Examining trajectories of change for prosperous forest landscapes in Cambodia

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Key words

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Abstract

Tropical forest landscapes are undergoing rapid transition. Rural development aspirations are rising, and land use change is contributing to deforestation, degradation, and biodiversity loss, which threaten the future of tropical forests. Conservation initiatives must deal with complex social, political, and ecological decisions involving trade-offs between the extent of protected areas and quality of conservation. In Cambodia, smallholders and industrial economic land concessions drive deforestation and forest degradation. Rural economic benefits have not kept pace with development aspirations and smallholders are gradually expanding agriculture into protected forests. We examine the drivers and effects of rural forest landscape transitions in Cambodia to identify trade-offs between conservation and development. Using historical trends analysis and information gathered through key informant interviews, we describe how local communities perceive social and ecological changes, and examine the implications of local development aspirations for conservation. We explore three scenarios for the future of conservation in Cambodia, each with different conservation and community development outcomes. We contend that conservation efforts should focus on strengthening governance to meet social and environmental requirements for sustainable forest landscapes. We suggest potential entry points for governance improvements, including working with local decision-makers and fostering collaboration between stakeholders. There is a need for realistic priority setting in contested tropical forest landscapes. Prosperous rural economies are a necessary but not sufficient condition for conservation.

Introduction

Negotiate a river by following its bends, enter a country by following its customs.

Khmer Proverb

Tropical forest landscapes are in transition. Demand for the conservation of global public goods, including irreplaceable tropical biodiversity, is competing with pressures for local social and economic development. Seventy-three percent of tropical and sub-tropical deforestation is due to the conversion of forest to agriculture (FAO, 2016). Throughout the tropics, human population and development aspirations continue to grow. Countries are pursuing greater affluence through infrastructure development (Laurance & Arrea, 2017). Rural economies are still highly dependent on agricultural commodities but there is increasing investment in manufacturing and services to stimulate economic growth (Szirmai, 2012). Global efforts to conserve tropical

forests are also intensifying (Barlow et al., 2016; Laurance, 2007; Morales-Hidalgo et al., 2015). Yet conservation efforts are struggling to prevent the loss of irreplaceable biodiversity or severe environmental degradation (Balmford & Cowling, 2006; Ghazoul & Chazdon, 2017).

Cambodia lies within the Indo-Burma biodiversity hotspot (Mittermeier, 2004) and is one of the least developed countries in Southeast Asia. In contrast to neighbouring countries Thailand and Vietnam, Cambodia has not yet passed through a forest transition; the shift from net deforestation to net reforestation (Leblond, 2019; Mather, 1992; Meyfroidt & Lambin, 2008b; Riggs et al., 2018). The Government of Cambodia allocates 41% of the national territory to protection. But these protected areas (PAs) are vulnerable to pressures associated with lack of political and public support, food insecurity, poverty, and low levels of education (Johnson et al., 2014; Mahanty & Milne, 2015). These issues are characteristic of many of the countries within Southeast Asia that struggle to reconcile economic interests with forest protection (Estoque et al., 2019). Yet divergent trends exist; forest cover across the region is entwined with contextual factors and processes that occur at sub-national scales. Frontier forest areas exhibit high rates of deforestation and illegal activity, while other areas traditionally used for agriculture are now a major source of timber production (Curran et al., 2004; Meyfroidt & Lambin, 2008a). The sustainability trajectories of these landscapes often depend on governance – the ways decisions are made and implemented (Adger et al., 2003; Graham et al., 2003). Governance determines the allocation of and access to resources, the availability of goods and services, and the incentives and policies for inclusive sustainable development.

In Cambodia, forest landscapes are on a trajectory towards an unsustainable future. Governance is not ensuring equitable development opportunities from resource conversion (Beauchamp et al., 2018b; Hansen et al., 2013; Riggs et al., 2018). Cambodia's economic transformation following the Khmer Rouge conflict resonates with wider trajectories of change across Southeast Asia (Hughes & Un, 2011). However, rapid economic growth does not capture the full spectrum of political and social dynamics that have shaped Cambodia's forest governance. The manipulation of forest policy reform by political elites and the early failures of externally driven forest management regimes have led to a culture of personal enrichment and patron-client relations (Cock, 2016; Le Billon, 2000; Mahanty & Milne, 2015). In recent history, protected forests have been a source of development benefits for rural forest-dependent Cambodians (Clements et al., 2014b). But agrarian change via the expansion of smallholder cash crop production and industrial economic land concessions is driving forest conversion at a

rapid pace (Davis et al., 2015; Kong et al., 2019). Increasing access to infrastructure, education, and physical assets is enabling more lucrative livelihood strategies (Jiao et al., 2017). Rent seekers act to gain wealth without reciprocal gains to society, contributing to inequality and political imbalance (Milne, 2015; Tullock, 1967). As development needs and aspirations rise, the economic foundations for development will likely require relinquishing much of the PAs to other, more profitable land-uses with more inclusive benefits. Efforts to conserve significant Cambodian biodiversity must reconcile these basic trade-offs.

Navigating conservation and development trade-offs and synergies between humans and natural resources has become one of the defining issues of the Anthropocene (Lewis et al., 2015; Mehrabi et al., 2018; Palomo et al., 2014). Fervent debates over intensified 'land sparing' farming approaches vs. low intensity 'land sharing' systems highlight the dichotomy between biodiversity conservation and human development needs (Kremen, 2015; Phalan et al., 2011). Recently, these debates are converging to a discourse beyond that dichotomy, towards multi-functionality (Fischer et al., 2017). The path to sustainability in tropical forest landscapes is complex and requires comprehensive considerations of multiple knowledge systems, actors, and decision makers (Cornell et al., 2013; Gibson et al., 2000; van Noordwijk, 2017). Too often, efforts to conserve forested landscapes do not take into account the needs and aspirations of people living in those landscapes (Agrawal & Gibson, 2001; Boedhihartono et al., 2018; Brown, 2002). Without local support, conservation is not sustainable. Yet finding locally appropriate development pathways that might simultaneously have a more benign effect on biodiversity is challenging (Terborgh & Peres, 2017).

In this paper, we present a case study of two forest landscapes representing the conservation development nexus in Cambodia. We address the following questions: What are the historic and future trajectories of change in forest landscapes in Cambodia? What strategies might nurture landscape transitions for better social and environmental management decisions at the landscape scale? Within this context, we examine socio-economic, political, and environmental components of landscape change to identify trade-offs between biodiversity protection and local community development. We take an inductive, grounded theory approach using place-based transdisciplinary practices to analyze the contexts of change (Brandt et al., 2013; Corbin & Strauss, 1990; Thomas, 2006). From this, we derive three potential scenarios with contrasting strategies and different outcomes for conservation and development. In both landscapes, efforts to conserve tropical forests compete with local development aspirations and exogenous economic and political forces. Conservation agencies, including non-

