory, agricultural intensification aims to maximise synergies amongst development and conservation trade-offs and promotes multiple goals: increasing national yields and reducing carbon emissions by transitioning from smallholder slash-and-burn agriculture to larger-scale

commercial agriculture; increasing employment for local labour; and facilitating investment in already degraded areas rather than new unconverted areas (Foley et al. 2004; Foley et al. 2011; Lambin & Meyfroidt 2011b; Tilman et al. 2011).

However, recent research has highlighted that large-scale agro-industrial conversion can drastically alter landscape soil and hydrological functions by clearing high-biodiversity value land for single species plantation (Fox et al. 2014; Ziegler et al. 2009). Additionally, the opportunity cost of these investments can be seen as a divesture from financing development and improves access to markets for small land holders, failing to deliver poverty-reduction in rural communities (De Schutter 2011; Sperfeldt et al. 2012; Vrieze & Naren 2012). Major concerns have arose especially around the poor adaptation to local conditions of certain preference plantation crops such as rubber and the economically volatile and unsustainable conditions this creates for the future livelihoods of local farmers (Ahrends et al. 2015; Gironde & Peeters 2015).

Reports at the national or subnational levels about how trade-offs between conservation and development interventions materialise once implemented are limited, but point to the influence of a multiplicity of local geographical and historical contexts (Ferraro & Hanauer 2010; Pender et al. 2004; Gurney et al. 2014). These include land conversion drivers such as illegal logging, infrastructure construction, smallholder clearance by farmers and by resettlements (Baird 2014a; Lambrick et al. 2014; Michinaka et al. 2013; Stibig et al. 2014). The nature of specific attributes related to agro-industrial development policy in Cambodia, including soil fertility, accessibility and population density, are also key in determining trade-offs between different land use change (Peeters 2015). Hence regionalised analyses are required to better understand how land use trade-offs materialise spatially once policies are executed (Geist & Lambin 2002; Rudel et al. 2009).

Here I explore influences on the spatial placement of large-scale agro-industrial development interventions, their outcomes in terms of deforestation rates, and the extent to which development interventions trade off against conservation goals. While the overlap between development and conservation interventions can be observed in several developing countries, Cambodia presents an interesting case study for the analysis of the impacts of trade-offs between development and conservation on land cover change in a context of growing and industrialising economy. The Cambodian context reflects similar situations in developing countries where large-scale land acquisitions have been taken place against a background of weak governance and insecure customary tenure rights (Clements et al. 2010; Sekiguchi & Hatsukano 2013). Yet overlaps between ELCs and other land uses such as small-scale agriculture and different levels of conservation activities highlight the importance of a regional-scale analysis using accurate data (Edelman 2013; Messerli et al. 2015; Milne & Mahanty 2015).

4.2 Background

4.2.1 Development and conservation policy in Cambodia

Both conservation and development are stated as priorities of the Royal Government of Cambodia (RGC)'s long-term development 'Rectangular Strategy' and the related National Strategic Development Plans (NSDP 2014). The Cambodian protected area network, designed in 1993, includes 23 protected areas covering 3.3 million hectares, or 18.3% of Cambodia's total area (MRC 2003). In 2010, forests covered about 55% of the country, representing a substantial source of its natural wealth and contribution to local livelihoods (USAID 2012). Political commitments to biodiversity conversation in Cambodia have been sustained in recent years, with policy objectives of the country's forest cover reaching 59% of its total area by 2013. Despite these statements, Cambodia recorded the world's fifth highest national deforestation rate between 2000 and 2012, with a 7% loss of its official forest cover during that period (Hansen et al. 2013). Deforestation proves additionally tricky to identify under large-scale land conversions to plantations such as rubber,

which has similar spectral characteristics to natural tropical forest and can change seasonally (Dong et al. 2013; Li & Fox 2011).

In parallel, Cambodia has also seen rapid economic progress, registering annual GDP growth of almost 10% per year between 1998 and 2008, along with an average annual population growth rate of 1.7% between 2000 and 2013 (World Bank 2011; World Bank 2013). More specifically, it has seen an intensification of granting of Economic Land Concessions (ELCs) in recent years. While Cambodia had already started granting land to private companies for investment in plantations and large-scale agriculture in the 1990s, ELCs as a process for agro-industrial development became formalised through the 2001 Cambodia Land Law and the subsequent 2005 sub-decree n°146 on ELCs (RGC 2001; RGC 2005). According to RGC's strategic policy documents, ELCs respond to the national impetus for economic development by boosting agricultural production and generating work for local communities (Arias et al. 2012; MAFF 2015; Phelps et al. 2013).

Cambodia recognises three categories of land tenure: privately owned land, state-owned public land and state-owned private land. State land, both public and private, accounts for 75-80% of Cambodia's total land area (GTZ 2006; Thiel 2009; USAID 2011). Whereas state-owned private land can be leased, granted as a concession, or held in usufruct, state-owned public land is classified as land that contains property of 'natural origin' – such as forest – and land that carries a public interest use which may not be sold or transferred, for example land that is part of the protected area network (Bolin 2013).

State law requires ELCs to be located in state-owned private land, which is considered to be 'free' or 'non-use' land; in contrast with state-owned public land under which protected areas are designed (MAFF 2015; NSDP 2014; RGC 2005). The 2001 Land Law and the 2005 sub-decree n°146 on ELCs stipulate the criteria that proposed ELC projects are evaluated against (Article 5). As well as the need to generate state revenues and to increase agricultural production, ELCs must also: create local employment to diversify livelihoods

in rural areas; promote living standards of the people and avoid or minimise adverse social impacts; and perpetuate environmental protection and natural resource management (Article 5). Sub-decree n°146's Article 4 also contains commitments to the inclusion of comprehensive environmental protection provisions within concession management. This includes the completion of an environmental and social impact assessment and the development of a sustainable land-use plan, which has to be put to public consultation and needs final approval from provincial authorities (MAFF 2015; RGC 2005).

4.2.2 Rising concerns: deforestation and ELCs

In 2008, a review of the Protected Areas Law opened up for ELCs to be conceded within Cambodia's Protected Areas network (RGC 2008). Already existing concerns about the negative environmental impacts of ELCs' increasing threats in under-funded protected areas increased as the review introduced a new system of zoning, allowing the conversion of public land into private land (Sperfeldt et al. 2012; WWF 2007). Since 2008, several sub-decrees have been passed classifying core and conservation areas as "sustainable use zones" which allows economic activities in these areas according to its Art. 11 III (RGC 2008). For example, 2008 sub-decree 206 rezoned 9,237 hectares as sustainable use zones in Kulen Prumtep Wildlife Sanctuary, and granted the land for agro-industry investment to Cambodia Dawn Plantation Ltd (RGC 2008; RGC 2011) The granting of ELCs also increased apace, along with rising foreign direct investments in agriculture (Arias et al. 2012; LICADHO 2014; Ullenberg 2009). According to MAFF (2014), 118 companies were granted ELCs over a total land area of 1,204,750 hectares by the beginning of 2013. The figure is contested by several local and international NGOs, claiming that over 2 million hectares, covering almost half of Cambodia's total arable land, have been granted (LICADHO 2014; Neef et al. 2013; Peeters 2015). In recent years, communities and local and international organisations have increasingly raised concerns about the impacts of the widespread granting of ELCs and the lack of adherence to the established legal criteria in the granting process (BICP 2012; GW 2009; 2012; LICADHO 2005; 2014). Issues have arisen specifically around unfair eviction

from land, human rights abuses, rapid deforestation rates, and ELCs being granted over high value forests and protected areas (Bues 2011; Hor et al. 2014; Sperfeldt et al. 2012; Subedi 2012; Subedi 2014; Ullenberg 2009; Vrieze & Naren 2012).

Partly in response to external pressures, and with looming national elections, the RGC introduced a moratorium on the granting of new ELCs and a systematic review of all ELCs in May 2012 (Bolin 2013; LICADHO 2014; RGC 2012). However, reports have indicated that at least 16 new concessions were granted between 2012- when the ban was announced- and 2014, totalling over 80,000 hectares. Amongst these, 35,000 hectares of land have been granted within the protected area network since the moratorium (LICADHO 2014). Additionally, field reports have shown that most ELCs, once cleared of forest, remain largely unexploited for agriculture, hence not contributing to agricultural productivity in Cambodia (CEA 2009; GW 2009; GW 2012). Bickel (2011) states that ELCs remain mostly unproductive because of the lack of access to finance (both equity and loans), the lack of access to skilled labour, slow net cash inflows in agriculture for tree crops, or due to the political nature of ELCs. Contributions to local rural economies come further into question with studies showing that most ELC workers are migrants coming from outside the province (Sperfeldt et al. 2012) and that little is done by the private investors to collaborate with local farmers, or to provide technical or financial support (Üllenberg 2009). Due to a continuing lack of transparency in the granting of ELCs, the mechanism has been implicated as primarily serving the interests of elite wealth accumulation through land grabbing for high value timber logging, over the intended provision of development and agricultural goods (Biddulph 2010; Neef & Touch 2012; Un & So 2011Vrieze & Naren 2012).

Qualitative accounts of ELCs' impacts are numerous, with detailed analyses of processes and meta-analysis of case studies now available (Messerli et al. 2015; Sperfeldt et al. 2012). However, spatial analyses have focused on providing a visualisation of the location of ELCs to grant insights into their characteristics, for example the type of concession and their implementation

stage (Diepart & Schoenberger 2016; LICADHO 2014; Peeters 2015; Schönweger et al. 2012). This is partly due to issues with data transparency and the reliability of geospatial data on forest cover and ELC location at the national level (Dwyer 2013; Frewer & Chan 2014; Scoones et al. 2013). While Davis et al. (2015) have investigated the contribution of ELCs to deforestation at the national level, and a few studies have highlighted the negative influence of ELCs on deforestation (Clements & Milner-Gulland 2015; Hor et al. 2014; Rainey et al. 2010), they have not enquired into the spatial patterns of their location nor evaluated the scale of their influence in relation to environmental change in a regionalised context.

Without appropriate methods and a regionalised approach, untangling the socio-ecological contributing factors and analysing the spatial overlaps between ELCs and protected areas can be tricky. Here I use regression models to investigate two issues. Firstly, what are the correlates of ELC placement as implemented within Cambodia's stated development policy? Secondly, what are the correlates of recent deforestation, and specifically, what is the role of ELCs in deforestation, in the context of other factors?

4.3 Materials and methods

4.3.1 Study area

This analysis focuses on Northern Cambodia, more specifically the provinces of Preah Vihear and Kampong Thom, as well as the provinces of Stung Treng and Kratie up to the Mekong river (Figure 4.1). The 3,333,486 hectare study area contains several ecosystems including an evergreen dry forest home to 80% of Cambodia's economically valuable and endangered endemic tree species, hence of considerable biodiversity value (Olsson & Emmett 2007; Strange et al. 2007). The landscape contains 50 ELCs and 4 protected areas, at times overlapping (Table 4.1; Appendix B.1). The study area was bounded by the availability of triangulated spatial data for land cover change between 2008 and 2013 (CI 2013; Hansen et al. 2013).

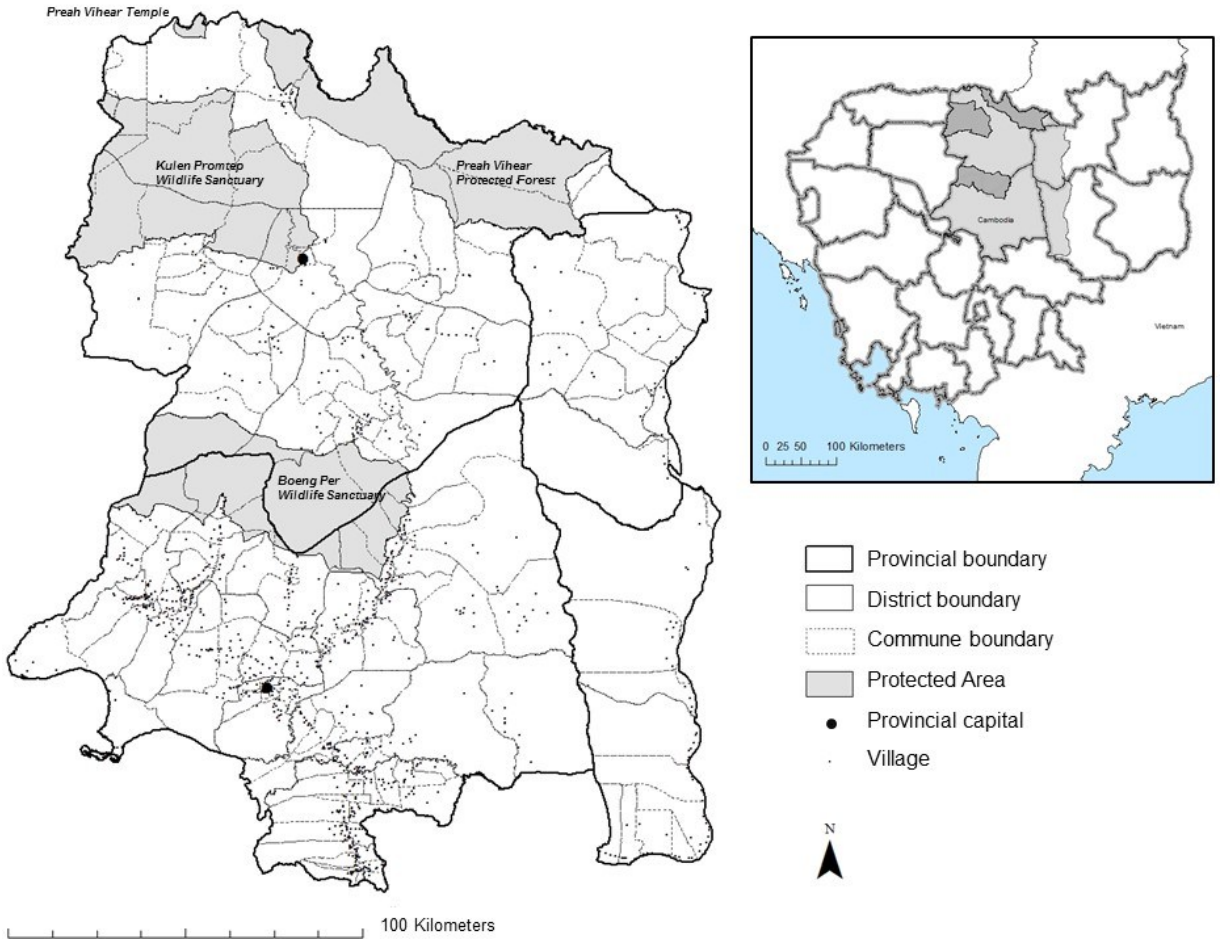

Figure 4.1: Location of the study area showing villages and administrative boundaries at the provincial, district and commune level as included in the analysis

Amongst the four protected areas, three have been actively managed by the RGC since the beginning of the 2000s. The Kulen Promtep Wildlife Sanctuary (KPWS), which was established in 1993, is managed by the Ministry of Environment, and the Preah Vihear Protected Forest (PVPF), declared in 2002, is managed by the Forestry Administration (FA) of the MAFF. The section of KPWS located in the Preah Vihear province and the PVPF are part of the Northern Plains landscape, where the international non-governmental organisation Wildlife Conservation Society (WCS) has been supporting the MoE and FA's conservation efforts since 2005 (Clements et al. 2010; Clements & E J Milner-Gulland 2015). The Preah Vihear Temple, a UNESCO World Heritage Site since 2008, is managed by the Ministry of Tourism. The Boeng Per Wildlife Sanctuary (BPWS) is, by law, under the management of the MoE, yet has seen insufficient law enforcement activities and was identified by

Lacerda et al. (2004) as the protected area second most threatened by land encroachment in Cambodia.

Three other intervention types present in the landscape and that may have had additional effects on deforestation include Community Forests (CFs), Community Protected Areas (CPAs), and Social Land Concessions (SLCs). They have not been included in this study because they average less than five hectares in size.

Table 4.1: Area of the study site under PA and ELC land use designations, not mutually exclusive

Intervention status	Area (ha)	% of total area
Outside of PAs	2,690,481	80.7%
Inside PAs	643,005	19.3%
Boeng Per Wildlife Sanctuary	213,340	6.4%
Kulen Promtep Wildlife Sanctuary (East)	236,109	7.1%
Preah Vihear Protected Forest	189,978	5.7%
Preah Vihear Temple	3,578	0.1%
Inside ELCs	476,049	14.3%
Outside ELCs	2,857,437	85.7%
Total study area	3,333,486	100.0%

The landscape is also home to 1088 villages, which contain between 18 and 1002 households each. The main livelihoods revolve around small-scale rice farming, non-timber forest-product harvesting and fishing (Clements et al. 2014; USAID 2011b). While the aggregated impacts of human activities such as small-scale illegal logging and farming are recognised as contributors to deforestation, the limited extent of each activity makes local community livelihoods a relatively small contributor to deforestation in Cambodia (DeFries et al. 2010; Milne & Chervier 2014; Schneider 2011; Vrieze & Naren 2012).

4.3.2 Statistical models

I first present a binomial mixed-effect regression model of the presence and absence of ELCs to explore the spatial patterns of ELC placement across the landscape, followed by a zero-altered negative binomial model to identify the

importance of predictors of deforestation in the study area between 2008 and 2013.

The ELC model's response variable is the presence or absence of a new ELC in a pixel in 2013 when compared to a 2008 baseline, which marks the start of the legal granting of ELCs in the protected area network, and of a recorded increase in the number of concessions granted (Arias et al. 2012; LICADHO 2014; Ullenberg 2009). The location of ELCs was based on national data from LICADHO (May 2014) and externally confirmed by local experts and through field visits. While I recognise that ELC characteristics can influence the dynamics of land use change and ELC effects, many of such decisive indicators are difficult or impossible to capture fully using spatially explicit data, with factors such as time of investment or characteristic of land allocation rarely being publicly available (Messerli et al. 2015). Several data sources about ELCs are also often inaccurate and incomplete, for example nationality of owners, type of agricultural investment planned, and stated start date of operation (Dwyer 2015b; Edelman 2013; Oya 2013). Without this level of accuracy being available for the 50 ELCs present in the landscape, I thus chose to use the indicator of ELC presence/absence only.

The distribution of the percentage of a given pixel deforested between 2008 and 2013 was zero-inflated, non-negative, and bounded between 0 and 100, and was hence treated as count data. Overdispersion was found in both the zero and the positive count sections of the data, indicating a negative binomial error structure. A zero-altered negative binomial (ZANB) model, also called hurdle or two-part model, was used to fit the data (Hardin et al. 2007; Hilbe 2011; Zuur et al. 2009). This entailed fitting a binary logistic regression with absence and presence of deforestation as a response variable, to explain the zero part of the data (hurdle model), then fitting a negative binomial model with percentage deforestation as the zero-truncated, or positive count part of the data as a response variable (count model). The distribution of the binary response variable used in the hurdle model was 5490 pixels with no

deforestation and 4510 pixels with deforestation values above zero, the latter forming the data for the count model.

Deforestation data was obtained from two sources: a land cover change private dataset from Conservation International (CI) (2013) categorizing 2011 land cover across the study area, including patches deforested between 2008 and 2011; and Hansen et al (2013)'s global forest change data between 2012 and 2013 (CI 2013; Hansen et al. 2013). Both datasets are at 30 square metre resolution. The CI dataset was selected as the basis for work as it included a consolidation of all available historic deforestation data over the area, including the RGC Forestry Administration land cover data, and WCS's private spatial cover data, done for the purpose of a pre-feasibility project study. The methodology used by CI included accuracy assessments against high resolution imagery as well as using ground truth data from biomass surveys (see Appendix B.2). Deciduous and evergreen forest classifications from the CI dataset were aggregated under a single 'forested' classification for the analysis (see Appendix B.2). The Hansen dataset identified deforested patches on a yearly basis, thus deforested areas for 2012 and 2013 were juxtaposed using conditional formatting in ArcGIS over the 2011 land cover data to identify total deforestation between 2008 and 2013.

4.3.3 Predictor variables

Predictor variables for each model were selected based on previous literature and local expertise concerning their relevance to the placement of ELCs, and as drivers of deforestation (Table 4.2). The following variables were evaluated for every pixel: protected area status; carbon values; proportion of non-forest in surrounding area; soil quality; elevation; slope; distance to village; distance to major road; distance to river; and population density per commune (Table 4.3). As different levels of conservation efforts can be a factor that affects deforestation in PAs, the four protected areas were included separately in the deforestation model.

Spatial data for each variable was first mapped with ArcGIS and, when required, resampled using a 1 kilometer square grid. This was judged an appropriate and computable size with the available resolution of the data at 30 metre square, yet given that the smallest intervention to be analysed is Preah Vihear Temple at 4000 hectares (40 kilometre square). It is also computationally tractable for the construction of non-parametric models over a large area. Only pixels completely inside or outside an intervention, either ELC or PA, were used; thus leaving 26 945 pixels for analysis over the landscape. A sample of 3000 pixels was then randomly subset to limit spatial autocorrelation (Lichstein & Simons 2002).

Collinearity between predictor variables was tested and led to the exclusion of forest cover within the pixel as a variable. Carbon values were considered a better proxy for the mix between quantity and quality of forest present in a pixel, which is relevant when looking at patterns of deforestation across different land uses. Carbon data was factorised in three categories to reflect the multinomial distribution of carbon values across forest types. An interaction between carbon values and proportion of non-forest in surrounding area was introduced to reflect differences in forest fragmentation around a pixel depending on the forest type. Continuous predictor variables were scaled using the interquartile range and median instead of standard deviation to account for the skewed distribution of spatial data (Babyak 2009).

Table 4.2: Hypothesis supporting the selection of variables included

Variable	Hypothesised correlation to ELC presence in 2013	Hypothesised correlation to deforestation between 2008-13
ELC presence 2013	ELCs are expected to be located in non-used, low-forest-value areas yet that are suitable for commercial agriculture. Location of ELCs taken after the implementation of the Moratorium in January 2013.	*Not used in model: post-hoc*
Deforestation 2008-2013	*Not used in model: assumed outcome not driver.*	Deforestation is expected to occur close to development factors: infrastructures, villages, in easily accessible areas for timber transport and trade.
ELC presence 2008	*Not used in model: self-predictive.*	**Negative:** ELCs to be located in areas with high proportion of non-forest in already degraded and fragmented areas rather than in non-converted forests.
Protected Area status in 2008	**Negative:** ELCs to be located in the private state domain primarily; while PAs to be located in public state domain. ELCs to follow criteria of "perpetual environmental protection and natural resources management".	*Not used in model: "Protected Area identity in 2008" used to allow differentiating between the level of conservation management effort between the different protected areas.*
Protected Area identity in 2008	*Not used in model: "Protected Area status in 2008" variable used as per legislation all protected areas are in public state domain and no need to differentiate*	**Negative but PA-dependent:** Protected Areas prevent deforestation through management of natural resources and enforcement of protection laws.
Carbon values in 2008	**Negative:** Variable used as a proxy for the extent and type of forest present in a pixel. ELCs should follow criteria of "perpetual environmental protection and natural resources management", hence located in areas with lower carbon values.	**Positive:** Carbon values, as a proxy for the extent of forest present in a pixel, are expected to be targeted for deforestation of high value timber; except in managed Protected Areas.
Proportion of non-forest in surrounding area in 2008	**Positive:** ELCs to be located in areas with high proportion of non-forest in already degraded and fragmented areas rather than in non-converted forests.	**Positive:** Deforestation likely to occur where timber is easily accessible in areas surrounded by low proportion of non-forest.
Soil quality in 2008	**Positive:** Soil quality linked to agricultural suitability and hence to greater potential for land conversion and ELC presence.	**Positive:** Soil quality linked to agricultural suitability and higher rate of land conversion.
Elevation	**Negative:** ELCs less likely to be located on high elevation as less suitable for agriculture.	**Negative:** High elevation linked to less accessibility and lower rate of land conversion.
Slope	**Negative:** ELCs are less likely to be located on high slopes as less suitable for agriculture.	**Negative:** High slopes linked to less accessibility and lower rate of land conversion.
Distance to village in 2008	**Positive:** ELCs aim to create rural local employment; should be located far from settlements.	**Positive:** Areas close to villages are more likely to be converted or logged due to accessibility, transport and trade.
Population density in 2008	**Negative:** ELCs aim to create rural local employment; should be located in low population density areas.	**Positive:** Areas with high population are more likely to be converted or logged due to accessibility, transport and trade.
Distance to road in 2008	**Negative**: ELCs more likely to be located close to a road for accessibility of rural employment and large-scale agriculture operations	**Positive:** Areas close to roads are more likely to be converted or logged due to accessibility and transport.
Distance to river in 2008	**Positive:** Areas with access to water are better suited for commercial agriculture; ELCs should be located close to rivers.	**Positive:** Areas close to river are more likely to be converted or logged due to accessibility and transport.
Sources	De Schutter, 2011; Lambrick et al., 2014; NSDP, 2014; RGC, 2008; RGC, 2001; Schönweger et al., 2012	Clements & Milner-Gulland 2015; Etter et al. 2006; Kaimowitz & Angelsen 1998; Lambin et al. 2003; Liu et al. 2009; Müller et al. 2011; Peeters 2015

Table 4.3: Description of selected variables and their sources

Variable	Type / units	Methodology (source)
ELC presence 2013	Binary: 0= absence 1= presence	Location of ELCs as of January 2013 after the implementation of the Moratorium (MAFF, 2015; NSDP, 2014). Absence or presence of an ELC as 100% of a pixel (WCS 2013, LICADHO 2014)
Deforestation 2008-2013	Continuous & Binary 0 = absence 1= presence	Area deforested between 2008 and 2013 in hectares per pixel / Absence or presence of deforestation in a pixel (CI 2013, Hansen et al 2013).
ELC presence 2008	Binary 0= absence 1= presence	Absence or presence of an ELC as 100% of a pixel (WCS 2013, LICADHO 2014)
Protected Area status in 2008	Binary 0= absence 1= presence	Absence or presence of a Protected Area as 100% of a pixel (WCS, 2013).
Protected Area identity in 2008	Categorical: 1= Boeng Per 2= KPWS 3= PVPF 4= PVT	Absence or presence of each Protected Area as 100% of a pixel (WCS 2013)
Carbon values in 2008 (in (Mg/ha)	Categorical: 1= Low (0-100) 2= Medium (100-200) 3= High (>200)	Carbon values in a pixel in 2008 as Above Ground Biomass, obtained by applying average carbon value per land cover type to 2008 land cover change map (CI 2013, Baccini et al. 2012),
Proportion of non-forest in surrounding area in 2008	Percentage	Proportion of non-forest in the 4 nearest neighbour levels of pixels (48 surrounding pixels), reflecting average forest fragmentation surrounding a pixel. This excludes the central pixel's value as the latter is better captured under carbon values. (CI 2013).
Soil quality in 2008	Categorical: 1= Low 2= Medium 3= High	Category of soil fertility as 100% of a pixel (WCS, 2013)
Elevation	Continuous (metres)	From digital elevation model (WCS, 2013)
Slope	Continuous (degrees)	From digital elevation model (WCS, 2013)
Distance to village in 2008	Continuous (km)	Distance to nearest village in 2008 (WCS, 2013)
Population density in 2008	Continuous (ppl/km^2)	Population density on a commune basis in 2008 (WCS, 2013)
Distance to road in 2008	Continuous (km)	Distance to 'all weather' road in 2008 (WCS, 2013)
Distance to river in 2008	Continuous (km)	Distance to river in 2008 (WCS, 2013)
Communes	Categorical (278)	Added as random effect to account for data hierarchy (WCS, 2013)
Districts	Categorical (19)	Added as random effect to account for data hierarchy (WCS, 2013)

4.3.4 Model selection and validation

All statistical analysis was done in R. 3.20 and models were fitted using the function ‘gmler’ in R package ‘lme4’ version 1.1-7 (Bates et al. 2014).The ELC model was fitted with administrative units as nested random effects (communes within districts) to account for the structure of the data. This reflects the scale at which ELCs are implemented spatially across administrative boundaries and the levels at which ELC impacts are observed. The corrected Akaike information criterion (AICc) was used to select and rank the most parsimonious models. Inclusion of final variables was confirmed by comparing model weightings from dredging (Barton 2015) and computing the variable relative importance using the top models selected based on AICc <4 (see A1).

Model selection for the two-step deforestation model was done at both stages, with models being fitted first with all *a priori* variables. The models were validated by using changes in AICc when dropping non-significant variables (see A2). Excluding variables did not lead to an AICc change higher than four, hence all variables were kept in the final model.

All three models were tested for spatial autocorrelation by testing model residuals using variograms (‘gstat’ version 1.0-23). The Best Linear Unbiased Predictors (BLUPs) (Pinheiro & Bates 2006) of the random effects extracted from the ELC model were also plotted, to graphically check the unexplained deviance of each commune. All graphical outputs from both tests showed minimal spatial autocorrelation effects in the models.

4.3.5 Average Predictive Comparisons

Parameter estimates derived from mixed-effect models are difficult to interpret directly because of the presence of interactions, and, in the case of binomial regressions, nonlinearity. I therefore present regression coefficients, which allow interpretation of the direction of correlation between response and predictor variables, as well as average predictive comparisons (APCs) of focal variables for each model. This allows interpretation of the expected difference in outcomes associated with changes in individual inputs of interest. I do so by

calculating the means and confidence intervals of responses simulated from the fitted models to evaluate their predictions at different values for one variable at a time, holding all others constant (Gelman & Hill 2007; Gelman & Pardoe 2007). Key explanatory variables were predicted at both low and high values to reflect realistic scenarios according to each predictor. Low and high values for continuous variables were calculated respectively as the first and third quartile ranges in the data distribution, rounded up to the nearest decimal (see Table 4.4).

Table 4.4: Descriptive statistics for predictor variables and values used in Average Predictive Comparisons

Predictor variable	Min	Median	Mean	Interquartile range	Max	Low predicted value	High predicted value
ELC presence 2008	-	-	-	-	-	0 (absence)	1 (presence)
Protected Area status in 2008	-	-	-	-	-	0 (absence)	1 (presence)
Protected Area identity in 2008	-	-	-	-	-	0 (absence)	1 (presence)
Carbon values in 2008	-	-	-	-	-	Low	High
Proportion of non-forest in surrounding area in 2008 (%)	0.0	8.9	24.6	Unscaled	100.0	25%	75%
Soil quality in 2008	-	-	-	-	-	1 (Low)	3 (High)
Elevation (metres)	5.8	79.8	79.4	57.1	550.0	48.5	105.0
Slope (degrees)	0.0	1.1	1.5	0.8	23.5	1.0	2.0
Distance to village in 2008 (km)	0.0	5.5	6.6	6.6	25.3	3.0	10.0
Population density in 2008 (ppl/km^2)	1.8	10.9	25.0	24.2	297.6	6.0	30.0
Distance to road in 2008 (km)	0.0	1.0	1.8	2.1	18.6	0.5	3.0
Distance to river in 2008 (km)	0.0	5.1	6.2	7.2	23.8	2.0	10.0

4.4 Results

4.4.1 Factors influencing ELC placement

In 2008, there were 7 ELCs covering 114,808 hectares (3.4%) over the study area, with no overlap between ELCs and protected areas. This increased to 50 ELCs in 2013, covering 1,018,321 hectares (30.5%) of the landscape and more specifically 14% (91,366 hectares) of the overall protected areas (Figure 4.2a and Figure 4.2b).

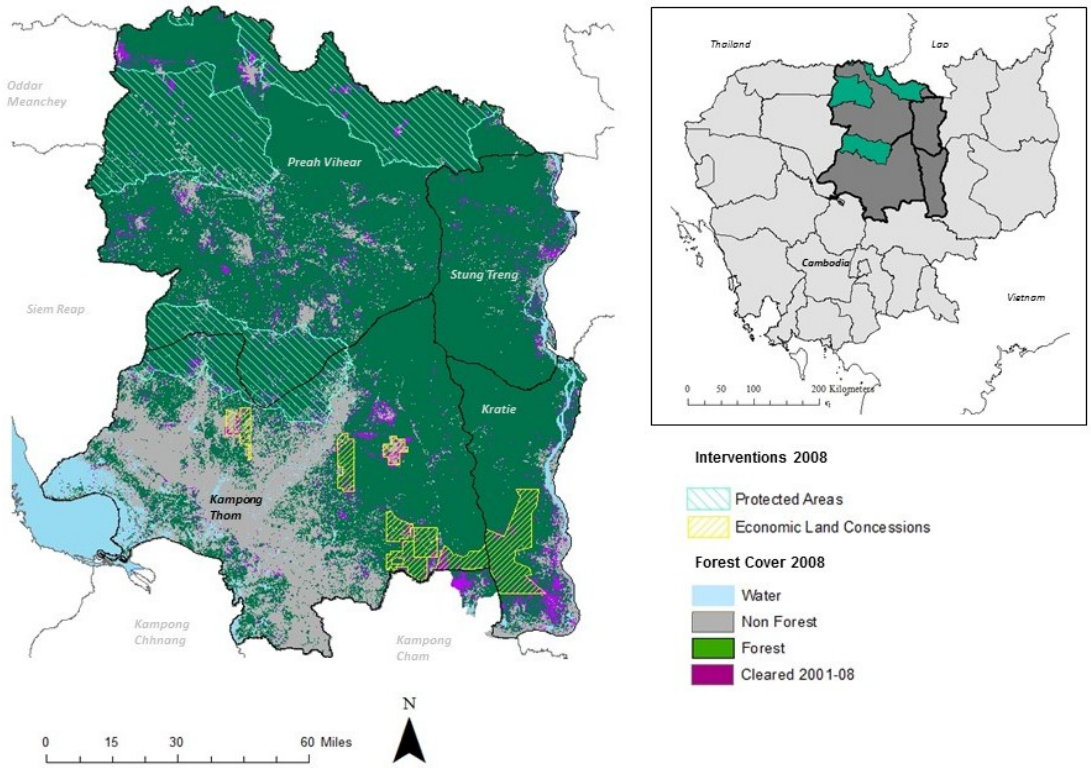

Figure 4.2a: Protected Areas and Economic Land Concessions over land cover in 2008

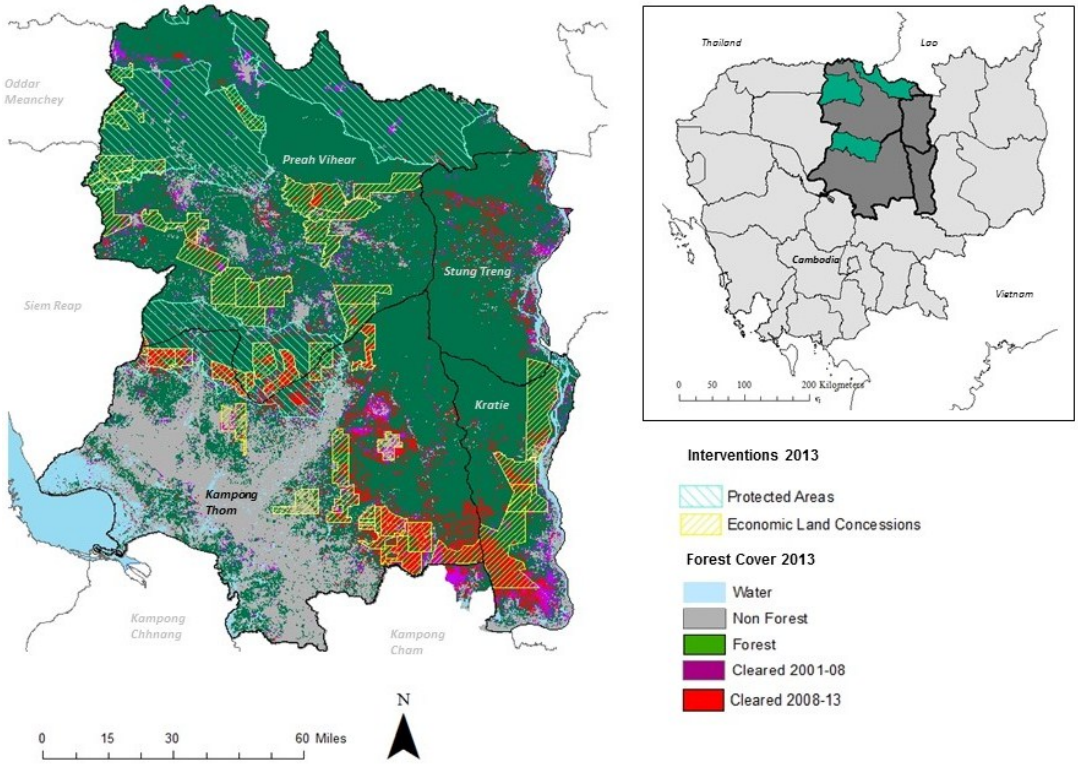

Figure 4.2b: Protected Areas and Economic Land Concessions over land cover in 2013

ELC overlap with PAs is concentrated in Boeng Per Wildlife Sanctuary (25% of its area), where there is no enforcement of the Protected Area Law, as well as in Eastern KPWS (16% of its area: Table 4.5).

