Understanding Conservation Challenges: Investigating Conflict in a Forest-Agriculture Fringe in Southern India Using Multidisciplinary Approaches

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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ABSTRACT

Lying between farmland and forest, the fringe is a contact zone for people and wildlife. In the tropics, these productive zones are beneficial to wildlife such as pigs, deer, monkeys, elephants and carnivores. Tropical commodity agriculture and subsistence benefits also accounts for vital support for people living in such landscapes. However, balancing human livelihoods, biodiversity protection and ecosystem services is frequently characterised by conflicts and disagreements between stakeholder groups who entertain divergent aspirations for the same land, and whose perceptions are backgrounded by a number of historical and contemporary factors. This research attempts to understand the different ecological and social themes that interact in tropical forest-fringe landscapes and looks at ways to integrate them meaningfully.

The theoretical and methodological novelty of this work is an attempt towards integration across disparate themes, data structures and disciplinary boundaries. This is carried out through a case study which examines the dynamics of a heavily populated forest fringe in the Western Ghats hotspot of Kerala, India. Here, extended periods of crop depredations and agrarian distress have ushered in an atmosphere of conflict resulting in retaliatory killings of wildlife and widespread opposition to conservation. On the basis of multidisciplinary theoretical inputs and a mixed methods protocol ranging from quantitative and qualitative approaches (Bayesian belief networks, generalised linear models, qualitative probabilistic networks) to discursive methodologies (oral history analyses and ethnographical inputs), a suite of different components related to conservation conflict are examined.

Two key themes receive special attention on account of their critical significance to the research topic. The first is an exploration of species-habitat relationships in modified landscapes and their predictions based on available expertise, fast and frugal methodologies and simple models such as naïve Bayes networks. Methodologically these analyses attempt to move away from conventional data and effort intensive methodologies and the development of good enough solutions in data-deficient, uncertain systems. The second relates to a detailed understanding of the social aspects of conservation by means of an analysis of place-based explorations relating to the engagements of different groups

of stakeholders and the analysis of historical and political ecological chains of explanations. Here, contrasting engagements between different groups such as migrant settlers, indigenous forest-dwelling communities, and state actors are examined in the context of forestry protection and conservation.

Further, using the conservation conflict as a case in point, an interdisciplinary analysis has been attempted to integrate different disciplinary themes and data on a common platform. Model building was carried out by the construction of a probabilistic network based on qualitative reasoning framework. For this, other thematic foci such as the analysis of ecological factors driving crop-depredations, socio-economic factors relating to agrarian distress and vulnerability, inputs from cognitive psychology and the behavioural studies were also incorporated. The methodological significance of this modelling exercise lies in its ability to synthesise disparate (yet necessarily complementary) types of data from different disciplinary spheres to project an emergent view of conservation conflict. This holistic perspective is typically missing from single-dimensional research and associated methods of analysis which only afford a partial (and often distorted) view of conflict. In terms of real-world significance, this research points to the benefits of expanding conservation query frameworks towards identifying root causes as opposed to proximate causes and symptoms. Using a combination of research methods and disciplinary perspectives, this research demonstrates that in addition to visible causal mechanisms (e.g. crop damage, direct attacks), opposition to wildlife is also a reflection of numerous typically unaccounted costs (e.g. opportunity costs, repercussions on food security), invisible psycho-social impacts (e.g. emotional distress, poor physical health, stress), historical contingencies (e.g. migration, agricultural choices), subaltern and mainstream resistance strategies (e.g. everyday resistance, periodic retaliation) and perceptions of marginalisation and distributive justice.

As this study focused on understanding the dynamics of a forest fringe landscape where conservation conflict a recurring phenomenon, some concrete avenues towards conflict resolution can be proposed. This study traced the evolution of conflict and shows that local resistance to conservation is backgrounded by a number of historical factors including prior marginalisation, migrancy, and memories of deprivation. Two issues that require immediate attention include high levels of pestilence by wildlife, especially

wild pigs, and the problems surrounding tree preservation which is opposed by the local community citing agricultural losses and livelihood concerns. Given the complex nature of these problems, simplistic conservation interventions such as forced protectionism through legislation or compensation measures alone are unlikely to resolve the current situation. In this scenario, the most significant avenue towards successful conservation engagements will be the adoption of a more democratic form of conservation and the facilitation of dialogue between local community representatives, civil society groups, and the Forest Department.