131 government and government organizations, attempt to reconcile conservation and development trade-offs, but
132 must deal with rapidly changing and uncertain circumstances. We use key informant interviews, focus group
133 discussions, and quantitative household surveys to examine underlying drivers and effects of rural forest
134 landscape transitions in Cambodia, emphasising how changes are perceived by local communities and their
135 impact on the natural environment. Our research is guided by the ethos of 'embedded science', wherein we
136 acknowledge the complexity and depth of social-ecological challenges in landscapes, and apply
137 transdisciplinary research principles, working with local partners to generate research objectives, and integrating
138 knowledge from multiple disciplines to solve real world problems (Lang et al., 2012; Langston et al., 2019;
139 Scholz, 2000).
140
141 **Understanding and nurturing conservation and development in Cambodia's changing landscapes**
142
143 At the base of the Lower Mekong, The Kingdom of Cambodia is emerging as a rapidly developing state.
144 Described as a frontier of change (Mahanty & Milne, 2015), political dynamics and market processes are
145 shaping economic growth and natural resource exploitation. Development banks and foreign investment are
146 promoting regional economic integration within the Greater Mekong Sub-region, with widespread investment in
147 transport networks and infrastructure (ADB, 2012, 2016). Industrial agriculture, new road development and
148 demand for land among the rural population are driving landscape transitions; the social, economic, and
149 environmental changes apparent at a landscape-scale (Bürgi et al., 2005; Ichikawa et al., 2006; Zhang et al.,
150 2016).
151
152 Emerging from landscape ecology, landscape transitions recognise that human influences, including economics,
153 politics, social structures, technology and value systems, shape the natural environment and the use of natural
154 resources, and vice versa (Bailes, 1985; Kaplan & White, 2002; Russell, 1998). Studies examining landscape
155 transitions draw from a social-ecological systems (SES) perspective, which explicitly acknowledges feedback
156 links between human (communities, society, economy) and natural systems (Berkes et al., 2008; Berkes &
157 Folke, 1998). A SES systems perspective recognizes that understanding what is driving change in landscapes,
158 and how these changes unfold, requires a multi-level systems approach; examining both internal and external
159 processes that shape outcomes at different scales (Turnheim et al., 2015). Applying an SES perspective can lead
160 to critical insights into the governance arrangements that influence the pace and direction of environmental

change, and opportunities to enhance sustainable development pathways (Dewi et al., 2017; Ostrom, 2009; Pokorny & De Jong, 2015).

In the context of Cambodia, landscape transitions provide a useful framework for analysing the temporal interactions between socio-economic, political, cultural, and environmental complexities in rural forest landscapes. In this study, we examine landscape change guided by a SES perspective, focusing on landscape as a form of 'place', drivers of change, and leverage points for nurturing change. By considering landscapes within the concept of place, we acknowledge the political, cultural, economic, and environmental interactions that occur within a space, and how these interactions shape identity, worldviews and actions (Altman & Low, 2012; Cheng et al., 2003; Williams & Stewart, 1998). Place is not a static concept; it is continually influenced by social, political, and biophysical dynamics (Greider & Garkovich, 1994). These interactions can be captured by analyzing drivers of change, including non-linear relationships between political and market forces, local behaviour and decision-making, and subsequent environmental impacts (Lambin & Meyfroidt, 2010; Meyfroidt et al., 2018; Warrener, 2004; Wood & Handley, 2001). With an in-depth understanding of change processes within a landscape, we can draw insights into future aspirations and potential landscape trajectories from a diverse range of sources. Opportunities to influence or 'nudge' change may appear through the identification of leverage points – places to intervene in a system (Meadows, 1999; Thaler & Sunstein, 2009).

Leveraging landscape transitions to improve social and environmental outcomes requires explicit identification of trade-offs (Brown, 2004; Hirsch et al., 2011; McShane et al., 2011). In Cambodia, both conservation and development are stated as priorities in the Government's long-term strategic development plans, yet in reality there are few opportunities for synergies (Beauchamp et al., 2018b). The Government established Economic Land Concessions (ELCs) in 2005 after the demise of the timber concessions in the late 1990s to drive rural development through large scale industrial agriculture. Implementation of ELCs has led to more than 2 million hectares of Cambodia's land being leased to private companies for economic development and this has greatly increased deforestation (Davis et al., 2015). The rapid spread of concessions and scramble for land resulted in social unrest in the form of land disputes, forced evictions and land grabs throughout Cambodia (Neef et al., 2013). Social Land Concessions (SLCs) to provide land to poor and landless Cambodians also require land in forest areas, contributing to further conflict and deforestation (LICADHO, 2015; Rainey et al., 2010). Since 2012, Prime Minister Hun Sen has maintained a moratorium on the allocation of new ELCs. Protected areas,

already vulnerable to politically profitable cancellation, or encroachment, are currently influenced by a complex network of smallholders, industrial agriculture, SLCs, and a growing presence of energy and transport infrastructure.

Protected area management in Cambodia is supported by international and local non-government organizations, drawing on scientific methods for conservation planning and management (Clements et al., 2014b; Gray & Phan, 2011; Ibbett et al., 2017). Yet as Cambodia's rural landscapes become increasingly shared by diverse actors, finding sustainable landscape trajectories that meet the needs of stakeholders, including government agencies, private bodies, local communities and conservation advocates, is inherently challenging. Recent decentralization placed protected area management under the purview of the Provincial Department of Environment (PDOE). Decisions are overseen by the General Directorate of Administration for Nature Conservation and Protection (GDANCP) and must be approved by the Provincial Governor. Conflicting conservation and development initiatives are often negotiated among a range of stakeholders, but negotiation is constrained by politics (Paley, 2015). Patronage networks exert substantial influence over the development of forest land, with little room for community involvement in decision making (Persson & Prowse, 2017). Conservation agencies must navigate provincial and national directives whilst responding to the needs of local people living in and around PAs. In general, the success of conservation depends on public support and societal values that shape conservation policy (Brown et al., 2010; Miller & Hobbs, 2002; Rose, 2015). The risk is that conservation in Cambodia will not likely succeed if it does not contribute to socially inclusive development and build a constituency for sustainable natural resource management. Yet navigating social-economic and political components of an unpredictable and complex environment requires accepting some irreversible costs. This paper provides contextual information to stimulate a practical evaluation of the trade-offs of different conservation and development decisions at multiple levels in Cambodia.

Study sites: The Keo Seima Wildlife Sanctuary and Northern Plains Landscape

We selected two study sites which exemplify conservation and development pressures on Cambodia's protected area network (Figure I). Both landscapes are subject to long-term interventions from conservation agencies, which have influenced management decisions and contributed to a repository of diachronic data on social and biophysical components of the landscape. The Keo Seima Wildlife Sanctuary (KSWS) and surrounding area has undergone transformative agrarian change since conservation activities began in early 2000s, most apparent

since the construction of the major road linking the province to Phnom Penh that began in 2007 (Clements et al., 2014a). In contrast, the Northern Plains has remained relatively isolated from neighbouring provinces and is transitioning at a slower pace than KSWS in the Eastern Plains of Cambodia. The two landscapes are situated in the provinces with the highest population growth, with annual growth rates of 3.5% in Preah Vihear and 3.4% in Mondulkiri (NIIS, 2019). Similar natural resource governance arrangements exist in both landscapes, with a significant exception being the strong presence of indigenous communities in the Eastern Plains. Prior to 2016, PAs in Cambodia were under the management of the Ministry of Environment (MoE) or the Ministry of Agriculture, Forestry, Fisheries (MAFF) (Souter et al., 2016). In 2016, sub-degree 69 transferred PAs under the authority of the MAFF to the MoE. In the two study sites government-led PA management is supported by the Wildlife Conservation Society (WCS) Cambodia Program, which has been actively engaged in both landscapes since 2000.