Table 4.5: Overlap between ELCs and Protected Areas in 2013

Protected Area	PA under ELC (ha)	PA under ELC (%)
Boeng Per Wildlife Sanctuary	54,274	25
Kulen Promtep Wildlife Sanctuary (East)	37,092	16
Preah Vihear Protected Forest	0	0
Preah Vihear Temple	0	0

The top model for the influence of predictor variables on the placement of ELCs between 2008 and 2013 included all variables hypothesised as important *a priori*. Model selection led to the exclusion of slope, distance to road, distance to river and distance to village in the final model (Table 4.6; Appendix B.3).

ELCs are more likely to be located in pixels with high and medium carbon value. The interaction between the proportion of non-forest surrounding area and carbon values suggests that ELCs are also more likely to be located in areas that contain high and medium carbon values, but that are generally surrounded by non-forest. In other words, ELCs are more likely to be found in easily accessible high-value carbon areas. ELCs are also less likely to be placed in pixels substantially surrounded by non-forest, at high elevation, with high soil fertility and in highly populated areas. There is no evidence of an effect of protected area status on ELC placement.

Table 4.6: Parameter estimates from the selected 2013 ELC placement generalised linear mixed model, with ELC presence/absence as a binary response variable to predictor variables at a 2008 baseline. Pseudo R-squared = 0.42. Model selection table is shown in Appendix B.3. Significance values: 'ns' = non-significant; '.' = P <0.1; '*' = P <0.05; '' = P <0.01; '***' = P <0.001.**

Variable	Estimate	SE	P-value
Intercept	-4.19	0.68	***
Protected Area presence in 2008	0.14	0.16	ns
Carbon values in 2008: medium	1.04	0.28	***
Carbon values in 2008: high	1.07	0.3	***
Proportion of non-forest in surrounding area in 2008	-0.95	0.23	***
Soil fertility in 2008: medium	-0.04	0.16	ns
Soil fertility in 2008: high	-0.42	0.11	***
Elevation in 2008	-1.23	0.13	***
Population density in 2008	-1.18	0.27	***
Proportion of non-forest in surrounding area * Carbon values: medium (2008)	-1.03	0.27	***
Proportion of non-forest in surrounding area * Carbon values: high (2008)	1.17	0.31	***
Random effect	**Variance**	**SD**	
Commune	8.18	2.86	
Districts	3.13	1.77	

The mean probability of ELC presence in a pixel was 0.12. The average predictive comparison found that, with all other variables held constant, the probability of ELC presence was substantially increased by high carbon values (by 57%: Figure 4.3). Other factors increasing the probability of ELC presence include low population density and high soil fertility (both 27%) and the presence of a Protected Area (21%). High population density greatly reduced the probability of ELC presence (94%). Low carbon values and high soil fertility were also influential in decreasing ELC presence by 30% and 21%. A high proportion of non-forested surrounding area slightly decreased the probability of ELC presence by 13%.

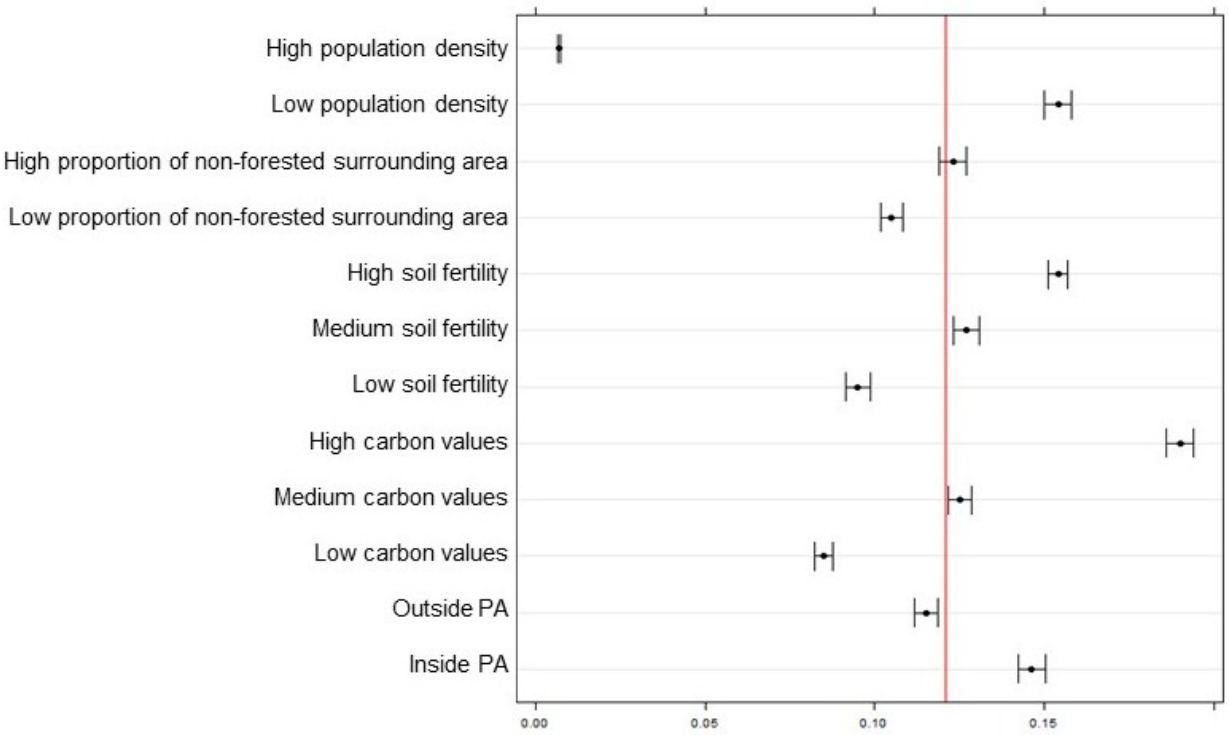

Figure 4.3: Average predictive comparisons illustrating the effect of each predictor variable (on their interquartile range and median scale) on the probability of ELC presence. The red vertical line indicates the predicted overall mean response for the original dataset. The diamond points indicate the predicted mean response for the sample dataset when variables are set at different values (see Table 4.4 for scenario values).

4.4.2 Factors influencing deforestation between 2008 and 2013

Raw data analysis indicated that total forest loss over the study area between 2008 and 2013 was 181,587 ha, at an average annual rate of 1.77% (Table 4.7). Deforestation rates were higher outside protected areas, with the exception of the Boeng Per Wildlife Sanctuary which recorded a 3.95% deforestation rate over the period. Higher still was the forest loss rate under the presence of ELCs, which reached on average 5.19% per year. Overall forest loss is computed at 8.85% over the period, which is higher than the 7% national forest loss rate between 2000 and 2012 (Hansen et al. 2013).

Table 4.7: Forest area and deforestation between 2008 and 2013 per intervention status

Intervention status	Forested area in 2008	Forested area in 2013	Deforestation 2008-13 (ha)	Average annual deforestation rate 2008-13
Outside of PAs	1,555,545	1,404,669	150,876	1.94%
Inside PAs	496,677	465,967	30,710	1.24%
Boeng Per Wildlife Sanctuary	143,561	115,226	28,335	3.95%
Kulen Promtep Wildlife Sanctuary	193,866	192,276	1,590	0.16%
Preah Vihear Protected Forest	157,451	156690	761	0.10%
Preah Vihear Temple	1,800	1775	25	0.28%
Inside ELC	285,205	211,124	74,081	5.19%
No ELCs	1,767,017	1,659,512	107,505	1.22%
Total forest in study area	2,052,223	1,870,636	181,587	1.77%

These observations are confirmed by the second two-part model which looks at predictors of deforestation in the study area between 2008 and 2013. Both the hurdle and the truncated count models show similar results suggesting that the same processes are at play with regards to predicting the presence or absence of deforestation as well as the degree of deforestation, if present. Analytically, this confirms that the high occurrence of zeros is neither part of a structural design nor observation failures, in other words are not false negatives. The one exception is population density, which is initially negatively correlated to the presence of deforestation, but is positively correlated with extent of deforestation once a pixel is deforested.

Deforestation is likely to occur in ELCs (Table 4.7 and Figure 4.2b). Deforestation, similar to predictors of ELC placement, is also more likely to occur in high and medium carbon value areas, especially when such areas are surrounded by a high proportion of non-forest. While deforestation shows a significant negative correlation with two of the four Protected Areas, it is more likely to occur in Boeng Per Wildlife Sanctuary, which is the only unmanaged PA of the four. Deforestation is less likely to happen at high elevation, or close to villages and roads.

The most important variables influencing deforestation were high carbon values and the presence of an ELC. The probability of deforestation in a pixel increased respectively by 2.88 and 2.75 times, while all other variables were held at their mean values (Figure 4.4). The APCs also showed that

deforestation was more likely to occur in areas with high proportions of non-forest, and in BPWS. Keeping all else equal, predicted probabilities of deforestation decreased in the other three managed protected areas, as well as in areas far from roads.

Table 4.8a: Parameter estimates from the final zero hurdle deforestation model. Presence or absence of deforestation between 2008 and 2013 in 1 km^2 pixel as a binary response variable to predictor variables at a 2008 baseline. Model selection table is shown in Appendix B.4. Significance values: 'ns' = non-significant; '.' = P <0.1; '*' = P <0.05; '' = P <0.01; '***' = P <0.001.**

Variable	Estimate	SE	P-value
Intercept	1.41	0.13	***
ELC presence	1.35	0.16	***
Protected Area: Boeng Per Wildlife Sacntuary	0.32	0.1	**
Protected Area: Kulen Promtep Wildlife Sanctuary	-1.82	0.09	***
Protected Area: Preah Vihear Protected Forest	-2.3	0.15	***
Protected Area: Preah Vihear Temple	-13.52	110.47	n.s.
Carbon values: medium	-0.83	0.13	***
Carbon values: high	-0.52	0.15	***
Proportion of non-forest in surrounding area	-1.81	0.09	***
Soil fertility: medium	-0.21	0.16	n.s.
Soil fertility: high	-0.05	0.02	n.s.
Elevation	-0.46	0.05	***
Slope	0.05	0.01	***
Distance from village	-0.46	0.04	***
Population density	-0.1	0.03	***
Distance from road	-0.23	0.03	***
Distance from river	-0.32	0.23	n.s.
Proportion of non-forest in surrounding area * Carbon values: medium	2.09	0.12	***
Proportion of non-forest in surrounding area * Carbon values: high	5.15	0.28	***

Table 4.8b: Parameter estimates from the zero-altered negative binomial deforestation model. Area of deforestation between 2008 and 2013 per 1 km^2 pixel as a continuous response variable to predictor variables at a 2008 baseline. Model selection table is shown in Appendix B.4. Significance values: 'ns' = non-significant; '.' = P <0.1; '*' = P <0.05; '' = P <0.01; '***' = P <0.001.**

Variable	Estimate	SE	P-value
Intercept	-3.05	0.35	***
ELC presence	1.75	0.14	***
Protected Area: Boeng Per Wildlife Sacntuary	0.64	0.14	***
Protected Area: Kulen Promtep Wildlife Sanctuary	-1.99	0.38	***
Protected Area: Preah Vihear Protected Forest	-1.71	0.52	***
Protected Area: Preah Vihear Temple	-12.05	316.75	n.s.
Carbon values: medium	0.13	0.36	n.s.
Carbon values: high	1.38	0.36	***
Proportion of non-forest in surrounding area	-1.56	0.29	***
Soil fertility: medium	0.35	0.29	n.s.
Soil fertility: high	-0.51	0.31	n.s.
Elevation	-0.37	0.08	***
Slope	-0.63	0.55	n.s.
Distance from village	-0.17	0.07	*
Population density	0.16	0.06	***
Distance from road	-0.4	0.06	
Distance from river	0.13	0.07	***
Proportion of non-forest in surrounding area * Carbon values: medium	1.27	0.31	.
Proportion of non-forest in surrounding area * Carbon values: high	2.31	0.33	***

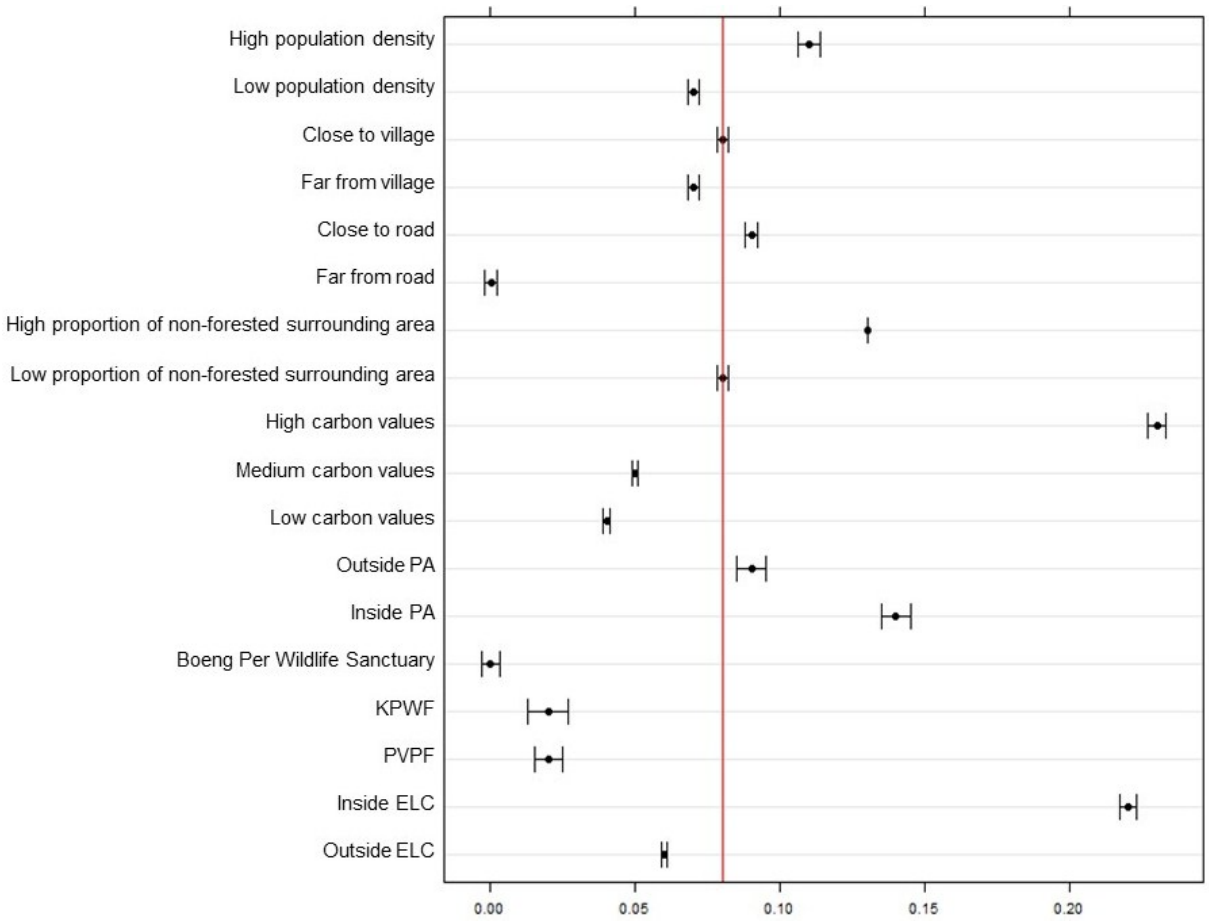

Figure 4.4: Average predictive comparisons illustrating the effect of each predictor variable (on their interquartile range and median scale) on deforested area in a pixel. The red vertical line indicates the predicted overall mean response for the original dataset. The dots indicate the predicted mean response for the sample dataset when variables are set at different values, based on the zero-altered negative binomial deforestation model (see Table 4.4 for scenario values).

4.5 Discussion

This chapter examined the patterns of ELC placement across Northern Cambodia by first using a logistic mixed-effect model to detect the importance of different socio-economic and environmental factors in determining the location of ELCs. Secondly, a zero-altered negative binomial model examined the influence of different regional drivers on deforestation across the study site. Spatial overlays provided underlying data about the factors considered in models, and APCs further explored the relative importance of each predictor on the response variable's mean outcome.

Overall, results reveal that both drivers of ELC placement and drivers of deforestation between 2008 and 2013 do not generally correspond to the initial hypotheses assumed in this study, which were based on the RGC's criteria for placement of ELCs (Table 4.9). Our first model refutes the assumption that drivers of ELC placements reflect the objectives and implementation criteria stated in Cambodia's development policies. In fact, the analysis disproves 7 out of 9 *a priori* hypotheses of correlation with individual explanatory variables.

Table 4.9: Correlation between response variables and individual predictor variables for each model and resulting response with regards to *a priori* hypothesis of correlation (Table 4.2).

Variable	Correlation with ELC presence	Accepted (√) or refuted (X)	Correlation with deforestation	Accepted (√) or refuted (X)
ELC presence 2008	N/A	N/A	Positive	X
Protected Area status in 2008	N/A	X	Negative & positive	X
Carbon values in 2008	Positive	X	Positive	√
Proportion of non-forest in surrounding area in 2008	Negative	X	Negative	X
Soil quality in 2008	Negative	X	N/A	N/A
Elevation	Negative	√	Negative	√
Slope	N/A	N/A	N/A	N/A
Distance to village in 2008	N/A	N/A	Negative	X
Population density in 2008	Negative	√	Positive	√
Distance to road in 2008	N/A	N/A	Negative	X
Distance to river in 2008	N/A	N/A	Positive	√
Proportion of non-forest in surrounding area * Carbon values: medium (2008)	Negative	N/A	Positive	N/A
Proportion of non-forest in surrounding area * Carbon values: high (2008)	Positive	N/A	Positive	N/A

There is no evidence that ELCs are more or less likely to be in PAs. This is in line with the raw data measuring the overlap of ELCs with 14% or 91,366 hectares of the total protected area territory in the study area. Overall, this suggests ELC placement is not related to whether the land has a Protected Area designation, despite the criterion that ELCs should be located in the private state land and not public state land.

ELCs are more likely to be placed in areas with high carbon values yet surrounded by low proportions of non-forested land, instead of in non-use, low carbon value land. In fact, other studies have suggested that ELCs are not implemented in already-degraded land, but rather in high timber value yet accessible forest land (Neef et al. 2013). This is additionally supported by the negative correlations between ELC locations and elevation, which makes access to an area more difficult (Peeters 2015).

When it comes to providing for rural employment, our model reveals that ELCs are more likely to be located in areas with low population density. This is not surprising as companies are legally expected to provide employment and diversification of livelihoods in rural areas which are less populated. However, there is no evidence that distance to village, the presence of road or river, or the suitability of soils influence the placement of ELCs; all of which are specific attributes related to agro-industrial development policy in Cambodia. In short, the first model suggests that ELC placement does not respond to expected socio-environmental factors that are related to implementation criteria in policy documents.

Furthermore, our second model points to the negative environmental outcomes correlated with ELCs. ELCs represent the most significant driver of deforestation of the factors considered. Their substantial contribution to deforestation highlights again the failure to abide by the environmental criteria stated in the 2001 Land Law and the 2005 sub-decree n°146 on ELCs. These results are in line with multiple qualitative reports identifying ELCs as a driver of deforestation over the recent years, and a national study of the impact of ELCs on deforestation rates (Davis et al. 2015; GW 2009; LICADHO 2014).

Other significant drivers of deforestation include the presence of high carbon values and a high proportion of non-forest in surrounding areas, suggesting there is targeted deforestation of easily accessible high-value forests. While the probability of deforestation is lower than average in PVPF and KPWS, it is higher than average in the only protected area which is not actively managed.

This suggests that the level of biodiversity conservation management is potentially an important driver of deforestation. In fact, research has shown that deforestation rates within the KPWF and PVPF have significantly decreased after the increased PA management in collaboration with WCS in 2005 (Clements & E J Milner-Gulland 2015). Additional potential factors at play when observing deforestation patterns are linked to the types of ELCs granted over BPWS: the investor nationality, the time of investment and the stated type of crop have been shown to be key factors in the implementation process of ELCs (Messerli et al. 2015). This study confirms results from Peeters (2015) highlighting that recent granting of ELCs in Northern Cambodia have primarily been focused on rubber plantations; the development of which can accentuate deforestation in the area (see Appendix B.1).

On the other hand, results support the idea that small-scale farming and local timber harvesting around villages are not initially the primary drivers of deforestation, yet they become more influential once an area has started being cleared. In fact, households' responses to the delimitation of an ELC close to their village often includes clearing in order to assess their informal possession rights to a piece of land, or logging within the ELC boundaries which is considered legal (Gironde & Peeters 2015). The APCs confirmed that distance to village did not have a major influence on probability of deforestation. Deforestation is much less likely to occur far from roads.

When comparing results between the two models and related APCs, a similarity can be observed between the location patterns of ELCs and deforestation, in terms of the direction of the correlation with, and scale of influence of, individual predictors. Both ELCs and deforestation are positively correlated with, and significantly influenced by, the interaction between high carbon value and low proportion of surrounding non-forest. This suggests, not surprisingly given the results of the models, that factors driving decision-making about where ELCs and deforestation occur are closely related.

In light of previous research and current findings, this analysis raises the question as to whether choices about ELC placement are in fact driven by factors aimed at fostering development through agricultural intensification. While existing policies prescribe a balance in trade-offs between the development and conservation agendas, results point to discrepancies in the implementation of land regulations, more specifically the 2005 sub-decree n°146 on ELCs, and a lack of synergies between development and conservation. Failure to achieve policy-intended balanced trade-offs also suggests that development impacts may compromise environmental sustainability in the long-run.

4.6 Conclusion

Overall, this study corroborates qualitative reports suggesting that ELCs are mechanisms for the Cambodian ruling elite to enable land grabbing, clear-cutting, and selling of high-value timber under the pretext of an agricultural intensification strategy (Biddulph 2010; GW 2012; Neef et al. 2013; Oldenburg et al. 2014). In such a case, ELCs would affect not only forest retention, but also impede future positive development in Northern Cambodia and negatively impact local communities.

Quantitative research about the potential future effects of ELCs on rural development and accompanying trade-offs is seriously hampered by the unavailability of information about concessions in Cambodia. Better records of large-scale land deals, especially with regards to qualitative, comprehensive, and accessible sources about ELC characteristics, and for spatially explicit data, are necessary for unbiased policy recommendations (Davis et al. 2015).

This study has not addressed the adverse effects of ELCs on local people's livelihoods as raised by several reports (Bues 2011; Neef et al. 2013).This is because understanding the social impacts of ELCs on human well-being requires a more complex and grounded mixed method evaluation (Scoones et al. 2013; Woodhouse et al. 2015). However, the analysis provides a basis to question the stated policy goals which underpin the decisions about ELC

placement as an agricultural intensification policy. This study also shows that regionalised and contextualised analyses are required to explore land-use dynamics and the trade-offs between development and conservation, and suggests that interventions are more often than not the results of politicised implementation processes rather than being primarily driven by pre-existing socio-economic and environmental conditions (Biddulph 2010; Messerli et al. 2015).

5. Assessing medium-term impacts of conservation interventions on local livelihoods in Northern Cambodia

5.1 Introduction

The effect of conservation interventions on human lives has long been a topic of contentious debate (Brockington & Wilkie 2015; Wells et al. 1992), continuing to this day as new methods for assessing impacts constantly evolve (Baylis et al. 2015; Woodhouse et al. 2015) . There is an increased consensus among international policy circles that conservation should at the very least 'do no harm' to the local populations affected by interventions (CBD 1992; IUCN World Parks Congress 2003, 2014), and a wide range of conservation interventions now aim at mitigating poverty, improving local livelihoods, and even further, enhancing human well-being (Leisher et al. 2013; Milner-Gulland et al. 2014). But despite an extensive literature exploring the effects of conservation on human livelihoods, studies rarely point to clear cut arguments about net outcomes and often suffer from lack of methodological robustness (McKinnon et al. 2016; Oldekop et al. 2016).

Recent research using quasi-experimental methods for rigorous scientific impact evaluation have provided new and promising insights into the social effects of different types of conservation interventions on local communities. Studies from Bolivia (Hanauer & Canavire-Bacarreza 2015), Cambodia (Clements & E J Milner-Gulland 2015; Clements et al. 2014), Costa Rica (Arriagada et al. 2012), Indonesia (Gurney et al. 2014) and Thailand (Andam et al. 2010) point to conservation interventions having either no additional impact on local communities or making positive contributions to poverty mitigation, when compared to counterfactuals. More importantly, these studies have underlined the importance of not only exploring whether conservation interventions improve or exacerbate local livelihoods, but also of understanding the mechanisms through which these effects take place (Brockington & Wilkie 2015; Ferraro & Hanauer 2015).

Conservation projects rarely operate in isolation, yet interventions can often have disconnected, if not conflicting objectives and approaches (Pender et al.

2004; Scheidel et al. 2013). Teasing out heterogeneous effects within a fast-paced context featuring a myriad of interventions at play is challenging partly because social changes take time to translate into observable household livelihood habits and strategies (Baral, Stern, et al. 2007). Despite these challenges, understanding heterogeneous impacts is critical in order to determine which subsets of society benefit or incur costs from interventions. Even so, most quasi-experimental studies to date have focused on indicators determined via a single metric of poverty, over a single time period, or over a small number of study sites (but see Gurney et al. 2015).

Investigations of the depth, magnitude and distribution of the social effects of conservation must take a long-term perspective over multiple time periods in order to identify differentiated impacts as well as potential unintended consequences, even after the intervention has ended (Pressey et al. 2015; Pullin et al. 2013). A landscape approach is necessary to identify the interactions between the social impacts of interventions on different sub-groups within communities, and how these interacting effects vary geographically across multiple treatment and counterfactual sites (Agarwala et al. 2014; Pomeroy et al. 2011). Only by recognizing the different pathways through which livelihoods change within a broader socio-economic context can practitioners gain external and internal validation for projects and ultimately achieve both positive conservation and livelihood outcomes (Bottrill et al. 2014; Suich et al. 2015). However, due to the novelty of the appetite for applying quasi-experimental designs to evaluate conservation intervention impacts and the difficulty in applying these retrospectively, few studies have been able to provide a medium to long-term perspective on these issues (Ahmadia et al. 2015).

Here I present one of the first multi-period impact evaluation studies, which includes three longitudinal surveys over six years, to explore how conservation interventions have impacted households' pathways of development in the context of a dynamic socio-economic landscape, increasing general economic development, and environmental change. The project was first evaluated three years after inception by Clements & Milner-Gulland (2015), to measure the

effects of PAs and PES projects on three socio-economic indicators of local livelihoods in Northern Cambodia. This study takes Clements & Milner-Gulland's (2015) evaluation of the short-term social impacts of conservation interventions to the medium term, in order to clarify the mechanisms through which social effects take place and how this translates into the development pathways adopted by households.

I aim to answer the following questions: Firstly, how has household socio-economic status changed in a landscape of fast land-use change? Secondly, how does this vary for different groups between and within villages? Thirdly, how much do conservation interventions, in terms of PAs and additional PES programmes, contribute to this change and on what timescales?

I first present an assessment of the effects of PAs on three socio-economic indicators of local livelihoods in Northern Cambodia over two three-year time periods between 2008 and 2014. I use quasi-experimental and mixed methods to estimate the changes in household economic status, rice harvests and food security, in villages inside PAs compared to villages outside protected areas across the landscape. I then focus on a set of four core villages that have been the focus of PES activities since 2008 to assess the additional effect of PES on the three socio-economic indicators.

5.2 Study site

Cambodia has seen rapid economic progress and globalization over the past decade (Mah 2015). Despite a sharp reduction in 2009, Cambodia's GDP has been growing at nearly 7% between 2008 and 2014, along with an average annual population growth rate of 1.7% between 2000 and 2013 (ADB 2015; World Bank 2013). The national poverty more than halved between 2004 and 2011, yet GDP per capita remains low at US$1,020 in 2014 (Sobrado et al. 2014). Government policies to promote development include infrastructure improvements such as road and communication networks, as well as the promotion of agri-industrial developments through the granting of land for Economic Land Concessions (ELCs). However, disputes have arisen

specifically around unfair eviction of local communities from their land, and the patchwork pattern of ELCs granted over high value forests and protected areas, thus affecting local livelihoods (Bues 2011; Hor et al. 2014; Ullenberg 2009). In parallel, Cambodia has also recorded the fifth highest rate of deforestation worldwide between 2000 and 2012 (Hansen et al. 2013), primarily due to land grabbing and illegal logging (Beauchamp et al. in review). These macro development drivers are often felt disproportionately in rural areas, where trade-offs from environmental depletion can hinder human development in rural Cambodia (LICADHO 2009; Scheidel et al. 2013).

The Northern Plains of Cambodia is a landscape located in the province of Preah Vihear, along the border with Thailand and Lao (Figure 5.1). It is one of the largest remaining areas of deciduous Dipterocarp forest and is considered an area of high biodiversity interest (Myers et al. 2000; O'Kelly et al. 2012). The core and contains two PAs: Kulen Promtep Wildlife Sanctuary (KPWS), managed by the Ministry of Environment (MoE), and Preah Vihear Protected Forest, managed by the Forestry Administration (FA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF). While PVPF was declared in 2002, KPWS was established in 1993 as part of Cambodia's first protected area network.

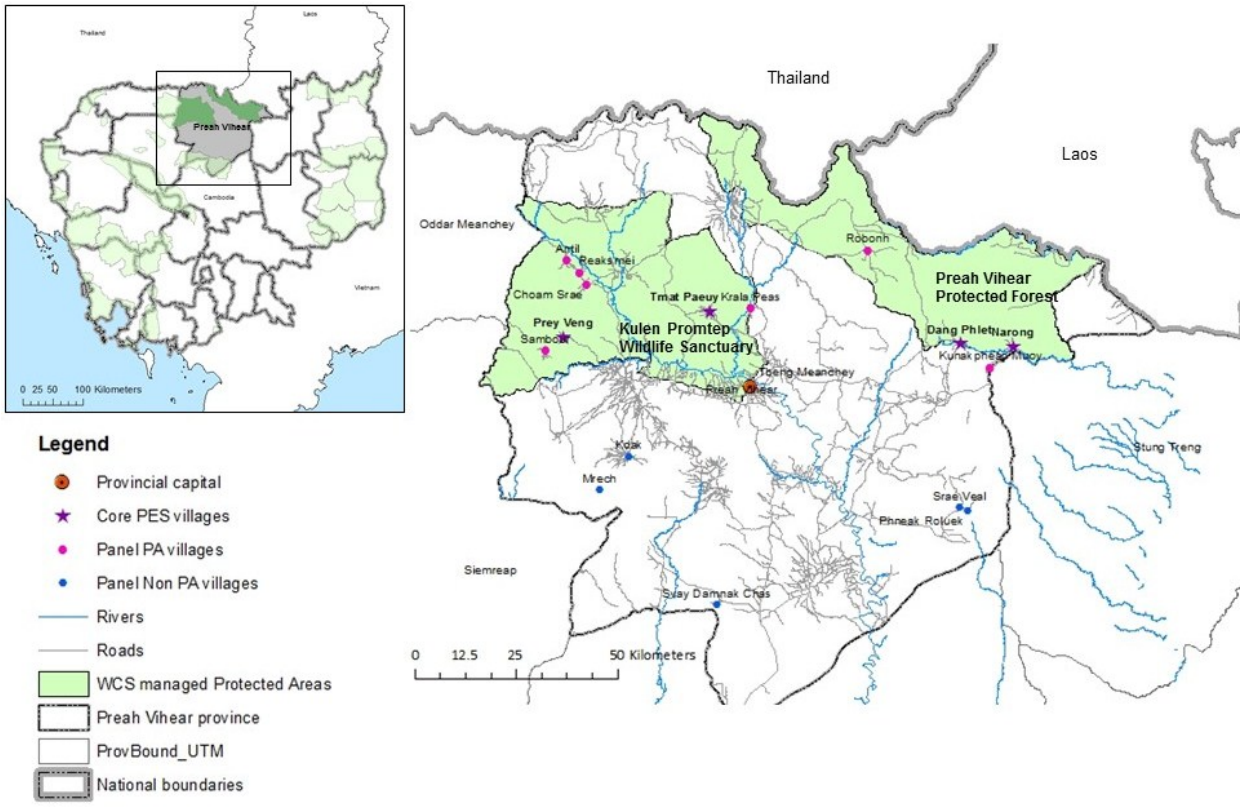

Figure 5.1: Map of the surveyed villages across the province of Preah Vihear

Since 2005, international non-governmental organisation the Wildlife Conservation Society (WCS) has assisted the MoE and FA's conservation efforts in both PAs (Clements & E J Milner-Gulland 2015). Additionally, three PES programmes were instituted to complement PA management in a number of villages: a bird nest protection programme, a premium payment scheme for eco-friendly rice (Ibis Rice), and an ecotourism programme. The bird nest protection programme, which started in 2003 and is now implemented across over 24 villages, provides small direct payments (up to 5 USD/day) to local villagers who report and protect the nest of a specific endangered bird species during nesting period (Clements et al. 2013). The Ibis Rice scheme started with 4 villages in 2008 and has now been expanded to 11 villages. This agri-environment payment programme enables farmers that keep to PA rules to sell their rice through a village committee at a higher premium than that of the traders. Additionally, ecotourism projects have included three villages to date, the most prominent of which started in 2003, one in 2008, and the last in 2010 (Clements et al. 2010; Clements 2012).