Chapter 1: Introduction

1.1 The research context and key questions

Human modification of the earth's surface has been an ongoing process for many millennia, with the scale of anthropogenic activities accelerating over the last several centuries. The resultant modified landscapes are complex environments where interactions between humans and their natural environment are greater than ever before. This complexity is a pronounced feature of tropical systems which not only encompass high levels of biological diversity and endemism, but also feature significant levels of human social and cultural diversity (Myers et al. 2000; Harmon and Maffi 2002). Very often, modified landscapes, such as those located along tropical forest fringes support both biodiversity and human livelihoods, and eventually become sites of contestations between people with divergent objectives such as wildlife preservation and agriculture. Conservation in these regions becomes embedded in complex ecological, social and historical contexts, making practical and theoretical integration difficult within the conventional paradigms of nature protection. Although a growing body of scholarship calls for a holistic treatment of such systems, understanding ecological and social issues either as stand-alone aspects or as parts of a whole involves considerable practical as well as disciplinary challenges.

This study addresses several themes that have the potential to understand conservation challenges and to inform conservation planning in a forest-fringe landscape in the Western Ghats hotspot of southern India. The Western Ghats mountain range has been designated as one of the ten 'hottest' global hotspots on account of its extremely high levels of species diversity and endemism and equally significant levels of anthropogenic threats. Concerns include limited opportunities for expansion of the protected area (PA) network and the ecological degradation of modified landscapes which serve as corridors between protected areas. Located between two major PA complexes in the southern Western Ghats, the Ranni Forest Division (Figure 1.1) in Kerala is a typical mountain landscape with extensive forests fringed by small subsistence holdings and some commodity plantations. On account of its location, faunal diversity, and extensive forest cover, this

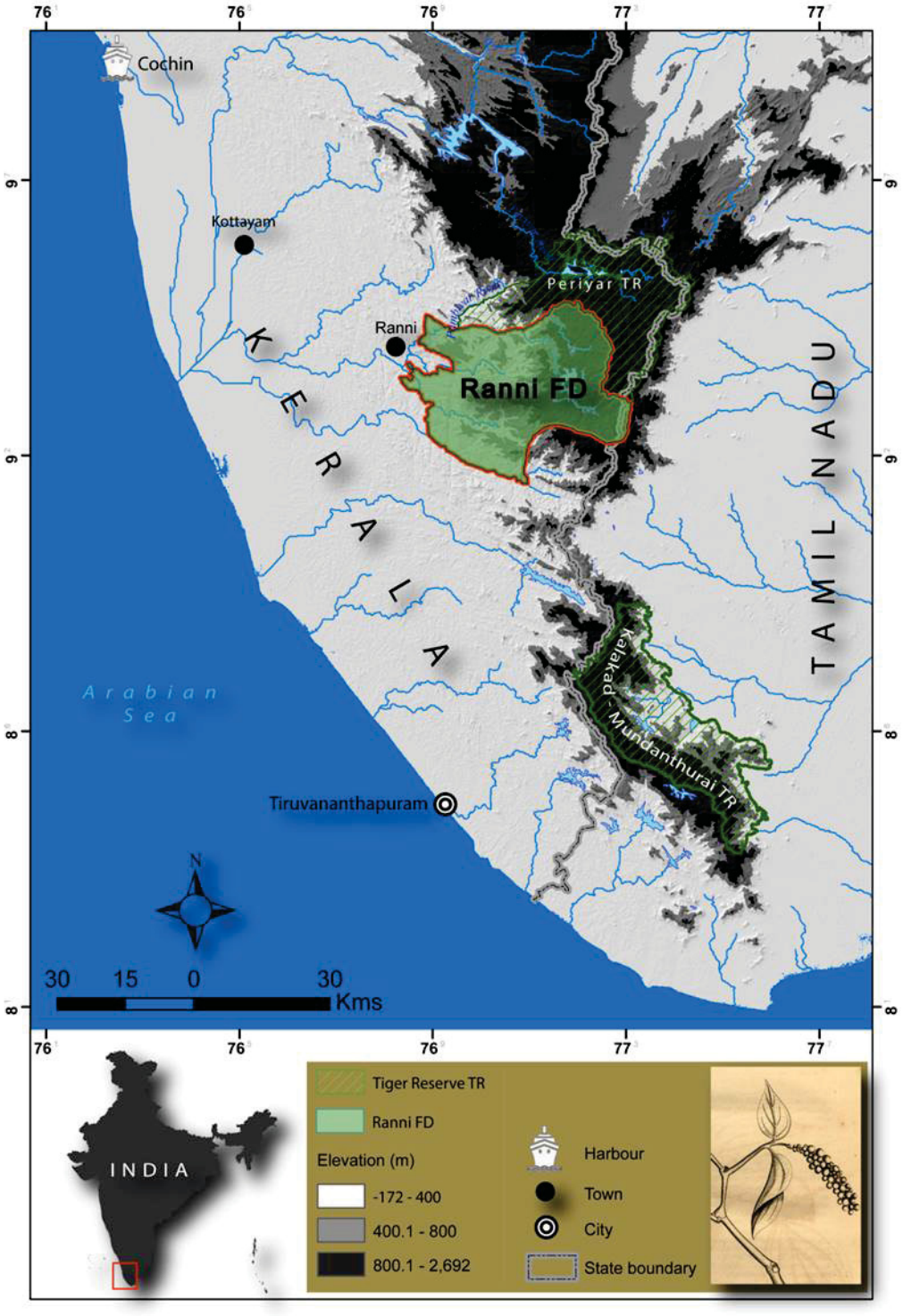


Figure 1.1: Study area. The Ranni Forest Division (depicted in the figure as Ranni FD) is situated between two protected area complexes in southern India. These include the Periyar Tiger Reserve and the Kalakkad-Mundanthurai Tiger Reserve.