KSWS[1] (292,690 ha) is located within Mondulkiri Province. The local population consists of indigenous ethnic groups, primarily Bunong or Stieng, and ethnic Khmer. Rural livelihoods are predominantly derived from agriculture and forest use, including rain-fed rice paddy, cassava, cashew, rubber and resin tapping from *Dipterocarpus* species, *D. alatus* and *D. intricatu* (Travers et al., 2015). KSWS conserves large areas of both Annamitic evergreen forest and deciduous dipterocarp forests of the eastern plains, forming a complex mosaic of forest types that provided habitat for endangered flora and fauna. The wildlife sanctuary includes an established REDD+ project, eco-tourism, Indigenous Communal Tenure (ICT) and community forestry schemes (Travers et al., 2016).

Large scale development projects exist and are planned in the landscape, including mining, economic land concessions for rubber, new roads, and power transmission lines. Due to the proximity of the Vietnamese border, illegal logging of high value timber is a major concern for PA authorities. Migration and demand for farming land continues to drive conversion of forest to agriculture in areas in close proximity to roads and markets. While deforestation is reducing wildlife habitat, conservation agencies perceive hunting to be the major imminent threat to terrestrial species. Biodiversity monitoring shows that populations of ungulates are decreasing but that primate populations are stable (unpublished data). Reduction or local extinction of

[1] Formerly Seima Protection Forest, management transferred from MAFF to MOE in 2016

249 populations of such species changes floristic and faunistic composition of forests (Wright, 2003). If species
250 populations are reduced to such low levels that they are "ecologically extinct", they may be unable to fulfil their
251 ecological role, with repercussions on the long-term diversity and health of tropical forests (Redford, 1992).
252
253 The Northern Plains Landscape consists of a network of three PAs in Preah Vihear Province, the Kulen Promtep
254 Wildlife Sanctuary (KPWS), Preah Roka Wildlife Sanctuary (PRWS) and Chhep Wildlife Sanctuary (CWS)[2],
255 collectively encompassing 535,000 hectares. Rural communities primarily practice rain-fed paddy cultivation;
256 some households also grow cash crops including cassava and cashew. Additional income is made through resin-
257 tapping and the collection of Non Timber Forest Products (NTFPs) (Beauchamp et al., 2018a). Villages inside
258 the PAs contain a mixture of indigenous and non-indigenous people, former soldiers, and recent immigrants
259 from the central plains of Cambodia (Clements, 2012). Most of the Northern Plains landscape is dry deciduous
260 forest, although patches of evergreen forest and other forest types exist. Forests and agricultural areas are habitat
261 for critically endangered and vulnerable mammal and bird species.
262
263 Since 2008, over 61,000 ha of land inside CWS and KPWS has been allocated to economic and social land
264 concessions, increasing the population of the area and impetus for illegal activities. Deforestation is prominent
265 in these areas. Conversion of forest to agriculture by local communities and immigrants also occurs, but a
266 number of interventions are working to strengthen local incentives for conservation, including wildlife friendly
267 agriculture, payments for environmental services (PES) programs, ecotourism and land use planning (Clements
268 et al., 2014b). The longest of these programs involves small conditional payments to local people to protect the
269 nests of highly threatened bird species from collection for consumption and trade. The program, established in
270 2003 and currently implemented across 24 villages, has contributed to long term partnerships between local
271 villagers and protected area managers (Beauchamp et al., 2018a; Clements et al., 2013). Monitoring of bird
272 nests and fledglings in CWS and KPWS show that conservation interventions may be effective in maintaining
273 bird populations, but no mechanisms exists for combating habitat loss by conversion in concessions (Harrison &
274 Mao, 2017). According to Harrison and Mao (2017), the number of bird nests and fledglings rose between 2002
275 and 2008, after which they stabilised and then have fallen at a steady rate since 2012. The decrease in the

[2] Formerly Preah Vihear Protection Forest, management transferred from MAFF to MOE in 2016

number of nests and fledglings is attributed to habitat loss, logging of high value timber in nesting sites, hunting, and egg collection.

Fig. I *Location of study sites, villages surveyed, and deforestation between 2000 and 2017. Land cover data including forest cover, administrative data and other spatial components of the landscapes was obtained from WCS's private spatial dataset. Detailed methodology is available in Rainey et al. (2010) and Evans et al. (2009)*

Methods

We have visited the landscapes of focus for short periods annually since 2015 to explore and discuss research objectives with natural resource management agencies. Following principles of inductive research (Thomas, 2006), inquiry was driven by a broad set of issues and not a predetermined hypothesis. We reviewed existing data available for both landscapes, including forest cover change, biodiversity surveys and household surveys. Our preliminary findings indicated a wealth of available quantitative data covering both biophysical and social attributes of the study sites. We found gaps in information on how local communities perceive the social and environmental components of their landscapes and the governance arrangements that influence outcomes at a landscape level. These gaps emerged due to the changing nature of landscapes; past partnerships appeared to be based on informal relationships, which inherently change over time. Relationships and institutional memory have not kept pace with new leadership, new actors, and changing societal values.

We spent six weeks in each landscape between November 2017 – February 2018, engaging with natural resource management agencies and local communities. Drawing from conceptual and empirical understandings of social-ecological interactions of landscape change (Cheng et al., 2003; Meyfroidt et al., 2018), principal attention was given to the following characteristics:

- Local perceptions of landscape transitions and future aspirations
- Institutional arrangements influencing conservation and development outcomes
- Leverage points for development pathways

Three villages were visited in each landscape. In KSWS, we visited Sre Preah, Gati and Chak Char and in the Northern Plains we visited Dangphlat, Kunapheap and Antil. Key informant interviews and focus group discussions were conducted by two authors and a translator. Translation of key concepts occurred prior to

meetings. During the interviews and discussions, conversation was translated continuously, as well as after each meeting for further clarification. We sought to build from existing datasets through information gathered in formal interviews and focus groups and informal discussions for a more holistic problem focused approach (Leavy, 2016). We selected the villages to represent low, medium, and high accessibility inside or on the border of an established PA. As transport infrastructure is often an indicator of rural development (Roberts et al., 2006), accessibility was selected to capture villages at different stages of landscape transitions. Time and financial constraints limited our coverage to three villages in each landscape. Our second criterion was the presence of contemporary issues in rural Cambodia within the village, including economic land concessions, transport infrastructure, indigenous communal tenure, migration and various conservation schemes (Table I).