Households across the landscape are subsistence farmers whose livelihoods revolve around small-scale rice farming, with additional non-timber forest product harvesting and fishing around villages. Collecting liquid resin from Dipterocarp trees has also traditionally been an important livelihood in Northern Plains' communities (Clements et al. 2014; Rainey et al. 2010). Resource use rules within the protected area under Cambodian law allows local uses such as NTFP collection, although forest clearance, commercial logging, and hunting or trade in threatened species are illegal. Villages are permitted by PA authorities, however, to expand agriculture to a limited extent within agreed land-use plans.

Availability of productive land is central to the livelihoods of most families in rural Cambodia. Based on prior research, household socio-economic status is expected to have a greater rate of change outside PAs in comparison to inside PAs (Clements & E J Milner-Gulland 2015). This is because land expansion within PAs is controlled, whereas outside PAs there has been a recent rush by local people to acquire land resources, driven by a decrease in land availability due to population growth and competition with ELCs (Dwyer 2015b). Because households have different levels of access to and use of natural resources, effects are also expected to vary according to the type of livelihood strategy a household follows, as well as their original socio-economic status at the start of the study. Households practicing traditional livelihoods such as resin tapping and shifting agriculture are expected to have a lower rate of growth than families that have mechanised and intensified farming by practicing both rice paddy farming and shifting agriculture (Clements et al. 2014). It is also expected that families that have diversified away from agriculture into non-farm activities due to land unavailability, for example selling labour, will be more prominent outside PAs and grow more slowly than households with a large land base (Scheidel et al. 2014).

5.3 Methods

5.3.1 Survey design

Causal inference in impact evaluation rests on the comparison of outcomes in an intervention with a relevant counterfactual (Ferraro 2007). In a dynamic environment it is rare that all control and treatment units would have evolved with similar trends apart from the intervention over a medium-term period. I therefore combine covariate matching with difference-in-differences (DiD) estimation to increase confidence that this assumption is met in the current analysis (Abadie & Imbens 2011).

This analysis is based on the original survey design of Clements & Milner-Gulland (2015), using co-variate matching to compare the effect of PAs at the village level, which uses four key factors characterizing village-level poverty prior to the initiation of the PAs in 2005: forest cover within 5 km of the village; village size; and distances to roads and markets (Clements 2012). Among the 211 villages in Preah Vihear province, 11 villages in PAs were selected for analysis (see Figure 5.2). The PES projects have been implemented at different scales across the 11 PA villages, four of which have been the focus of higher conservation activities by WCS. Five villages that were located at least 20 km away from the PA border, to control for spillover effects, were selected for the counterfactual.

Data was collected for a longitudinal panel of households in 2008, 2011 and 2014 across the 16 villages identified through matching. In 2008, a total of 709 households were interviewed across the 16 villages included in this analysis: 889 were surveyed in 2011, and 944 in 2014, to account for the increasing number of participants in the PES projects (Figure 5.2). The resulting panel household dataset contains 596 household interviews across all three time periods, 173 of which are located in the four core PES villages.

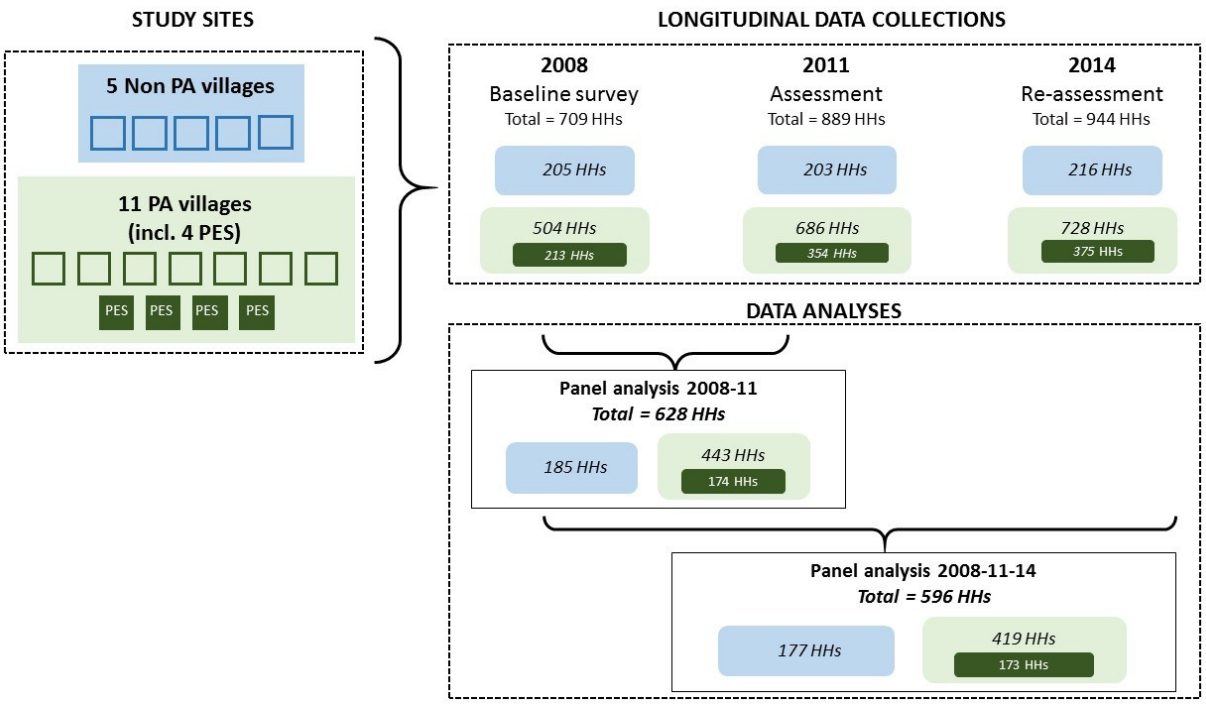

Figure 5.2: Number of households interviewed in 2008, 2011 and 2014, and number of panel households across treatment type included in the panel analyses. The five non-PA villages are indicated in white boxes and the 11 PA villages are indicated in light grey boxes, within which the four core PES villages are indicated in dark grey boxes.

5.3.2 Socio-economic indicators

Economic status was calculated using the Basic Necessities Survey (BNS) methodology, which incorporates multiple aspects of poverty into a single score for each household in the sample (Davies & Smith 1998; Pro-Poor Centre & Davies 2006). This method uses a locally-derived list of assets and services to assess the level of local livelihoods by weighting which items respondents classify as basic necessities (BN) that "everybody in the village should have, and nobody should go without" among the presented list (Wilkie 2007). The economic status of individual households is then calculated as the product of how many items within the list a household possesses and the weighting of that item. A strength of the BNS is that it is both participatory in its approach, using focus groups in communities to gather a list of locally perceived basic necessities, yet it is applicable to systematic assessments through the construction of an index.

Perceptions of what a BN is vary over time, potentially influencing the modelled effect of change between years through the weighting used to calculate scores. As an extreme example, having a mobile phone was considered a BN by 32% of the households interviewed and owned by 12% in 2008, whereas 93% considered it to be a BN and 75% owned one in 2014 (see Appendix C.1). Density plots comparing BNS weighting show only minor differences when applying the 2008 versus the 2014 weightings. This chapter thus uses the 2014 BNS weights retrospectively as it accounts slightly better for variance between households.

The use of historical datasets for medium-term evaluations imposes certain limitations on survey design, for example the inclusion of new relevant variables as time goes. This chapter thus fails to capture well-being outcomes considered relevant by local people - such as tenure security, education, ability to insure against shocks, or political power (Agrawal & Redford 2006; Gough & McGregor 2007; Sen 2001). While poverty indicators are one of the key measures used to assess social development in impact evaluations, it is recognised that economic proxies do not often reflect the whole range of people's priorities (Stiglitz et al. 2009). This chapter thus expands its assessment of the effect of conservation interventions on two further socio-economic indicators: agricultural productivity and food security. Agricultural productivity is measured in total annual rice harvest in kilograms, rice being the primary diet and source of income for Cambodian subsistence farmers. Food security comprises all rice sources (harvested, bought, received) and deducts annual food requirements for the household. This allows the capture of a potential path of differentiation in livelihoods, for example shop owners divesting from agriculture yet being able to buy rice from alternative incomes.

5.3.3 Statistical analysis

This chapter first uses DiD methods on the dataset of a longitudinal panel of households in matched villages both inside and outside PAs, to assess the effects of being within a PA (the treatment) on changes in household economic

status, agricultural productivity and food security between 2008 and 2014 (Gertler et al. 2011). I tested for the effect of time and treatment by modelling time as a dummy variable, which accounts for baseline status of households (Walter et al. 1987). Accounting for confounding factors in a post-matching regression further improves the attribution of the effects to the intervention versus other external elements occurring on a similar temporal and spatial scale (Andam et al. 2008). After controlling for other factors, a significant interaction between treatment and time indicates that the PA had an effect on the response variable. Conversely, a non-significant interaction and a significant treatment would indicate that the response variable differed significantly between within PA and outside PA villages, but that this was not due to the presence of the PA, because the difference did not change over time and was present before the intervention began.

I then use DiD models to assess the effect of PES participation on the same response variables within a reduced longitudinal dataset of four core villages within the PAs, where the PES programmes have been in place since 2008. Participation in the PES schemes can vary over time: I thus measure participation separately for the two time periods. I model it as time variant binary variables of whether or not a household participated in each PES programme for at least a year during 2008 and 2011, and then between 2011 and 2014. The approach of DiD and controlling for other confounding factors through multivariate modelling was deemed superior to matching at a household level between the four villages for this analysis. This is because of the smaller number of villages involved in the analysis, all of which are very different, so that matching may induce correlation across observations even after controlling for treatment status and covariates in the study designs (Hanson & Sunderam 2012). For example, matching two households of the same absolute wealth between two villages in which the average wealth and socio-economic context was very different would not represent a fair comparison. Model selection was done as for the full dataset models.

For both model types, *a priori* predictor variables were included to control for exogenous trends as well as endogenous household and village level factors

hypothesised to contribute to changes in response variables (Table 5.1). I accounted for different types of livelihood strategies, in order to interpret pathways of impacts across different types of household.

Impact attribution cannot be established at the level of confounding factors, yet inference from regression correlations about the non-treatment conditions associated with the measured changes can still be drawn if livelihood strategies are relatively similar across the landscape studied, as in this case. Explanatory variables were tested for collinearity before their inclusion in the model, and their distribution was examined to determine transformations of skewed variables. Village was included as a random effect to reflect the nested structure of the data (Cameron & Miller 2015; Maas & Hox 2004).

Full models were first formulated, then backward selection of supported variables was carried out with AICc values calculated using maximum likelihood, removing variables and interactions that did not improve the model with an AICc > 4 (see accompanying documents). Models were checked by plotting residuals against fitted values and using QQ-plots to examine the normality of errors as well as examining the residual variance of the random effect. Modelling was done in R version 3.2.2 using package lme4 (Bates et al. 2014).

Table 5.1: *A priori* variables included in full model for selection. Variables inputted as time-variant between 2008, 2011 and 2014 except for Protected Area treatment which remained time-invariant.

Variables	Description	Type & transformation	BNS models	Rice harvest models	Food security models
Wellbeing variables					
Poverty (BNS score)	BNS score (2014 weights applied retrospectively)	Continuous	*N/a*	*N/a*	*N/a*
Rice harvest (kg)	Total rice harvest (paddy & shifting cultivation).	Continuous (sqrt +1000)	√	*N/a*	*N/a*
Food security (kg)	Food security = Total rice collected (harvested & bought) - annual household rice requirements	Continuous (sqrt +5000)	*N/a*	*N/a*	*N/a*
Treatment level					
Intervention PA		Binary: 0: Non-protected area; 1: Protected area	*Panel dataset models only*		
PES participation					
Participation in Ibis Rice	Involved in project at least one year per period: 2008-11; 2011-14	Binary - Yes/No	*PES subset models only*		
Participation in Ecotourism	Involved in project at least one year per period: 2008-11; 2011-14	Binary - Yes/No			
Participation in Bird Nest	Involved in project at least one year per period: 2008-11; 2011-14	Binary - Yes/No			
Household characteristics					
Household size	Total number of members	Continuous (sqrt +1)	√	√	√
Female headed household		Binary - Yes/No	√	√	√
Working adults	Working adults = (children<15 yo + elders>60 yo)	Continuous (sqrt +1)	√	√	√
Household head education	Maximum level of education achieved by the household head	Continuous (sqrt +1)	√	√	√
Household head age	Factorized into 3 category referencing a 1) new household; 2) a mature household; 3) an aging household	Categorical: 1: HH age < 35 2: HH age 35-55; 3: HH age >55	√	√	√
Household Livelihood Strategies					
Own >1 hectare	Owning more than 1 hectare of rice land; included in BNS menu	Binary - Yes/No	x	√	√
Resin-tapper		Binary - Yes/No	√	√	√
Rice farmer		Binary - Yes/No	√	√	√
Cash crop farmer		Binary - Yes/No	√	√	√
Rice farmer type		Categorical: 0: Both 1: Paddy only; 2: Shifting cultivation only (chamkar); 3: None	√	√	√
Employed	Employed by either private, NGO or public sector (army service excluded)	Binary - Yes/No	√	√	√
Service provider	Rice threshing & milling excluded	Binary - Yes/No	√	√	√
Shop keeper		Binary - Yes/No	√	√	√
Sell labour		Binary - Yes/No	√	√	√
Household Assets					
Own mini-tractor	Owning more a mini-tractor; included in BNS menu	Binary - Yes/No	x	√	√
Number of cattle heads	Number of adult cattle owned	Continuous (sqrt +1)	√	√	√
Village level variables					
Village Population Size	Number of households in village	Continuous (sqrt +1)	√	√	√
Years of schooling in the village	Top year of school available in village	Continuous (sqrt +1)	√	√	√
Time to provincial capital	Dry season time to travel to Tbeng Meanchey	Continuous (sqrt +1)	√	√	√
Time to market	Dry season time to travel to nearest full day market	Continuous (sqrt +1)	√	√	√

5.4 Results

5.4.1 Change in livelihoods over time

Average economic status, rice harvest and food security all improved considerably in the surveyed population between 2008 and 2014 (Table 5.2). Average economic status in the PA villages is significantly higher than in non-PA villages at all three survey times, however the average economic status within PAs rose by 34% while villages outside PA saw a 50% improvement between 2008 and 2014. Higher rice harvests and better food security were also found on average in PA villages compared to villages outside PA in 2008, and in 2014.

Table 5.2: Household characteristics and livelihood strategies for a panel of 596 households within and outside PAs between 2008 and 2014. Tests of difference applied to compare variable values for households in PA villages against non-PA villages at each year.

	Control			PA			Test of difference (PA vs. non-PA)		
	2008	2011	2014	2008	2011	2014	2008	2011	2014
Households	177	177	177	419	419	419			
Household Size	6.0	6.1	5.8	5.8	6.0	5.9	ns	ns	ns
Working Adults	3.0	3.2	2.9	3.2	3.3	3.3	ns	ns	*
Dependency Ratio	1.1	1.1	1.1	1.0	1.0	1.0	ns	.	*
Household head age (yrs)	38.3	40.6	42.8	42.1	44.3	46.4	***	***	***
Household head education (yrs)	2.0	2.0	2.7	3.4	3.4	4.0	***	***	***
Female-headed households (%)	6	5	11	7	7	10	ns	ns	ns
Livelihood variables									
Economic status	7.9	11.5	11.8	9.5	12.1	12.8	***	.	**
Rice harvest (kg)	1305	2355	2802	1879	2554	3325	***	ns	*
Food security (kg)	-628	1140	1302	-228	1375	1532	***	ns	ns
Livelihood strategies									
Resin tapper (%)	31	41	28	58	63	54	***	***	***
Rice farmer (%)	95	95	100	91	97	100	ns	ns	ns
>1 ha of paddy fields (%)	63	79	80	74	85	85	*	.	ns
Mini tractor (%)	27	37	69	30	61	74	ns	***	ns
Rice shifting cultivation (%)	46	40	20	37	26	16	*	***	ns
Cash crops	18	10	24	4	2	12	***	***	***
Employed (%)	3	4	6	6	9	15	ns	.	**
Service provider (%)	2	28	36	3	25	42	ns	ns	ns
Shop owner (%)	13	8	6	14	9	8	ns	ns	ns
Sell labour (%)	1	44	58	3	33	46	ns	*	*
Cattle (number)	3.52	4.11	1.84	4.89	3.63	2.43	***	ns	*

Other characteristics and livelihood strategies of households within PAs varied significantly when compared to households living in villages outside PAs at each survey time. Household heads tended to be older and more educated in PA villages, yet within similar average household sizes. All villages saw rice farming as the dominant livelihood, with 100% of the panel households practicing rice farming in 2014. Households outside PAs were also more likely to practice shifting cultivation in 2008 and 2011, but this practice had decreased overall by 2014. This coincided with an increasing number of households having over one hectare of paddy land outside PAs by 2014, which up until then had been significantly higher amongst PA households.

With increased land holdings, households were able to switch from shifting agriculture to more intensive and productive practices of rice and cash crop farming. Cash crop farming saw a substantial increase in uptake across the landscape, with the percentage of PA households practicing it tripling by 2014.

While PA households still count a higher number of resin tappers, numbers have fluctuated, producing a decrease in tappers below 2008 levels by 2014. In parallel, non-traditional livelihoods such as selling labour and providing services also increased between 2008 and 2014. Selling labour was more likely to be undertaken as a livelihood strategy by families outside PAs, while families within PAs had a higher employment rate in 2011 and 2014, most likely as a result of hiring local villagers for conservation activities (Clements et al. 2014).

Improvements in the three socio-economic indicators were seen for both the highest and lowest economic status quintiles in the sample (Appendix C.2). However, the richest quintile improved their economic status, agricultural productivity and food security at a faster rate than the average population, and almost 50% faster than the poorest quintile. More families within the richest quintiles included additional livelihoods over the period, with the exception of there being a decreasing number of shifting agriculture farmers. By 2014, 97% of richer families owned at least one hectare of rice land, and almost half were

still resin tapping. Cash crop farmers were twice as numerous and employment rates had tripled since 2008. Richer households were more likely to own a shop and provide a service, to own a mini-tractor and a higher number of cattle, and to be involved in all three PES programmes. While the poorest quintile also increased the number of livelihoods undertaken since 2008, both the absolute values and rates of change were lower. In 2014, only 54% of the poorest quintile owned over one hectare of rice land and more families tended to practice shifting agriculture and sell labour compared to the population average.

5.4.2 Factors driving medium-term changes in socio-economic indicators

Absolute values show that the average economic status of households in PAs is significantly higher over the years when compared to outside PAs, yet rates of increase in economic status were higher outside PAs (Table 5.2). After controlling for other factors in the DiD post-matching regression, the presence of a PA slightly slows the rate of change of household economic status over the study period, when compared to households outside PAs (Table 5.3). However, the effect of PAs over the six-year period is relatively small when compared to other factors influencing change in economic status: household characteristics, livelihood strategies and village-level factors such as years of schooling in the village.

Larger, more educated, and more agriculturally productive households tended to increase their economic status faster, whereas female-headed households experienced a slower rate of change. Households living in villages where a higher level of education was available were further advantaged, while villages located far away from the provincial capital were in a more disadvantaged position. Families that either provided a service or owned a shop in the village saw the fastest improvements in their economic status, followed by those who were employed or farmed cash crops. Resin-tapping households saw a slower change in economic status overall, but within PAs the status of resin tappers improved at a faster rate than that of non-resin tappers.

Table 5.3. Parameter estimates from the final regressions on panel dataset (596 HHs) of the effect of predictor variables on changes in household a) economic status, b) rice harvests, and c) food security between 2008 and 2014. Significance values: 'ns' = non-significant; '.' = P <0.1; '*' = P <0.05; '' = P <0.01; '***' = P <0.001. Shaded variables in the economic status model were excluded from the analysis as they were items calculated within the BSN score.**

	A) Economic status		B) Rice harvest		C) Food security	
(Intercept)	2.19	*	13.09	***	74.58	***
Time and treatment interventions						
Time 2008-2011	2.11	***	11.39	***	11.88	***
Time 2008-2014	2.30	***	14.63	***	12.45	***
PA interventions	0.40	ns	5.90	*	1.87	ns
PA interventions * 2008-2011	-0.58	ns	-5.84	***	-1.71	ns
PA interventions * 2008-2014	-0.65	*	-2.91	ns	-1.43	ns
PA interventions * Resin tapper	1.09	***				
PA interventions * Shifting cultivation only			3.83	ns	0.63	ns
PA interventions * None			-3.28	ns	-3.33	ns
PA interventions * Rice paddy only			-0.42	ns	0.08	ns
Household characteristics						
Household size	0.65	***	3.23	**	-5.85	***
No. working adults			1.59	***	0.61	**
Household head education	0.43	***	1.68	***	1.17	***
Female-headed household	-0.93	***				
Rice harvests (kg)	0.06	***				
Livelihood strategies						
Resin tapper	-0.56	*				
Owning over one hectare			5.07	***	2.61	***
Rice farmer type: shifting cultivation only			-16.21	***	-5.60	**
Rice farmer type: None			-38.38	***	-8.52	***
Rice farmer type: Rice paddy only			-3.38	*	-1.93	*
Cash crop farmer	0.56	*				
Employed	0.99	***				
Selling labour			-3.28	***	-1.72	**
Service provider	1.14	***	3.76	***	2.11	***
Shop owner	1.71	***	2.52	*		
Owning mini-tractor			-1.42	ns	-0.29	ns
Cattle (heads)	0.16	***	0.61	***	0.36	***
Owning one hectare * Owning mini-tractor			9.72	***	3.90	**
Village characteristics						
Distance from provincial capital	-1.18	***				
Years of schooling in the village	1.11	***				
% residual variance from RE						
Village	13.48%		10.71%		8.86%	

With regards to rice harvests, a similar trend appears: while absolute values for agricultural productivity were higher within PAs, PA households saw a slower rate of change in their rice harvests between 2008 and 2011.However, the effect of being within a PA is not significant between 2011 and 2014, nor does it influence results between the different rice farmer types over the 2008-2014 period.

Larger families counting more adults and more educated household heads increased their rice harvests faster overall. Households that had transitioned to mechanised agriculture and owned a mini-tractor as well as one hectare of rice land improved their status at a greater rate, especially if they practiced both shifting and paddy rice farming. Farmers practicing only shifting cultivation saw slower progress, most likely due to the lower input yet reduced output they receive from this type of farming. Being a household that sold labour was associated with reduced improvements in agricultural productivity.

Being in a PA had no significant effect on food security over time, while overall, the explanatory variables were relatively similar in terms of direction and magnitude of effect to the ones in the agricultural productivity model. The overall effect of being in a PA is therefore limited to slightly reducing the rates of change in average economic status between 2008 and 2014, with the exception of it benefitting resin-tapping households, and to reducing rates of increase in agricultural productivity between 2008 and 2011, relative to controls outside the PAs.

5.4.3 PES participation

Panel data for the four core PES villages included 173 households or 41% of the total panel dataset. While the ecotourism programme only operated in three of the four core PES villages, participation by the panel households in the two other PES programmes was much higher within the four core PES villages than over the PAs as a whole (Table 5.4).

Table 5.4: Comparison of participation of panel households in PES programmes between all PA villages (11 villages, 419 HHs) and core PES villages (4 villages, 173 HHs) for 2008-11, and 2011-14.

	Core PES villages		All PA villages	
	2008-11	2011-14	2008-11	2011-14
Households	173	173	419	419
Ecotourism				
Participant households	64	59		
% of total panel households in subset of villages	37%	34%		
Households participating for >1 year	37	41		
Average annual payment per participating household	101	119		
Ibis Rice				
Participant households	52	83	52	105
% of total panel households in subset of villages	30%	48%	12%	25%
Households participating for >1 year	24	48	24	55
Average annual payment per participating household	234	289	234	254
Bird Nest				
Participant households	18	14	18	27
% of total panel households in subset of villages	10%	8%	4%	6%
Households participating for >1 year	4	3	4	4
Average annual payment per participating household	53	69	53	66

More households joined the Ibis Rice and the Bird Nest programme between 2008 and 2014, while the number of families involved in ecotourism slightly decreased. Ibis Rice had a large and increasing number of households from 2011 to 2014, with 25% of the overall panel households involved for more than one year. The ecotourism programme had a higher proportion of participating families being involved for more than one year, most likely because, once trained, households were more likely to continue to participate.

Between 2008 and 2014, both the ecotourism and the Ibis Rice programmes included at least four times more families in the richest quintile than in the poorest quintile (Appendix C.2). Participants in each of the PES programmes had greater economic status, agricultural productivity and food security compared to non-participants in the respective project for both the 2008-2011 and 2011-2014 periods (Appendix C.3). In similarly-sized households, families involved in all three PES programmes were more likely than non-participants to be more educated, to own a shop and to provide a service. A greater number of the PES participating families owned mini-tractors and had more livestock on average. Non-participants were generally more likely to practice shifting

agriculture and sell labour. Average annual payments per participating household were highest for Ibis Rice participants and increased during the second period.

5.4.4 Additional effect of PES on changes in household livelihoods

After controlling for other factors, households involved in the Ibis Rice programme improved their economic status and their agricultural productivity faster than non-participants between 2008 and 2014 (Table 5.5).

However, there were no significant effects from the Ibis Rice programme on economic status and rice harvest for the earlier 2008-11 time period, which suggests the benefits from participation have taken some time to trickle down into well-being improvements. The ecotourism and the bird nest programmes showed no significant effect on changes in economic status, rice harvest or food security.

A number of trends appear across both the full panel and the PES subset models. Providing a service and owning a larger number of cattle were associated with greater rates of improvement in all three socio-economic indicators. Owning one hectare of rice land increased a household's rate of improvement in the agricultural productivity and food security models, while households that were not practicing both paddy and shifting cultivation agriculture had a reduced rate of improvement. Lastly, female-headed households and households located in a village far from the provincial capital had reduced rates of socio-economic improvement, while the opposite was true for households with greater rice harvests and for cash crop farmers across the landscape analysis and within the PES villages. The prevalence of effects related to the livelihood strategies undertaken by families at the two scales of analysis, rather than treatment effects, highlights that despite a higher level of conservation activity in the four PES villages, other micro and macro elements still prevail as the primary drivers and barriers of change in development pathways in the study area.

Table 5.5. Parameter estimates from the regressions on the subset panel households from four core PES villages (173 HHs) of the effect of predictor variables on changes in household a) economic status, b) rice harvests, and c) food security, between 2008 and 2014. Significance values: 'ns' = non-significant; '.' = P <0.1; '*' = P <0.05; '' = P <0.01; '***' = P <0.001.**

	A) Economic status		B) Rice harvest		C) Food security	
(Intercept)	12.11	***	-69.24	ns	36.83	ns
Time and treatment interventions						
Time 2008-2014	0.31	ns	17.33	**	15.07	***
Time 2008-2011	0.44	ns	24.65	***	15.09	***
Ibis Rice * 2008-2011	-0.17	ns	-1.64	ns	2.87	ns
Ecotourism * 2008-2011	0.80	ns	-4.36	ns	-3.59	ns
Bird Nest * 2008-2011	-0.01	ns	-1.70	ns	1.45	ns
Ibis Rice * 2008-2014	0.70	.	5.12	*	0.55	ns
Ecotourism * 2008-2014	-0.27	ns	2.33	ns	1.97	ns
Bird Nest * 2008-2014	0.05	ns	1.53	ns	0.71	ns
Household characteristics						
Household size			7.19	***	-4.71	***
No. working adults						
Household head age: mature			2.81	.		
Household head age: aging			3.18	.		
Household head education					1.55	**
Female-headed household	-1.69	***				
Rice harvests (kg)	0.07	***				
Livelihood strategies						
Owning over one hectare			7.12	**	3.37	*
Rice farmer type: shifting cultivation only			-17.12	**	-7.60	*
Rice farmer type: None			-46.21	***	-15.42	***
Rice farmer type: Rice paddy only			-7.24	**	-4.69	**
Cash crop farmer	1.05	**				
Employed						
Selling labour			-4.35	**		
Service provider	1.02	***	5.47	***	2.56	*
Shop owner	1.23	***				
Owning mini-tractor			7.07	***	3.40	**
Cattle (heads)	0.14	***	0.52	***	0.31	***
Village characteristics						
Distance from provincial capital	-2.85	***	17.81	*	6.35	ns
Years of schooling in the village			12.42	ns	6.57	ns
Distance from market			8.28	.	4.68	.
Random effect	Var	SD	Var	SD	Var	SD
Village	0.43	0.65	64.25	8.02	10.64	3.26

5.5 Discussion

5.5.1 Livelihood diversification and agricultural intensification over two time periods

From the 2008 baseline survey, Clements et al (2014) had hypothesised that rural subsistence farmers of the Northern Plains would follow one of two main pathways out of poverty: agricultural modernization or livelihood diversification. From the repeat assessment in 2011, Clements & Milner-Gulland (2015) concluded that mechanisation of agriculture was underway, yet differences between livelihood strategies remained between households within and outside PAs. The current analysis further confirms the importance of micro and macro development factors driving socio-economic change both inside and outside PAs, pointing to a homogenisation of lifestyles across the landscape, influenced by better roads, access to markets and an increase in trade across Preah Vihear.

Differences remain in the livelihood strategies adopted inside and outside PAs, but these gaps are narrowing. This is due to an intensification and modernisation of agricultural practices and to a pronounced diversification from traditional livelihoods into labour-based activities. The general increase in mini-tractor ownership and the move away from rice shifting cultivation practices across the landscape illustrate these trends. The divestment away from traditional livelihoods into non-farm activities was probably fuelled by an increase in roads providing access to markets and goods, facilitating the movement and marketisation of labour as well as the desirability of direct cash payments in preference to the commodification of non-agricultural resources such as cattle and liquid resin.

These trends did not affect all groups within communities similarly, however; an increasing discrepancy between the livelihood status of the top and bottom economic status quintiles can be observed between 2008 and 2014. The top quintile was most likely to undertake both mechanisation and diversification at the same time, while the poorest families showed limited improvements in all three indicators. This suggests families with enough assets could invest in a

mini-tractor, thus increasing yields, and in turn both income and food security. The additional income, as well as time freed up by mechanisation, enabled their entry into new livelihoods. Conversely, households unable to acquire enough natural, livestock or agricultural resources to launch an alternative livelihood or mechanise their agricultural practices remained in a poverty trap. The bottom quintile was more likely to practice shifting agriculture and to sell labour, which potentially provides an alternative stepping stone out of poverty and into agriculture - a strategy expected as a response to shortage of land (Scheidel et al. 2014).

5.5.2 Livelihood pathways inside vs. outside Protected Areas

This analysis demonstrated that PAs in the Northern Plains have slightly limited the rate of increase in economic status and agricultural productivity for households between 2008 and 2014, when compared to households outside PAs. However, this is based on changes from 2011-2014, with no significant effect being recorded for the first period 2008-2011. This is similar to Clements & Milner-Gulland's (2015) impact evaluation results from 2011, and is unsurprising, as Cambodian PAs are primarily designed to protect ecosystems from external drivers of loss and do not aim to improve communities' livelihoods. In turn, the greater rates of change experienced in villages outside PAs between 2011 and 2014 can be explained by the lack of constraints on household land expansion, combined with the pressure for households to acquire and develop new land before other competing actors or ELCs appropriate it (Scheidel et al. 2013; Rudi et al. 2014).

Despite this, conservation interventions have not prevented households from developing livelihoods to provide routes out of poverty, as increases in all three outcome variables were recorded across the landscape. In fact, PAs have successfully provided tenure security for resin trees and allowed resin tappers to improve their economic status, unlike resin tappers outside PAs who appear comparatively disadvantaged. The importance of resin to household economies in Cambodia has been well documented (Clements et al. 2014; Evans et al. 2003). However, the lack of formal tree tenure, the time-

consuming nature of resin tapping and the lack of centralised markets for its resale may have contributed to an overall move away from practising tapping, especially outside PAs.

The measured rates of change in economic status may be partly explained by the fact that BNS scores do not increase linearly with improvements in household wealth. In Cambodia, a large number of the items used in the BNS menu are relatively cheap to buy or easy to access. It was therefore relatively easy for a household to move from a low to a medium score. By contrast, at the upper end of the scale the items were usually very expensive or hard to obtain, for example a house made of concrete. Consequently, it is harder for a household to move further up the scale. A related consequence is that decreases in scores are easier to detect, suggesting that our results are a conservative, non-inflated measure of change in livelihood status. The slower rate of increase in household wealth in PAs may partly, therefore, be attributed to their already higher BNS scores on average in 2008. However, the similarity of the agricultural productivity and food security results to the economic status results gives confidence that the observed effects are real.