area has been identified by global and regional assessments as a priority corridor area for the conservation of significant populations of large mammals and endemic species. To this end, this region is being investigated as a potential site for biodiversity conservation particularly in the context of developing informal conservation arrangements via civil society engagements. These include the development of informal arrangements that aim for democratic solutions and voluntary engagements as opposed to conservation arrangements imposed in a top-down fashion.

A purely ecological evaluation of this area is insufficient to plan conservation action as it supports the livelihoods of a number of forest-dweller communities, as well as agriculturalists and other settler groups. Over the years, the need for protection of the region's diverse biota and ecosystem services combined with imperatives for commodity production and subsistence agriculture, have resulted in protracted contestations over land, resources and governance. Both human-wildlife conflict (antagonistic interactions between people and wildlife such as elephant, pigs and large carnivores) and a more generic conservation conflict (where people oppose environmental protection measures proposed by the state or by conservationists) are common in this landscape. In a pattern that is typical of many forested districts in the Ghats, the transformation of this landscape too can be related to immigration events linked to lowland famines, colonialism and Indian independence, that motivated an influx of poor and marginalised settlers as well as rich landowners, and a collateral displacement of forest-dwelling tribal communities. Compared to large landowners (or lessees) with cash crops such as rubber whose fortunes are determined largely by non-local forces and cushioned by corporate investment, small-holder settler livelihoods show a greater dependence on local influences such as uncertain land tenure (a consequence of disagreements between local landholders and the state over encroached land), agrarian distress, local political upheavals and extended periods of human-wildlife conflict. Understanding social-ecological systems, especially those with the potential to undergo profound transformations, therefore calls for a reconciliation of frameworks that combine and analyse information across disciplines, approaches and time scales.

This study aims to understand conservation challenges in tropical forest fringe land-

scapes by addressing a series of generic questions and narrowing them down to specific themes using a case study approach. These include: What are the significant themes relating to biophysical and socio-political contexts relating to conservation in modified, forest-fringe landscapes of the developing tropics? What are the ecological and social aspects of conservation in such landscapes and how do we study them in diverse, data deficient, real-world systems? How can our understanding of ecological and social dynamics in a forest-fringe landscape be integrated? How can this integration be used to understand complex conservation challenges in this landscape? What are the theoretical and methodological possibilities, and applied recommendations?

Using a case study approach, this study explores the ecological and social aspects of conservation along a heavily populated forest fringe. These two themes are central to resolving conservation conflict which currently pervades most aspects of daily life in the region. As the first major objective, biodiversity presence and persistence in modified landscapes of the southern Western Ghats is explored from the perspective of species responses to habitat modification. These analyses provide a necessary background to the underlying ecological dynamics of conflict in the study region. The next objective examines human-environment relationships, physical and cultural transformations and the wider socio-political linkages that bring about conservation conflict in the study area. This objective is achieved by integrating social and environmental histories and political ecologies centred on the concepts of place and landscape. An integrative analysis is attempted at the final stage to bring together different (yet necessarily complementary) forms of data and disciplinary perspectives on a common platform. The integration is carried out using a methodological template which has been recently developed in the study of complex systems and projects an emergent view of conservation conflict that is not apparent from stand alone explorations of ecology or history. Since, the place-based, case study approach problematises a contemporary conservation issue, the results of this study also lead to a modest set of practical recommendations which can serve as pointers for actual conservation planning at this site. However, the latter needs to be viewed with the caveat that these are the recommendations of a single researcher (albeit one with a long-term engagement with the site). Actual conservation planning needs to be a democratic and inclusive process that goes beyond such research outputs.