Table I Overview of villages selected for study, including socio-economic conditions, conservation activities, and sample contribution to study. Basic Necessities Survey (BNS) scores (Davies & Smith, 1998) are used as an indicator of wealth and normalised according to the maximum possible score for each landscape. Score is for comparison between villages but does not represent standardized value for comparison between the Northern Plains and Eastern Plains

	Northern Plains			**KSWS**		
Village	Dangphlat	Kunapheap	Antil	Sre Preah	Gati	Chak Char
Village Accessibility	High	Medium	Low	High	Medium	Low
Dominant livelihoods	Paddy rice, cash crops, labour	Paddy rice, chamkar rice, cash crops	Paddy rice, labour, cash crops	Cash crops, labour, paddy rice	Chamkar rice, labour, cash crops	Paddy rice, cash crops, labour
Ethnicity	Khmer, Kuoy	Khmer	Khmer	Banong, Khmer	Banong, Khmer	Banong, Khmer
Basic Necessities Score (mean and standard deviation)	0.68, 0.11	0.59, 0.11	0.55, 0.11	0.63, 0.11	0.63, 0.12	0.57, 0.11
Indigenous Communal Tenure	No	No	No	No	Yes	Yes
Conservation presence:						
Protected Area	✓		✓	✓	✓	✓
Birds Nest Protection	✓		✓			
Wildlife friendly rice	✓					
Community Forest		✓				
REDD+				✓	✓	✓

Economic Land Concession	Nearby	Nearby	Nearby	Nearby	Distant	Nearby
Focus Group Discussion participants (F=Female)	6 (2F)	7 (2F)	5 (1F)	7 (3F)	7 (2F)	7 (2F)
Key Informant Interviews	13	11	10	10	10	12
Households surveyed 2017/2018	111	44	58	32	31	31

321

322 *Key Informant Interviews*

323 We selected our key informants based on their involvement in a specific component of the landscape, such as
324 agriculture, small business, health, education, conservation, migration, decision-making, and wealth. Selection
325 began with a consultation with the village chief, followed by snowball sampling whereby we asked individuals
326 (key informants or villagers) to recommend interviewees until we reached a saturation point (Newing, 2010).
327 Recognizing the heterogeneous nature of social landscapes, informants represented a range of age groups,
328 income levels and cultural backgrounds. We interviewed 65 informants at the village level (Table 1) and
329 conducted a further 47 interviews with representatives of government and non-government organizations
330 engaged in natural resource management decisions in the landscapes. Organizations operated at various scales,
331 from village to national, but actions directly impacted the landscapes of focus. Grounded theory (Corbin &
332 Strauss, 1990) - the integration of data collection and analysis - guided our interview process. Key informant
333 interview questions were structured around themes of governance, natural resources, wealth, development
334 aspirations and perceptions of change over time, but tailored to individuals and topics. We analysed each
335 interview for the emergence of issues and concepts relevant to our research objectives, and pursued these issues
336 further in subsequent interviews. We followed principles of appreciative inquiry (Reed, 2006), discussing
337 potential solutions to issues as they emerged locally.

338

339 *Focus Group Discussions*

340 In each village, we convened a focus group to discuss drivers of change and social-ecological impacts. We
341 worked with the village chief to invite participants in person, selecting villagers in the older demographic with
342 knowledge of the history of the village. We ensured the final group reflected the diversity of household incomes
343 in the village and included both women and men to build consensus on the discussion outputs. In each group,
344 we used historical trends analysis (adapted from Basuki et al., 2011; Boedhihartono, 2012; Shepherd &
345 Blockhus, 2008) to understand social-ecological change and local perspectives at the village scale. By

346 constructing histories through the identification of events, we hoped to gain insights on integrated causes and
347 effects of specific change processes, capturing trends over time (Walters, 2017). In each discussion, we built a
348 historical timeline for the landscape, including social, environmental and political events that occurred within
349 the village and at higher scales. We did not define a timeframe, allowing participants to offer information on
350 what they felt was relevant to the discussion. We asked participants to identify key events that had an impact on
351 natural resources, and whether the impact was positive or negative. We repeated the question for life in the
352 village, asking which events have brought positive and negative changes to people's lives. We did not restrict or
353 define quality of life, instead leaving the question open-ended for participants to define individually. We then
354 asked participants their future expectations for the landscape and which organizations they expected to have
355 influence in future conservation and development outcomes.
356
357 *Household surveys*
358 During the period of research, WCS conducted household surveys in the Northern plains landscape and in
359 KSWS. The 2017 surveys covered socio-economic information and local perceptions, and contributed to long
360 term datasets on local livelihoods in areas where conservation activities are taking place. The household survey
361 in KSWS is part of the Social Impact Assessment (SIA) for the REDD+ project. Households were randomly
362 selected in each of the twenty villages involved in the REDD+ project, with a minimum sample of thirty
363 households per village for a total of 620 responses. In villages that are separated into discrete settlements, the
364 sample was proportionally stratified by settlement. The design and purpose of the household survey in the
365 Northern Plains is to evaluate the impact of biodiversity conservation on local communities (Clements, 2012).
366 Household selection was initially random stratified sampling based on a participatory wealth ranking exercise in
367 villages inside and outside the PA network, according to the original survey design by Clements and Milner-
368 Gulland (2015). The 2017 survey followed the original survey design and involved 1046 responses from 18
369 villages, (11 within the PAs). The methodology and medium term results of the impact evaluation are described
370 in Beauchamp et al. (2018a).
371
372 In both sites, interviews were conducted with the household head using structured questionnaires. The Basic
373 Necessities Survey (BNS) is used in the Northern Plains and KSWS as a wealth index, specifically derived in
374 the local context. Davies and Smith (1998) outline the procedures for establishing and using the BNS to monitor
375 livelihoods in a specific location. As such, BNS scores cannot be compared across the two landscapes. For the

purpose of this study, household surveys covering the period 2008-2014 are used to verify long term landscape trends described in interviews and focus groups. The 2017 surveys provide landscape-wide perspectives on natural resources, governance and livelihood performance.

Analysis

The iterative nature of grounded theory allowed for the categorization of themes as they emerged, which further directed inquiry. Focus group discussions elucidated key drivers of development and consequent deforestation and degradation, which were further explored in key informant interviews. Interview content was categorized into ten themes that inductively emerged from discussions: institutions, natural resources, aspirations, migration, infrastructure, agribusiness, health, education, wealth, and illegal activities. The historical trends analysis conducted in each focus group discussion was collated for each landscape to expose key events and trends. Our analysis focused on the intersection between biophysical conditions, institutional and socio-economic processes, and knowledge, values and belief, in line with understandings of place (Cheng et al., 2003). Historical similarities between all villages gave rise to key trends, reflecting thematically similar but temporally different development pathways. Timelines allowed for exploration of themes over time, verified by historical data, observations, and secondary sources, including articles from peer-reviewed journals and grey literature. From the information gathered we identified feasible development pathways in each landscape and potential repercussions for conservation. We determine likely future scenarios and potential leverage points for navigating trade-offs. Scenarios were developed post-hoc with the intention of contrasting social-ecological change in landscapes under different conservation approaches, building from historical trends. Three scenarios were chosen to capture different conservation paradigms of exclusion, integration and prioritization. Themes highlighted in scenarios reflect those that were raised during discussions about the future of each landscape.