5.5.3 Additional benefits of Ibis Rice programme

Households involved in the Ibis Rice programme improved their economic status and agricultural productivity at a greater rate than non-participants in the same villages between 2008 and 2014, while the ecotourism and Bird Nest programmes showed no significant effect. There is no sign that any of the three programmes have negatively impacted household livelihoods. However, participation in the PES programmes is voluntary, so it is possible that families that could afford to divert labour from one of their other livelihoods might participate more.

The fact that Ibis Rice's impacts are most significant in the 2011-2014 period is possibly a case of benefits taking time to be converted into lifestyle gains. Continued investments by WCS in the Ibis Rice project have also contributed

to the growth of the scheme. This supports the idea that longevity is key to achieving integrated conservation and development goals (Baral et al. 2007).

This analysis supports the contention that there can be important social co-benefits to conservation interventions when programme design is well thought out and local conditions are favourable (Clements & Milner-Gulland 2015; Pagiola et al. 2005). In fact, while the primary goal of Ibis Rice is to reduce the conversion to agricultural use by smallholder farmers of important forest and wetland habitat for several globally important populations of endangered bird species, it also delivers benefits to participants' livelihoods. Although PES programs are designed to change behaviour by compensating participants for more than the opportunity cost for the constraints of their activities (Wunder 2007), the perceived risk of altering livelihood strategies might still hinder marginal households' participation. This study suggests that the extent of Ibis Rice's economic impact is more limited due to the reduced opportunities for the poor to participate, yet recognises that PES as a form of institutional innovation can provide access to development opportunities for villagers.

5.6 Next steps

Understanding to what extent conservation affects human well-being in the context of wider socio-economic change, how, and for whom, requires the use of methods that allow changes in well-being to be attributed to the intervention versus other confounding factors; exploration of the causal linkages enabling the changes to occur, as well as consideration of the heterogeneity of effects within the subgroups studied (Porro et al. 2015; Woodhouse et al. 2015). In one of the few quasi-experimental studies looking at the long-term effects of conservation intervention on well-being, Gurney et al (2014) further underline the importance of looking at the varying time scales at which different impacts take effect and can be sustained after external support for an intervention is terminated. Given its initially matched survey design and the number of iterated assessments, the Northern Plains of Cambodia represents a site of global importance for following long-terms trends in the social effects and

mechanisms of conservation interventions, as well as for testing current and future best practice methodologies in impact evaluation.

This case study shows that the PAs in the study site were not detrimental to households' economic development, and that well-designed PES programmes can bring additional livelihood pathways for rural economies amid a complex and dynamic social and economic landscape. Longer-term monitoring of this site will allow understanding of whether the currently minor limiting effect of PAs on economic status will further constrain well-being improvements in PAs, despite the increasing presence of development. Alternatively, the resource protection offered could provide a longer-term and more sustainable basis for pathways out of poverty, compared to resource depletion from the rush to resources occurring outside PAs: increasing the resilience of households within PAs against external shocks. Whether conservation interventions can protect households from land shortages while stimulating sustainable development pathways and protecting nature in the presence of strong external drivers is still an open question.

6. "Living a good life": Conceptualisations of well-being in a conservation context in Cambodia

6.1 Introduction

Conservation practice has sometimes been criticised for relying on simplistic assumptions about social contexts in resource management, and underestimating the importance of understanding differences between, and relationships among, individuals and groups within communities (Agrawal & Gibson 1999; Dawson & Martin 2015; Waylen et al. 2013). At the beginning of the millennium, several critics pointed out that failures in both biodiversity conservation and social outcomes from devolved conservation policies were largely due to the lack of understanding of local social structures and values, disregard of experiences from the field, and naïve assumptions about the social context within which interventions were embedded (Ban et al. 2013; Dawson & Martin 2015; Wells & McShane 2004). At the time, researchers had highlighted the challenge of understanding and incorporating a community's perceptions into the design of conservation programmes, given widely differing customs, practices and social norms and the impossibility of applying a one-size-fits-all procedure (Adams et al. 2004; Barrett & Arcese 1995).

Over the past decade, the field of conservation has come a long way in incorporating social concepts into a biologically-dominated discipline. A body of literature now reinforces the conviction that the success of conservation strategies depend heavily on communities' structure, motivations and aspirations (Brooks et al. 2013; Howe et al. 2014; Roe, Walpole, et al. 2010). Conservation projects have increasingly incorporated development goals such as poverty alleviation and sustainable livelihoods, in addition to biodiversity conservation outcomes (Bossel 1999; Robinson 1993; Smith et al. 2013).

Recently, conservation literature has started to incorporate the social concept of human well-being as a key consideration in designing successful policies and measuring intervention impacts (Agarwala et al. 2014; OECD 2011). A human well-being framework provides a holistic and potentially powerful

approach to integrating goals related to different values within decision-making, which can also help to build political support and mobilise funding (Bottrill et al. 2014). Additionally, the concept of well-being allows researchers to acknowledge and evaluate trade-offs between more diverse and subjective aspects of human development and the protection of nature, which is essential for conservation management and policy decisions (Daw et al. 2015).

For these reasons, the link between conservation and human well-being has been increasingly emphasised in international policy and reflected in conservation organisations' mandates and activities (Cardinale et al. 2012; CBD 1992; Gurney et al. 2015). The acknowledgement of the importance and complexity of social dynamics proves an invigorating (and challenging) development in conservation science. But little empirical work has been done to date to understand local communities' perceptions of well-being in a conservation context.

6.1.1 Conceptualising well-being in a conservation context

Since the 1990s, several studies have contributed to advances in conceptualising the interface between poverty, well-being and the environment and aimed to guide practitioners towards increasing consideration and inclusion of local perspectives (Bottrill et al. 2014; Woodhouse et al. 2015). Using subjective measures that are person-centred instead of externally defined indicators has long been empirically established in health sciences to appropriately define one's quality of life (Diener & Emmons 1985; Ruta et al. 1994). Applications in the field of development have further provided a basis for its adoption in conservation. This notably includes the World Bank 'Voices of the Poor' study published in 2000 (Narayan et al. 2000), the Millennium Ecosystems Assessment (2005), the three approaches studied by the University of Bath's Well-being in Developing Countries (WeD) research (Gough & McGregor 2007), which includes the Global Person Generated Index (Martin et al. 2010; Camfield & Ruta 2007). While some argue for slightly different approaches, convergence has appeared in academic and

international policy circles over two main principles for conceptualising human well-being.

First, human well-being is a multidimensional concept (Gough & McGregor 2007; MEA 2005; White 2010). Well-being can be understood in terms of three interacting dimensions: the material circumstances of a person; a subjective evaluation by the person of their goals and the processes they engage in to attain them; and a relational component capturing their ability to achieve these goals through social networks and interactions (Gough & McGregor 2007). Several frameworks now see well-being as encompassing five primary domains across these three dimensions (Figure 6.1) (MEA 2005; Narayan et al. 2000; Woodhouse et al. 2015). Human well-being is not only multidimensional in terms of domains but also in terms of the degrees to which it is shared; or collective, rather than individual (Gough & McGregor 2007; Woodhouse et al. 2015).

The second principle observed is that conceptualisations of human well-being are heterogeneous (Agarwala et al. 2014; Dawson & Martin 2015). Well-being is a social construction, and hence needs to be understood from the 'eye of the beholder' and defined by the individuals and communities where well-being is to be assessed (Gough 2004; Schaaf 2010). Heterogeneity can occur along with geographical variations, but also along socio-economic lines, including but not limited to gender, religion, economic status, age, ethnicity, and livelihood type (Agarwal 2001). The idea of 'communities of interest' (Ziller 2004) suggests that the interests or concerns which pattern social life and interactions of groups of people can be more relevant than physical location (Hoggett 1997).

These two principles form a strong foundation upon which to base further research on well-being in the context of conservation. But despite the term's popularity, well-being is rarely defined or carefully examined in an empirical context by those concerned with conservation, with only a handful of studies

exploring local perceptions of well-being (Abunge et al. 2013; Britton & Coulthard 2013; Dawson & Martin 2015; Schaaf 2010).

One of the key steps forward is to build up a collection of case studies to draw out generalisable lessons, and to identify commonalities and general rules in researching and understanding conceptualisations of well-being (Milner-Gulland et al. 2014). This chapter seeks to address this by providing one of the first careful examinations of local conceptualisations of well-being in a conservation context based on a WeD-inspired framework. It does so by focusing on conceptualisations of well-being within a landscape in which the conservation and development context varies, but the underlying attributes of the ecological and social system do not.

I investigate three sites in a Northern Cambodian landscape as a case study, using qualitative and quantitative analysis to answer two overarching questions: Firstly, how are the principles of multidimensionality and heterogeneity of well-being conceptualisations reflected in local realities in Northern Cambodia? Secondly, what are the implications of these findings for the design of conservation interventions which aim to measure and improve human well-being as part of their activities?

This chapter uses a well-being framework which integrates the Voices of the Poor and WeD's perspectives to provide conceptual guidelines for measuring the impacts of conservation interventions on human well-being (Figure 6.1).

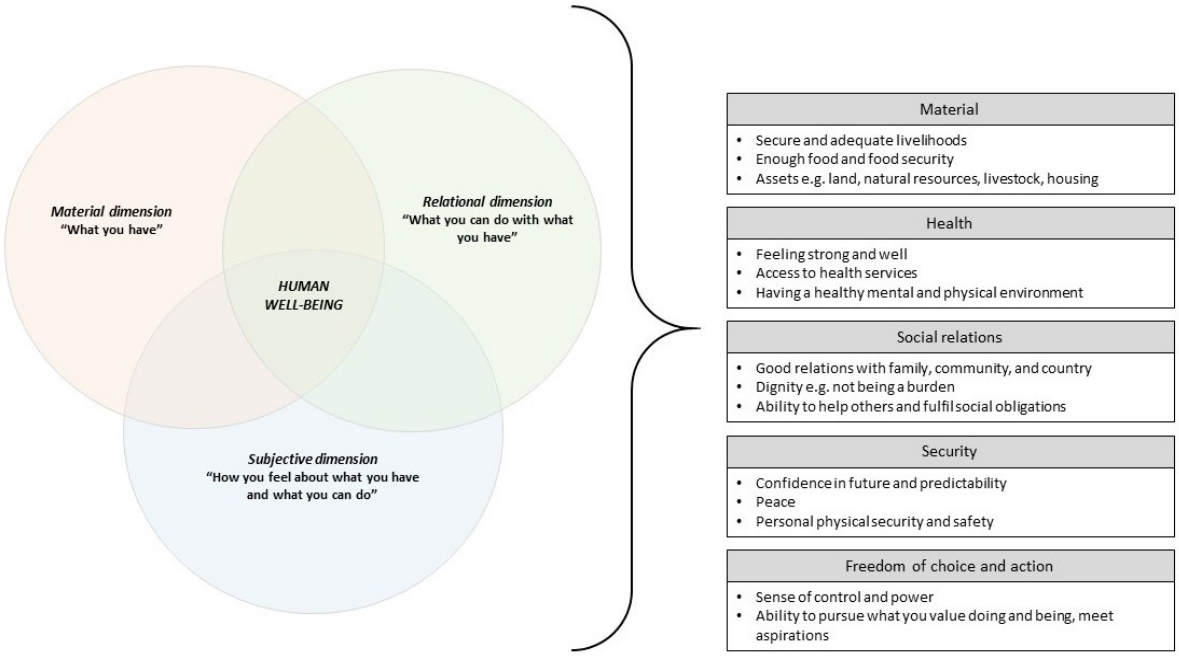

Figure 6.1: Framework for researching human well-being used in this study, based upon McGregor & Sumner (2010), and drawing upon the World Bank's 'Voices of the Poor' research (Narayan et al. 2000)**.Well-being encompasses five primary domains, which can each be seen through the lens of the three dimensions.**

6.2 Study site

Cambodia provides an interesting milieu in which to examine conceptualisations of human well-being across different conservation and development settings, being shaped simultaneously by both agendas. Since 2008, Cambodia has seen rapid economic progress, registering annual GDP growth of nearly 7%, along with an average annual population growth rate of 1.7% between 2000 and 2013 (ADB 2015; World Bank 2013). Part of Cambodia's national development strategy takes the form of Economic Land Concessions (ELCs), or the granting of land to private companies for investments in plantations and large-scale agriculture. While ELCs are meant to respond to the national impetus for economic development (MAFF 2015; Phelps et al. 2013), disputes have arisen specifically around unfair eviction of local communities from land, human rights abuse, and the patchwork pattern of ELCs granted over high-value forests and protected areas (Bues 2011; Hor et al. 2014; Ullenberg 2009).

The Northern Plains of Cambodia has been affected by both conservation projects and development pressure of ELCs. Located in the province of Preah Vihear (see Figure 6.2), the landscape is considered an area of high biodiversity interest (Myers et al. 2000; O'Kelly et al. 2012) and contains two Protected Areas (PAs): Kulen Promtep Wildlife Sanctuary (KPWS) managed by the Ministry of Environment (MoE) and Preah Vihear Protected Forest (PVPF) managed by the Forestry Administration (FA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF). While PVPF was declared in 2002, KPWS was established in 1993 as part of Cambodia's first protected area network. Since 2002, international non-governmental organisation the Wildlife Conservation Society (WCS) has assisted MoE and FA's conservation efforts in both PAs (Clements et al. 2010; Clements et al. 2012; Clements & E J Milner-Gulland 2015).

More specifically, WCS supported the Royal Government of Cambodia's agencies in implementing three types of Payment for Environmental Services (PES) schemes within the two PAs: a bird nest protection programme, a premium payment scheme for eco-friendly rice (Ibis Rice), and the development of community-based eco-tourism schemes. The bird nest protection programme is implemented across over 24 villages, while the Ibis Rice scheme started with 4 villages and has now been expanded to 11 villages. The eco-tourism scheme involves three villages to date; two of which started in 2008 and the other in 2010.

Within this dynamic system of social, economic and environmental change, three sites were chosen for examination due to their contrasting conservation and development contexts. This was considered the best approach to capture most variation in local well-being conceptualisations across the area.

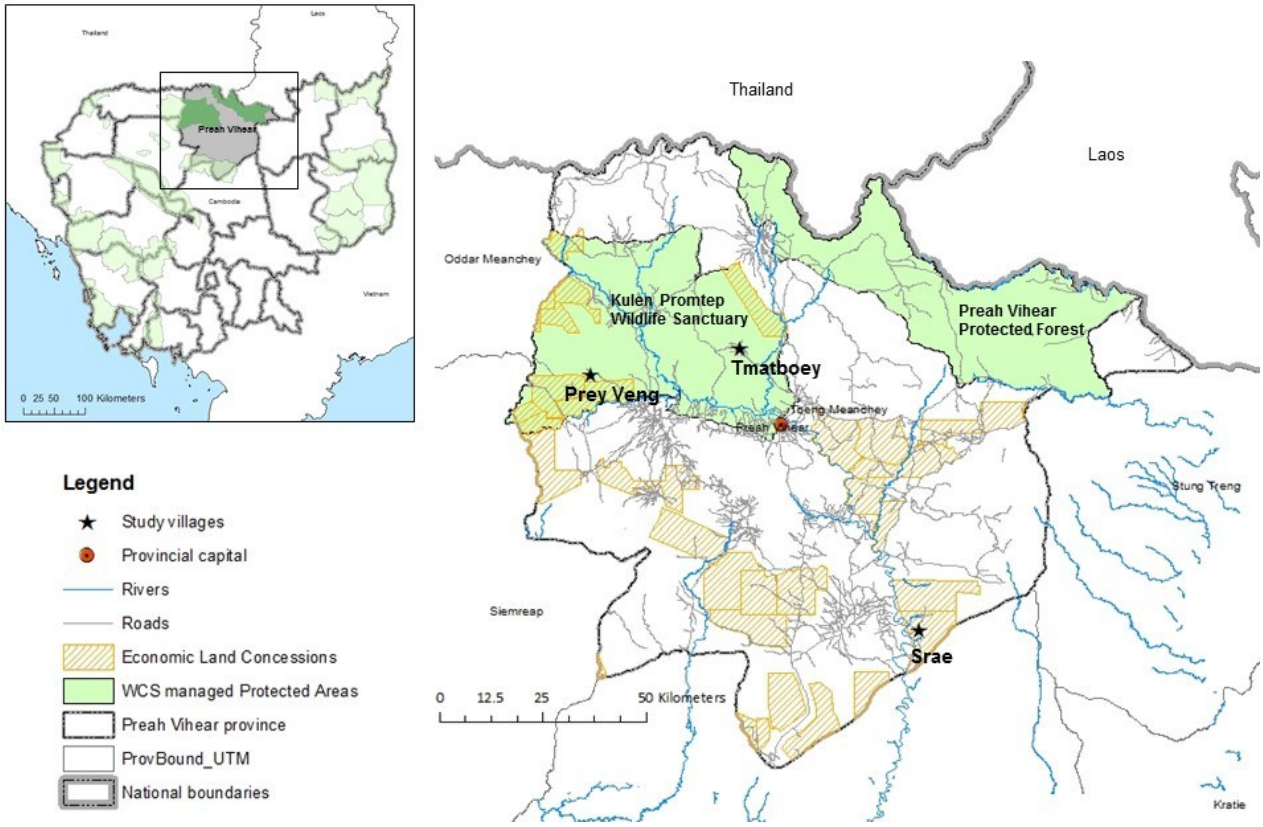

Figure 6.2: Northern Plains landscape in Preah Vihear province, Northern Cambodia

Tmatboey is a core village for conservation projects in KPWS, with all three PES schemes having been run since 2008. It features high local community involvement in the three PES schemes and contains mature village-level institutions that have been managing the eco-tourism scheme independently since 2012. The village has not been impacted by ELC pressures.

Prey Veng has been included in the three conservation schemes, but joined at a later stage in 2010, and so community involvement in conservation and village-level conservation institutions is still developing. In 2008, conflict with an ELC over the southern part of the village's land erupted; however, following collective action supported by WCS, the ELC gave back most of the land and the conflict was resolved at the time of writing this thesis.

Srae is located outside of the Protected Areas and does not feature a conservation project. However, it has been faced with high pressure from

ELCs, two of which together cover the entirety of the village and its agricultural land. This has been a source of unresolved conflict since 2009.

6.3 Methods

Research was conducted between October 2013 and May 2014 across the 3 villages. On average, a month was spent in each village during which the interviews were conducted, to accustom the villagers to the researchers' presence with the aim of dispelling suspicions and to reduce strategic bias or lack of openness (Sheil & Wunder 2002). I used a complementary set of focus groups, semi-structured interviews for villagers, and key informant interviews to gather information at the relevant household and village scales. Discussions were conducted in Khmer by interviewers who were not from the villages, and usually by an interviewer of the same gender as the respondent, to minimise respondent's potential discomfort when talking about potentially sensitive issues. Participants for individual interviews and focus groups were chosen randomly from a hand-drawn map of the village and according to household availability.

All research protocols were approved by Imperial College Research Ethics Committee before the start of the research. Prior to each interview and focus group, the purpose of the research and content of the interview were explained. Participants were informed they were not obliged to participate, that they could stop the interview at any point, and that all their answers would be kept anonymous. Due to low levels of literacy, participants gave their verbal consent to continue. To avoid strategic bias in responses, our research group was clearly introduced as a team of independent social researchers.

6.3.1 Focus groups

Focus groups and key informant interviews were first conducted to understand the population dynamics in the village and confirm meaningful issues in the communities. Two focus groups were held in each village: one for women and one for men. The focus groups were meant to provide triangulation for individual interviews and additional understanding of factors influencing

perceived changes in well-being at the village level. The focus groups provided a forum to explore themes around well-being and attribute causes to the changes at the village level.

Each focus group included between 6 and 9 individuals of the same gender. Groups were first asked to discuss “what it means to have a good life”, and were allowed to free-list as many components as they wished. Participants were then asked whether each named component had improved or deteriorated at the village level over the past 3 years, with a focus on causes of changes. This was done using visual diagrams to facilitate understanding of the questions and generate discussion, with changes being rated using a visual Likert scale describing the changes as: highly positive (+3); moderately positive (+2); slightly positive (+1); no change (0); slightly negative (-1); moderately negative (-2); highly negative (-3). Focus groups lasted between 120 and 180 minutes, with provision of local snacks and drinks as a compensation for participation.

6.3.2 Individual interviews

The individual semi-structured interviews focused on defining personal conceptualisations of well-being for the respondents (see Table 6.1). Available members willing to participate were chosen within randomly selected households, with the sample roughly stratified by age, gender and economic status to improve representation across demographic sub-groups. Age groups were simplified in 2 categories to reflect generational perceptions with a cut-off at 40 years old, which reflects a mature age. The economic status of each household was identified during the field visit from discussions with key informants classifying the household as either above or below the average household status in the villages.

Interviews were semi-structured, allowing new questions and topics to be discussed according to the individual’s responses. Questionnaires were designed to elucidate important aspects of human well-being for individuals using free-listing, so as to place responses within the broader context of the

respondent's life and to avoid imposing categories or prompting responses. Respondents were asked to list as many things as they wished in response to the question “For yourself, what does it mean to have a good life?”. They were also asked about their personal satisfaction with, and issues they faced with regards to each component of well-being they had named. A total of 56 interviews were completed, which lasted between 30 and 60 minutes.

Table 6.1: Interview statistics across villages

Village	Population	Total interviews	Sub-**groups**					
			Women	Men	Older	Younger	Richer	Poorer
Tmatboey	315	21	10	11	11	10	11	10
Prey Veng	85	17	10	8	11	7	8	10
Srae	105	18	9	8	6	11	8	9
Total	505	56	29	27	28	28	27	29

6.3.3 Qualitative analysis

The semi-structured interviews and focus groups provided insights on conceptualisations of well-being across the three villages. A narrative analysis approach was used, which seeks to preserve the integrity of personal biographies or a series of events that cannot adequately be understood in terms of their discrete elements (Riessman 2005). Responses and personal stories told during interviews were categorised into themes by consensus amongst the research team and categorised into well-being components for analysis, while retaining the nuanced discussion about the components mentioned, in order to convey the granularity of cultural meanings and social dynamics in the Cambodian villages. Often, components are valued and thought of in many different ways at the same time, with different themes being strongly interrelated. Quotes are thus used to support quantitative results and better express the reality of experienced well-being. Changes in satisfaction with well-being components enunciated during focus groups were aggregated at the village level as no significant difference was observed between women's and men’s groups from the same village.

Free-lists were analysed by component frequency using the concept of cultural salience as defined by Bernard (2006). This assumes that items mentioned earlier in a free-list are more salient than items named later; and that items mentioned by more individuals are more salient. Cultural salience refers to the importance of an item to the culture of studied communities, aggregating the salience of items across all respondents. Cultural salience can be calculated by the following equations:

$$Salience = \frac{1 + Length_i - Position_i}{Length_i}$$

$$Cultural\ salience = \frac{\Sigma\ Salience_i}{n}$$

Here length is the number of components named by an individual i, and position is the location of the component within the list. Cultural salience is the sum of individual item saliences, divided by n- the number of individuals interviewed. In addition to salience, the frequency of an item being mentioned was added to the analysis to reflect the recurrence of an item across interviews and the homogeneity across responses. Frequency is helpful to differentiate sources of salience; for example, a low salience score can reflect either an item named early by few respondents, or an item named later by most respondents.

6.3.4 Statistical analysis

Binomial regressions were used to explore the relationship between the ten most culturally salient well-being components and hypothesised predictors of variation within the landscape, namely gender, age group, economic status, and village in individual interview responses (see Table 6.2). Individual component binomial regression models were fitted as a binary response (yes/no) depending on whether that component had been ranked in the top three of a respondent's free-list. Village was treated as a fixed factor in the models because the villages were selected deliberately due to their contrasting conservation and development contexts. This enabled elucidation of specific village effects. It would not have been appropriate to use village as a random

effect, because the villages were not chosen from a wider sample and were not intended to be totally representative of other villages in the landscape.

Pearson Chi-squared tests were used to confirm whether significant differences were found in responses between demographic sub-groups and between villages.

Table 6.2: Variable description

Variable	Type	Description
Component	Binary	Yes - ranked in top 3 of interview No - not ranked in top 3 of interview
Age	Binary	Younger - below 40 years-old Older - 40 years-old and above
Sex	Binary	Male Female
Economic status	Binary	Richer than average village Poorer than average village
Village	Categorical	Tmatboey - high conservation / low pressure Prey Veng - medium conservation / medium pressure Srae - low conservation / high pressure

6.4 Results

6.4.1 Domains of well-being

In most interviews, the most frequent first response to 'What does it mean for you to have a good life?' was "agricultural land". Indeed, agricultural land has the highest salience score (0.59) and frequency (77%) across all villages (Table 6.3):

> "Land is life. It provides for everything."
>
> 56 year-old man, Tmatboey

When talking about land, respondents clearly specified its agricultural function and associated this mainly with rice production, and sometimes with cash crops that are a rapidly expanding new source of income. Such land is distinctively considered separate to other natural resources, the latter category

including respondents' references to the common pool resources of forests, grasslands and non-timber forest products, including resin.

Within the top ten most culturally salient components, eight can be categorised as material resources, while one component relates to health and another to social relations. Well-being components with salience scores above 0.30 or with over 50% frequency include food, health services, income from livelihoods, education services. Natural resources came up as the sixth most salient component, with frequency of 61% yet a salience of 0.29. Natural resources are primarily referred to as a source of consumption and income, especially in Tmatboey where ecotourism is established and generating significant revenues. But the value of ecosystem services provision is also recognised:

> "Forest is my friend: it gives me wood for my house and my fire, leaves and wildlife to eat, and it makes money from tourists. It is also good because it keeps rain water in the soil."
>
> 32 year-old woman, individual interview, Prey Veng

A house, agricultural material, water availability, the road, family and love, and solidarity in the village were all named by at least a third of respondents. Most components were linked with well-being of the household rather than the individual or a wider community. In fact, young couples generally operated as different economic units after only a few years of marriage:

> "Having a good life is having a good rice field to take care of your wife and children. You care for one another and work together as a team."
>
> 27 year-old man, individual interview, Tmatboey

Table 6.3: Salience score and associated frequency of well-being components named in individual interviews across the 3 villages, ranked according to cultural salience. The top ten most salient components are in bold.

Well-being domain	Components named	Frequency	Cultural salience
Material	**Agricultural land**	**77%**	**0.59**
Material	**Food**	**46%**	**0.35**
Health	**Health services**	**57%**	**0.34**
Material	**Income from livelihoods**	**43%**	**0.32**
Material	**Education services**	**59%**	**0.30**
Material	**Natural resources**	**61%**	**0.29**
Material	**House**	**46%**	**0.27**
Material	**Agricultural material**	**41%**	**0.25**
Material	**Water availability**	**36%**	**0.21**
Social relations	**Family and love**	**38%**	**0.21**
Material	Road	43%	0.20
Material	Livestock	29%	0.18
Material	Transportation material	23%	0.13
Social relations	Solidarity in village	32%	0.09
Material	Clothes	16%	0.09
Material	Market access	16%	0.07
Security	Access to natural resources	16%	0.06
Material	House material	11%	0.05
Health	Hygiene	5%	0.05
Material	Infrastructure - electricity	9%	0.04
Social relations	Religious services	13%	0.04
Social relations	No violence	5%	0.03
Security	Equality and ethics in village	4%	0.01
Security	Security & safety	4%	0.01
Social relations	External development support	2%	0.00

The higher salience of family and love, in contrast to solidarity in the village, supports the view that conceptualisations occur primarily at the household level. Across the landscape, respondents' conceptualisations of well-being did not include elements related to freedom of choice and autonomy.

6.4.2 Geographies and communities of interest

Men mentioned components related to health slightly more, and components related to security more than twice as often as women did. The older age group named health and social resources well-being components more frequently than the younger group. Lastly, richer than average households tended to state components in the health category more frequently, while households poorer than average spoke more often of social resources. However, none of these differences between demographic sub-groups were significant (at $p<0.05$) (Table 6.4).

Table 6.4: Frequency of components being named in individual interviews aggregated by well-being category between demographic sub-groups. P-values from Pearson Chi-squared tests in responses within demographic sub-groups (df = 3) included.

Well-being categories	Men	Women	Older	Younger	Richer	Poorer
Material	100%	100%	100%	100%	100%	100%
Health	63%	55%	63%	55%	64%	54%
Social resources	70%	72%	74%	69%	61%	82%
Security	33%	14%	22%	24%	18%	29%
Freedom	0%	0%	0%	0%	0%	0%
Chi square p-value	0.06		0.12		0.91	

While components of well-being showed minor differences between demographic subgroups, ideas of what it means to live a good life varied considerably more between villages (Table 6.5). Tmatboey's respondents were significantly more concerned with components from the social resources dimension, followed by Srae. Tmatboey respondents also discussed issues related to the security dimensions of well-being more often than the two other villages, especially issues related to access to land and natural resources, and equality and ethics in the village.

Table 6.5: Frequency of components being named in individual interviews aggregated by well-being category between villages. P-values from Pearson Chi-squared test for differences in responses between villages and named categories of well-being (df = 6, p-value = 0.003).

Well-being categories	Tmatboey High conservation/ Low ELC	Prey Veng Moderate conservation/ Moderate ELC	Srae Low conservation/ High ELC
Material	100%	100%	100%
Health	57%	59%	61%
Social resources	95%	41%	72%
Security	33%	18%	17%
Freedom	0%	0%	0%

A more detailed look at the differences between villages was taken by singling out the top-ten most culturally salient components across the landscape and running binomial regressions to detect whether membership of a sub-group or village was a significant predictor of well-being preferences (Appendix D.1). Only three models came out with significant variables at $p<0.05$: agricultural land, income from alternative livelihoods, and family and love. R^2 values were generally low, except for family and love; younger people and those in Srae were more likely to highlight this as important.

Variation between villages in the salience of components was more frequent than between age groups, while gender and economic status were found not to be significant predictors of components' salience. Srae respondents noticeably focused on income from other livelihoods and family and love as the more prominent components in their conceptualisations, while agricultural land was more likely to be named as one of the top three components in a free-list in Prey Veng. The village has seen an increase in the conversion of rice field to new types of crops, mostly by younger families:

> "Life is better than before, even if I lost my resin trees. I now grow cassava on new land and get more money from traders."
>
> 24 year-old man, individual interview, Prey Veng

This appears to be a generational divide in well-being preferences: younger generations favour traditional livelihoods such as being only a rice farmer, and diversify their income sources from other livelihoods than agricultural land less

frequently than older generations. Family and love ranks higher in younger respondents' well-being conceptualisations.

6.4.3 Developments over the past three years

Perceived changes in the status of named components of well-being during focus groups were mostly positive, yet variations between villages are observed (Table 6.6). The condition of agricultural land, in terms of current quantity and quality, has greatly increased in Tmatboey, moderately increased in Prey Veng, but deteriorated moderately in Srae. While Prey Veng have seen the return of most of the land first taken by an ELC, a large section of Srae's agricultural land – and hence the primary source of food and money for many households – has been claimed by ELCs:

> "We lost our land to the ELC three years ago. Now we have to borrow rice from other families and our children have to work with us to pay back our debts."
>
> Man, focus group, Srae

Prey Veng and Srae also recorded negative changes in the condition of their natural resources, and access to natural resources had moderately decreased in Srae. This was linked by discussants to the presence of ELCs in their village area, but also to the ripple effects of intra-provincial corruption and illegal logging. These external pressures are strongly influencing the villagers' livelihood strategies, causing them to turn to alternative livelihoods such as timber logging in Srae, where no conservation measure is in place:

> "My husband started timber logging a month ago, the trader advanced us the money for the chainsaw. It doesn't matter because if we don't cut our own trees, outsiders will come and take them."
>
> 37 year-old woman, individual interview, Srae

The resolution of conflict and the presence of conservation actions seems to have made a difference in moderating the negative impacts of the ELC on the forest in Prey Veng, albeit local conservation efforts are still developing:

> "Four years ago there was the ELC and a lot of outsiders coming to cut our trees. Since the Community Protected Area was established, there is more control against these activities and things will get better soon."
>
> Woman, focus group, Prey Veng

Both Tmatboey's focus groups emphasized that solidarity in the village had deteriorated over the past three years, a change reported by individual respondents as well:

> "We are not helping each other as much as before because money has become more important. For example, we now sell food to each other instead of sharing."
>
> 56 year-old woman, individual interview, Tmatboey

On the contrary, focus group respondents from Prey Veng and Srae registered improvements in solidarity in the village over the past three years. Srae also notably recorded highly positive perceived changes in equality and ethics in the villages, linked to the village's response to the two ELCs over their land.

> "To increase security against outsiders, we had to increase solidarity in the village".
>
> Woman, focus group, Srae

Table 6.6: Perceived changes in satisfaction with well-being components named in focus groups between villages, ranked according to cultural salience. Changes rated as: highly positive (+ + +); moderately positive (+ +); slightly positive (+); no change (.); slightly negative (-); moderately negative (- -); highly negative (- - -).

Well-being component	Tmatboey	Prey Veng	Srae
Agricultural land	+ + +	+ +	- -
Food	+ +	+ +	+ +
Health services	+ +	+	+ + +
Income from livelihoods	+ +	+	+ + +
Education services	+ +	-	+ +
Natural resources	+ +	- -	- - -
House	+	+ +	+ +
Agricultural material	.	+ +	+
Water availability	+ +	+ +	+ + +
Family and love	+	+ +	+ +
Road	+ +	.	+
Livestock	+	.	.
Transportation material	+ + +	+ +	.
Solidarity in village	-	+ +	+ + +
Clothes	+ +	+ +	+ +
Market access	.	+	+
Access to natural resources	.	.	- -
House material	+ +	.	+ + +
Hygiene	.	+	+
Infrastructure - electricity	.	.	+
Religious services	.	+	.
No violence	+ +	.	.
Equality and ethics in village	.	+	+ + +
Security & safety	+	.	.
External development support	.	+ +	+

6.5 Discussion

This chapter used mixed methods to explore the composition of, and variation in, well-being conceptualisations across three villages. The case study supports the suggestion that well-being is multidimensional and heterogeneous, and sheds light on important features essential to understanding the social dynamics of the landscape in which a conservation

project is implemented. Knowledge, rather than generalisation, about which well-being dimensions are prioritised and how this varies across a landscape is required when it comes to designing realistic project goals and incentives, supporting and building local governance in a dynamic landscape, and understanding intervention impacts.