1.2 Conceptual and methodological approaches: multidisciplinary and interdisciplinary perspectives for complex conservation challenges

The emergence of a diverse suite of perspectives surrounding the complex 'social-ecological systems' of the Anthropocene, and the need for real-world problem solving has challenged the restrictive philosophies of the 'Edenic Sciences' [1] (Robbins and Moore 2012). Within conservation research, these developments have prompted a shift from conservation biology and its rich species-centric traditions (as envisaged by Soulé 1985), to a pushing of boundaries in the form of a broader conservation science approach to meet complex challenges (Kareiva and Marvier 2012, Rissman and Gillon 2016). Multidisciplinary engagements with the social sciences have emphatically brought into focus the central nature of politics and cultural engagements as well as the rewards of analysing discursive and representational articulations such as oral histories and discourses, and non-discursive/non-representational expressions such as emotion, identity and perception which are missing from the aggregated statistics and quantification of the natural sciences (Escobar 1998; Robbins 2012). Inter-disciplinarity too has witnessed organic growth through the incorporation of the human dimension, i.e., via the integration of the social sciences into the biological sciences when the latter proved inadequate for problem solving (Newing 2010). However, as Newing (2010) cautions, there is no silver bullet approach to interdisciplinarity in conservation science because the extent and type of integration is likely to be contingent on the specific challenge or question at hand. Moreover, as Karlqvist (1999) points out, interdisciplinarity is a challenging prospect along several fronts. Interdisciplinary explorations not only require finding ways to translate appealing ideas from theory to practice, and gaining new insights, but also necessitate the bridging of disciplinary chauvinisms and preconceived notions that are common among practitioners wedded to specific disciplinary silos.

In attempting to research a set of real life, everyday issues that cannot be encapsulated neatly within a single disciplinary or theoretical framework, this study approaches the

1 A set of disciplines (including conservation biology, restoration ecology and invasion ecology) that interrogate and assume ecological baselines separating pre- and post-human impacts on nature. The proponents of such an Edenic view, consider nature conservation in terms of a return to a ‘natural’, ‘stable’ past, despite a lack of evidence for such pristineness and the problematic separation between humans and nature (see also Hulme 2009; Žižek 2015; Head 2016).

problem from a perspective of disciplinary and methodological openness. In the context of knowledge generation, this includes pluralism and an acknowledgement of the value of different types of knowledge (e.g. hard/ soft/ critical) and research paradigms (positivist/ relativist/ constructivist, etc.) for understanding different components of complex challenges such as conservation conflict. Multi-disciplinary analysis in this study was identified through a broad process of 'progressive contextualisation' (Vayda 1983), a method by which the study was initiated with a series of open questions and multiple working hypotheses (Chamberlin 1890)[2], moving progressively outward (or inward) along different spatial scales and scales of enquiry. Ecological and economic themes related to conservation in modified landscapes are analysed from a positivist research perspective. For the ecological analyses, while existing species-based research and expert-derived values provide the relevant inputs for models, the simple predictive models such as naïve Bayes (Lowd and Domingos 2005) and frugal heuristics frameworks (Gigerenzer and Goldstein 1996; Gigerenzer 2007) used in this study are an attempt to move away from an inordinate dependence on data-intensive traditional methods. In other words, alternatives to methods such as regression analyses (that typify most studies on habitat suitability) are explored to develop simpler 'satisficing' (Simon 1955) models that perform well under conditions of uncertainty. The socio-political and historical themes are analysed through relativist notions which better explain the dynamics of power relations and culturally rooted traditions. The latter set of analyses are particularly relevant for this study as they go beyond conventional conservation research to bring to the fore the more intimate scales of analyses. These marginal viewpoints throw new light on the complexities and power differentials that abound in conservation conflicts. Analyses pertaining to the generation of lasting dispositions and attitudes are analysed through the conceptual lenses of habitus and memory (Bourdieu 1977; Halbwachs 1992 [1941, 1952]; Casey 1987, 2000; Nora 1989; Creet and Kitzman 2010). Phenomenological analyses, explored via emic (insider) and etic (outsider) approaches and centred on the issue of place-making (Rodman 1992; Casey 2001 a,b; Stewart and Strathern

2 Chamberlin (1890) points out that it is necessary to approach problems in an open minded way in order to circumvent what he terms ‘the dangers of parental affection for a favourite theory’ or ‘the partiality of intellectual parentage’. In the initial stages of enquiry, instead of adopting a single ruling theory (which ends up becoming a controlling idea by shoehorning evidence), he suggests the use of multiple working hypotheses that could be examined in order to arrive at an answer.

2003) are complemented by tracing political ecological pathways analysed via 'chains of explanation' (Blaikie and Brookfield 1987) and 'webs of relation' (Rocheleau 2008) that enable a structural visualisation of interacting themes. Though locally centred, the latter set of perspectives emphasise the connected and translocal nature of such contexts (Appadurai 1988 a,b; Massey 1994). Together, these analyses contribute to a constructivist as well as materialist history of the landscape.