Results

Forest landscape transition histories

The pace and direction of change in rural forest landscapes in Cambodia over the past 40 years have been influenced by diverse factors at multiple scales. The focus groups generated historical timelines in each village documenting important social, economic, cultural, political, and environmental events. While each village conveyed unique histories, similar themes ran through both landscapes. According to focus groups, the Khmer

406 Rouge (1975-1979) affected all villages, forcing communities to relocate to the district centre. Resettlement
407 occurred at various stages after 1980. When communities returned, they began a process of rebuilding
408 livelihoods, restoring farmlands and exploiting forest products for food, shelter, and income. Gradual stability
409 and tenure security between 1980 and early 2000s enabled a slow accumulation of capital and resources. Table
410 II highlights key features of the historical timeline. Focus groups, key informant interviews, and secondary
411 sources are used to expand the timeline below.
412

413 *Table II Historical Timeline for the Northern Plains (left) and KSWS (right) in Cambodia. Information on*
414 *events were gathered in discussions in three villages in each landscape and amalgamated to form a rich history*
415 *of changing forest landscapes in rural Cambodia*

<table>
<tr><th></th><th>Northern Plains</th><th>KSWS</th></tr>
<tr><td>1975</td><td colspan="2">Khmer Rouge Regime
People were moved from their villages to the district</td></tr>
<tr><td>1980</td><td>Rebuilding and Instability
People returned to their villages, began to farm collectively and then privately.
Khmer Rouge maintained a presence in Preah Vihear, conflict continued, and some people were unable to settle in their village
Fear of Khmer Rouge meant people did not participate in elections</td><td>Rebuilding
People returned to their villages, collected resin, farmed rice and vegetables, raised livestock and hunted
Bridge and road were damaged from war, repaired in 1990.
Accessible villages began to grow cashew
Health Centre built</td></tr>
<tr><td>1995</td><td rowspan="2"></td><td rowspan="2">Asset transformation
Samling logging company established
Khmer migration to more accessible villages
Villagers buy motorbikes, open shops
Villagers log high value timber, grow cassava and cashew
NGOs commence conservation and development initiatives in villages</td></tr>
<tr><td>2000</td><td>Asset transformation
Conflict ended in 1998, and people began to build houses and open shops. Bucket wells were built, followed by pump wells.
Some people bought motorbikes.
More accessible village bought minitractors</td></tr>
</table>

2007	**Capital accumulation** *Better roads increased access to healthcare and markets* *Less accessible villages bought mini-tractors* *Villagers began to diversify crops, including cassava and sesame* *Economic Land Concessions established and begin to clear forest* *Health and education infrastructure improved*	**Capital accumulation and re-investment** *More accessible villagers grow rubber* *Micro-finance available* *Indigenous Communal Tenure initiatives and private land tenure established* *Economic land concessions established and clear forest* *Corruption and illegal logging are high concerns* *Transport and communication infrastructure improve accessibility of remote villages*
Present		

416

417 During the focus groups in the Northern Plains villages of Dangphlat, Kunapheap and Antil, participants shared
418 how guerrilla warfare between the Khmer Rouge and Government continued to threaten local communities after
419 resettlement, inhibiting their ability to recover from the war and regain social and economic stability. Villages
420 grew rice for subsistent consumption, unable to produce and sell surplus due to the continued conflict,
421 challenging environmental conditions, and Preah Vihear's relative isolation from external markets. In the 1980s,
422 households increased their income by expanding their farms, shifting from communal rice to farming as
423 households, and selling resin. When the Khmer Rouge dissolved, ex-Khmer Rouge, demobilized soldiers and
424 displaced people remained in the area, and villages consisted of large settlements comprising heterogeneous
425 groups (Clements, 2012). As conflict de-escalated in the late 1990s, households began to build their assets with
426 small shops, motorbikes, and improved houses. Gradual stability brought new infrastructure to the villages,
427 including wells, schools and basic health facilities. In the early 2000s, farmers in the more accessible villages
428 began to purchase mini-tractors and expand land for cultivation, contributing to growing incomes and
429 accumulation of assets.

430

431 In the late 2000s, new roads began to increase accessibility. The road from the district town to Dangphlat village
432 was initially built in 2008 and improved in 2013, creating access to healthcare, markets, and services. The road
433 to Kunapheap village was built in 2012 by the Government prior to commune elections but a local leader told us
434 the road has remained in poor condition as the Government did not allocate funding for maintenance. A good
435 road to Antil village is yet to be built, although mini-tractors and motorbikes can access the village most of the
436 year. The value of roads for improving livelihoods was highlighted in all three focus groups and in key
437 informant interviews, as stated by a young teacher in Antil village:

438

"Only a new road can change their lives. With a new road people will have more exposure to outside markets and opportunities and they will be motivated to improve their lives"

With improved access to markets and mini-tractors to expand land holdings, villages in the Northern Plains have recently started to produce cash crops such as cassava, cashew, and sesame. Household surveys show cash crop farmers in the Northern Plains were twice as numerous in 2014 as they were in 2008, and five times as numerous in 2017. Wealthier households in more accessible villages capitalize on new opportunities and diversify their income, while households with smaller landholdings or in more remote villages continue to grow subsistence rice. Key informants stated that when households owned a mini-tractor, they could clear more forest, increase efficiency and diversify income. According to Beauchamp et al. (2018a), wealthy households in the Northern Plains are more likely to own a shop and provide a service, to own a mini-tractor and a higher number of cattle, and to be highly involved in programs organized by local conservation NGOs. Households unable to acquire enough land, livestock, or agricultural resources to reinvest in assets or mechanised agricultural practices remained in a poverty trap (Beauchamp et al., 2018a).

More recently, local leaders stated that economic land concessions have posed threats to villages, including the expropriation of land and logging of resin trees with little or no compensation. In response, households are clearing forest to secure farmland, unperturbed by its legal status as a protected area. In two of the villages, key informants reported conflict with neighbouring economic land concessions, involving loss of resin trees, issues of compensation and disagreement over land ownership. These experiences reflect reports of land-grabs throughout the region (Beban et al., 2017; Leblond, 2019). Social land concessions providing land for soldiers and their families also influence the trajectory of change in the Northern Plains. The proximity of the landscape to the Thai border has led to strategic placement of military in the area, resulting in forest clearance, other illegal activities, and a complicated social and political situation.

In KSWS, focus groups stressed the significance of the proximity of the villages to Vietnam as a driver of economic growth for the area. In 1988, local authorities began repairing the road on both sides of the Vietnamese border, allowing for trade. Subsequently, villages close to the border generated income from a range of activities, including retail shops and the sale of resin, vegetables, cashew, livestock and rice. Remote villagers did not develop at the same pace; the focus group in Chak Char said the village did not start growing cashews

until 2000, and shops did not open until 2005. Close to Sre Preah, the Samling International Chhlong logging concession was granted in 1994. It was logged for three dry seasons between 1997 and 1999 before closing due to the nation-wide moratorium on logging concessions. Although the concession was established as a protected forest soon after, logging tracks increased accessibility into the forest, creating avenues for illegal logging and hunting. In the late 1990s, communities began to invest income from farming into new assets, including motorbikes, housing and village infrastructure, such as pump wells, health posts, and schools.

The rehabilitation of Provincial Road 76, linking the provincial town to the capital, coincided with the establishment of economic land concessions, as well as the introduction of cassava by Vietnamese traders and increasing waves of Khmer and Cham migration. These events set the landscape into a rapid and transformative transition, evident by the large scale of deforestation that occurred during this period (Figure I). In all three focus groups, participants described how villagers and new migrants increased their wealth by growing cassava and engaging in the illegal timber market, giving rise to issues of debt, corruption, and elite capture of resources. Key informants emphasised how illegal logging generated wealth for households, but gave various dates for when this activity peaked. According to one farmer in Gati village:

Logging of high value timber began in 2002 when middlemen arrived in village, and peaked in 2006. The villagers benefited, they bought rice, paid labourers to farm their land and upgraded their houses. Now there is less timber, so families have stopped logging and returned to farming. But logging continues to occur because of corruption.

In Chak Char, increased logging coincided with the conversion of neighbouring forest in Snoul Wildlife Sanctuary and part of KSWS to a rubber concession in 2012. Roads built through the rubber concession brought benefits of increased accessibility to the village, but participants in the focus group felt conflict between villagers and the concession and corruption overshadowed these benefits.