6.5.1 "Land is Life"

Considering the multidimensional experiences of well-being within a society can give valuable information about priorities for the local population and drivers behind local behaviours. The primacy of material components in our case study supports the view that basic assets and services are first required to meet human needs (Alkire 2002; Max-Neef et al. 1991), yet conceptualisations of well-being were still highly multidimensional. Dimensions related to social relations, health, and security were also central to human well-being in the area. The incentives introduced by conservation interventions should mirror people's aspirations and balance potential trade-offs in well-being.

For example, it is hardly surprising that agricultural land was most valued across the study area, rice farming being the foundation of livelihoods across the landscape. Creating and implementing rules to prevent land expansion in conservation areas is likely to be a sensitive issue with villagers. However, in a context of high development pressure, gaining security of access to land and protection from ELCs is likely to offset the concern of losing the opportunity to increase livelihoods by farming more extensively. In fact, Tmatboey and Prey Veng reported positive changes to the status of agricultural land, and maintained access to natural resources after conservation interventions to implement participatory land use planning (local agreements that limit agricultural expansion in exchange for improved tenure security). As such, the claim that "land is life" is itself multifaceted, representing the status and condition of a villager's land, the food and livelihood derived from farming, the security of providing for future household needs, as well as a form of status within the village.

6.5.2 Conservation governance in a dynamic system

Heterogeneity in well-being conceptualisations between individuals and communities is often highlighted as an obstacle to collective action (Agrawal & Benson 2011). Understanding communities' interests and responding in an appropriate manner and at the right scale is therefore necessary if conservation interventions are to align with local considerations. The results of this study suggest that geographical location (village) is a more important factor in explaining variation in local conceptualisation of well-being than gender or economic status, although age group was also important. In this case, attention should be given to enabling local entities that are representative at the village level and that accommodate both the traditional views of older generations and the aspirations of youth.

Tmatboey valued social relations the most, however this was thought to be on the decline. By contrast, the adverse effects of ELCs in Prey Veng and Srae seem to have increased the relative value they gave to agricultural land and their sense of community solidarity, compared to Tmatboey. This falls in line with notions that responding to adversity can be a strong driver of formation of communities of interest (Dalby & Mackenzie 1997). Presenting a united front against a common threat can be a strong basis for creating collective thought and action. Adversity may alter well-being preferences, and provide a suitable institutional and governance system under which local collective action can be undertaken (Agrawal & Benson 2011; Ostrom 2014).

Britton and Coulthard (2013) found that discussing challenges allowed communities to establish new social networks during crises. Such is the case in Prey Veng, where feelings of solidarity, equality and ethics in the village increased over the past 3 years following the fight against the ELC. In this case, conservation seems to have played a positive role for the village, as the presence of NGOs helped them reclaim land. This contrasts with the situation in Tmatboey, where the only well-being component seeing a decrease was

solidarity in the village. With the success of the eco-tourism and premium rice PES schemes in Tmatboey came a commodification of rural life and further exposure to economic development, eroding the traditional spirit of solidarity in the village.

This supports the idea of Dawson and Martin (2015) that material improvements resulting from interventions are unlikely to achieve improved well-being if power inequalities are not addressed. Other studies on local perceptions of well-being (Abunge et al. 2013; Coulthard et al. 2011;) have stressed that while conservation interventions can improve the well-being of some stakeholders, this often conflicts with the freedoms and well-being of others whose access and conditions may have been compromised by the new rules and institutions required to deliver conservation outcomes. Clements & Milner-Gulland (2015) showed that the ecotourism and premium rice interventions operating in Tmatboey have increased material well-being of participants (Chapter 5), but that these participants were better off than average to start with, and more likely to be village elites.

6.6 Conclusion

Conservationists have responsibilities towards the communities they work in, to ensure at the very least they do not harm people (Roe, Oviedo, et al. 2010); however, negative consequences can occur from imperfect implementation or from unintended side-effects (Bottrill et al. 2014; Larrosa et al. 2016). Well-being can be useful as a holistic socio-economic indicator for elucidating subtle conservation impacts on people, which are amongst the most complex to assess as they affect multiple aspects of human lives (Woodhouse et al. 2015). Local perceptions of the causative relationships between interventions and well-being change can be obtained post-hoc, as in this study. It is important to understand how people view the impact of conservation on their lives, as perceptions will affect engagement and participation in interventions as well as subjective well-being. However, gauging the extent to which changes in well-being are actually caused by the conservation intervention would require the establishment of a well-being baseline at the beginning of the project.

Using the concept of well-being is not without challenges, mainly due to its inherently subjective nature. Firstly, the determinants of subjective well-being can change radically when a situation changes (Fry et al. 2015). As a result, the process of establishing domains needs to be repeated each time well-being is assessed, rather than simply asking about changes in already-described domains. It is not possible to assess well-being against a static baseline.

Additionally, just as conceptualisations of well-being vary, so do individual timelines for perceiving changes in their well-being. For example, some individuals might consider perceived changes over a year or two, while others might compare their well-being over a longer time frame. Therefore, working through a well-being framework requires constant adaptation at different geographical and temporal scales. Additional case studies are needed to provide the evidence supporting the move from theory to real-life application and identify potential communalities in well-being conceptualisations across different settings, especially with regards to the perceived impacts of interventions on village solidarity, equality and ethics.

Enquiring about conceptualisations of well-being should not just be a preliminary step but should become an integral part of the participatory process of conservation interventions, including impact evaluations. The bottom-up approach used here provides some of the internal validity needed to complement large scale policies, capturing the multidimensional and heterogeneous dynamics of the system which is required for effective project design and accurate evaluation (Gurney et al. 2015; Leach et al. 1999).

7. Investigating perceptions of land issues in a threatened landscape

7.1 Introduction

Issues related to management, security and access to land feature highly in conceptualisations of well-being among rural communities in developing countries (Britton & Coulthard 2013; Copestake 2009; Schaaf 2010). Similar issues were identified as being important aspects of the conceptualisation of well-being in the study landscape (see Chapter 6). The interests and motivations that lead local people to sustainably manage their resources, including resources of conservation interest, are therefore likely to be strongly affected by their perceptions of land and land rights (Adams & Sandbrook 2013; Chevalier & Buckles 2012). Locally valued resources such as land have material but also relational and symbolic dimensions (White & Ellison 2007); for example a household can have a landholding above the village average, yet feel their family needs are not met if they have lost or been denied land in the recent past (Chapter 6).

Subjective evaluations (or perceptions) of the multiple dimensions of priority aspects of human well-being (such as land management and access) are important to understand, in order to appreciate the potential trade-offs experienced within and between communities due to conservation and development pressures (Adams & Sandbrook 2013; Webb et al. 2004). This is particularly the case in landscapes where conservation spatially overlaps with other development programmes and external pressures that can negate or even erode the intended effects of conservation on local communities' environments, institutions and well-being (Pender et al. 2004; Scheidel et al. 2013; Seppelt et al. 2013).

While an abundance of literature has aimed at assessing the social outcomes of conservation over recent decades (Brockington & Wilkie 2015), research has primarily focused on the material, observable dimensions of human well-being (de Lange et al. 2015; Oldekop et al. 2016). To date, qualitative case

studies have dominated the evidence base on relational and subjective aspects of human well-being in a conservation context (Brooks et al. 2013). Inferences from these studies may have the power to explain and contextualise effects in complex and overlapping land systems, yet non-statistical attributions from a small number of sites can be unreliable and lack the transferability needed to support policy decisions (Khagram & Thomas 2010; de Lange et al. 2015). Outcomes from the subjective dimensions of human well-being, based upon assessing individual perceptions, have rarely been documented quantitatively and reliably at a landscape scale (McKinnon et al. 2016; Pullin et al. 2013). Locally-defined perception indicators can thus provide important insights into the issues underlying the social impacts of conservation, such as the internal legitimacy and the acceptability of conservation rules and institutions, and how these interact with other interventions (Bennett 2016; Bennett & Dearden 2014).

This chapter presents an analysis of factors influencing household perceptions of land issues in 20 villages located across different conservation and development contexts in Northern Cambodia. I assess whether the presence PAs and ELCs influence local perceptions of issues related to land use. While the overlap between development and conservation interventions can be observed in several developing countries, Cambodia presents an interesting case study for the analysis of these questions considering the increased competition for land resources it has experienced over the last decade (Neef et al. 2013).

I focus on perceived current and future access to land, participation in land management decisions, and trust in local authorities that implement land rules, as they represent important aspects of locally-defined human well-being conceptualisations in communities in Northern Cambodia (Chapter 6; Milne & Mahanty 2015). I ask: What are the factors influencing perceptions of well-being related to land issues across different settings of competing land use? Secondly, how does the presence of conservation and development interventions, in terms of PAs and ELCs, affect these perceptions? Thirdly,

how do perceptions vary for different groups between and within villages? Lastly, how do these perceptions vary between the wider landscape and villages where community-based PES programmes have been implemented?

Availability of productive land is a central necessity for the livelihoods of most families in Northern Cambodia. Given the recent rush to acquire land resources, and the consequent decrease in land availability for rural families due to population growth and competition with ELCs (Dwyer 2015b), perceptions of land issues are expected to vary between PAs (where land expansion is controlled) and outside PAs. Given the negative environmental and social impacts of ELCs reported, ELC presence is expected to strongly undermine perceptions of access to land (Davis et al. 2015; Neef et al. 2013; Peeters 2015). However, perceptions of trust in land authorities are expected to be higher inside PAs, where local institutions have been supported through the PA intervention over the past nine years. Because households have different levels of access to and use of natural resources, effects are also expected to vary according to the type of livelihood strategy a household follows, for example whether a household has diversified outside resource-based strategies or not. Other important factors that can contribute to perceptions of trust, management, security and access to land include human capital factors, such as household size, level of education, and age of the head of household, and proxies of household assets, such as the socio-economic status and the amount of land owned.

7.2 Study site

Cambodia has seen rapid development and globalisation over the past decade (ADB 2015; Mah 2015), paralleled with a similarly high rate of resource depletion in terms of deforestation rates and illegal logging (Engvall & Kokko 2007; Hansen et al. 2013; Milne 2015). The Royal Government of Cambodia's (RGC's) promotion of ELCs as a mechanism for agricultural intensification has raised increasing concerns about the impacts of their widespread granting and the lack of adherence to the established legal criteria in the granting process (Chapter 4; Davis et al. 2015; Neef & Touch 2012; Oldenburg & Andreas

2014). Concerns have arisen specifically around ELCs being a façade for land grabbing and causing unfair eviction of communities from their land and human rights abuses (Biddulph 2010), with the number of land disputes having been on the increase since 2001 (Sekiguchi & Hatsukano 2013).

The landscape of the Northern Plains of Cambodia represents an appropriate site to study the perceptions of land issues in a context of high and contrasting resource pressures, as it contains a combination of different levels of conservation interventions – PAs and PES – as well as overlapping ELCs. The Northern Plains is a landscape located in the province of Preah Vihear along the border with Thailand and Lao (see Figure 7.1).

As previously outlined, the study site is one of the largest remaining areas of deciduous Dipterocarp forest and is considered an area of high biodiversity interest (Myers et al. 2000; O'Kelly et al. 2012). Rural households in the study site are subsistence farmers whose livelihoods revolve around small-scale rice farming, with additional non-timber forest product harvesting and fishing around villages. Collecting liquid resin from Dipterocarp trees has also traditionally been an important livelihood in Northern Plains' communities (Rainey et al. 2010; Clements et al. 2014). While customary land rights, or "possession rights", were recognised under the 1992 Land Law, they were replaced in the 2001 Land Law by modern landownership where titles are required (Sekiguchi & Hatsukano 2013).

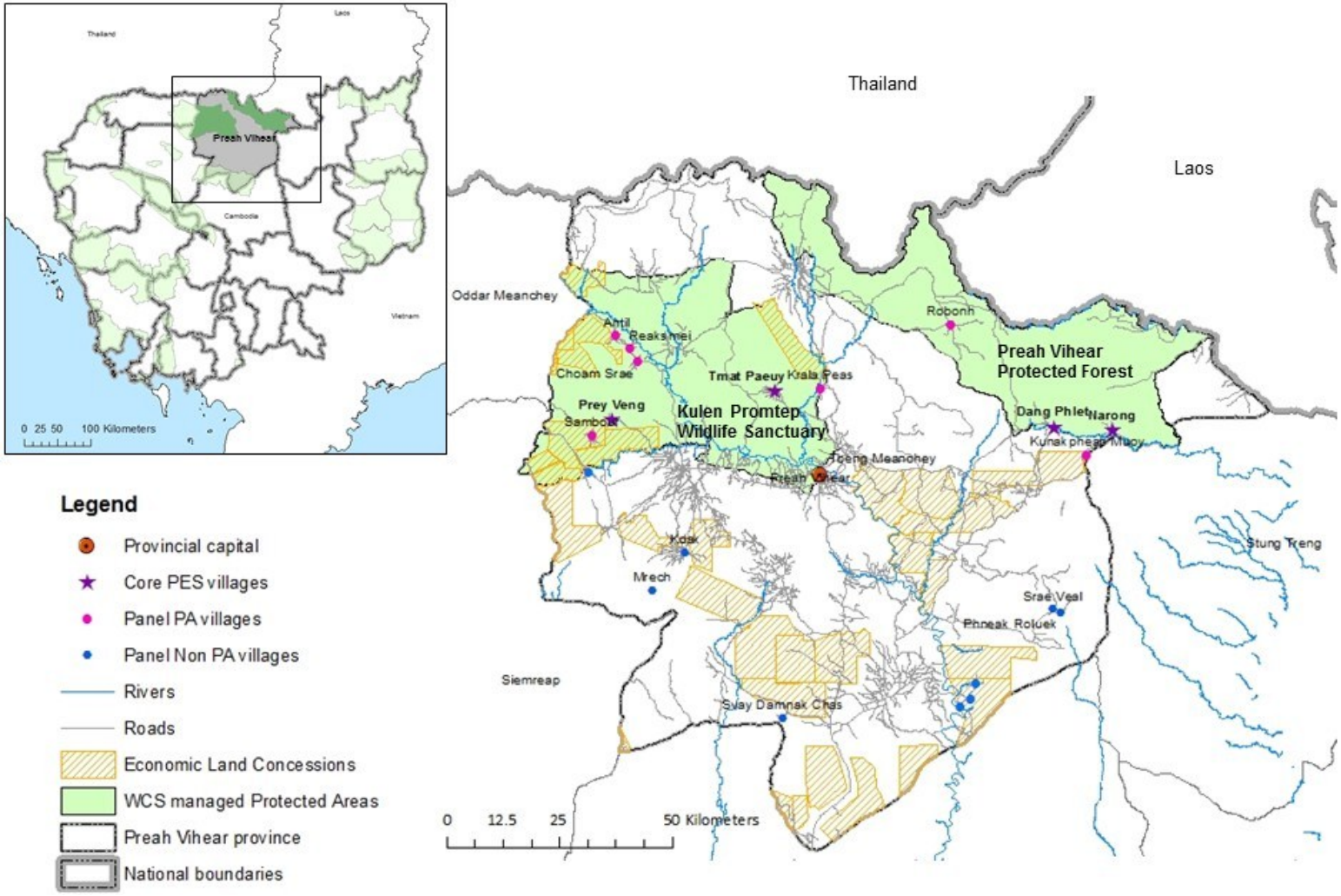

Figure 7.1: Locations of the surveyed villages

7.2.1 Protected Areas

The landscape contains two PAs: Kulen Promtep Wildlife Sanctuary (KPWS) managed by the Ministry of Environment (MoE) and Preah Vihear Protected Forest (PVPF) managed by the Forestry Administration (FA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF). While PVPF was declared in 2002, KPWS was established in 1993 as part of Cambodia's first protected area network. Since 2005, international non-governmental organisation Wildlife Conservation Society (WCS) has assisted MoE and FA's conservation efforts in both PAs (Clements & E J Milner-Gulland 2015). One such ongoing effort since 2005 is community development assistance to develop Participatory Land use Plans (PLUPs) for PA villages, in order to gain official status and formalise the customary tenure rights in place (Clements et al. 2014).

Resource use rules within PAs under Cambodian law allows local uses such as non-timber forest product (NTFP) collection, although forest clearance, commercial logging, and hunting or trade of threatened species are illegal. The imposition of conservation resource-use rules may prevent local communities accessing certain resources and from diversifying livelihoods, risking creating a dependency on subsistence use of forest resources and leading into a "poverty trap" (Angelsen & Wunder 2003; Coad et al. 2008). Within KPWS and PVPF, households can expand agriculture within the agreed boundaries of locally-developed PLUPs. The creation of new settlements within PAs is forbidden, and the number of households allowed to migrate to PA villages is limited.

7.2.2 PES programmes

As a complement to PA management, WCS has supported the RGC's agencies in implementing three types of PES schemes within the two PAs: a bird nest protection programme, a premium payment scheme for eco-friendly rice (Ibis Rice), and an ecotourism programme. The bird nest protection programme, which started in 2003 and is now implemented across over 24 villages, provides small direct payments (up to 5 USD/day) to local villagers

who report and protect the nest of a specific endangered bird species during nesting period (Clements et al. 2013). The Ibis Rice scheme started with four villages in 2008 and has now been expanded to 11 villages. This agri-environment payment programme enables farmers that keep to PA rules to sell their rice at a premium price to the traders. Lastly, the ecotourism programme has included three villages to date: the most prominent one of which started in 2003, one in 2008, and the last in 2010 (Clements 2012; Clements et al. 2010).

The three PES schemes were designed in response to a high level of threat where conservation opportunity costs, at least for conversion of forest lands, were also moderately high (Clements et al. 2010). Implementing PES in the context of weak institutions can be difficult (Wunder 2007), thus both the ecotourism and Ibis Rice projects worked towards strengthening local village institutions and land rights, using the PLUPs to measure compliance (Clements et al. 2010; Clements & Milner- Gulland 2014). In each PA village, a locally elected Community Protected Area (CPA) committee manages the compliance to rules for participating households and oversees that PA rules are respected around the village. For example, Ibis Rice payments to individual farmers are linked to CPA monitoring of their compliance with the land-use plan and no-hunting rules, with external verification by WCS.

7.2.3 ELC interventions

The study landscape contains 30 ELCS covering a total of 242,505 hectares; 77,175 of which are located within designated PA areas (Chapter 4). As a result, the impacts of ELCs are often felt disproportionately in rural areas, where land and resources are technically still owned and managed by the state and villagers' rights are unclear (Clements et al. 2010). ELCs have also been reported being granted over high-value forests and over protected areas, driving Cambodia's high deforestation rates (Chapter 4; Bues 2011; Davis et al. 2015; Hor et al. 2014). The contribution of ELCs to local rural economies comes into question further with studies showing that most ELC workers are migrants from outside the province (Sperfeldt et al. 2012).

7.3 Methods

7.3.1 Survey design

Quantitative data was collected as part of a wider study which surveyed 1129 households across 20 villages in the province of Preah Vihear between July and December 2014 (described in Chapter 3). The survey design builds on a historical dataset of 11 PA villages and nine counterfactual villages selected through co-variate matching, using four key factors characterising village-level poverty prior to the initiation of the PAs from a 2005 baseline (Clements & E J Milner-Gulland 2015). Five counterfactual villages located at least 20 km away from the PA border were retained for the purpose of a multi-period impact evaluation of socio-economic indicators (Chapter 5). The 2014 data collection added four new villages that were among the matched results from the original quasi-experimental design, but that had not been surveyed in 2008 and 2011. These villages- Rumchek, Bangkan, Srae and Slaeng Toul- were added in 2014 due to the presence of ELCs close to their village, thus providing an interesting contrast against which to assess the influence of conservation.

In a dynamic environment it is rare that all control and treatment units evolve with similar trends but for an intervention over a medium-term period, as is required for statistical inference to be made based solely on matching without longitudinal data. This is especially the case in the study landscape where a large number of ELCs have been granted since 2008. Out of the 11 villages located in PAs, five are now affected by ELCs; while six of the nine villages located outside PAs are affected by ELCs (see Figure 7.1 and Appendix E.1 for village information). This study therefore represents a landscape-scale comparison, rather than a formally matched design. While the three PES schemes have been implemented at different intensities across the 11 PA villages, the four villages that have been the focus of higher conservation activities by WCS since 2008 are used to assess the additionality of effects of PES in PA areas (see Chapter 5).

The questionnaires contained sections on households' demographic information, their livelihood strategies and economic status, and their perceptions of land issues. Perceptions and subjective well-being issues are often at risk of being misunderstood (Ridder et al. 2014), so translation of the concepts was done by the research team along with translation professionals. The questionnaire was piloted in two villages prior to data collection.

As previously mentioned, all research protocols were approved by Imperial College Research Ethics Committee before the start of the research. Prior to each interview, the purpose of the research and content of the interview were explained. Participants were informed they were not obliged to participate, that they could stop the interview at any point, and that all their answers would be kept anonymous. Due to low levels of literacy, participants gave their verbal consent to continue. To avoid strategic bias in responses, our research group was clearly introduced as a team of independent social researchers, rather than representatives of WCS or the government.

The perception indicators used in this study were developed following extensive work in the communities defining individual conceptualisations of well-being (see Chapter 6). While the multidimensionality and geographical heterogeneity of well-being conceptualisations was apparent, agricultural land featured as the most prominent well-being item across all villages and population sub-groups (Figure 7.2).

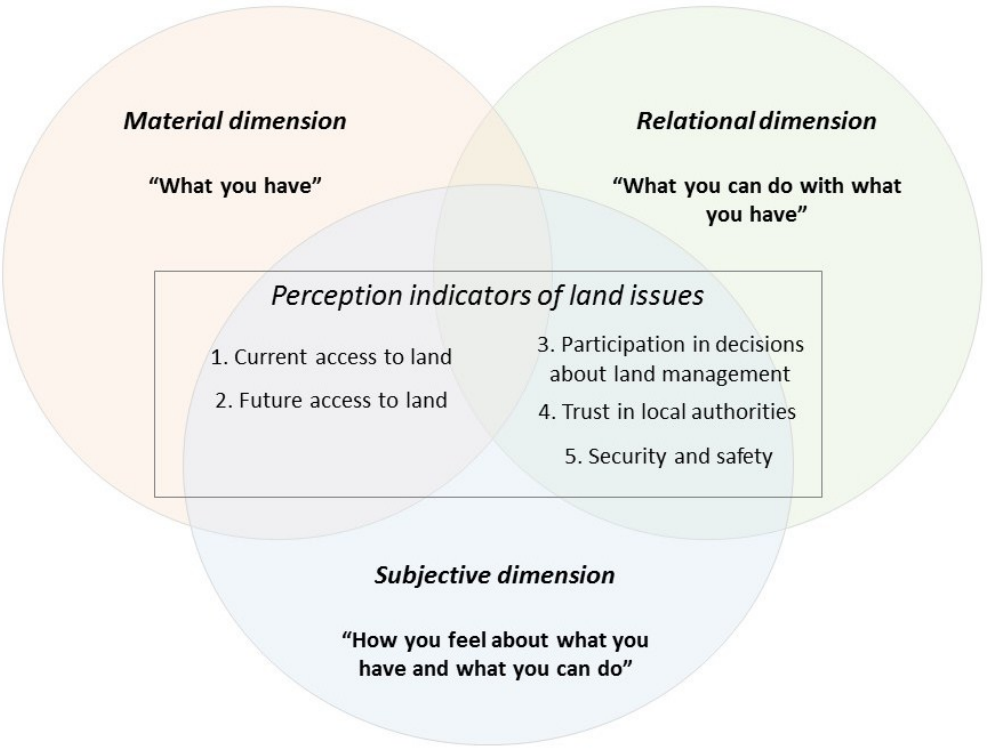

Figure 7.2: Perception indicators representing subjective evaluations of well-being issues related to land

7.3.2 Defining perception indicators

Based on prior research, five indicators relating to trust, management, security and access to land were developed (see Table 7.1). The questions were phrased as an opinion statement with a choice of six answers along a Likert scale going from: 5) "Strongly disagree"; 4) "Disagree"; 3) "Neutral"; 2) "Agree"; 1) "Strongly agree"; adding 6) "I do not know/Not applicable/Do not wish to answer". The latter was excluded from the regression analysis. Each indicator thus represents the respondents' perceptions as a response variable (Greene 2003).

Table 7.1: Opinion statements for eliciting household perceptions on issues of access to, participation and trust in management of land

Access to resources
"You feel that you currently have enough access to land for your household needs"
"You feel that you will have enough access to land for your household needs in three years' time"
Participation in management
"You feel that you are involved in decision-making about land-use management in your village"
Trust in authorities
"You feel that you can trust the commune council to implement land laws and policies in your village" (all villages)
"You feel that you can trust the CPA committee to protect the forest and implement land laws in your village" (PES)

7.3.3 Variables

Likert-type indicators were modelled as response variables to the binary treatments of PA and ELC presence, controlling for other *a priori* external variables (Table 7.2). While PA presence can be straightforwardly determined by the village location inside or outside the PA, not all declared ELCs are active, or even active across their entire area (Edelman 2013). Presence of ELCs was thus determined as whether an active ELC was located within 3 km of the village, with confirmation from field surveys and reports from villagers. In this sense, ELC presence was defined as a function of geographical presence along with villagers' perceptions of ELC presence (see Appendix E.1).

Perceptions were also linked to demographic and socioeconomic attributes such as gender, age, economic status and level of resource dependence of the respondent's livelihood (Baral & Heinen 2007; Bennett 2016). Other *a priori* predictor variables consequently included were factors hypothesised to influence perceptions of trust, management, security and access to land between and within villages in 2014. Economic status was calculated using the Basic Necessities Survey (BNS) methodology, which incorporates multiple aspects of poverty into a single score for each household in the sample (Davies & Smith 1998; Wilkie 2007). Research has shown that access to formal education can be a useful proxy for the level of development, with schools being an epicenter for human capital and nexus of population movement (Barro & Lee 2013; Fägerlind & Saha 2014; Hanushek 2013). Villages with a higher level of education available to residents, such as Bankan, Dongplat and

Tmatboey, are therefore also more populated compared to neighbouring villages and represent a hub in their respective commune for commerce and transport connections (see Appendix E.1 for village information).

Two different models were analysed, one at landscape scale covering all 20 villages, and one for a subset of the four villages with the most intensive PES interventions, all of which were within PAs. For the landscape models, independent variables included binary variables indicating presence of PAs and ELCs. For the PES subset models, binary explanatory variables indicating participation in each of the 3 PES programmes were used. A compliance variable was added to the PES models, representing the number of years between 2008 and 2014 that a household had broken PA rules and illegally cleared new land. The expectation was that those households which had not complied with the rules may have had lower levels of trust in authorities, perceived access to land and involvement in decisions.

7.3.4 Statistical modelling

Collinearity was tested using a correlation matrix and a Variable Inflation Factor (VIF) test and continuous variables were square-rooted to improve model convergence.

I used ordered logistic mixed regression models to analyse the Likert scale indicators as response variables. I adopted a four-step procedure to generate a final model of probability for levels of response. Firstly, I fitted a full (global) model with the *a priori* fixed effect variables and proceeded to variable selection using backward selection from full models including all supported variables, using AICc values and removing variables that did not improve the model, as represented in an AICc > 4. Secondly, once the most parsimonious fixed effect model was selected, I evaluated the influence of intra-village correlation by comparing the fit of adding 'village' as a random effect against the fixed effect model only, using a likelihood-ratio $\chi 2$ test. If significant, the final models were fitted with village as a random effect, which is assumed to

act additively to the baseline of the log-odds function (Lam et al. 2002; Tutz & Hennevogl 1996).

Thirdly, final model validation was performed by confirming the accuracy of the error in the reported value of the log-likelihood through a convergence test, and by testing the proportional odds assumption using likelihood ratio tests of equal slopes (Christensen 2015). Lastly, the convergence properties of the fitted model were illustrated by plotting slices of the log-likelihood function; the relative profile likelihood of the parameters within confidence intervals were also plotted to check the symmetry of the confidence intervals and illustrate effects of parameters in the fitted model. If the final model was multilevel, the conditional modes of the random effect were plotted with 95% confidence intervals based on the conditional variance. The package ‘ordinal’ was used to fit the model (Christensen 2015).

Table 7.2. Predictor variables to be included in full models

Variables	Description & comments	Type	Full dataset	PES subset
Interventions				
Intervention PA		Binary: 0: No PA; 1: PA	√	
Intervention ELCs	Presence of an active ELC within 3 km of village and confirmed disturbances from ELCs reported by villagers	Binary: 0: No ELC; 1: ELC	√	
Individual characteristics				
Head of household age		Continuous (sqrt+1)	√	√
Head of household gender		Binary - Male/Female	√	√
Head of household education		Continuous (sqrt+1)	√	√
Household characteristics				
Household size	Total number of members	Continuous (sqrt+1)	√	√
Poverty (BSN score)	BSN score (2014 weights applied retrospectively)	Continuous (sqrt+1)	√	√
Land owned (ha)	Total land owned - paddy, chamkar and cash crop (hectares)	Continuous (sqrt+1)	√	√
Resource & livelihood strategies				
Resin tapper		Binary - Yes/No	√	√
Rice farmer type	0: Both 1: Paddy only; 2: Shifting cultivation only (chamkar); 3: None	Categorical	√	√
Cash crop farmer		Binary - Yes/No	√	√
Employment	Employed by either private or public sector (army service excluded)	Binary - Yes/No	√	√
NGO employed	Employed by NGO	Binary - Yes/No	√	√
Service provider or shop keeper	Service provider (rice threshing & milling excluded) or shop keeper	Binary - Yes/No	√	√
Sell labour		Binary - Yes/No	√	√
Village level variables				
Years of schooling in the village	Top year of school available in village	Continuous (sqrt+1)	√	√
Time to provincial capital	Dry season time to travel to Tbeng Meanchey (hours)	Continuous (sqrt+1)	√	√
PES subset level variables				
Ecotourism participant	Has received payment from Ecotourism project between 2008-14	Binary - Yes/No		√
Ibis Rice participant	Has received payment from Ibis Rice project between 2008-14	Binary - Yes/No		√
Bird Nest participant	Has received payment from Bird Nest project between 2008-14	Binary - Yes/No		√
Broke rules	Number of years cleared field illegally 2008-14	Continuous (sqrt+1)		√

7.4 Results

7.4.1 Perceptions of access to land

Access to land comes out as a significant concern across the 20 villages surveyed, with 62% of the 1129 respondents disagreeing with the statement that their current land access was enough to meet their household needs, and 47% of respondents stating their future access would not be enough (Figure 7.3).

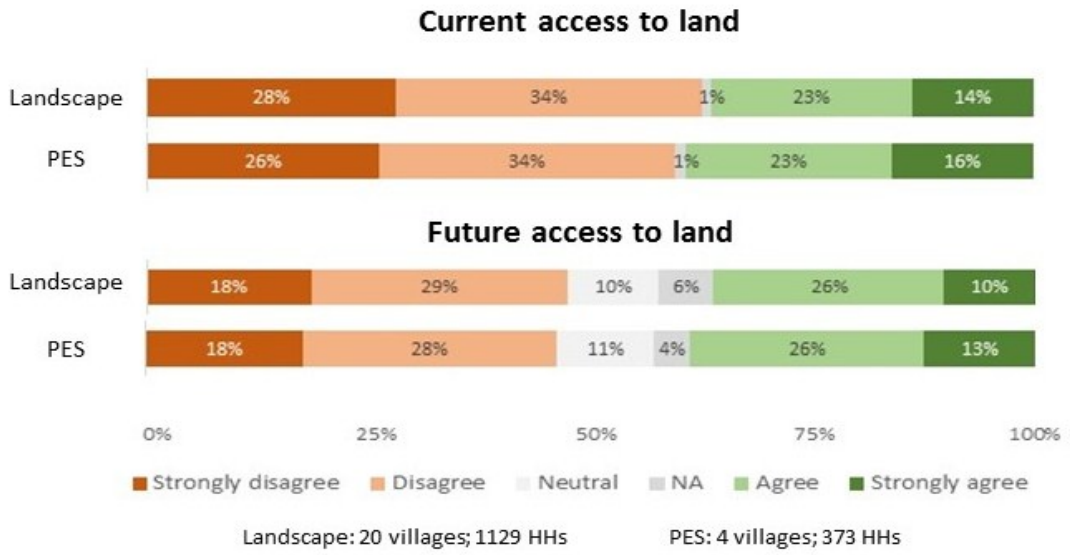

Figure 7.3: Perceptions of respondents on current and future access to land across the full dataset, and the core PES villages.

Results within the four core PES villages were similar to the landscape-wide results, with 60% of households feeling they didn't have enough land for their current needs and 46% believing their future needs wouldn't be met (Figure 7.3). Furthermore, the regression results allowed the identification of significant factors influencing household perceptions of land access issues across the landscape (Figure 7.4).