This study also attempts the integration of different thematic components that relate to the conservation dynamics of the fringe. However, as pointed out by Simon (1969) and underscored by Diamond (1987) in the context of complex systems, the soft sciences are often harder than the hard sciences when it comes to modeling. In this case, the challenges in the integration of different forms of data have been overcome by the adoption of a qualitative probabilistic network (QPN) format which makes use of qualitative reasoning to translate the causal relationships identified as part of the study into a probabilistic framework. Such a graphical network approach not only provides a probabilistic analogue to progressive contextualisation and political ecological analyses (via an illustration of chains of explanation and webs of relation), but also provides a general way to examine Berry's (1981) elegant concept of 'solving for pattern'. Apart from providing a bird’s eye view of our understanding of interrelationships between interacting events and processes, a network approach also alerts us to the potential for unintended consequences as a result of their ability to incorporate the impacts of probabilistic influences throughout their structure.

In addition to the adoption of a mixed methods protocol, this study also aimed to develop methods that support practical research imperatives in the developing tropics. Part of the challenge has been to methodologically address some of the common obstacles related to conservation planning. For example, tropical hotspots are typically poorly studied systems characterised by high levels of diversity, poor availability of research funding and inadequate conservation effort. In most cases, there is not enough information on patterns of occurrence and distribution even for common species. At the same time, there exists a need to understand the role of habitat modification on species persistence especially since there are extensive commodity and subsistence landscapes

interspersed with forests in these regions. Since the extent of diversity makes it difficult to carry out single species-based explorations, it makes sense to look at quick, cost-effective methods with predictive capacities. This study addresses some of these issues by developing simple predictive models derived from existing research outputs and available expertise. The development of these models has also been carried out using efficient modeling techniques that combine expert derived information and mechanical combination processes. Following Einhorn (1972), such techniques use expert judgement for those types of data that human cognition is efficient at (e.g. picking key habitat attributes that impact species) along with machine-based approaches for those components that are difficult for the human brain to process (e.g. mechanical combination processes of these attributes). The probabilistic graphical models and networks utilised in two of the chapters were also selected from the perspective of efficiency and ease of understanding. Both naïve Bayes models and QPNs are amenable to quick, additive, improvements with the availability of new information, and their graphical structure is intuitively comprehensible to experts and lay persons alike. This latter feature is particularly useful in the context of sharing research outputs and incorporating stakeholder comments. A detailed description of the conceptual and methodological backgrounds and the datasets utilised for the different thematic components (mentioned above) are provided within the individual chapters of the thesis. Interviews with human subjects in this study are covered under an ethics approval UTS HREC 2012 183A.

1.3 The structure of the thesis

Addressing conservation challenges in forest-agriculture fringe landscapes as the general focus of enquiry, this thesis explores a set of specific research themes outlined below as individual chapters. This is preceded by a review of literature that addresses the biophysical and socio-political contexts relating to conservation research in the modified tropics. The thesis has chapters addressing stand-alone disciplinary components as well as an integrative chapter that brings together the results of the ecological and social analyses. The structure of the thesis and different thematic focus areas are illustrated in Figure 1.2. Brief outlines of Chapters 1 – 6 are provided below:

Review: Biophysical and socio-political contexts relating to research on conservation in modified landscapes of the developing tropics

(summarising tropical land use trajectories, identifying recurring and emerging themes in tropical conservation research)

- inferences and insights from tropical ecological research
- historical drivers and their current legacies
- tropical agriculture: commodities, food security and farmland
- dominant paradigms of conservation
- neoliberal conservation agendas and counter discourses
- cultural and non-material influences

Assessing potential levels of biodiversity in tropical modified systems: a case study using mammals

(understanding and predicting biodiversity responses to habitat modification in data-deficient, uncertain, systems: a case study using selected mammal species and groups in the Western Ghats)

- utilising existing literature and expert elicitation
- variable selection using frugal heuristics
- naïve Bayes probabilistic networks

Linking historical contexts with conservation: stakeholder engagements with place, experience and conservation conflict

(a selection and analysis of critical historical and contemporary factors affecting landscape transformation and attitudes to conservation – incorporated within a historical and political ecological exploration of the landscape)

- understanding interacting webs of influence
- analysing place-making by different groups of people
- identifying entry points into the system

Exploring and integrating different disciplinary perspectives: a case study of conservation conflict along the forest-agriculture fringe

a multi-disicplinary understanding of conservation conflict, an interdisciplinary explanatory model for integrating disciplinary components on a common platform

- identification of individual themes (as derived from the broad ecological and social objectives of this study)
- identification of quantitative/ qualitative variables that can be fed into a predictive framework and graphical model
- development of qualitative probabilistic network (QPN) to aid decision-making in the landscape

Figure 1.2: A conceptual framework for the study. This framework outlines the main components of this study and their organisation within the thesis

Chapter 1: Introduction

This chapter introduces the study and identifies the broad themes of research that are explored in the following chapters. A brief description of each of the chapters as well as a short introduction to the conceptual and methodological approaches that inform different ecological and social components and their integration is provided (Detailed theoretical and methodological descriptions are provided in each chapter). This chapter also provides a detailed description of the study area and the geographical context of this study.