Similar to the Northern Plains, road rehabilitation in KSWS is followed by new infrastructure, including electricity, cell towers and village buildings, bringing new opportunities to villages. The 2017 REDD+ SIA in KSWS found that in 2012 and 2017, wealthy households were associated with owning more land, operating a shop, having at least one source of off-farm income or better educated household heads (unpublished data).

Remote indigenous communities with strong ties to their environmental surroundings are facing tough decisions on how to ensure their families can access development opportunities while protecting forest for future generations. We spoke with a local representative of the Indigenous Peoples Party, who expressed the challenges of conserving culture in a landscape of changing values and expectations. He felt development had brought positive changes to the village, but was concerned about concessions and migration taking away forest and land from indigenous people.

Indigenous Communal Tenure (ICT) was recently established in Gati and Chak Char, formalizing indigenous ownership over forest and land. Still in its early stages, key informants in both villages had mixed feelings over the benefits of ICT. They hoped ICT will help to leverage NGO support for conservation and development through the REDD+ project. Yet the perceived value of ICT in delivering social and environmental benefits depended on the functionality of local governing agencies, which varied between villages. As identified in Travers et al. (2015), communal land management is influenced by community leadership, institutions, and shared values within the community, affecting both compliance with local rules and the sustainability of ICT.

Local perceptions of key events in landscape transitions

In the historical trends analysis, focus groups linked various components of landscape change with individual or household experiences. As such, members identified several events and changes that have had a positive impact on the villages (Figure II). Expanding land-holdings, logging, roads, and cash crop production brought wealth to households, creating development opportunities (Riggs et al., 2020). Participants frequently noted the importance of 'outsiders' or external agents in facilitating these opportunities, particularly the role of middle-men and migrants opening shops and logging. As stated by a young male entrepreneur in KSWS:

"It is good that new people arrive, they know outside economics and people can learn from them"

As shown by Figure II, the villages most accessible by road in each landscape, Sre Preah and Dangphlat, identified more positive changes than the villages with lower road accessibility. Three villages identified logging as positively impacting their development. However, all six villages also identified negative impacts. Logging and the associated corruption negatively affect the environment, which in turn negatively affect people's lives through events such as flooding. In Sre Preah, the focus group viewed the establishment of

529 microfinance in the village as both positive and negative. Participants noted that microfinance brought
530 opportunities for villagers to increase agricultural production but if yields are low, it can bring debt and
531 difficulty. Currently, both landscapes are undergoing extensive road improvement, and the SIA for REDD+
532 finds that wealth indicators in remote villages of KSWS are catching up to accessible villages (unpublished
533 data).
534
535 ***Fig. II*** *Events and changes with the most significant impact on livelihoods and the surrounding environment, as*
536 *perceived by villagers. Columns show if the event was listed as significant in the focus group discussion that*
537 *took place in each of the six villages. If the event was identified as a positive impact, it is marked above the*
538 *black line. Events with a negative impact are marked below the black line. The four events identified with an*
539 *environmental impact are on the right*

540 In focus groups and interviews across all six villages, respondents felt that change positively impacted their
541 communities and life improved with each new generation. At the household level, improvements in livelihoods
542 largely focused on income, reflected in the 2017 household surveys. In response to the question "has your
543 livelihood improved in the past 5 years?", 53% of households in the Northern Plains and KSWS combined
544 responded "improved" (Figure III). When asked why, 74% and 60% of households in Northern Plains and
545 KSWS respectively explicitly referred to income, earnings or involvement in commerce.
546
547 ***Fig. III*** *Response to "Has your livelihood improved in the past 5 years" in the 2017 Household Survey in*
548 *KSWS and the Northern Plains*

549 During interviews, we also discussed broader aspects of wellbeing linked to sustainable livelihoods, including
550 natural, economic, human and social capitals (Scoones, 1998). Key informants frequently raised subjects of
551 access to land, secure and stable income, healthy family members and fairness when discussing quality of life.
552 Villagers referred to fairness as inclusion in local decision making and development opportunities and fair
553 implementation of local rules. Broader issues regarding corruption and law enforcement that extended beyond
554 social relations in the village were also a concern for many key informants, especially if rules were perceived to
555 unfairly restrict access to land or natural resources. Improvements at the village level or higher were observed to
556 be easier access and better-quality education, infrastructure such as electricity, roads and cell towers, and access

to credit through micro-finance institutions and savings groups. But, as an elderly poor rice farmer observed, village-level improvements had a greater effect on households that could afford to benefit.

"The road has no effect on me because I can't sell rice to the middleman. I do not have a mini-tractor and grow rice only for eating"

Our key informant discussions echoed well-being dimensions explored in-depth in Beauchamp et al (2018), specifically the importance of land. According to some of the poorest households in the villages, land underpins wellbeing. Land is of both instrumental and intrinsic value to Cambodians in rural forest landscapes. Key informants felt that without land, households cannot grow their income, as an elder farmer stated:

"The best way to improve households is to clear more land so they have land to farm in the future"

Villagers also recognise that land is a scarce resource in both landscapes. According to census information, the populations in Preah Vihear and Mondulkiri provinces are increasing at a rate of over 3% annually, due to migration and birth rates. Population density is still low in comparison to other provinces, supporting the likelihood that migration rates will stay high in the foreseeable future (Diepart et al., 2014). Many farmers grow fragrant rice which is low yielding, requires fewer inputs but receives a premium price. From the household surveys, average yields for paddy rice are 1.9t/ha in the Northern Plains and 1.6t/ha in KSWS. For cassava, the average yield is 4t/ha in the Northern Plains. In KSWS, cassava productivity has dropped from 3.5t/ha in 2012 to 1.8t/ha. Declining yield is consistent with reported trends in cassava cultivation across Asia, as continuous cassava production over long periods of time without fertilizer inputs degrades the soil and reduces its productivity (Howeler, 1991).

In focus groups, participants anticipated future livelihoods that are dependent on agriculture and off-farm income. In both landscapes, they expected the continued expansion of agriculture to replace forest cover, as well as smaller land parcels, more concessions, and natural hazards due to forest loss. Despite this, participants were eager for the younger generation to remain in the village and support the local economy, as stated by an elderly woman in the Northern Plains;

We want [the younger generation] to have a good education and become a teacher or doctor or mechanic because there will not be enough land to farm. We do not want them to move, but to create better jobs in the commune.

All groups desired improved infrastructure (schools, hospitals, toilets, wells, electricity) and identified a role for government and NGOs in reaching their desired objectives, based on observations of current and past projects. Focus groups in the more remote villages desired improved roads. When we inquired about the future in key informant interviews, responses reflected a focus on the present and less thought for the future, typical of poor rural populations (Banerjee et al., 2011). Interviews echoed the responses in the focus group discussions, expecting forests to decrease but also hoping for the villages to continue to develop. Some interviewees expected their children to farm, others hoped for high skilled jobs through improved education. In KSWS, the representative of the Indigenous Peoples Party spoke of '*protecting poor people in the village from powerful concessions companies that take their land*'. His response reflects the pervasive discourse throughout rural Cambodia on dispossession due to land concessions (Baird & Fox, 2015; Neef et al., 2013).

Declining forest cover and implications

In the 2017 household questionnaires, 98% of respondents said the forest provided them with benefits. The six most common responses were consistent across both landscapes (Figure IV). In the Northern Plains, 91% of respondents identified construction as the main benefit from forests. However, in KSWS, respondents were more likely to identify ecosystem services, possibly due to the presence of the REDD+ project.