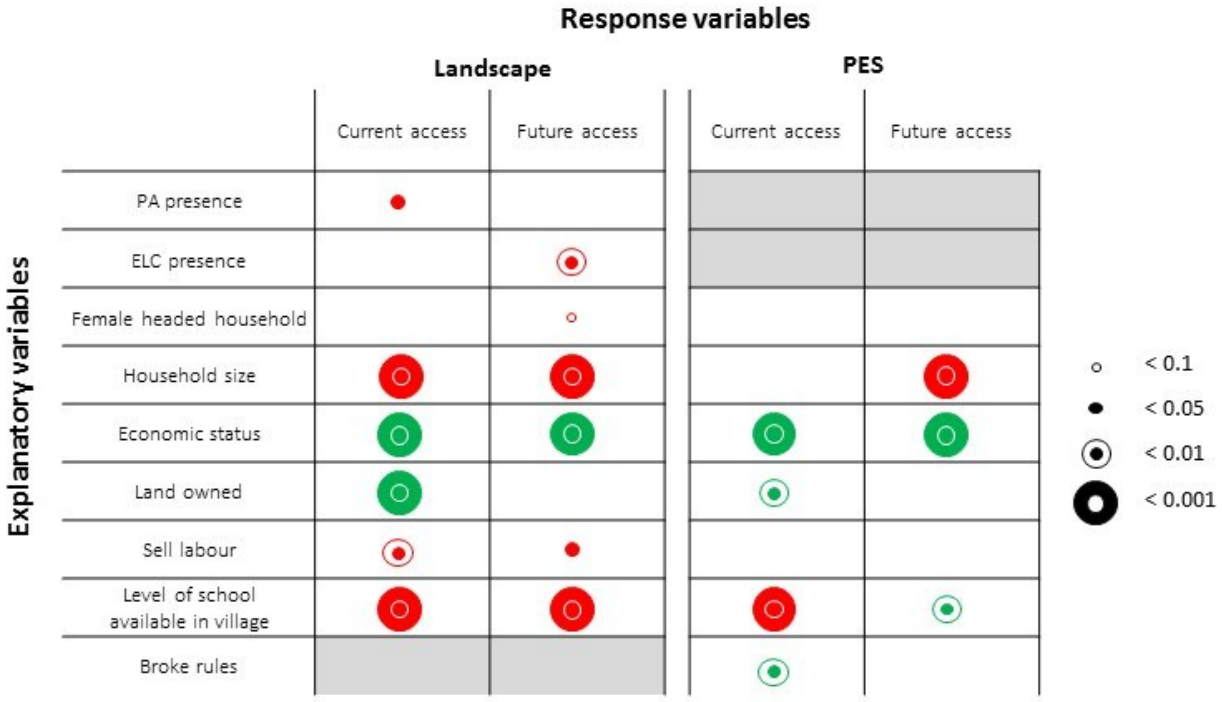

Figure 7.4: Factors influencing perceptions of current and future access to land across the landscape (20 villages) and the core PES villages (four villages). Results are based on the ordinal regressions of five level response variables of agreement to Likert-type item statements (see Appendix E.2 for full results). The legend illustrates size of symbols corresponding to coefficients' p-values: green symbols indicate a positive correlation to response while red symbols indicate a negative correlation to response.

While few of the livelihood strategies outlined in the full model were considered to be significant influences, household characteristics come out as the factors with the biggest magnitude of effects on perceptions. In fact, households with higher economic status felt less concerned about current and future access issues across the landscape and within the PES subset: richer families were 2.6 times more likely to feel secure about their current access to land (p-value < 0.001), and 1.4 times more likely to feel similarly with regards to their future access (p-value < 0.001), when compared to lower income families across the 20 villages.

> "Some people in the village have relatives working in the military or the government so they are protected. They also have connections with outsiders to buy more land and sell timber [illegally]. Commune and village authorities are not as 'powerful' and cannot stop them".
>
> Man, 32 years-old, Srae village

Families with more land felt more secure in their current access in both the 20 villages and the PES village subset, being respectively 3.1 and 2.6 times more likely to strongly perceive current access as secure. However, there is no evidence supporting the expectation that current ownership translates into perceived security of land access. Larger households felt concerned about access to land, with odd ratios indicating that they are 0.5 and 0.6 times (p-value < 0.01 & 0.001) more likely to feel negatively about their current and future access across both the whole landscape and the PES villages.

Selling labour was also correlated with perceived lack of current and future access to land across the 20 villages. There is no evidence that households selling labour are likely to be poorer than average (Chapter 5), however there are significantly higher percentages of households selling labour in villages outside PAs, and also in villages affected by ELCs (Appendix E.4). The direction of the causality here can be questioned, as active ELCs can provide an opportunity for nearby villagers to sell labour while, at the same time, potentially being the source of land evictions pushing families into selling labour. The latter situation is particularly the case for Srae, Slaeng Toul and Bangkan villages. This correlation might have been aggravated in villages where higher levels of education were available, attracting newcomers:

> "Many newcomers come here from other provinces because there is a lack of land in their home area. They now make 8% of the population of the commune; but they come to Bangkan because of the school and health centre. They need new rice land and timber for their house. According to the Land Law we have to allow them to clear up to 5 hectares per family – if they can".
> Man (Rieb Roy Commune Council), 56 years-old, Bangkan village

There is no evidence that variance between each village is significant, based on testing the effect of the addition of a random effect to the models. Yet patterns in the availability of school years in a village show that the level of connectivity plays an important role in shaping household perceptions of land access. In fact, households in villages with higher levels of education available were respectively 0.4 and 0.7 times more likely to feel insecure about current

(p-value < 0.001), and future (p-value < 0.001) land access across the 20 villages. A similar effect is observed in the PES subset for current access, however connectivity is positively correlated to perceived future access to land within the PES villages. This might be explained by the continuous expansion of conservation activities in the some of the four villages:

> "Since the CPA started there is less destruction. But the CPA cannot protect everything everywhere; new families need more land, and outsiders and companies still come cut trees in the PA area. Thankfully, there are plans for the CPA to expand."
>
> Man, 48 years-old, Tmatboey village

Overall, the presence of conservation and development interventions have more limited effects on perceptions than household characteristics. However, the presence of PAs emerged as a factor perceived to curtail people's current access to land. Households inside PAs were 0.7 times more likely than households located outside PAs to consider that current access was not enough for their household needs (p-value < 0.05).

> "I'm not satisfied with my current land because of the CPA and PA rules. I only have two hectares for my 4 children. But I have requested more and next year it will be better."
>
> Man, 55 years-old, Prey Veng village

In turn, presence of ELCs is associated with perceived lack of future access to land: households in villages affected by ELCs were 0.8 times more likely to be concerned about their future access to land in three years than households in villages not affected by ELCs (p-value < 0.01).

> "There is no company active here yet because we are far away in the forest and roads are bad. But I'm worried they [ELCs] come soon and steal land like happened in Antil village close by".
>
> Woman, 32 years-old, Reaksmei village

7.4.2 Perceptions of participation and trust in land management

Across the 20 villages, the majority of respondents had positive perceptions of their participation in land management decisions (79%), and trusted the commune council to implement land laws (53%) (Figure 7.5). Within the PES subset, respondents felt less involved in land management decisions than across the landscape in general (60%), however, most families (55%) perceived CPA committees to be effective in their role of protecting the forest.

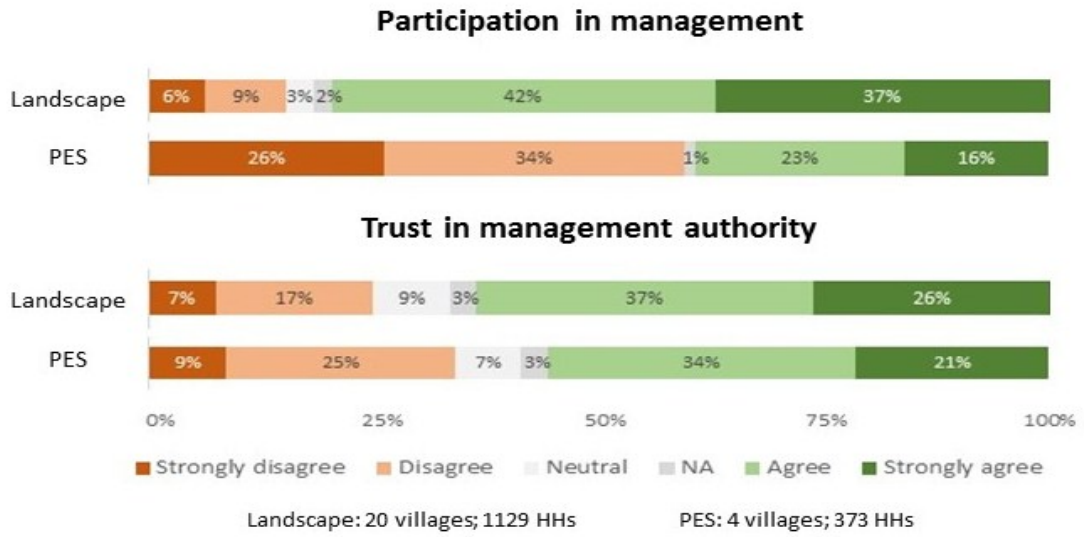

Figure 7.5: Perceptions of respondents on participation and trust in land management across the full dataset, and the core PES villages.

Fewer factors influenced perceptions of participation and trust in land management (Figure 7.6). Richer families were 1.8 times more likely to feel involved in land management compared to poorer families across the 20 villages (p-value < 0.001). Families currently owning a larger area of land felt more involved in management decisions as well; however, the direction of causation is unclear. One may argue that those with the power to influence land management decisions effectively grant themselves high amounts of land, but the converse may also be true.

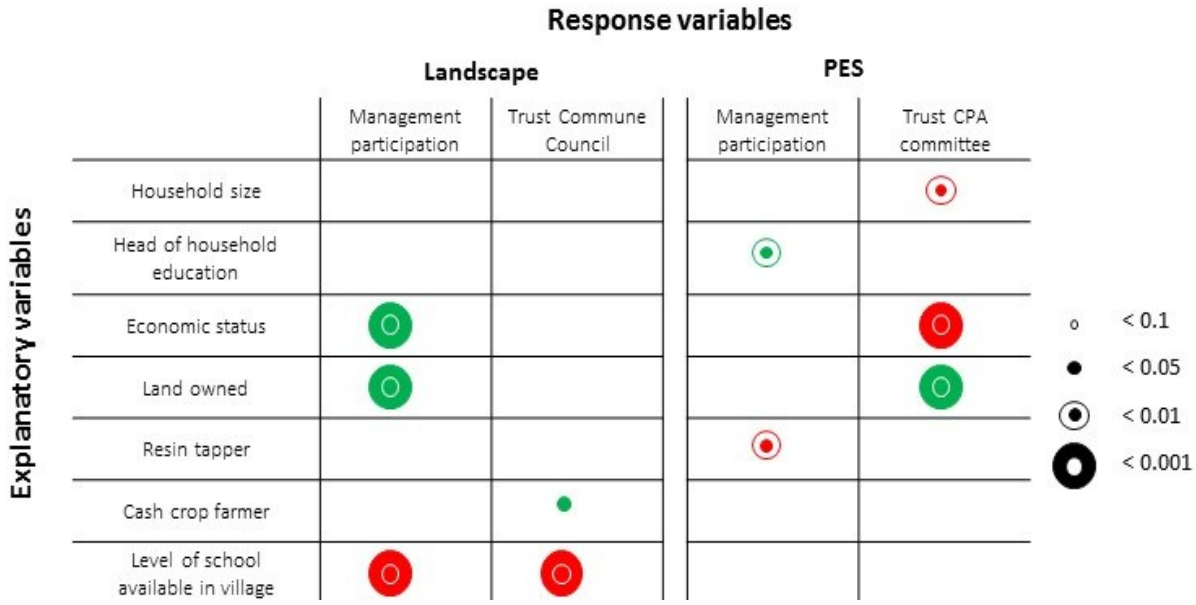

Figure 7.6: Factors influencing perceptions of participation and trust in land management across the landscape (20 villages) and the core PES villages (four villages). Results are based on the ordinal regressions of five level response variables of agreement to Likert-type item statements, modelled to *a priori* predictor variables (see Appendix E.3 for full results). The legend illustrates size of symbols corresponding to coefficients' p-values: green symbols indicate a positive correlation to response while red symbols indicate a negative correlation to response.

Both economic status and land owned did not affect perceptions of trust in the commune council, posing the question as to whether the laws implemented by the commune council are effectively translated into village-level management decisions.

Residents of more connected villages felt much less involved in the land management decisions in their village, and trusted their commune councils less. These two points resonate with comments from Bangkan village pointing to connectivity and related in-migration imposing increased pressure on land access, as well as to the idea that the commune councils are less important implementers of land decisions than village authorities. These factors do not emerge within the PES subset, which suggests that the in-migration and development limits imposed in the PES villages could be effective at preventing these pressures.

Within the subset of PES villages, educated households were 1.5 times more likely to positively perceive their involvement in land management decisions in their village than less educated families (p-value < 0.01). This is not surprising as several roles within the CPA committee require a person to be able to read and write. Here again, the analysis points to those being in charge of land management being more educated rather than richer. In fact, wealthy families were 0.4 times less likely to trust their CPA committee than poorer ones. Lastly, resin tappers were less likely to feel involved in land decisions.

7.5 Discussion

7.5.1 Perceptions of land issues in highly threatened landscapes

Overall, household characteristics are consistently influencing perceptions of land issues more than village-level variables and interventions, with a general sense of insecurity in maintaining access to land. In fact, economic status is the only factor perceived to assure current and future access to land.

Our original hypothesis that there are strong relationships between the natural resources that households command (such as land area) and the levels of needs satisfaction they achieve, based on previous studies of subjective well-being in developing countries, has not been confirmed (McGregor et al. 2007). Current possession does not assure future access, which is presumably a consequence of the prevailing insecurity of land rights within the study landscape, given the history of top-down government land management decisions that limit or reduce these rights (Sekiguchi & Hatsukano 2013). Even if a family currently commands enough land and resources, translating this into accessible economic power takes time and thus may not be helpful in securing future land (Baral et al. 2007; Chapter 5).

Other studies suggest that economic status is often correlated with political leverage in Cambodia (Hall et al. 2015; Un & So 2009). In fact, Neef et al (2013) suggest that the existing land-sector configuration is dictated by ruling elites to promote political legitimacy through the politics of patronage. Local

elites, richer and with more political agency, are thus also more likely to be involved in decisions about land management in the village and consequently to allocate themselves larger land areas.

7.5.2 Influence of village-level factors on perceptions

Surprisingly, households in villages affected by ELCs did not worry about their current access to land: this is possibly because not all ELC areas are fully active and not all ELCs dispossess current land rights. However, respondents in ELC affected villages strongly perceived their future access to be threatened. This supports an abundance of research highlighting the negative impacts of ELC violations of human rights through evictions (Gironde et al. 2015; LICADHO 2014; Neef & Touch 2012). Households within PAs where rules were being applied that limited resource use felt they had less current access to land; yet this did not affect their perception of future access.

The effect of ELCs on perceived future threats can be aggravated by increased migration, as most ELC workers are migrants coming from outside the province (Sperfeldt et al. 2012). This is especially the case for regional epicentre villages such as Bangkan or Kdak, which preferentially attract migrant families fleeing from environmental shocks or other land conflicts to remote provinces where new land is available (Bylander 2015). The correlation between perceptions of land access and security, and the level of education available in villages is primarily negative. This is probably because these epicentre villages are more likely to have better schooling and infrastructure. Connectivity and accessibility can make people more worried about land access and trust in the management process for allocating land to newcomers (Marschke 2006; Pasgaard & Nielsen 2016), to whom commune councils must provide land by law (RGC 2001).

7.5.3 Strengthened institutions in PES villages

While overall responses to the questions were similar between the full sample and the PES subset, the regression results point to the long-term presence of PES having successfully strengthened local village institutions by providing

transparency in land issues. The absence of evidence that richer households feel more positive about participatory management in PES villages, yet distrust CPA management, suggests that the land management system put in place in the PES villages is not influenced by economic status and may have circumvented corruption in land management at the local level. PA rules and CPA oversight may have limited households' current access, yet seem to have provided a system through which land demands can be processed fairly. There is always a potential for 'educated elite capture', although research has shown that projects managed by democratically selected leaders often perform better than if villagers are randomly selected, as these people are more able and motivated to deliver results (Turley et al. 2014). Thus, despite lower perceived participation in land management, quotes support the idea that the PLUP land management process is perceived as fair and secure by the majority.

Villages where a higher level of education is available correlated with a less positive perception of future access to land within the wider landscape; yet a positive correlation was found in PES villages. Thus members of the more connected villages of Dongplat and Tmatboey were more likely to think their future access to land was secure; potentially due to the high level of conservation activities in these villages compared to the other PES villages-Narong and Prey Veng (Travers et al. 2014).

Unfortunately, land management by CPAs has not provided perceived security of access for larger households, who might still feel insecure because the process of getting land is too slow to meet their growing needs. Additionally, land-management decision-making processes have led to resin tappers feeling somewhat excluded or poorly supported. This is arguably because the participatory land use plans developed through the village-level PES focus primarily on providing for agricultural expansion in certain sectors adjacent to the villages, rather than on supporting forest-based livelihoods such as resin tapping. The CPA and their local monitoring patrols' remit focuses on the CPA area only, whereas the rest of the PA is monitored by MoE or FA patrols. However, resin trees are located everywhere around the village, not

necessarily in the CPA area. In addition, illegal logging (which affects resin trees) is harder to prevent and monitor than land clearance. Thus, while showing overall positive perceptions of land issues in PES villages, the current management plans appear weaker at taking the needs of resource-dependent families adequately into account.

7.6 Conclusion

While perceptions are one type of information that is often dismissed as anecdotal by those arguing for evidence-based conservation, they should be an integrated part of the information used to advise conservation policy (Camfield et al. 2008). This study shows that using a quantitative assessment of perception indicators allows the analysis of individual subjective experiences while situating these experiences within their social, economic and intervention contexts to untangle significant patterns across a larger landscape (Roelen & Camfield 2015).

The current analysis sheds light on the overall concerns about land issues across villages in Northern Cambodia, especially in terms of perceived future access to land and trust in local land-management authorities. Household characteristics, and especially economic status, are the main factors influencing perceptions of land issues. Yet interventions also affect perceptions: with particular regards to the negative effect of development pressures such as ELCs and population growth on perceived future access to land. While the presence of PAs does not quell insecurity about future land access, there is evidence that implementation of PES in the villages does improve perceptions of security over land resources.

8. Discussion

The debate about how conservation interventions affect human lives has a long history and is ongoing (Brockington & Wilkie 2015; Leverington et al. 2010; Muradian et al. 2013). It is intrinsically linked to the constant evolution of conservation practices and the deepening recognition of the scale and character of their social impacts (de Lange et al. 2015; Leisher et al. 2013). The aim of gaining a rounded understanding of the social outcomes caused by conservation interventions first requires one to consider impacts as complex trade-offs within the wider political, economic and development context in which conservation takes place. This is important in order to understand the relative magnitude of the effects of conservation, and to ultimately document the pathways through which changes take place. Secondly, it requires the assessment of impacts across the multidimensional and heterogeneous dimensions of human well-being between different groups of the population.

This thesis contributes to progress in both these areas. This study presents lessons learned firstly about how the wider context of development, including ELCs, have affected rural transitions in Northern Cambodia, amid which conservation interventions are operating. Secondly, it furthers the evidence about the social impacts of Protected Areas and of PES programmes, documenting the pathways through which they occur. In this last chapter I review the evidence brought to light in this study before focusing on recommendations for practical changes within the agenda of conservation in the Northern Plains and future avenues for research to maximise the scope for action of my work. Lastly, I discuss the novel methodologies used in this thesis and suggest avenues for future research.

8.1 Rural transitions in fast developing Cambodia

Cambodia is a unique location to explore the trade-offs between development and conservation due to the fast-paced economic development and globalisation trends it has been undergoing since the new millennium (Mah 2015). In fact, Cambodia's socio-economic development has arguably been

the fastest among post-conflict societies, experiencing an almost doubling of GDP since the civil war ended with Khmer Rouge factions in 1998 (Hill & Menon 2013). However, post-conflict Cambodia was starting from a low baseline and still has far to go to improve standards of living. This is particularly the case in rural areas, where 80% of poor families live (ADB 2009). Consequently, rural livelihoods in Cambodia have been in transition, from near total reliance on natural resources for subsistence to more diversified approaches (Naron 2011).

Such changes have been observed in the Northern Plains, where micro and macro development factors have been the primary drivers of rural transitions (Chapter 4). Average economic status, rice harvest and food security have all improved considerably in the surveyed population between 2008 and 2014, for both the poorest and the richest quintiles of the population. There has also been a homogenisation of lifestyles across the landscape, influenced by better roads, access to markets and increase in trade. Chapters 4, 5 and 6 have documented how rural Cambodian livelihoods have followed pathways out of poverty by moving away from traditional resource-based livelihoods into mechanised agriculture, cash crop farming, and labour-based activities (Clements et al. 2014; Naron 2011). In parallel, there has been an overall decrease in the traditional forest-dependent resin tapping livelihood and in shifting agriculture practices. Paddy rice farming remains the primary source of life sustenance for Cambodians, however; land being a principal element of their well-being (Chapter 5).

Not all households benefited equally from these developments. While geographical variations occurred, primarily based on the absence or presence of an ELC or of a conservation intervention (Chapter 5), social effects have differed most between community sub-groups. For example, socio-economic status and related political agency (Chapter 6) shows a clear division line, with vulnerable families such as female-headed households being marginalised (Chapters 4 & 6). Objective, socio-economic improvements in livelihoods have been observed, yet other aspects of human well-being have been eroded. For

example, development has weakened the moral economies in some villages (Chapter 5). More importantly, a majority of Cambodians are concerned about their access to land (Chapter 6), which points to a key source of vulnerability for human well-being in rural Cambodia.

8.2 ELCs as adverse drivers of development

This study contributes to the growing body of evidence highlighting the negative environmental and social effects of ELCs in Cambodia. Chapter 3 demonstrates that drivers of ELC placement do not respond to the socio-environmental factors that are stated as criteria for determining ELC placement in government policy. ELCs are a prominent driver of the high deforestation rates that have occurred across the study landscape. Chapter 5 further documents the adverse effects on livelihoods resulting from eviction and land dispossession by ELCs, while Chapter 6 demonstrates the perceived insecurity in accessing land in the near future in villages affected by ELCs. This concern is exacerbated in the case of well-connected villages through the indirect attraction of migrant families for work and land (Gironde & Peeters 2015; Peeters 2015).

ELCs have been shown to narrow people's pathways out of poverty by usurping their primary livelihood and reducing their access to natural capital. For example, land evictions caused by ELCs have forced some households to sell labour or to turn to illegal activities to provide for their families (Chapter 6). A few ELCs have been granted in urban areas with similar dire repercussions including evictions and environmental damage (e.g. Boeung Kak Lake in Phnom Peng). Yet the impacts of ELCs are often felt disproportionately by communities in rural areas (Bues 2011; Hor et al. 2014; Jiao et al. 2015; Subedi 2012; Subedi 2014; Ullenberg 2009; Vrieze & Naren 2012), where land and resources are technically still owned and managed by the state, thus making villagers' rights unclear (Sekiguchi & Hatsukano 2013).

With the development of ELCs and the initiation of a more modern land-titling system, Cambodia has started to move into a monetised land market; yet one

that is pervaded with corruption by elites at both the national and the local levels (Diepart & Dupuis 2013; Messerli et al. 2015). Within such a system, rural livelihood strategies based on natural resources cannot adapt quickly enough to the fast-paced economic development trends at play in the landscape, leading to dispossession and disempowerment (Gironde & Peeters 2015). These trends are not isolated to the study site (Davis et al. 2015), and extensive research has confirmed that Cambodian ELCs are in fact a land grabbing mechanism rather than an agro-industrial process (Messerli et al. 2015; Neef et al. 2013).

Despite the well-documented violations of human rights and environmental depletion taking place under the pretext of agricultural intensification policy, there have been no sanctions against the Cambodian government by the international aid communities (Neef et al. 2013). In fact, international aid for land reforms have increased over the past years, facilitating the status quo of the current system (Oldenburg et al. 2014). Thus, solutions to counter the further granting of ELCs are unlikely to emerge unilaterally from top-down policy circles. On the other hand, there have been a small number of well-organised grass-root community approaches which have to date fared better at recovering land from ELCs (Chapter 5; Lambrick et al. 2014). Given the recent rush to acquire resources and the consequent decrease in land availability (Dwyer 2015a), Cambodian families' current and future access to land is tenuous (Messerli et al. 2015). This lends particular weight to the question of whether conservation interventions in Northern Cambodia affect the human well-being of local communities, and how they operate against the competing development forces at play.

8.3 Impacts of conservation interventions on human well-being

8.3.1 PAs as barriers to external shocks

PAs have been shown to be an effective tool for biodiversity conservation in a range of contexts and countries (Andam et al. 2008; Geldmann et al. 2013; Joppa & Pfaff 2011; Leverington et al. 2010). Chapter 3 supports this by

demonstrating that actively managed PAs in Northern Cambodia have some effect on reducing deforestation and preventing land use change drivers such as ELCs at a landscape scale, thus preserving natural capital that is central to global environmental commitments and to the livelihoods of households, as well as salient components of well-being for local populations (Chapter 5). This follows Clements & Milner-Gulland's (2015) findings that both Kulen Promtep Wildlife Sanctuary and Preah Vihear Protected Forest were effective at securing habitat from conversion following the start of active management in 2005.

Despite this relative conservation success, Chapter 4 shows there is no major differential impact of PAs on household socio-economic status, agricultural productivity or food security, when compared to households outside PAs. Furthermore, Chapter 6 demonstrates that PAs are perceived as a barrier to current access to land by households, due to the rules imposed on resource access. Yet natural resources are a salient item of individual well-being conceptualisations (Chapter 5) and are locally recognised as an essential source of food and livelihood materials, as well as maintaining soil fertility.

This highlights the complexity of links between the ecosystem services and human well-being, and the importance of assessing the social impacts of conservation at various geographical and temporal scales (Fisher et al. 2014; MEA 2005). For example, certain regulating ecosystem services, such as climate regulation, play an important role in reducing environmental vulnerability, but the mechanism by which people benefit from them does not necessarily require direct access (as it would for provisioning services), and potentially depends on a more complex set of biophysical processes and human actors, sometimes over large spatial scales (Fisher et al. 2013). Because benefits from avoided deforestation can take time to translate into socio-economic well-being improvements for rural households, the positive effects of common pool resource protection for communities need to be assessed over longer time scales (Marschke 2006). In fact, poor people are commonly constrained in their ability to rapidly transform natural capital into

other forms of capital, or even, as Chapter 6 highlights, current ownership of land may not be enough to ensure future access to land and secure future capital (MEA 2005).

PAs still offer a direct protection for some traditional livelihoods on the Northern Plains. Between 2008 and 2014, PAs have successfully provided better tenure security for resin trees and allowed resin tappers to improve their economic status. This contrasts with resin tappers outside PAs who appear comparatively disadvantaged within their communities, to the extent that the livelihood is reducing significantly in frequency (Chapter 5). Yet considering the high rates of illegal logging in PAs, this benefit is likely to become obsolete in the years to come. Testament to this is the decreased significance of the effects of PAs on objective well-being since 2008 (Chapters 4 and 6). While PAs remain a factor influencing perceptions of current access to land, they are not perceived as affecting future access to land (Chapter 7). In this sense, PAs still present a real, if frail obstacle against external development pressures, but it is questionable for how long this will last.

8.3.2 PES as trusted governance mechanisms

While the presence of PAs has a limited effect on well-being, there is evidence from this study that more intense conservation activity through community-based PES programmes does provide additional benefits to human well-being. Over the past decade, PES have become a popular tool for conservation, promoted by the idea that they are a more cost-effective mechanism for sustainable resource management than indirect strategies such as Integrated Conservation and Development Projects (Engel et al. 2008; Ferraro & Simpson 2002; Wunder et al. 2008). Conceptually, PES are useful as they explicitly recognise the need to address difficult trade-offs by bridging the interests of environmental service providers and external actors through compensation (Wunder 2007). In fact, PES mechanisms provide a framework for environmental services to be valued economically and secured through market transactions with local communities on the condition of the service

provision, with the potential for directly incentivising local communities to carry out conservation actions (Sommerville et al. 2009).

There has been some criticism of the political processes underlying PES practices in Cambodia, more specifically linked to a lack of consideration of the multi-dimensionality of livelihoods and land-use practices, and the overestimation of communities' governance potential (Milne & Adams 2012). By providing alternative institutional arrangements at the village level, PES also create the risk of elite capture and disempowerment of certain less vocal, and often more vulnerable, sub-groups in the population (Grieg-Gran et al. 2005; Mahanty et al. 2013; Newbold et al. 2016). This in turn creates uncertainty over the likely outcomes of environmental and conservation initiatives, which could lead to unintended negative consequences for poor people affected by PES programmes (Agarwala et al. 2014).

This study, however, shows that well-designed PES programmes can bring benefits for rural households amidst a complex and dynamic social and economic landscape. In line with the short-term evaluation results from 2011 (Clements & E J Milner-Gulland 2015), the medium-term analysis in this study shows that the Ibis Rice programme has delivered continuous positive increases in the rate of change of socio-economic status and agricultural productivity of participants since 2008 (Chapter 4). Overall, none of the PES projects were shown to be detrimental to the socio-economic well-being of the communities in four core PES villages, nor to produce negative perceptions in relation to salient land issues (Chapters 4 & 6). Even more so, the presence of a trusted mediating NGO supporting village institutions can successfully help resolve land conflicts with ELCs (Chapter 5; Ingram et al. 2014; Lambrick et al. 2014). The institutional arrangements created in the four core PES villages seem to have provided a successful alternative to the inequality of the Cambodian national land system. In fact, the majority of households trusted the Community Protected Area (CPA) committee to oversee land management around their villages, a system which seems to circumvent local elite capture by richer families (Chapter 6).

In such a form, PES mechanisms can open up a variety of pathways out of poverty through the creation of markets, in addition to preserving natural capital used for existing livelihoods. The provision of a direct income in areas where converting natural resources to money might be difficult can improve household resilience to environmental and economic shifts by providing additional 'safety nets' (Angelsen & Wunder 2003; Naron 2011). The diversification of livelihoods is essential for households to better adapt to external influences (Coulthard 2012; Leslie & McCabe 2013; Marschke 2006); PES schemes such as ecotourism and the Bird Nest programmes can provide opportunities for this diversification, and Ibis Rice and ecotourism can support a transition into the national market economy.

However, participation in the PES programmes is voluntary, and hence only families that can afford to divert labour out of one of their current livelihoods tend to participate (Mahanty et al. 2013). In the case of Ibis Rice, poorer families with less land simply do not produce enough rice surplus to sell any of their harvest. This opens the door for disagreements and perceived unfairness in communities, damaging solidarity in the village (Chapter 5) and potentially hindering the long-term benefits from the programme. In fact, the PES processes in the Northern Plains have not provided perceived security in access for larger households, as the process of getting land is too slow to meet their growing needs, nor has it made households practicing the traditional livelihood of resin tapping feel included (Chapter 6).

8.4 Fair and sustainable conservation in the Northern Plains

It is easy to forget that Cambodia is still recovering from decades of social unrest. While progressive development and deepened peace have emerged, deep-seated tensions have arisen over the entrenchment of the ruling party that poses severe questions on Cambodia's long-term development (Öjendal & Ou 2013). Given Cambodia's economic development rate, and improvements in infrastructure and trade at the local and national levels, overall increases in socio-economic well-being were to be expected. The

presence of PAs has not hindered these improvements, and the PES schemes seem to have enhanced it in some dimensions. But are these conservation interventions sustainable? The current exigency of insecurity in the face of decreasing resource pools can force situations in which safeguarding present well-being involves sacrificing the future (Agarwala et al. 2014); thus current well-being improvements may limit the potential for improvements in future living standards.

Success in preventing these pressures in PA areas is reinforced in core PES areas. This study has shown that PES can provide social co-benefits as well as building good governance mechanisms in places where democratic institutions are weak or non-existent, when implemented through a long-term presence to build local capacity, and with transparent governance mechanisms (Clements et al. 2010; Ingram et al. 2014; Milder et al. 2010). The relative social success of the PES projects lies in the overlay of different incentives for sustainable resource management through multiple projects that directly connect households to conservation through trusted local actors. Faced with the ineffectiveness of Cambodia's democratic institutions (Stuart-Fox 2008), the aggregated effect of democratically-elected village-level conservation committees can provide increased tenure security and the basis for development. This study points to three key issues related to fairness and social inclusion that must be addressed in order for the PES programmes to be effective and sustainable in the long-run.

8.4.1 Including poor people in PES programmes

Those who are most vulnerable to global economic forces beyond their control are the ones unable to adapt in beneficial ways to these changes (Fisher et al. 2013). The more they depend on natural resources the poorer they become, because the quality and quantity of natural resources are diminishing rapidly as a result of these same forces (Naron 2011). Given the gendered impacts and vulnerabilities resulting from unfair land management systems (Hall et al. 2015) and the potential beneficial effects of conservation on tenure security in the context of weak institutions (Chapter 6, Clements et al. 2010), conservation

should endorse more direct goals that promote the inclusion of the vulnerable sections of the population despite possible short-term trade-offs in the level of success of biodiversity outcomes and cost efficiencies (Pagiola 2007; Wunder 2008).

The low levels of inclusion of the poorest households in the current PES schemes is problematic as material improvements resulting from interventions are unlikely to achieve improved well-being if power inequalities aren't addressed (Dawson & Martin 2015). While the very poor typically constitute a lower threat to biodiversity due to their inability to make a serious impact on their resources, the long-term sustainability of projects can be compromised if conflict and divisions in the community erupt (Mahanty et al. 2013; Wunder 2007). Theoretically, this lack of pro-poor inclusion also breaks the oath to 'do no harm' to the communities affected, as unfair benefit sharing can hurt vulnerable families.

To be sustainable, interventions must find a way to lower the opportunity costs of participating so they become more accessible (Milder et al. 2010). For example, the Ibis Rice project could allow for pro-poor 'positive action' by including participation quotas for poorer households (Grieg-Gran et al. 2005). Along with lower costs of participation through better technical assistance, such as facilitating access to mini-tractors, this could effectively attract poorer families to participate in the scheme. However, pro-poor inclusions should not disincentivise other families, nor distort the conditionality of the delivery for the environmental services, a point which has been shown to be an important factor in changing behaviour for conservation purposes (Nilsson et al. 2016; Sommerville et al. 2009).

8.4.2 Reinforcing village-level capacity

The main goal of the Northern Plains' PES programmes is to protect targeted species of endangered birds by avoiding the conversion of their habitats around villages, and through direct nest protection (Clements et al. 2010). In 2011, Clements & Milner-Gulland (2015) found that habitat conversion through

deforestation was reduced by an additional 50% within PAs when compared to matched areas outside PAs. Yet the attribution of the successful environmental protection achieved is blurred due to the multiple interventions at play in the villages, which are monitored and implemented by the same village entities and often started at a similar time (Chapter 5). Arguably, this is one of the strengths of the overall Northern Plains programme, which provides both individual and collective incentives for conservation. Yet ensuring that the right drivers of deforestation are addressed will become more and more important as the schemes expand within villages and to further villages. With limited budgets available, there should be a clear identification of the level of individual versus collective rewards needed to incentivise long-term behaviour change (Travers et al. 2014).