Chapter 2: Biophysical and socio-political contexts relating to research on conservation in modified landscapes of the developing tropics

A broad range of factors contribute to our understanding of conservation in tropical modified landscapes. While some of these are generic in nature, others are context specific. This chapter reviews the key literature on ecological and socio-political contexts relating to human-modified landscapes in the tropics. The aim of this chapter is to provide a broad overview of research and conservation challenges as outlined in different disciplinary literatures. This review sets the background for the focused explorations that are carried out in the following chapters. In terms of ecological analyses, the review points to the incomplete nature of knowledge in high diversity tropical systems and the need for better predictive models with greater robustness and cost-effectiveness. An evaluation of interacting social themes points to a common ancestry for both land use and conservation trajectories through the overarching influences of large-scale historical and contemporary processes (e.g., colonialism, neoliberalism). Together, the themes explored in the review identify modified landscapes as products of interlinked ecological and social histories, and call for an integration of these aspects in addition to standalone explorations.

Chapter 3: Assessing potential levels of mammalian presence in modified systems: a case study using mammals

The maintenance and persistence of species in modified landscapes is the result of a number of bio-physical and social factors, and is a central research theme in conservation biology. However, research questions revolving around species-habitat relationships are typically dealt with using methodologies that require large volumes of data from time-consuming, costly surveys, and complex analytical frameworks. In tropical systems that are characterised by high diversity and gaps in data availability, their effectiveness is limited. This chapter experiments with a set of non-traditional ecological modeling exercises (Bayesian networks) that aim at developing predictive models for species in complex, uncertain systems. From a broad array of habitat attributes (distilled from published studies and expert opinion) that can be used to characterise modified land uses, the aim is to arrive at a small, yet powerful suite of indicators or surrogates that can be used to predict the presence of species or groups of interest. The prediction accuracies of several types of cost-effective models (frugal sets, expert and literature derived) are compared. While predictive frameworks are developed for mammals, the same concepts and methodology can be applied to other taxa as well. The integration of simple Bayesian networks (in this case naïve Bayes models) with inputs from fast and frugal research methods helps to overcome an extreme dependence on detailed data for habitat suitability explorations. The results of this modeling exercise provide a significant part of the ecological information for the interdisciplinary predictive framework developed as part of this study.

Chapter 4: Linking historical contexts with conservation: stakeholder engagements with place, experience and conservation conflict

This chapter addresses the social component of this interdisciplinary thesis. Using a combination of insights from the big-picture review of literature on the developing tropics and an examination of regional and local legacies, a place-centred examination of the study area is attempted. Place-making by *adivasi* communities, migrant settlers and state officials have resulted in differing biophysical juxtapositions (forests, planta-

tions and home gardens) that reflect multiple influences (shifting political ideologies, livelihood-related exigencies, and embodied environmental relationships), and have evoked different sentiments among disparate groups of people positioned variously in terms of social memory, aspirations and ties to land. A historical exploration uncovers multiple identities for the place in question: a once-bountiful source of timber, ivory and minor forest produce, a refuge for tribal communities, a harsh and impenetrable forest frontier filled with wildlife depredations for impoverished migrant settlers, a source of revenue and large-scale projects for the state, and, finally, as a contested landscape where a state-imposed, urban conservation ethic engendered widespread opposition and subversive resistance among local communities. The different engagements with place (both physical and cultural) outlined above, are analysed in terms of memory and trauma and the generation of varied attitudes towards contemporary land management among different stakeholders. The focus of this exercise has been the identification of 'local entry points' that can be distilled from these relationships and can be employed towards reconciling conservation conflict. Since landscapes with similar complements of stakeholder groups and contestations are a common feature of the Western Ghats, a number of insights from this research can be generalised. Moreover, the key themes and sub-themes explored for this study serve as the nodes of a progressively contextualised network for the integrative exercise carried out as part of this study.

Chapter 5: Exploring and integrating different disciplinary perspectives: a case study of conservation conflict along the forest-agriculture fringe