Fig. IV *Perceived benefits from forests, obtained through household questionnaires in 2017. Participants often identified more than one benefit. Responses were coded into categories. Graph shows frequency of category mentioned in responses*

Despite recognising indirect values, people tended to be fatalistic about the future of the forest, seeing it as a resource that would eventually diminish for future generations.

"If we keep clearing land and have no forest then that is our destiny" – Farmer, Northern Plains

Focus groups were also not optimistic about the future of the forest. In Gati and Chak Char villages in KSWS, participants wanted help from NGOs to protect the forest for future generations. In interviews we received mixed responses on whether forest should be protected; some felt PAs were inhibiting land expansion and income, others felt the need to conserve forest for future generations. In the Northern Plains, we spoke with villagers involved in bird nest protection who expressed the difficulty of the situation. He said some people were glad to take part in conservation programs, but local authorities also gave permission to villagers to cut trees and clear forest in nesting sites. While they thought stronger law enforcement could strengthen protection, they were uncertain how to bring about that change. No observations were made about change in management for KSWS and CWS from MAFF to MoE. In KSWS, we spoke with an indigenous person who did not see a conflict between conservation and land expansion, but instead emphasised the importance of management.

"Land clearance is not a problem because indigenous people have managed their lands for generations without harming the forest".

Our discussions on forests frequently tended to shift towards rights and access, rather than conservation and threats. Views on whether to protect or use the forest were diverse in all villages, but emphasis on the lack of fair rules and implementation remained consistent. During interviews and focus groups, protected forests were at the centre of corruption concerns, including government agencies facilitating illegal logging and inequitable implementation of laws and regulations regarding forest clearance and use. As a result, some of our key informants shared their distrust in village and PA authorities and were concerned about growing disparities between wealthier, well-connected households and poorer households.

"Only the rich can afford to cut trees. The [conservation intervention] makes poor people poorer and the rich richer".

Distrust in local authorities was also reported in the KSWS 2017 household survey, with 68% of households responding no to the question "local leaders consider your concerns when they make decisions that affect you". Similarly, in the Northern Plains 2017 survey, 79% of households responded disagree to the question "I think that everybody in the village is able to obtain land fairly".

Discussion

Livelihoods in rural Cambodia are improving across generations. Driving this improvement is accessibility, expanding agricultural markets, and resource exploitation. Yet as households have built and accumulated capital in the years following the Khmer Rouge, they have also confronted issues of corruption, elite capture, and inequality. As such, individual perceptions of change and well-being are inseparable from the broader institutional and environmental processes that exist within the landscape. Control of, use of, and access to land has become a key issue of concern in many rural communities, especially those living in and around highly valued tropical forest.

Development pathways in the Northern Plains and KSWS show similar trends but are unique to the geographical, political and historical circumstances in each place. In KSWS, proximity to the Vietnamese border, earlier accessibility and soil conditions enabled the uptake of cash crops as the dominant livelihood. The social and environmental change resulting from the boom and bust cycle of the cassava crop in Mondulkiri is a primary example (Mahanty & Milne, 2016). In the Northern Plains, limited accessibility and the longstanding practice of rice cultivation resulted in a slower uptake of cash crops, with mechanized agriculture driving livelihood improvement.

Currently, villagers in the Northern Plains and KSWS see agricultural expansion as the most viable pathway for improving livelihoods. For some households, migration and an illegal economy of high value timber, is providing the push they need to build assets. Protected areas are constraining expansion, and illegal and corrupt use of forest resources are creating dissatisfaction among villages. Portions of PAs that have not received NGO support and investment are already lost to settlement and are emerging as flourishing rural towns. Remote villages desire better infrastructure and access, and despite recognition of natural values, accept that settlements may replace forests in the future (Riggs et al., 2020). As populations grow, economic activity and migration to these landscapes is likely to continue, intensifying the rate at which forest is converted to other land use. Unlike neighbouring Vietnam, economic growth in Cambodia's forest landscapes is not a yet associated with agricultural intensification (Meyfroidt & Lambin, 2008a). Forests are still considered an abundant resource and national forest cover is regionally high (FAO, 2015). Observing current trends, it appears unlikely that pressure on forests in Cambodia will decrease in the foreseeable future.

We see three plausible scenarios for the future of forest landscapes in Cambodia under different conservation approaches. The three scenarios, described below, draw from the historical trends analysis and aim to capture components of the present that may intensify in the future under different management approaches, such as agricultural expansion, population growth, economic activity, and NGO involvement in the landscape. Different conservation approaches are distinguished to highlight difficult trade-offs in meeting socio-economic and environmental objectives along landscape transitions. By grounding these trade-offs in realistic futures for tropical forest landscapes, we hope to guide decision making for long term engagement in protected areas and rural development. The scenarios are stylized to typify across a spectrum of possibilities and cannot represent the full complexity of the situations they describe. In reality, development pathways will fall along a spectrum due to the complexity and unpredictability of social-ecological systems.

Under scenario 1, conservation agencies collaboratively prioritise geographic areas for *in situ* protection of biodiversity at the national or regional level. Prioritization directs resources towards a smaller number of PAs, reducing competition between biodiversity and processes that threaten its existence (Cullen, 2013). Prioritization assumes PAs in Cambodia constrain smallholders and that rural economies will benefit from development opportunities made available through increased land access and security. Several methods are proposed for conservation prioritisation (Margules & Pressey, 2000; Sarkar et al., 2006), all of which require accurate and comprehensive inventories of components of biodiversity such as taxa sub-sets, habitat types, etc. In this scenario, it is essential that prioritization takes into account social and political conditions that constrain conservation and include tenure, law enforcement, cultural ties to land, and future land use scenarios, in addition to biophysical conditions. Reducing the geographic size of PAs strategically targets resources towards existing conservation, but also allocates resources towards socio-economic programs that can lead to long term conservation wins. For example, secure tenure, infrastructure, and agricultural intensification may reduce smallholder deforestation if supported by good governance (Acheampong et al., 2018; Kubitza et al., 2018; Robinson et al., 2014). This pathway is about getting the human population quickly engaged with potentially prosperous development opportunities and building a constituency for conservation once they are relatively well-off. It assumes that strategic targeting of conservation resources will increase effectiveness, and accepts a degree of loss of biodiversity in exchange for long term conservation outcomes for other species. Broad-scale conservation is a future by-product of development in this pathway.

In scenario 2, existing PAs are retained, and conservation agencies restrict development to protect ecological integrity. The entire area of intact forest inside PAs is considered core conservation and cannot be allocated for future conversion. Smallholders are considered a threat to PAs, and conservation agencies take strict actions to prevent encroachment and logging. Proposed infrastructure development is subject to rigorous environmental impact assessment, and remote communities remain inaccessible to avert negative repercussions of road development. Conservation agencies attempt to restrict the use of chemicals in agriculture and all wildlife hunting is banned. As a result, rural economies remain socio-economically stagnant; they are not able to intensify their agriculture, and they are penalized for logging or expanding agricultural land. In this future scenario, conservation agencies direct their resources towards threat-based conservation, responding to stresses instead of into long-term strategic planning, or proactive, adaptive theories of change. Conservation programs such as birds nest protection and wildlife friendly rice do not exist, and farmers struggle to increase their income. Day-to-day conservation activities in this scenario might correspond to what Boedhihartono et al. (2018) describes as whack-a-mole, in which interventions are triggered by issue-cycles and populism, instead of an integrated long-term approach to solving problems within a system. Threat-based measures taken by conservation organizations create animosity among local farmers and drive insidious exploitation, resulting in a degraded and unproductive landscape, and death by a thousand cuts (Laurance, 2010). Strict protection may lead to social conflict and immigration out of PAs. A key assumption in this scenario is the power of conservation agencies to carry out strict protection and have the highest authority on land use decisions. Recent conversion of large tracts of PAs in Cambodia to industrial agriculture (Yin, 2017) suggest conservation agencies may not be able to withstand forest conversion by powerful elites, reinforcing the notion that it will be poor smallholders who suffer under this scenario.