Research has shown that individual rewards can be more effective and less sensitive to social factors than collective rewards (Midler et al. 2015), but that conditions are highly dependent on circumstances (Sommerville 2010). Chapter 3 highlighted that the main drivers of land-use change in the area related primarily to unpredictable and uncontrollable development pressures rather than smallholder agriculture. Bearing this in mind, it is questionable whether individual payments can be effective at preventing these drivers and affecting behaviour change in the long-run (Davis et al. 2015).

To date, there is still little evidence that the implementation of the Ibis Rice programme has had a significant lasting impact on the clearance of forest in three of the four core PES villages (Travers et al. 2014). However, this does not mean that environmental protection of critical habitats has been unsuccessful around the villages through the capacity-building and awareness-raising carried out over the years. In fact, Chapter 6 showed that the rules in place were respected to the extent that households in PAs perceived their current access to be limited. It can be argued that it is the alternative land management system in place in PAs and in PES villages that serves as a primary barrier to new land clearing, rather than the direct household payments.

This study also highlights the potentially higher combined objective and subjective well-being benefits from taking a community development approach rather than prioritising individual incentives. In fact, the significance of PAs and the PES effects on socio-economic change is remarkably small when compared to other predictors in the models presented in Chapter 4. And these models only offer a window on the objective dimension of local human well-being. In turn, the CPA land management systems additionally provide perceived tenure security and a fair local alternative to the corrupt land system outside PAs (Chapter 6). However, a key objective for the long-term viability of both the Ibis Rice and ecotourism programmes rests in empowering local communities to strengthen their governance and institutions, to combat the weak governance of Cambodian land management institutions. Ultimately, the combined efforts to this aim would lead to the autonomous management of local resources and of the conservation programmes, as a sustainable development pathway (Brooks et al. 2013; Fry et al. 2015; Lambrick et al. 2014; Porter-Bolland et al. 2012).

8.4.3 Addressing future aspirations

The community-based PES programmes in the Northern Plains are currently effective (Chapters 5 & 7). Yet cooperation and incentives are highly dependent on institutional arrangements (Ostrom 2009). Under the current fast-paced change in Cambodia, village structures, local institutions and thus motivations for cooperation and incentives for conservation are likely to change rapidly as well (Nilsson et al. 2016). Failure to adapt to changing incentives in turn means the failure of years of community development assistance, thus conservation interventions must constantly adjust their incentives. Yet local motivations are heterogeneous and vary between social groups, and failure to cater to all groups in the population may inadvertently lead to erosion in village solidarity (Chapter 6).

Designing the right set of incentives requires research into the motivations of individuals and communities to engage. Methods such as scenario analysis

and behavioural games can help to anticipate the right level of institutional controls and to what extent incentives should focus on individual versus communal incentives (Travers et al. 2011). In villages such as Tmatboey, where solidarity in the village has been eroded since the implementation of the PES projects, addressing these concerns with the CPAs to decide on benefit sharing mechanisms is essential to avoid further disagreements. The use of predictive approaches can help foresee forthcoming changes and provide essential evidence allowing for the successful adaptation of incentives within community-based and PES conservation projects (Sandker et al. 2010).

Yet it is not enough to infer future behaviour, new activities must also address them. The behavioural change strategies employed under WCS's current conservation activities include deterrence, through PA and PES rules, and enticement, through PES communal and individual payments (St John et al. 2013). But the programmes fail to educate and inspire people towards independently undertaking more sustainable behaviours. There is a need for an additional strategy of behaviour change to address new aspirations across generations and to proactively include youth, which may not yet own land and thus may not yet be able to participate in PES. Catering to younger generations is especially important in the Cambodian context due to the population structure imbalance. As the largest cohorts (10–14 and 15–19 year-old), born during the post–Khmer Rouge baby boom, enter their main childbearing years, resources across sectors are likely to be placed under increasing pressure (Hukin 2014). The aspirations of the current youth should be taken into account as they in turn will become the next heads of households and the decision-makers for the forthcoming decades.

There is an opportunity for conservation education programmes in the Northern Plains to increase ecological awareness, foster more favourable attitudes toward the environment, and promote natural resource conservation (Jacobson 1987; Olson et al. 1984). Considering the lack of educational infrastructures in Cambodia, the development of conservation-oriented educational programmes and infrastructures could be particularly powerful.

Failure to address youth's aspiration can lead to generational gaps in maintaining village-level institutions and to declines in PES participation in the long run. This is especially important when considering that long-term participation in PES and in the PES's village committees is likely to induce fatigue and even burnout (Byron et al. 2001).

8.5 Using mixed methods to understand conservation impacts on human well-being

"It is better to be vaguely right than exactly wrong."
Carveth Read (1898) *Logic, deductive and inductive*

The lessons highlighted here are the results of the application of novel methodologies to understand the impacts of conservation interventions on human well-being. Throughout this thesis I have taken a pragmatic mixed methods approach to inform the development of my research design across stages and to complement and triangulate the evidence generated. I used multiple mixed methods, both across-stages and within-stages, and both across and within chapters, to achieve rigor and relevance towards answering this thesis's action-based research objectives. The use of mixed methods is justified by the need for development of knowledge from one phase to the other, for example using the findings from the primarily qualitative inquiries into local well-being conceptualisations in Chapter 6 to further assess, quantitatively and systematically, perceptions in land security issues, which had been named as a well-being priority in Chapter 7.

Mixed methods were also used for triangulation and complementarity. An example of the application of within-stage mixed methods is Chapter 7, in which both qualitative and quantitative questions were asked in the questionnaires and focus groups exploring local conceptualisations of well-being, and both qualitative and quantitative analysis were applied, through narratives, quotes and statistical tests. Another example is the application of the Basic Necessity Survey, which used focus groups to define the locally relevant basic assets and services in communities to be surveyed, and was embedded in the household survey questionnaire to quantitatively assess

impacts of conservation on socio-economic status. Lastly, the thesis narrative itself denotes an inherent mixed methods approach, with the quantitative nature of Chapter 4 assessing deforestation across the study site providing further complementarity to holistically understanding the effects of conservation on human well-being.

The use of mixed methods and a human well-being approach is therefore both a means to an end, in terms of contributing towards evidence on the social impacts of conservation, and a means in itself, as a contribution towards the evolution of more adequate and contextualised social evaluation methods. Such an approach is justified to appropriately capture impacts of conservation in the context of dynamic change. Unpredictable and uncontrollable events have come into play in the Northern Plains since the elaboration of the project's theory of change. For example, the aggregated impacts of recent land policy in Cambodia, the widespread granting of ELCs and the exponential deforestation rates in the country have completely transformed mechanisms of land use change over the six years studied. The statistically established 'control' villages used in the short term evaluation cannot still be considered as such, as the design violates the assumption that no other factors affect the treatment and control except for the intervention itself (Rosenbaum & Rubin 1985). The following section expands on the two areas where this study has contributed to advances in the application of novel methodologies to understand social impacts of conservation. I additionally highlight the next steps for future research to further strengthen the validity and relevance of findings using these methods.

8.5.1 Quantitative rigor in the face of dynamic change

The reality of shifting baselines due to unpredictable and dynamic change calls into question the long-term appropriateness of using quasi-experimental designs to evaluate social impacts. In fact, the attribution of impacts to interventions can be largely inflated without further controlling for other factors such as livelihood strategies in post-matching regressions (Honey-Rosés et al. 2011). In light of the temporal issues faced when using 'gold standard'

quantitative matching, I have combined complementary quantitative analysis as well as qualitative assessments to ensure the legitimacy and validity of my findings. By exploring the sub-group variations, I was able to significantly correlate and uncover the detail of drivers of rural transitions, such as the mechanisation of agriculture and the diversification of livelihoods into labour-based activities (Chapter 4). While these inferences were not based on household level matches, I was able to verify the assumption that village-level characteristics and trends affected sub-groups similarly in both treatment and counterfactual villages through in-depth qualitative research (Chapter 5). On this matter, it is questionable whether matching- which can only be done on observable factors- at such disaggregated levels would be a resource-efficient way of documenting pathways of development at the scale of this study (Camfield & Duvendack 2014; Harrison 2014).

I highlight the two main avenues needed to examine the robustness of long-term quantitative evaluation methods that emerge from this study. Firstly, future impact evaluations should focus on testing the difference in results from matching with the same covariates using different baselines, to ensure the validity of control villages in re-assessments. In this case, the original matching with a 2005 pre-intervention baseline should be compared with matching results with later datasets to ensure covariate means remain balanced, before continuing with the current survey design (Stuart 2010). If this is the case, it is certain that interesting results would stem from an evaluation of the 9-year, 4 time-point dataset, yet the sample size of a longitudinal dataset such as this is bound to be constantly decreasing.

Secondly, new horizons for evaluations should focus on comparing results between original designs against a design with a new set of covariates, which would mirror the developments that have occurred over the years. For example, a survey design based on pre-2011 intervention levels could take into account ELC presence, or a measure of development pressures at the village level such as connectivity, which would provide a more accurate picture upon which conservation intervention attribution could be based. Adjusting

evaluation baselines can allow the better capturing of effects along a series of "evolving snapshots" rather than aiming to statistically attribute long-term impacts, which may be impossible or even undesirable (Rogers & Peersman 2014). Longitudinal panel research remains useful to test whether development pathways have evolved as theorised; however, evaluations should pay close attention to assessing not just the impacts of interventions, but also confidence in attributing impacts and their related mechanisms against historical baselines in changing socio-ecological systems (Befani & Mayne 2014; Ton et al. 2014).

8.5.2 Internal validity and relevance in the long-run

As time changes so do people's aspirations, motivations and conceptualisations of well-being. Applying relevant indicators on an appropriate temporal and geographical scale is therefore tricky, and should be triangulated with localised qualitative inferences (Burrows & Read 2015). In landscapes where human well-being is affected by several factors, pre-intervention baselines often become inappropriate references against which to measure change over a long period (Hart et al. 2013; Phalan et al. 2011). For example, local perceptions of what constitutes a basic necessity varies over time, potentially influencing the magnitude of change calculated between years. As respondents consider more and more items to be a basic necessity according to their exposure to modern society, the variance in the scale of changes decreases if the original weighting in the BNS menu is maintained (Chapter 5). Moreover, the rate of development can vary unpredictably across villages; hence spatial variations in the perception of what constitutes a basic necessity may increase, despite the careful design of the original list to comprise of items that are homogeneously understood across the population.

Given the challenges experienced using quantitative evaluations of social impacts, it is necessary to complement any quantitative assessment with contextualised exercises, for example by correcting its potential bias through further post-matching regressions. Quantitative techniques could otherwise easily stray evidence away from some of the effects of an intervention. In this

regard, this study has shown that a non-prescriptive well-being approach is an appropriate and useful methodology to be used concurrently to validate quantitative findings and to capture non-observable issues experienced by the local population (Chapter 6). I have used a well-being approach within focus groups and individual interviews to understand the concerns of the local population, showing this to be an appropriate and relatively economical method of taking the pulse of changing attitudes in the communities. Hearing muted voices of dissatisfaction within and between communities is often difficult, yet is possible through the application of a sensitive participatory assessment focused on understanding locally-defined priorities. The use of a human well-being approach helps in fulfilling these reality checks, as well as highlighting the importance of considering all aspects of social impacts – intended or unintended – across the different groups in a community, such as rips in the social fabric of a village (Chapter 5).

In its current application, the framework used in this study as the combination of Narayan and WeD's perspectives proved successful in navigating the intangible nature of the concept within more concrete categories of well-being components. Yet a well-being approach is not prescriptive and must be adapted to the context in which it is used. Future work using a similar approach or adapting the framework used must therefore similarly justify its validity and carefully examine how it captures the different epistemologies upon which it is founded (Robeyns 2005).

This study has shown that in order to achieve better understanding of how conservation affects human lives, quantitative methods must be combined with qualitative inferences to gain greater insights – thus mixed methods should not be considered as best practice, but effectively as required practice for assessing the causal linkages at play in rural transitions (Khagram & Thomas 2010; McGregor et al. 2015; Woodhouse et al. 2015). At this stage, further studies applying the concept of well-being are needed in order to overcome the dearth of empirical evidence supporting the success of positively linking biodiversity conservation and poverty reduction (Leisher et al. 2013; Roe,

Oviedo, et al. 2010). Recent multi-sectoral efforts, such as Schreckenberg et al.'s (2010) review of rapid methodologies for social assessment and Woodhouse et al.'s (2016) guidance on evaluating well-being in conservation, should help drive this operationalisation.

8.6 Future research: diversifying sources of knowledge for better evidence

Through the use of a pragmatic mixed methods approach, I have produced an impact evaluation that answers questions to both inform the design and implementation of the WCS's conservation programme, and to advise on future avenues for social evaluations in conservation more generally. I have shown that adopting a contextualised well-being mixed methods approach enables holistic evaluation of the impacts of conservation projects, whilst maintaining rigor and relevance.

The Northern Plains represent a unique site for ongoing, multiple time point, quasi-experimental evaluations on a large scale. They thus also provide a platform from which to improve research addressing the social impacts of conservation. Despite methodological challenges linked to temporal and spatial dynamics, impact evaluations should continue to play an important role in the evaluation of theories of change that hypothesise how pathways of development unfold. (Camfield & Duvendack 2014; Lensink 2014b). Yet given the time- and resource-intensive nature of quasi-experimental survey-based impact evaluations, expectations that this should be common practice amongst NGOs are unrealistic (Camfield & Duvendack 2014; Pattanayak 2009).

Over the past decade, conservation has undergone a pronounced expansion, geographically and conceptually, towards more human-centred approaches. It is therefore imperative that research moves towards more human-centred assessment approaches as well. In practice, this means practitioners and researchers should consider quantitative impact evaluations as only one of many assessment methods to learn about the effects of their projects (Morgan 2007; Ton 2012). Conceptually, this encourages a 'plurality of thinking' as a

means to better accommodate environmental and social outcomes (Guijt & Roche 2014; White 2014). The use of a well-being approach has proved extremely helpful in thinking outside the box of easily observable factors and towards more nuanced impacts of conservation. It is thus a step forward towards a better integration of subjective states of well-being. For example, qualitative and quantitative assessments of local perceptions of conservation can play an essential part of improving knowledge and practices for better management outcomes (Bennett 2016). This is especially the case when considering the potential positive impacts conservation programmes can have on feelings of security, autonomy and freedom (Chapter 7).

In line with continuing efforts to operationalise well-being approaches, future conservation research should aim to leverage new sets of social science expertise to address more nuanced well-being issues, especially with regards to understanding conservation behaviours. Traditional expertise in conservation and development still falls short of considering psychological well-being in local communities. For example, despite taking the anthropologically-inspired approach of free-listing to explore local conceptualisations of well-being, no well-being items related to the component of freedom and autonomy were named by the respondents during this exercise (Chapter 6).

In this regard, I recognise that traditional socio-economic surveys can hardly engage in the meaningful dialogue required to give adequate consideration to people's freedoms and mental states (Alkire & Foster 2011). Understanding these well-being components is important to ensure PES programmes foster the fairness, social inclusion and social capital necessary for sustainable conservation initiatives (Pretty & Ward 2001). Thus, approaches and skillsets from social sciences, including sociology, anthropology, psychology and political sciences, among others, are indispensable in exploring the human well-being experience of conservation, not only its impacts. The increasing recognition of 'conservation social science' as a dedicated research agenda is testament to the necessity of further operationalising bridges between natural

and social science disciplines, and in parallel between positivist and constructivist research paradigms (Bennett et al. 2016; Mascia et al. 2003).

Conclusion

Social assessments are not confined to adopting the terminology “well-being”. For example, the ranked outcomes method has been shown to be a flexible and relatively affordable framework with which to define evaluation terms for all stakeholders from the outset, even in cases when evaluation and clear goal-setting are omitted from the original project design and planning (Sainsbury et al. 2015). Yet the essence and value of well-being thinking lies in the consideration of both objective and subjective outcomes. In this sense, an emphasis should be put on collaboration with local communities to ensure internal validity of assessments and of projects (Fry et al. 2015). In fact, deriving locally contextual measures of what successful environmental and social outcomes should be, and for whom, is both a means to an end, and an end in itself.

The true meaning of “adopting mixed methods” thus extends beyond the integration of qualitative and quantitative methods, towards the premeditated and justified use of multiple mixed methods at different time points along interventions, and at different spatial scales (Bamberger 2015; Davis & Baulch 2011; Khagram & Thomas 2010). Diversified social assessments that focus on the participation of communities provide a solution to discrepancies between research results and realities and can supply the continuous evidence required for adaptive management at reasonable cost (Armitage et al. 2012; Young et al. 2006). This is especially important for conservation interventions that take place in a context of rapid environmental and social change, such as that of Cambodia.

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Appendix A – Household survey questionnaire

Household Questionnaire – FINAL VERSION
Livelihood, BNS and well-being in Preah Vihear

General Introduction: I am a student from a university in Phnom Penh and work with the researcher from Imperial College from UK. We are interested to understand the livelihood of local people in the community. We come here for data collection for the study related to well-being and livelihoods. I would like to interview you about 40-60 minutes related to your livelihoods and livelihood activities. Can you allow me to interview?

0. Codes & Family history

Code 2014……..
Was this family interviewed in 2008? Yes☐ No☐
Was this family interviewed in 2011? Yes☐ No☐
Is this the same family interviewed in 2008 or 2011? Yes☐ No☐

---------- **If replacement**----------

If **no**, is the original family still in the village? Yes☐ No☐
If **still in village**, why replace?.....
Old (replaced) code…….. Code 2014…….....

Date:…… Interviewee:…… Sex:..... (should be Head of HH)
Interviewer:……..

1. Demographic Data

Village..... Commune.....
District..... Prov. Prearh Vihear.
Ethnicity.....
Education (Number of years in school):.....
Family status: Married (couple)☐ Single☐ Widow/(er)☐ divorced☐
Number of family's members ……persons
Women…….persons

Household members

No	Name and family name	Sex	Function in family	Age	Occupation (if working)	Nb. year school	Can read & write?	Location of occupation
1								
1-Khmer								
2								

2- Khmer								
3								
4								
5								
6								
7								
8								
9								
10								

When your family comes to settle in this village/commune?

……

2. Livelihood Data:

Here, we would like you to provide us the data related to livelihood activities and household resources:

*Notes: 1. Ask about last year (Oct 2013- Sept 2014)

2. Look around – indications of livelihoods
3. Rice /food security important

5.

No	Type of incomes	Quantity		Remark
1	Liquid resin collected per visit	……. Kan		1 Kan = 30 litters
-	Number of times to collect resin per month?	…… Times		Number of month per year(month that didn't go to collect).....
2	Nb. of trees you have (you own) for resin collection	……	Trees	
-	Nb. of resin trees you have (you own) not been taped yet	……	Trees	
3	How many Kampong do your family consume to cook rice per day?	……	Kampong	How many Kampong equal 1 kg?.....
4	Have you ever, borrowed, bought or earned rice from others to eat in last year (2013-4)	Yes☐ No ☐	How much you earned milled rice? .....Kg How much you borrowed milled rice? .....Kg How much you bought milled rice? .....Kg	
-	Have you received rice (for free) from others to eat in last year (2013-14)	Yes☐ No ☐	How much you "given" milled rice? .....Kg	
-	Rice harvest in last year (2013-4: Oct 2013 – Sept 2014) from paddy field:	.....Bei/year	…….Kg/Bei	Cultivated area of paddy: ……
-	Rice harvest in last year (2013-4) from chamkar:	…....Bei/year	…….Kg/Bei	Cultivated Area of Chamkar: ……

	Have you ever sold paddy rice last year?	Yes☐ No ☐	If yes, how many kg of paddy rice?	
-	Cash crop harvest in last year (2013-4):	Yes☐ No ☐	Kg / year	Cultivated area of Chamkar:…… ….
	Cassava (dry-product)	Yes☐ No ☐		
	Soybean	Yes☐ No ☐		
	Mung Bean	Yes☐ No ☐		
	Sesame	Yes☐ No ☐		
	Other…….	Yes☐ No ☐		
	Other…….	Yes☐ No ☐		
-	Do you let other people farm your rice fields	Yes☐ No ☐	Who?.....	How much do they pay /year?..... .

5	Livestock raising	Quantity		Number sold last year:
-	Number of pigs you have now?		Heads	
-	Number of buffalo you have now?		Heads	
-	Number of adult male cow you have now?		Heads	
-	Number of adult female cow you have now?		Heads	
-	Number of young cow you have now?		Heads	
6	Does your family engage in the following activities in the last 1 year?			
-	Collection of fuel wood (charcoal)	Yes☐ No ☐		
-	Collection of other NTFP (not mentioned above)	Yes☐ No ☐		
7	Grocery or operation of family enterprise:		Year started	
-	Village shop	Yes☐ No ☐	……..	
-	Rice threshing service	Yes☐ No ☐	……	
-	Rice milling service	Yes☐ No ☐	……	
-	Rice harvesting service	Yes☐ No ☐	……	
-	Produce rice wine	Yes☐ No ☐	……	
-	Karaoke shop	Yes☐ No ☐	……	
-	Generate electricity	Yes☐ No ☐	……	
-	Resin trader	Yes☐ No ☐	……	
-	Blacksmith	Yes☐ No ☐	……	
-	Carpenter	Yes☐ No ☐	……	

-	Wood cutting and sawing service	Yes☐ No ☐	……
-	Electrician (Electric service)	Yes☐ No ☐	……
-	Mechanical service	Yes☐ No ☐	……
-	Other……..…… [insert type]	Yes☐ No ☐	……
	Other……..…… [insert type]	Yes☐ No ☐	……
8	Public sector, private or NGO work:	Yes☐ No ☐	……
-	Village chief	Yes☐ No ☐	……
-	Commune officer	Yes☐ No ☐	……
	District officer	Yes☐ No ☐	……
-	NGO: which NGO……	Yes☐ No ☐	……
-	Teacher	Yes☐ No ☐	……
-	Policeman	Yes☐ No ☐	……
-	Soldier	Yes☐ No ☐	……
-	Other……	Yes☐ No ☐	……
-	Other……	Yes☐ No ☐	……

9	Does anyone in your family sell labour?(Last year)		Yes☐ No ☐
-	Where?…… To whom? ……	What?	How many months/year……... How many days/month…….
-	Where?…… To whom? ……	What?	How many months/year……... How many days/month…….
-	Where?…… To whom? ……	What?	How many months/year……... How many days/month…….
-	Where?…… To whom? ……	What?	How many months/year……... How many days/month…….
10	Did you borrow money last year?		Yes☐ No ☐

Notes and comments about demographics and/or livelihood sections:
……...
……

3. Basic necessity

Here, we will ask you about the basic necessity. ***Basic necessities are the minimum requirement for living that all households of the community should have and no-one should not have.*** We would like to get your perception or opinion of what you think is basic necessity or not currently in your village. It is not what you want or what you need. Now, I will inform you one by one with the following items:

*Note: 1. Ask about the whole village, not only the HH
2. Minimum requirement, not need/want - – not "if had money"

3. Give a definition of BNS, **give 3 examples at least**: BN (water, shoes, cook pot); not BN (washing machine, computer) and "in between" (car, gold, full day market in village)
4. Ask why to make sure
5. Ask about **NOW**

No	Type of basic necessity: (in the village)	Is it necessity? (y/n)*	Do you have it? (y/n)	How many ? (#)
1	Having at least one week holiday per year for all family members for tourist to visit other provinces or tourist site (Siem Reap) (do not include visiting relative or social obligation)			
2	Having three meals per day regularly: Breakfast, Lunch and Dinner			
3	Having gas-cook stove (with two stoves using with large gas containers – 14.7Kg)			
4	Having mosquito net for all family members			
5	Having for health insurance for all family members			
6	Having car battery (for lighting and/or watching television: 40A)			
7	Having at least two big cattle (buffalos or cows) for farming or pulling cart			
8	Having at least one water jar for keep water for consumption (300L - 500 L Jar)			
9	Having a big fan using electricity			
10	Having access to electricity (from public or generator service own generator)			
11	Having thick blanket for every members of family			
12	Having at least one long knife			
13	Having motor-trailer (Kor Yun)			
14	Having a fridge (not cooler box)			
15	Having at least one axe			
16	Having own hand pump well at home			
17	Having home-toilet connect with sewer or septic tank			
18	Having one wooden wardrobe			
19	Having access to a car-taxi service from village to provincial town when needed?			
20	Having one motorbike			
21	Having capacity or ability to pay for health services without selling assets: Land, Cattle or Motorbike (not consider for chronicle illness)			
22	Having roof with Zn or tin roof house			
23	Having wooden wall house			
24	Having a television			
25	Having a set of solar panels (400-500USD)			
26	Having VCR or Cassette Recorder/Player (or VCD and DVD Player)			
27	Having a mobile phone			
28	Having homestead land at least 20m x 40 m or 800m² (Residential land-land for settlement with home garden around)			
29	Having rice land for cultivation at least 1ha?			

30	Having a concrete house			
31	Having ability to participate in wedding parties at least 10 parties per year			
32	Having access to water supply system (arriving at home)			
33	Having capacity or ability to send children to at least lower secondary school			
34	Having capacity or ability to celebrate a traditional ceremony per year			
35	Having access to cattle vaccination regularly			
36	Having an electric rice cooker			
37	Having capacity to buy two sets of clothes for every members of the family per year (Not second hand clothes)**			

Notes and comments about BNS:

……..……

……

……

4. Well-being questions

We finish talking about basic necessity. Now, we would like you to share your opinions on some of the topics that important to you, whether you agree or disagree on these topics. We will give you as a statement and ask your personal opinion on it.

*Notes: 1. Give definition.
2. Explain and give **at least 2 examples**
3. Always introduce the sub section - make smooth transitions!
4. **NO more examples** during the process.
5. Write down "why" by using keywords – save time
6. Neutral = undecided. If **don't know** – DO NOT enter response (just write in comment)

**: Optional questions:
Sections 2a and 2b –last questions about chabbah *if* do not ask if don't have chabbah
Section 3 – Ask last question *if* CPA/CF only
Section 5 –according to interventions in village

Gender of respondent in this part: man ☐ woman ☐

1	Participation in decision-making about resource management					
-	I think you have the rights to be involved in decision-making about land use management in your village					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....
-	I think you have the right to be involved in decision-making about forest management in your village					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....

2a	Security of access to resources (current)					
-	I think you currently have enough access to land for your household needs					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....

-	I think you currently have enough access to NTFPs for your household needs					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....
-	I think you currently have enough access to chabbah trees for your household needs					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....

2b	Security of access to resources (future)					
-	After next 3 years, I think you will have enough access to land for your household needs					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....
-	After next 3 years, I think you will have enough access to NTFPs for your household needs					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....
-	After next 3 years, I think you will have enough access to chabbah trees for your household needs					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....
3	Trust in authorities					
-	I think you can trust the commune council to implement laws and policies in your village					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....
-	I think you can trust the police to provide security in your village					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....
**	I think you can trust the CPA/CF's management committee to protect the forest around your village (only when relevant)					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....

4	Fairness of access to resources					
-	I think that everybody in the village is able to obtain land "fairly"					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....
-	I think that everybody in the village is able to obtain NTFPs "fairly"					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....
-	I think that everybody in the village is able to obtain chabbah trees "fairly"					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....

5	Fairness of distribution of the impacts of interventions					
**	I think that the way villagers are impacted both positively and negatively from the Protected Area is unfair					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....
**	I think that the way villagers are impacted both positively and negatively from Ibis Rice is unfair					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....

**	I think that the way villagers are impacted both positively and negatively from Ecotourism is unfair					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....
**	I think that the way villagers are impacted both positively and negatively from the Economic Land Concession is unfair					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....

6	Access to justice/ conflict resolution mechanism					
-	I think that the conflict resolution in your village is fair and acceptable if there is conflict					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....

7	Ability to implement personal goals					
-	I think you have the ability to carry out the decisions I make in your life					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Why?..... .....

5. Other remarks on the process of interview

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Appendix B – Supplementary materials for Chapter 4

Table B1: Characteristics of the 50 ELCs located in the study area. Data sources for spatially explicit data from LICADHO (2015); data about ELC characteristics from ODC (2016).

Source (GIS data, ELC data)	ODC Data classification	Concessionaire name	Size (ha)	Province(s)	Investment intension	Purpose	Investor country	Contract date	Sub-decree date	Issue ministry	Protected Area name(s)
LICADHO, ODC	Government data complete	Am Phal Focus (Cambodia)	8000	Preah Vihear	Rubber plantation	Agro-industry	Not found	Not found	40963	Not found	Not found
LICADHO, ODC	Government data complete	Kol Veasna Investment Co., Ltd. (previously An Mady Group)	9863	Kampong Thom	Agro-industrial crops and animal husbandry	Agro-industry	Cambodia	09/05/2005	Not found	MEF	Not found
LICADHO, ODC	Government data complete	An Mady Group Co., Ltd.	9993	Preah Vihear, Kampong Thom	Rubber and other plantations	Agro-industry	Cambodia	Not found	40038	Not found	Boeng Per Wildlife Sanctuary
LICADHO, ODC	Government data complete	An Sophy Farming (Cambodia) Co., Ltd.	967	Kampong Thom	Agro-industrial crops and animal husbandry	Agro-industry	Cambodia	09/07/2009	Not found	Not found	Not found
LICADHO, ODC	Government data complete	BNA (Cam) Corp	7500	Kampong Thom	Rubber and cassava plantation	Agro-industry	Korea	25/09/2009	Not found	MAFF	Not found
LICADHO, ODC	Government data complete	Best Royal (K) Co., Ltd.	6500	Oddar Meanchey, Preah Vihear	Agro-industrial crops and rubber plantation	Agro-industry	Not found	Not found	40870	Not found	Kulen Promtep Wildlife Sanctuary
LICADHO, ODC	Government data complete	Bean Heach Investment Co., Ltd.	4385	Kampong Thom	Agro-industrial crops	Agro-industry	Vietnam	Not found	40207	Not found	Boeng Per Wildlife Sanctuary
LICADHO, ODC	Government data complete	Bean Heach Investment Co., Ltd.	5095	Kampong Thom, Preah Vihear, Siem Reap	Not found	Agro-industry	Vietnam	Not found	40623	Not found	Boeng Per Wildlife Sanctuary
LICADHO, ODC	Government data complete	Cambodia Dawn Plantation Ltd.	9237	Preah Vihear	Agro-industrial crops	Agro-industry	Singapore	Not found	40890	Not found	Kulen Promtep Wildlife Sanctuary
LICADHO, ODC	Government data partial	Cambodia Blue Haven Ltd.	9129	Preah Vihear	Rubber and Other crops	Agro-industry	Not found	Not found	41067	Not found	Kulen Promtep Wildlife Sanctuary

Source (GIS data, ELC data)	ODC Data classification	Concessionaire name	Size (ha)	Province(s)	Investment intension	Purpose	Investor country	Contract date	Sub-decree date	Issue ministry	Protected Area name(s)
LICADHO, ODC	Government data complete	Caoutchouc Mekong	7541	Kampong Thom	Rubber plantation	Agro-industry	Not found	Not found	40304	Not found	Boeng Per Wildlife Sanctuary
LICADHO, ODC	Government data complete	C C V Co., Ltd.	5730	Kampong Thom	Acacia plantation	Agro-industry	Cambodia	05/05/2010	Not found	MAFF	Not found
LICADHO, ODC	Government data complete	Chhun Hong Rubber Better	8202	Kratie	Rubber plantation	Agro-industry	Cambodia	29/01/2010	Not found	MAFF	Not found
LICADHO, ODC	Government data complete	China Great Cause (Cambodia) Investment	5980	Preah Vihear	Rubber plantation	Agro-industry	Not found	06/06/2012	40963	MEF	Not found
LICADHO, ODC	Government data complete	C R C K Rubber Development Co., Ltd.	6155	Kampong Thom	Rubber plantation	Agro-industry	Vietnam	05/05/2010	Not found	MAFF	Not found
LICADHO, ODC	Government data complete	C R C K Rubber Development Co., Ltd. II	7289	Kampong Thom	Rubber plantation	Agro-industry	Vietnam	Not found	40186	Not found	Boeng Per Wildlife Sanctuary
LICADHO, ODC	Government data complete	C R C K Rubber Development Co., Ltd. II	2183	Kampong Thom, Siem Reap	Rubber plantation	Agro-industry	Vietnam	Not found	40623	Not found	Boeng Per Wildlife Sanctuary
LICADHO, ODC	Government data complete	C X P B Development	8202	Kratie	Rubber plantation	Agro-industry	Cambodia	29/01/2010	Not found	MAFF	Not found
LICADHO, ODC	Government data complete	Distinct Harvest (Cambodia) Co., Ltd.	7960	Preah Vihear	Rubber plantation and agro-industry	Agro-industry	Malaysia	Not found	41124	Not found	Not found
LICADHO, ODC	Government data complete	Eminent Elite (Cambodia) Co., Ltd.	5973	Preah Vihear	Rubber plantation and other agro-industrial crops	Agro-industry	Malaysia	Not found	41124	Not found	Not found
LICADHO, ODC	Government data complete	F P Malaysia (Cambodia) Plantation Co., Ltd.	8200	Preah Vihear	Rubber plantation and other agro-industrial crops	Agro-industry	Not found	Not found	40934	MEF	Not found
LICADHO, ODC	Government data complete	(Cambodia) Farming Investment Co., Ltd.	901.22	Kampong Thom	Agro-industrial crops	Agro-industry	Cambodia	09/07/2009	Not found	MAFF	Not found
LICADHO, ODC	Other data	Gold Foison	5534	Kampong Thom	Not found	Not found	Not found	13/11/2007	Not found	Not found	Not found
LICADHO, ODC	Government data complete	Golden Farming Investment Co., Ltd.	925	Kampong Thom	Agro-industrial crops	Agro-industry	Cambodia	09/07/2009	Not found	Not found	Not found

Source (GIS data, ELC data)	ODC Data classification	Concessionaire name	Size (ha)	Province(s)	Investment intension	Purpose	Investor country	Contract date	Sub-decree date	Issue ministry	Protected Area name(s)
LICADHO, ODC	Government data complete	Green Choice (Cambodia) Co., Ltd.	6424	Preah Vihear	Rubber plantation and other agro-industrial crops	Agro-industry	Malaysia	Not found	41124	Not found	Not found
LICADHO, ODC	Government data complete	Heng Nong (Cambodia) International Company Limited	6488	Preah Vihear	Rubber, acacia and sugar cane plantation	Agro-industry	China	Not found	40730	MEF	Not found
LICADHO, ODC	Government data complete	Heng Ruy (Cambodia) International Company Limited	7607	Preah Vihear	Rubber, acacia and sugar cane plantation	Agro-industry	China	Not found	40730	MEF	Not found
LICADHO, ODC	Government data complete	Heng You (Cambodia) International Company Limited	8860	Preah Vihear	Rubber, acacia and sugar cane plantation	Agro-industry	China	Not found	40730	MEF	Not found
LICADHO, ODC	Government data complete	H.M.H Co., Ltd.	5914	Kampong Thom	Acacia and other plantation	Agro-industry	Cambodia	17/03/2006	41047	MAFF	Not found
LICADHO, ODC	Government data complete	Kim Chea Toun Group	8846	Preah Vihear	Rubber and acacia plantation	Agro-industry	Not found	Not found	40730	Not found	Not found
LICADHO, ODC	Government data complete	Lan Feng (Cambodia) International Company Limited	9015	Preah Vihear	Rubber, acacia and Sugar cane plantation	Agro-industry	China	Not found	40730	MEF	Not found
LICADHO	N/A	Lun Agritech Invesment company Ltd.	400	Oddor Meanchey , Preah Vihear					2012		
LICADHO, ODC	Government data complete	Ly Chhung Construction and Import Export	6000	Siem Reap, Preah Vihear	Agro-industrial crops and rubber plantation	Agro-industry	Not found	Not found	41022	Not found	Kulen Promtep Wildlife Sanctuary
LICADHO, ODC	Government data complete	Phoeuk Va Kampong Thom Rubber Development (previously Mean Rithy Co. Ltd.)	9784	Kampong Thom	Agro-industrial crops	Agro-industry	Cambodia	Not found	Not found	MAFF	Not found
LICADHO	N/A	Metri Peap Kase-Ousahakam Co.,Ltd	8441	Preah Vihear				2013			
LICADHO	N/A	N & Y Co.Ltd., Limited	9485	preah Vihear				2013			
LICADHO	N/A	Phureang	5534	Kampong Thom				2013			
LICADHO, ODC	Government data complete	P N T Co., Ltd.	7900	Preah Vihear	Rubber plantation	Agro-industry	Vietnam	05/05/2010	Not found	MAFF	Not found

Source (GIS data, ELC data)	ODC Data classification	Concessionaire name	Size (ha)	Province(s)	Investment intension	Purpose	Investor country	Contract date	Sub-decree date	Issue ministry	Protected Area name(s)
LICADHO, ODC	Government data complete	Rethy Granite (Cambodia) Co., Ltd.	2036	Preah Vihear	Not found	Agro-industry	Not found	Not found	40623	Not found	Boeng Per Wildlife Sanctuary
LICADHO, ODC	Government data complete	Ruy Feng (Cambodia) International Company Limited	8841	Preah Vihear	Rubber, acacia and Sugar cane plantation	Agro-industry	China	Not found	40730	MEF	Not found
LICADHO	N/A	Se Hong Plantation Companny Limited	4337	Oddor Meanchey, Preah Vihear				2012			
LICADHO	N/A	Serymony Transpotation & Construction	2030	Preah Vihear				2011			
LICADHO, ODC	Government data complete	Siv Guek Investment Co., Ltd.	601	Kampong Thom	Agro-industrial crops and animal husbandry	Agro-industry	Cambodia	09/07/2009	Not found	MAFF	Not found
LICADHO, ODC	Government data complete	Sovannaphum Viniyok Kase-Usahakam	9913	Preah Vihear	Rubber plantation	Agro-industry	Not found	Not found	40742	Not found	Boeng Per Wildlife Sanctuary
LICADHO, ODC	Government data complete	Ta Bien Kampong Thom Rubber Development	8100	Kampong Thom	Rubber plantation and constructing processing factory	Agro-industry and processing factory	Vietnam	18/07/2007	Not found	MAFF	Not found
LICADHO	N/A	Think Biotech	34133	Kratie				2011			
LICADHO, ODC	Government data complete	Thy Nga Development and Investment Co., Ltd.	6060	Preah Vihear	Rubber plantation	Agro-industry	Cambodia	25/09/2009	Not found	MAFF	Not found
LICADHO	N/A	Timas Resources	57363	Kratie				2008			
LICADHO, ODC	Government data complete	Try Pheap Import Export Co., Ltd.	9916	Preah Vihear	Rubber plantation	Agro-industry	Cambodia	Not found	40682	Not found	Boeng Per Wildlife Sanctuary
LICADHO	N/A	Tumring Rubber	6200	Kampong Thom				2011			

B.2. Methodology for historical deforestation analysis by Conservation International dataset

Classification using Landsat products

The deforestation classification of two Landsat scenes was updated to include deciduous forests and temporal resolution was improved. The Landsat scenes classified were 125/051 and 126/051, as defined by the world reference system of paths and rows for Landsat imagery. The methodology used identifies change detection within co-registered multi-temporal images.