This chapter demonstrates a method for integration of different types of data from multiple disciplines into a single predictive framework. Conflict between settlers and the forces of conservation (which is the primary issue of concern in the study area) is used as an example of a conservation planning problem that can be explored in this manner. Following from multidisciplinary evaluations and a mixed methods protocol ranging from quantitative approaches (e.g. Bayesian belief networks, generalised linear models) to discursive methodologies (e.g., oral history analyses and key informant inputs), an interdisciplinary analysis is carried out to integrate these themes on a common platform. The integration is made possible by approaching the problem based on intuitively sim-

ple and methodologically uncomplicated tools such as progressive contextualisation and chains of explanation, and the development of a probabilistic network based on qualitative reasoning. Such a network also incorporates elements of decision-making and has the capacity to model the impacts of potential interventions. The methodological significance of this modeling exercise lies in using the flexibility of network-based approaches to contextualise and synthesise different (yet necessarily complementary) data formats (from various disciplinary spheres) to project an emergent view of conservation conflict. This holistic perspective is typically missing from single-dimensional research and associated methods of analysis which only afford a partial (and often distorted) view of conflict. While such an exercise has a less than desirable representation of constructivist articulations especially in terms of representations of power and marginalisation, these are dealt with in the overall historiography. Progressively contextualised qualitative networks, though prone to observer bias and hindsight bias, still remain very useful tools in understanding the overall structure of multidimensional problems. Moreover, they offer the flexibility of being viewed as qualitative models (with actual probabilities) (this feature enables their use by managers or experts), or simply as visualisations of graphical structure (that can be informative to a lay person).

Chapter 6: Conclusion

The final chapter of this dissertation summarises the results of this study and identifies further avenues for exploration. This study is a preliminary attempt at understanding tropical human-modified systems in a holistic manner. There are numerous further areas for research and analysis that can inform conservation dynamics in forest fringe landscapes. In addition to reiterating the key results from this research, this chapter attempts to point out the caveats as well as outline potential improvements that can make future explorations more effective.

1.4 Study area (the geographical setting)

The geographical focus of this research exercise is a forest-agriculture fringe in the Western Ghats mountains of Kerala in southern India (Figure 1.1). The ecological and social character of the fringe has been to a large extent, a consequence of its location on the slopes of the Western Ghats. This study focused on a loosely defined landscape in the Ranni Forest Division in Kerala. While an intensive study area was demarcated for landscape level ecological assessments and household surveys and interviews, larger spatial units were considered to explore regional interlinkages. Therefore, in order to understand the socio-economic and political contexts related to conservation in the area, this study encompasses multiple spatial scales of analysis with the exact spatial extent of the study area being defined by individual queries within the study.

The intensive study area selected as part of this research exercise is located within the Seethathodu Panchayat located in the Ranni Forest Division. The Ranni Forest Division (constituted in 1958 with an approximate area of 1000 sq. km) is located in the state of Kerala in the southern Western Ghats of peninsular India[3]. This Forest Division is divided into three such ranges: Ranni, Goodrickal (variously spelt as Gudarackal, Gudarakal, etc.) and Vadaserikkara. In the larger landscape, this forest division constitutes the major part of a proposed biodiversity corridor that connects two large protected area complexes to the north (Periyar Tiger Reserve and National Park) and south (the Agasthyamalai complex of protected areas including the Kalakkad-Mundanthurai Tiger Reserve). Along its immediate boundaries are situated the Kottaym Forest Division (north), the Periyar National Park (northeast), and the Konni and Achenkovil forest divisions (south). The eastern boundary of Ranni is the Vasudevanellur and Sivagiri Reserve Forests located in the state of Tamil Nadu; along the western boundary are a number of villages and plantations that stretch into the plains of Kerala, especially the paddy producing regions of Kuttanad.

3 Forest Divisions are large administrative units of the Forest Department (FD) which can include various categories of reserved and protected forests that are under different protection and resource extraction regimes sanctioned by the FD in a particular state (National Parks, on the other hand, are centrally administered). Typically, in the Ghats, there are further smaller administrative units called ‘ranges’ which have geographical boundaries encompassing a river valley or a number of small valleys and their associated mountain ranges.

In the larger landscape, the Ranni Forest Division is situated between the Cardamom Hills and the Pandalam Hills north of the Achenkovil Valley, the Ariyankavu-Tenmala Pass and the Shencottai Gap (this gap is particularly important as it facilitated the development of historical trade routes between Kerala and Tamil Nadu and access to forest products). This landscape has the typical complex topography of the southern Western Ghats. Rising from the edge of Kuttanad (an extensive rice production area area located below sea level), the western slopes are an undulating forest region gaining altitude till the divide which also acts as the boundary between Kerala and Tamil Nadu. Beyond the ridge, the rain shadow of the Western Ghats drops abruptly to the plains of Madurai and Tirunelveli districts of Tamil Nadu. Altitudes range from just 10m in the western part of Ranni to over 1500 m in the Gudarackal Range. The region receives rainfall from both the south-west and the north-east monsoons. The bulk of rainfall is from the former. A high level of topographical complexity and monsoonal effects result in over 4800mm of rainfall annually in some places. Evergreen and semi-evergreen forests are predominant; lower rainfall areas, particularly areas closer to the rain-shadow region have deciduous and semi-arid vegetation. The Gudarackal range has among the most extensive stretches of evergreen forests in the region which are of high conservation value. The Division encompasses the watersheds of the river Pamba and its tributaries (Kakki, Kakkad, Kallar). These rivers are dammed at various places giving rise to a number of reservoirs in their submergence zones. The dams on the neighbouring Periyar (e.g. the Mullaperiyar and the Idukki dams) and those on the tributaries of the Pamba constitute the Sabarigiri and the Kakkad hydroelectric projects. Together they provide power and irrigation to the plains of Kuttanad, Kerala's primary paddy producing region and the Madurai district of Tamil Nadu. The foothills and plains of the region bordering Ranni are of significance due to historical as well as current interrelationships between people and forest products. The Kuttanad region which stretches from the backwaters to the foothills is the primary rice producing region in the state. With an area of approx. 900 sq. km, it straddles Alleppey, Kottayam and Pathanamthitta districts and a significant portion of the region is located below sea level.