Scenario 3 can be characterised as incremental change, as it describes a landscape that is transitioning gradually. In this scenario, Cambodia continues to designate significant land to protection, but all PAs are zoned as required by the 2008 Protected Area Law. Strict conservation areas exist in a mosaic of core, conservation, sustainable use, and community zones. The sustainable use zone is used for ecotourism, community forestry, recreation, mining, and economic land concessions. Incremental change assumes a degree of muddling through (Lindblom, 1959), in which decisions are made in response to social, economic and political signals, with the best available but incomplete information at the time. Indigenous Communal Tenure exists in the mosaic of land uses, and remote communities are gradually more accessible as they become recipients of infrastructure

initiatives led by government and non-government agencies. Endangered species remain at high risk due to smallholder forest conversion as accessibility within PAs increases, but over time households depend more on off-farm income to improve wellbeing. In this scenario, agencies use community-based conservation approaches to support local livelihoods and meet conservation goals. Conservation initiatives compete with more lucrative livelihood opportunities, limiting their ability to reduce degradation and deforestation (Brooks et al., 2013; Wright et al., 2016). As rural communities accumulate wealth over generations, forests are degraded and gradually decline. Incremental change assumes that zoning PAs will reduce pressures on forests, as communities are not strictly excluded. Yet the opportunity cost is high for locals to conserve their lands. Despite the presence of community conservation programs, locals pursue livelihoods that make the most sense to them and their economic needs. As a consequence, rural households continue to seek livelihoods that compete with conservation, and conservation agencies must continue to respond to changing conditions.

Collaborative governance of landscape transitions

Governance arrangements in each scenario described above will evolve differently, both affected by and affecting conservation and development outcomes. Good governance, including secure property rights, democratic participation, accountability, trust in collective leadership, and a conducive policy environment, would underpin prosperous and environmentally sustainable rural landscapes in Cambodia.

If the conservation strategy is to support a gradual shift to a sustainably managed mosaic landscape, conservation agencies would add value by contributing to a conducive institutional setting that supports collaborative approaches for governing systems (Armitage et al., 2012; Lockwood et al., 2010). The recent decentralization of natural resource management to the provincial level in Cambodia creates a window of opportunity for collaborative governance of PAs. Decentralized systems offer potential advantages such as subsidiarity, shared decision making authority, and democratic involvement in the allocation of resources (Colfer & Capistrano, 2005). Yet they also raise significant risks, such as elite capture and resource exploitation, especially if inhibited by governance constraints (Tacconi, 2007). The actors that can influence the social and environmental outcomes of landscape transitions are not restricted to conservation agencies; they include the informal and formal leaders within the village and at higher levels. Robust relationships characterized by high levels of communication and clear perceptions of roles and responsibilities among these leaders is fundamental for consensus driven decision making and navigating trade-offs. If conservation agencies can work with key

766 local decision makers, they can strengthen their capacity for good governance, which may lead to mutually
767 beneficial collective action with positive social and environmental outcomes (Beauchamp et al., 2019).
768
769 Recognising the difficulties of collaborative governance of natural resource management systems, it may be that
770 conservation agencies are limited in their ability to refocus existing operations with the goal of improving
771 governance. The experiences of conservation bodies in the Northern Plains and KSWS demonstrate the value of
772 long-term engagement, and the continued challenges that arise. In both cases, multiple methods and disciplines
773 have contributed to a better understanding of the social and political attributes that influence conservation and
774 development outcomes and have led to evidence based interventions (Clements, 2012; Evans, 2013). While
775 other PAs in Cambodia are also co-managed by NGOs, many do not receive the same support, and are faced
776 with similar or more extreme challenges. In the Northern Plains and KSWS, WCS works directly with local
777 decision makers to strengthen their capability for natural resource management. Yet, as the pace and nature of
778 landscape transitions evolve, conservation strategies must be continually revisited and adapted to local
779 conditions (Langston et al., 2019). Building rich histories and understanding local perceptions of change can
780 ensure that interventions to improve livelihoods connect with major economic opportunities. Approaches that
781 strengthen governance and foster collaboration can help achieve targeted and contextually driven conservation
782 and development objectives (Bennett et al., 2019)
783
784 We observed two initiatives that offer an opportunity for strengthening partnerships for better governance and
785 leveraging change for sustainability. In the Eastern Plains, conservation organizations are working with
786 indigenous groups to formalize Indigenous Communal Tenure, providing secure access and ownership over land
787 to indigenous communities. These partnerships also provide mechanisms for distributing and managing funding
788 for the REDD+ project in KSWS. Some villagers we spoke with were enthusiastic about community driven
789 schemes for protecting forests, but clearly stated needs for building capacity, authority and financial resources.
790 In the Northern Plains, three conservation projects, a bird nest protection program, a premium payment scheme
791 for wildlife-friendly rice, and an ecotourism program are providing incentives for communities to engage in
792 conservation, with economic benefits (Beauchamp et al., 2018a). These projects are strengthening collaboration
793 between conservation agencies and local government agencies, creating a space for regular interaction and
794 dialogue that could mobilize and engage more actors.
795

Conclusion

Tropical forest landscapes in Southeast Asia are in transition. While some countries experience net gains in forest cover, others are experiencing net loss with no indication of reaching a turning point (Austin et al., 2019; Riggs et al., 2018). The situation at sub-national levels is highly dynamic and diverse, with many forest landscapes confronting similar realities of the conservation development nexus (Langston et al., 2017; Mahanty & Milne, 2015; Sodhi et al., 2010). Long-term trends indicate that economic development may resolve short-term environmental concerns, but only if there is a supportive institutional and macro-economic environment (Liu et al., 2016). Understanding, interpreting and navigating immediate pressures for social, political, economic, and environmental demands of managing forest landscapes is inherently difficult. Situations are often highly complex and beyond the direct control of decision makers (Evans et al., 2017). Yet, if conservation scientists wish to embed themselves in tropical forest landscapes to protect biodiversity and environmental services, they must be prepared to reconcile conservation and development trade-offs (Langston et al., 2019).

Our results demonstrate the difficult trade-offs required if conservation is to better serve the needs of people living in tropical forest landscapes. In Cambodia, win-win scenarios meeting both biodiversity conservation and short term development goals do not exist. Conservation agencies will have to work with decision makers at multiple scales to strengthen governance and explore realistic scenarios for the future of protected areas and rural development. Harbouring realistic expectations, understanding that trade-offs are necessary and making those trade-offs explicit can help conservation agencies target their efforts to protect biodiversity accurately whilst contributing to the development of prosperous rural communities.

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