The classification goes back 10 years and includes 4 time periods namely circa 2001, c.2005, c.2008, c.2011. The 4 time periods also align with other data sources such as population census (c.2008), forest cover mapping (c.2002, c.2006), CALMS Forest trends (c.2001, c.2005, c.2008 and c.2010) and Eastern Plains forest cover (c.1998, c.2002, c.2008 and c.2010). The change between c.2001 and c.2011 and the change between c.2005 and c.2008 were classified as multi-temporal pairs. The 2 change classifications were then consolidated to obtain a single 4 period deforestation product which captures the long term and latest forest cover changes with a better temporal resolution. A 3x3 majority filter was used to reduce small variations and a final classified product with a minimum mapping unit of 1 hectare was created.

Accuracy Assessment using ancillary data, Google Earth and ground truth data from biomass survey

Generally, the accuracy of the last classified image is tested against the latest available high resolution imagery. However, given the lack of high resolution imagery for 2011, a spatio-temporal accuracy of the classified product was assessed using available forest cover mapping from the FA for c.2002, c2006, c.2010. It should be noted that the minimum mapping unit for the FA's forest cover mapping is 20 ha and has been updated for the various years using heads-up digitisation as opposed to a classified product which detects a lot more change.

The classification within the four provinces of Kampong Thom, Kratie, Stung Treng and Preah Vihear were assessed. A 5km grid was used over this area and a random sample point was generated for each grid cell. The points were checked to see whether the FA's 2010 forest cover matched with the 2011 classification. Where the 2010 forest cover data did not cover the 2005 classification, the points were validated against the RGC Forestry Administration's 2006 forest cover data. Areas classed as non-forest in FA'S 2002 data were considered to be non-forest in the later years and the areas classed as deforestation between c2005 and c2008 were also validated against what FA had classed as being deforested between c2002 and c2006. Further to this, the UN FAO land use classification provided additional information to assess the water class against areas of water or flooded vegetation, and also to verify shrubby areas which were classed as "Other forest" in FA's forest cover data. The overall accuracy of pixel following this accuracy test is 81% of pixels classified correctly.

The accuracy was also tested against the plot survey data (50%) that was available at the time of writing. The validation only included the Project Area and a 10km buffer. All ground truth points that were considered semi-evergreen are classed as evergreen, and biomass surveys considered plots that had forest in the centre-plot of each cluster but may include non-forest in other plots for a cluster. The overall accuracy of pixel following this accuracy test is 82% of pixels are correctly classified.

Consolidation of historical deforestation datasets

The study area, initially chosen as a reference region, included the 4 provinces of Kampong Thom, Kratie, Stung Treng and Preah Vihear. The classified Landsat imagery does not cover this entire reference region; however, the data gaps were filled using data from other studies in the region. These studies include data from the Forest cover trends in the Northern Plains of Cambodia 2002-2010 (WCS 2010) and the Eastern Plains REDD pilot study (WCS2011). The historic deforestation classification based on consolidation of the various data sources was used to calculate the baseline deforestation values. The calculations were performed for 1) A reference region which includes only the 4 provinces initially chosen for the analysis and 2) A reference region which also includes north-western Kampong Champ where data was available. The consolidated product map and tables with deforestation rates for evergreen and deciduous forests are shown below.

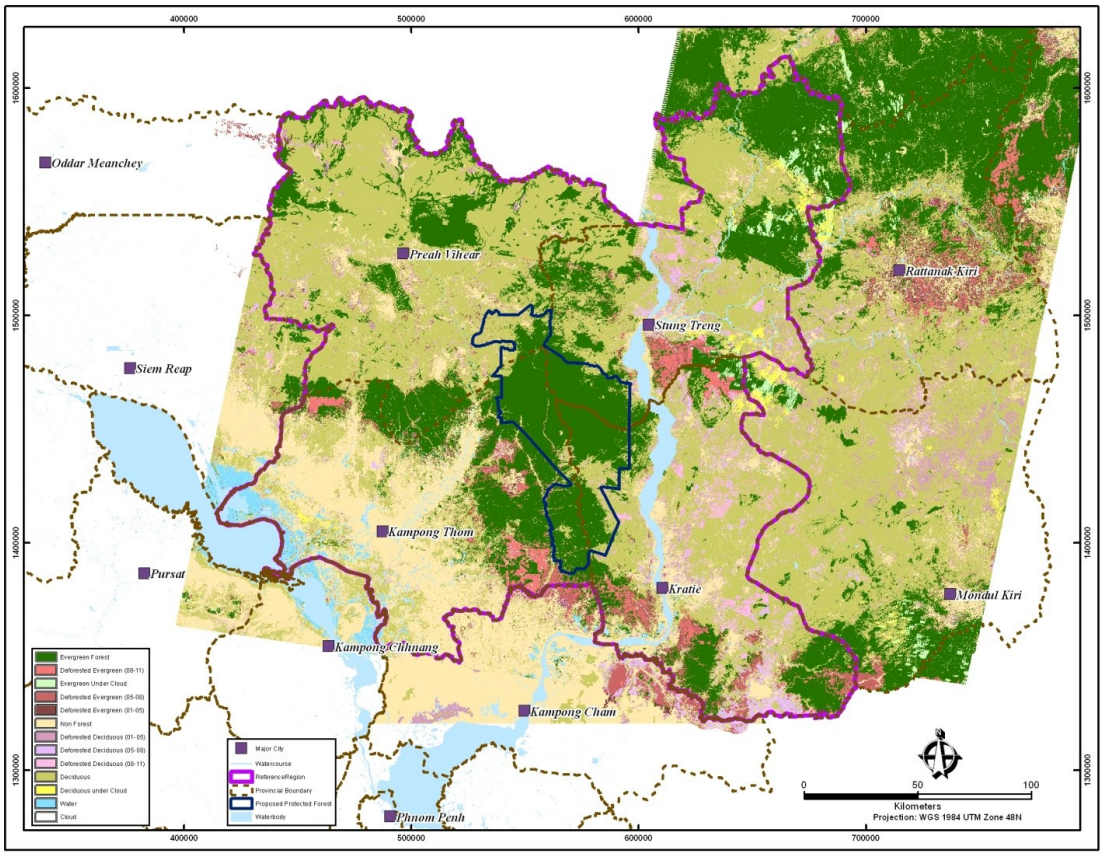

Figure B.4. Map of the original historical deforestation raster layer verified by Conservation International.

Aggregation of classification in current analysis

Classifications of CI's final deforestation dataset were re-classified for the purpose of this analysis as shown below.

Table B.4. Reclassification of CI symbology for the current analysis

CI symbology	**Beauchamp et al. symbology**
Cloud over Deciduous	Forest
Cloud over Evergreen	Forest
Clouds	No data
Deciduous cleared (01-05)	Non-forest
Deciduous cleared (05-08)	Forest
Deciduous cleared (08-11)	Forest
Deciduous Forest	Forest
Evergreen cleared (01-05)	Non-forest
Evergreen cleared (05-08)	Forest
Evergreen cleared (08-11)	Forest
Evergreen Forest	Forest
Non Forest	Non-forest
Water	Non-forest

Table B.3. Model selection and validation: Generalized linear mixed effect model of ELC placement in 2013

Set of models selected based on AICc for ELC placement using 'dredge' function in MuMIn v.1.14.0 (Barton, 2015). A full model with *a priori* variables was first fitted as a generalised linear mixed model with a binomial error structure and administrative units as random effect using 'glmer' function in lme4 v1.7-7 (Bolker, 2015). Final model coefficients presented in Table 4.6. The number of parameters in the model (k), the log-likelihood (log(L)), the information criterion value (AICc), the AICc difference (ΔAICc) and AICc weight are given for each model. Selected model scored 95% confidence interval and AICc<4.

(Intercept)	PA status	Carbon values	% non-forest	Soil fertility	Elevation	Slope	Population density	Distance to village	Distance to river	Distance to road	Carbon values + % non-forest	df	logLik	AICc	ΔAICc	weight
-3.15	+	+	-1.99	+	-1.17		-1.08				+	13	-736	1497.6	0.00	0.10
-3.05		+	-2.06	+	-1.22		-1.10				+	12	-737	1497.8	0.20	0.09
-3.06	+	+	-2.11	+	-1.104		-1.06	-0.17			+	14	-735	1498.4	0.76	0.07
-3.03		+	-2.13	+	-1.153		-1.06	-0.16			+	13	-736	1498.7	1.04	0.06
-3.10	+	+	-2.00	+	-1.095	-0.05	-1.08				+	14	-735	1499	1.38	0.05
-3.07	+	+	-2.05	+	-1.113		-1.07		-0.10		+	14	-736	1499.1	1.53	0.05
-3.03		+	-2.04	+	-1.137	-0.05	-1.11				+	13	-737	1499.2	1.63	0.04
-3.12	+	+	-2.00	+	-1.15		-1.09			-0.06	+	14	-736	1499.3	1.64	0.04
-3.02		+	-2.07	+	-1.212		-1.10			-0.06	+	13	-737	1499.4	1.83	0.04
NA	1.00	1.00	1.00	1.00	1.00	NA	1.00	NA	NA	NA	NA					

B.4. Model selection and validation: Zero-altered negative binomial model of deforestation between 2008 and 2013

Set of models selected based on AICc for deforestation between 2008 and 2013. Model selection for the two-step deforestation model was done at both stages, with models being fitted first with all *a priori* variables. The models were reduced to a more parsimonious model by dropping non-significant variables one by one, using changes in AICc to determine the final model. Final model coefficients presented in Tables 4.8a and 4.8b.

Step 1: Hurdle model selection

Model	D.f.	AICc
Full model - distance to river - soil fertility	16	10926
Full model - soil fertility	17	10926
Full model - distance to river	18	10928
Full model	19	10929

Step 2: Zero-truncated count model selection

Model	D.f.	AICc
Full model - soil fertility - slope	16	2342
Full model - soil fertility	17	2342
Full model - slope	18	2343
Full model	19	2343
Full model - distance to river	18	2346
Full model - soil fertility - slope - distance to river	15	2347

Appendix C – Supplementary materials for Chapter 5

Table C.1: Changes in Basic Necessity (BN) weightings between 2008 and 2014. Blue cell = decrease; pink cells = increase.

Items	2008 Is it BN?	2008 Have it?	2014 Is it BN?	2014 Have it?
>90% think are BN and >80% of people have				
Have 3 meals per day	100.00%	86.60%	95.10%	86.90%
Have at least one long knife	96.90%	86.90%	99.40%	93.50%
Have at least one big axe	98.20%	84.20%	99.70%	95.80%
Able to pay for health care without selling any property (chronical disease is not included)	99.90%	94.50%	95.00%	34.40%
>90% think are BN and between 50-80% of people have				
Have mosquito nets for all household members	99.40%	59.90%	99.30%	87.30%
Have at least one big water jar (300-500litres)	99.40%	60.70%	98.20%	75.30%
Have a wooden-wall house	99.70%	57.70%	96.40%	75.50%
Have a big homestead land (20mx40m=800m2)	99.90%	68.80%	99.00%	75.00%
Have at least 1ha rice cultivated land	99.90%	70.00%	96.50%	87.70%
>90% think are BN and between 30-50% of people have				
Have at least 2 big traction animals	97.70%	34.90%	79.30%	17.90%
Have thick blankets for all household members	99.90%	42.60%	81.70%	38.80%
Have a zinc house roof	93.20%	41.70%	96.50%	76.30%
Able to buy at least 2 sets of new cloth for each of all household members per year	97.90%	31.80%	96.20%	68.00%
>90% think are BN and between 0-30% of people have				
Have one hand pump well at home	91.20%	2.00%	73.70%	4.90%
Have access to taxi service from village to provincial town	90.60%	6.10%	61.30%	23.50%
Able to send children to school at least at grade 7	97.40%	15.60%	96.50%	28.10%
Having access to vaccination service for cattle regularly	95.80%	20.20%	78.10%	10.80%
Between 80-90% think are BN and between 0-30% of people have				
Have a battery (for lighting or TV)	80.60%	18.30%	95.00%	82.70%
Have a mini-tractor	89.20%	28.70%	98.20%	67.70%
Have one motobike	89.90%	28.00%	95.80%	53.40%
Able to participate in at least 10 weddings per year	82.50%	9.20%	78.70%	45.90%
Between 50-80% think are BN and between 0-10% of people have				
Have one toilet at home	75.90%	0.70%	67.00%	2.30%
Have one wooden wardrobe	69.00%	0.60%	10.10%	0.80%
Not Basic Necessities				
Between 30-50% think are BN				
Able to access electricity for using in the village	45.80%	3.90%	37.90%	1.30%
Have a TV	37.20%	10.00%	19.20%	6.40%
Have a VCD player	31.50%	9.10%	25.20%	32.70%
Have a mobile phone	31.90%	12.40%	92.80%	74.50%
Having access to clean water supply service	40.30%	0.50%	29.20%	0.50%
Able to initiate at least one ceremony per year	30.10%	2.60%	40.00%	7.80%
Between 0-10% think are BN				
Able to holiday for at least one week per year for tourism outside the	5.10%	0.80%	1.20%	0.50%
Have a gas cookstove (gas: 147kg)	5.20%	0.10%	1.00%	0.90%
Have health insurance for all household members	0.20%	0.00%	12.10%	0.90%
Having a concrete wall house	3.70%	0.10%	1.00%	0.50%
Have an electric rice cooker	2.30%	0.00%	0.50%	0.40%
Have a fridge	1.60%	0.00%	1.00%	0.40%
Added items				
Have a big fan using electricity (2011 & 2014			1.90%	0.60%
Have solar panels at home (2014)			26.40%	5.80%
BNS maximum score	21.44		20.7	

Table C.2. Household characteristics and livelihood strategies for the average, top and bottom quintiles of the panel of 596 households between 2008 and 2014.

	All			Bottom Quintile			Top Quintile		
	2008	**2011**	**2014**	**2008**	**2011**	**2014**	**2008**	**2011**	**2014**
Households	596	596	596	120	120	120	118	118	118
Household Size	5.9	6.0	5.9	5.4	5.7	5.0	6.3	6.4	6.4
♯ Working Adults	3.1	3.3	3.2	3.0	3.1	2.5	3.2	3.4	3.5
Household head education (yrs)	3.0	3.0	3.6	1.7	1.8	2.2	4.0	4.0	4.5
Household head age (yrs)	41.0	43.2	45.2	41.4	43.5	44.4	40.9	43.4	45.4
Female-headed households (%)	6.7	6.0	10	16.7	13.3	25.0	1.7	2.5	4.2
Well-being Variables									
Poverty	9.0	11.9	12.5	6.7	9.2	7.3	11.1	14.3	16.8
Rice Harvest (kg)	1708	2495	3170	1018	1482	1443	2236	3172	4866
Food Security (kg)	-347	1305	1464	-777	409	656	-61	1902	2352
Livelihood strategies									
Resin tapper (%)	50	56	47	39	45	33	51	53	49
Rice Farmer (%)	92	97	100	86	93	100	94	96	100
Have >1 hectare of paddyfields (%)	70	83	84	47	74	58	83	91	97
Rice Shifting Cultivation (%)	39	30	17	51	43	18	23	16	15
Cash crop (%)	8	5	16	5	2	8	11	8	22
Employed (%)	5	7	12	0	2	3	9	15	27
Service (%)	14	9	7	5	4	1	25	18	10
Shop (%)	2	26	40	2	12	18	3	45	61
Sell labour (%)	2	36	49	8	48	68	1	25	37
Household Assets									
♯ Cattle (heads)	4.5	3.8	2.3	2.4	1.9	0.8	7.8	6.7	4.7
Mini-tractor (%)	29	54	72	16	26	29	38	78	94
PES participation (08-11 / 11-14)									
Ecotourism participant (%)		11	10		5	6		28	24
Ibis Rice participant (%)		9	18		3	7		11	36
Bird Nest participant (%)		3	5		0	7		41	4

Table C.3: Comparison of household characteristics and livelihood strategies between participants and non-participants in the three PES programmes within the core PES villages (4 villages, 173 HHs) for 2008-11, and 2011-14.

	Ecotourism				Ibis Rice				Bird Nest			
	2008-11		2011-14		2008-11		2011-14		2008-11		2011-14	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Households	121	52	90	83	109	64	114	59	155	18	159	14
Household Size	5.9	6.2	5.9	5.9	6.0	6.1	5.9	6.0	6.0	6.2	6.0	5.0
♯ Working Adults	3.2	4.0	3.3	3.3	3.1	4.0	3.3	3.5	3.4	3.7	3.3	3.1
Household head education (yrs)	3.6	4.2	3.9	4.8	3.3	4.7	3.9	5.2	3.7	4.4	4.3	4.9
Household head age (yrs)	43.1	45.8	47.3	46.4	43.5	44.6	47.0	46.6	43.9	43.9	46.7	48.6
Female-headed households (%)	6.6	1.9	10.0	7.2	5.5	4.7	9.6	6.8	5.2	5.6	9.4	0.0
Well-being Variables												
Poverty	12.2	14.4	13.5	14.5	12.3	13.9	13.9	14.2	12.8	13.5	14.0	13.9
Rice Harvest (kg)	1276	2466	1705	2250	1625	1648	1817	2256	1566	2213	1945	2208
Food Security (kg)	2461	3753	3743	4991	2798	2937	4049	4907	2787	3384	4330	4472
Livelihood strategies												
Resin tapper (%)	68	62	66	43	68	63	61	42	66	61	53	71
Rice Farmer (%)	95	100	100	100	96	97	100	100	96	100	100	100
Have >1 ha of rice field (%)	94	96	91	95	95	94	92	95	94	100	93	93
Rice Shifting Cultivation (%)	8	2	8	4	6	6	5	7	7	0	6	0
Cash crop (%)	3	8	17	11	6	2	18	7	5	6	14	7
Employed (%)	7	17	12	27	7	16	13	31	10	11	18	29
Service (%)	5	15	7	10	6	13	6	12	8	11	8	14
Shop (%)	14	40	34	51	17	31	41	44	21	28	43	36
Sell labour (%)	31	25	38	43	22	41	41	39	30	22	39	57
Household Assets												
♯ Cattle (heads)	3.7	7.6	2.7	3.6	4.0	6.4	2.7	4.0	4.9	5.2	3.2	2.6
Mini-tractor (%)	61	85	76	90	64	75	77	93	68	72	82	86

Appendix D – Supplementary materials for Chapter 6

Table D.1. Parameter estimates from the selected well-being components' linear mixed models, with components being ranked in top three components in an interview as a binary response variable to predictor variables. Significance values: 'ns' = non-significant; '.' = P <0.1; '*' = P <0.05; '' = P <0.01; '***' = P <0.001. Significant correlations at P<0.05 and below are in bold, R-squared values included.**

Predictors	**Agricultural land**			**Food**			**Water**			**Education services**			**Health services**		
	Coef	S.E	p	Coef	S.E	p	Coef	S.E	p	Coef	S.E	p	Coef	S.E	p
Intercept*	0.16	0.67		**-1.48**	**0.75**	*	**-1.76**	**0.88**	*	**-1.36**	**0.82**	.	**-1.85**	**0.80**	*
Women	0.18	0.60		0.72	0.64		-0.12	0.79		0.47	0.76		0.86	0.72	
Younger	**-1.44**	**0.64**	*	0.21	0.64		-0.34	0.79		0.34	0.77		0.04	0.70	
Richer	-0.21	0.59		-0.35	0.62		0.88	0.78		0.07	0.74		1.64	0.72	.
Prey Veng	**1.75**	**0.77**	*	-0.15	0.78		-0.58	0.95		-1.94	1.15	.	-0.83	0.78	
Srae	0.38	0.70		1.00	0.73		0.02	0.87		-0.72	0.82		-1.19	0.85	
R^2	0.20			0.12			0.08			0.18			0.23		
Predictors	**Natural resources**			**Income**			**Family & love**			**House**			**Agricultural material**		
	Coef	S.E	p	Coef	S.E	p	Coef	S.E	p	Coef	S.E	p	Coef	S.E	p
Intercept*	-1.68	0.89	.	-1.09	0.80		**-3.95**	**1.59**	*	-1.51	0.80	.	-1.21	0.89	
Women	-1.13	0.80		-0.41	0.69		-1.54	1.09		-0.67	0.69		-0.94	0.83	
Younger	0.02	0.77		-0.76	0.69		**2.83**	**1.36**	*	0.67	0.70		0.99	0.84	
Richer	0.51	0.75		-0.45	0.68		-1.23	1.13		0.02	0.67		-0.74	0.83	
Prey Veng	-0.16	1.00		0.38	0.91		-0.16	1.55		0.61	0.79		-0.08	0.88	
Srae	1.07	0.87		**1.80**	**0.80**	*	**2.45**	**1.36**	*	-0.17	0.86		-1.57	1.22	
R^2	0.17			0.21			0.49			0.07			0.19		

* Intercept - Men; Younger; Poorer; Tmatboey village

Appendix E – Supplementary materials for Chapter 7

Appendix E.1: Village characteristics

Table E.1a: Statistics of villages surveyed; four core PES villages in bold.

Villages	Interviews	PA status	ELC affected	Distance to ELC (km)	Population (HHs)	Time to provincial capital (hrs)	Years of schooling
Bangkan	49	0	1	0	199	7	9
Kunapheap	43	1	1	0	143	4	6
Sambour	53	1	1	0	121	3	6
Slaeng Toul	45	0	1	0	64	3.5	6
Srae	46	0	1	0	102	5.5	6
Kdak	47	0	1	1.02	411	2.5	6
Svai Damnak Chas	42	0	1	1.5	187	2	6
Rumchek	45	0	0	1.57	184	2.5	6
Antil	57	1	1	2.42	215	6	6
Kralas Peas	50	1	1	2.70	295	2	6
Prey Veng	62	1	1	2.92	85	4	3
Reaksmei	57	1	0	3.15	137	2	6
Chomsrae	55	1	0	3.74	216	5	6
Dongplat	110	1	0	5.10	228	1.5	9
Mrech	41	0	1	5.90	125	3	3
Tmatboey	139	1	0	6.46	286	1.5	9
Narong	64	1	0	7.66	150	2	6
Srea Veal	42	0	0	9.24	170	3	6
Phneak Roluek	42	0	0	10.43	131	5	6
Robohn	41	1	0	29.49	83	6	6

Table E.1b. Number of households interviewed per treatment

	No ELC	ELC
Non PA	131	270
PA	466	262

Appendix E.2: Ordinal regression results of current and future land access issues

Log-odds coefficients and their exponentiated format into odds ratios are presented, along with cut-points of the threshold values between adjacent levels of the response variable. An odds ratio equal to 1 indicates a neutral effect of a given variable on the perception of mixed forests. Odds ratios > 1 represent a positive effect of the explanatory variable on the response level, while an odds ratio < 1 represent an inverse relationship between the explanatory variable and the dependent variable levels. Threshold (or cut-point) values between the five categories are given for each regression.

Table E.2a: Ordinal regression with a logit link function of perception of current access to land to predictor variables for the 20 surveyed villages.

Variables	Estimate	Std. Error		Odds ratio	CI (2.5%)	CI (97.5%)
PA presence	-0.30	0.12	*	0.70	0.60	0.90
HH size	-0.63	0.16	***	0.50	0.40	0.70
Economic status	0.96	0.14	***	2.60	2.00	3.50
Land owned	1.13	0.18	***	3.10	2.20	4.40
Sell labour	-0.33	0.12	**	0.70	0.60	0.90
School years in village	-0.90	0.18	***	0.40	0.30	0.60
1|2	-0.14	0.67				
2|3	1.50	0.67				
3|4	1.50	0.67				
4|5	2.93	0.68				

Table E.2b: Ordinal regression with a loglog link function of perception of future security of access to land to predictor variables for the 20 surveyed villages

Variables	Estimate	Std. Error		Odds ratio	CI (2.5%)	CI (97.5%)
ELC presence	-0.22	0.08	**	0.80	0.70	0.90
Household size	-0.55	0.11	***	0.60	0.50	0.70
Female headed household	-0.20	0.12	.	0.80	0.60	1.00
Economic status	0.37	0.08	***	1.40	1.20	1.70
Sell labour	-0.17	0.07	*	0.80	0.70	1.00
School years in village	-0.50	0.13	***	0.60	0.50	0.80
1|2	-2.14	0.47				
2|3	-1.25	0.47				
3|4	-0.90	0.47				
4|5	0.56	0.47				

Table E.2c: Ordinal regression a logit link function of perception of current access to land to predictor variables within four core PES villages.

Variables	Estimate	Std. Error		Odds ratio	CI (2.5%)	CI (97.5%)
Illegal clearings (# years)	0.39	0.12	**	1.5	1.2	1.9
Household size	-0.78	0.28	**	0.5	0.3	0.8
Economic status	1.23	0.29	***	3.4	1.9	6.0
Land owned	0.97	0.34	**	2.6	1.4	5.1
Sell labour	-0.60	0.21	**	0.5	0.4	0.8
School years in village	-1.25	0.25	***	0.3	0.2	0.5
1|2	-0.40	1.17				
2|4	1.28	1.17				
4|5	2.69	1.18				

Table E.2d: Ordinal regression a probit link function of perception of future security of access to land to predictor variables within four core PES villages.

Variables	Estimate	Std. Error		Odds ratio	CI (2.5%)	CI (97.5%)
Household size	-0.64	0.15	***	0.5	0.4	0.7
Economic status	0.67	0.14	***	1.9	1.5	2.6
School years in village	-0.37	0.14	**	0.7	0.5	0.9
1|2	-1.09	0.62				
2|3	-0.20	0.62				
3|4	0.11	0.62				
4|5	1.03	0.62				

Appendix E.3: Ordinal regression results of participation and trust in land management

Log-odds coefficients and their exponentiated format into odds ratios are presented, along with cut-points of the threshold values between adjacent levels of the response variable. An odds ratio equal to 1 indicates a neutral effect of a given variable on the perception of mixed forests. Odds ratios > 1 represent a positive effect of the explanatory variable on the response level, while an odds ratio < 1 represents an inverse relationship between the explanatory variable and the dependent variable levels. Threshold (or cut-point) values between the five categories are given for each regression.

Table E.3a. Ordinal regression with a cauchit link function of perception of participation in land management decisions to predictor variables for the 20 surveyed villages

Variables	Estimate	Std. Error		Odds ratio	CI (2.5%)	CI (97.5%)
Head of household education	0.30	0.08	***	1.40	1.20	1.60
Economic status	0.59	0.12	***	1.80	1.40	2.30
School years in village	-0.62	0.18	***	0.50	0.40	0.80
1|2	-3.94	0.78				
2|3	-0.97	0.57				
3|4	-0.60	0.56				
4|5	1.41	0.57				

Table E.3b: Ordinal regression with a log-log link function of perception of trust in commune council to predictor variables for the 20 surveyed villages

Variables	Estimate	Std. Error		Odds ratio	CI (2.5%)	CI (97.5%)
Cash crop farmer	0.37	0.15	*	1.50	1.10	2.00
School years in village	-0.75	0.17	***	0.50	0.30	0.70
1|2	-4.53	0.49				
2|3	-3.08	0.48				
3|4	-2.66	0.48				
4|5	-0.99	0.47				

Table E.3c: Ordinal regression a cauchit link function of perception of participation in land management decisions to predictor variables within four core PES villages.

Variables	Estimate	Std. Error		Odds ratio	CI (2.5%)	CI (97.5%)
Resin tapper	-0.53	0.20	**	0.6	0.4	0.9
Head of household education	0.39	0.14	**	1.5	1.1	1.9
1|2	-6.33	1.62				
2|3	-1.49	0.37				
3|4	-0.98	0.32				
4|5	0.93	0.30				

Table E.3d: Ordinal regression a logit link function of perception of trust in community protected area (CPA) committees to predictor variables within four core PES villages

Variables	Estimate	Std. Error		Odds ratio	CI (2.5%)	CI (97.5%)
Household size	-0.77	0.26	**	0.5	0.3	0.8
Economic status	-0.85	0.26	***	0.4	0.3	0.7
Land owned	1.44	0.33	***	4.2	2.2	8.1
1|2	-5.16	1.01				
2|3	-3.35	0.98				
3|4	-3.01	0.98				
4|5	-1.34	0.97				

Appendix E.4: Household characteristics and livelihood strategies for households affected by ELCs compared to households not affected. T-tests of difference applied to values for households between treatments.

Household characteristics	Non-ELC	ELC	p
Households	597	532	
Household size	5.7	5.6	ns
Household head education (yrs)	2.4	2.5	ns
Household head age (yrs)	44.6	42.4	ns
Female-headed households (%)	11.6%	9.4%	ns
Household assets			
Poverty	12.9	11.8	*
Rice Harvest (kg)	3502	2547	***
Food Security (kg)	1589	1199	*
Total rice land area (ha)	1.9	1.9	ns
♯ Cattle (heads)	2.3	2.1	ns
Livelihood strategies			
Resin tapper (%)	53%	25%	***
Rice Farmer (%)	100%	100%	ns
Rice Shifting Cultivation (%)	14%	19%	*
Have >1 hectare of paddyfields (%)	85%	80%	*
Cash crop (%)	20%	12%	*
Employed (%)	10%	10%	ns
Employed administrative government (%)	5%	3%	ns
Employed NGO (%)	3%	2%	*
Village service or shop (%)	29%	28%	ns
Sell labour (%)	43%	64%	***
Mini-tractor (%)	73%	61%	***