This landscape finds intermittent mention in ancient accounts if the Sangam period (300 BC. To 300 C.E) as well as to several of the recent accounts relating to the King-

dom of Travancore (Thiruvithamkur, Mal.). Sabarimala, Nilakkel, and Gavi are centres that have found mention in various contexts. It is believed that pilgrimage to the Hindu shrine of Sabarimala is at least a few centuries old. Although access to this temple has been improved in recent decades, in the past, pilgrims reached the temple on foot through a number of trek paths through the forest. The Sabarimala legend, i.e., that of its deity Ayyappan is itself is closely linked to hunting and wildlife of the surrounding forests. Early surveyors such as Ward and Conner and Bourdillion, who traversed this area during the early and latter years of the 19th century, mention these localities in their accounts. Similarly, although disputed due to the lack of sufficient historical evidence, the hamlet of Nilakkel has been mentioned in various texts as one of the churches established by St. Thomas the Apostle. Gavi, a small interior forest hamlet (inaccessible till the commissioning of the Sabarigiri Project) is said to have links with the Tamil kingdoms. Bourdillon (1893) reports the frequent presence of ruins in many forested areas in North and Central Travancore. He attributes this to the local population being driven out of their settlements by wild animals. Also attributing this to Ward and Conner, he states that population of Travancore is said to have been disarmed at the turn of this century (the disbandment of the Carnatic brigade in 1805, and that of the local militia after the attack on Col. Macaulay in 1808) and were hence powerless to defend themselves against animals, particularly elephants. In fact, Bourdillon (1893, p.15) states that '*They must have suffered a great deal from fever, and from the invasions of elephants, in fact even at the present time the villages of the inland show signs of having been built so as to be out of the reach of these animals. Thus at Chettakal, at Nuruvakkada and at Rani itself, the compounds surrounding the houses are protected by high stone revetments, rising 8 or 10 ft. above the path ways, and the houses themselves are only accessible by single pieces of stone let into the revetment, or by wooden bridges from one compound to another.*'[4] These reports are evidence to a long history of engagement between people and forests.

In addition to local ecological processes, both historical as well as contemporary dynamics of the fringe have antecedents and drivers far removed from the region in the

4 Ranni is now a bustling township and one of the largest commercial centres in Pathanamthitta District.

form of regional exchanges, colonial transformations, and political motivations. These have variously been tied to the politics of the lowlands as well as to imperialist and colonial demands and to the post-colonial aspirations of independent India. Current influences too are similarly a mix of local processes and extra-local contemporary commodity dynamics, conservation influences and similar globalising agendas. Ranni and adjoining regions were part of the kingdom of Travancore until the formation of the modern state of Kerala in 1956. Kerala was created from the merger of three distinct political units which shared a common linguistic, martial, mercantile and cultural heritage. These included the kingdoms of Travancore and Cochin, and the northern district of Malabar which till then was a part of the Madras Presidency. The linguistic unity of the state is embedded in Malayalam, the language spoken in all three units, and unifying cultural factors include the legend of the martial sage Parasurama, relating to the creation of Kerala[5]. Although as a geographical unit, whose isolation from the rest of the peninsula was facilitated by the Western Ghats or the *Sahyadri* mountains, the region's early history incorporates wide-ranging maritime trading relations with numerous foreign powers, as well as an extensive history of incorporation of several religions including early Dravidian traditions, mainstream Hinduism, Christianity, Judaism, Jainism, Buddhism and Islam. Historically, the region came under the rule of several large dynasties as well as feudal principalities and has been described as being under a perennial state of war, either between numerous feudal subunits which constantly vied for power or forming alliances and fending off attacks from foreign powers. This martial history along with cultural and economic legacies engendered a unique regional entity which according to the British resulted in a paradoxical position of having the greatest possible happiness among the largest numbers of people (Nair 2013)

5 A dominant legend about the origin of Kerala is the one attributed by Brahminical tradition to the martial sage Parasurama. This mythological hero, considered to be an avatar of Lord Vishnu, reclaimed land from the sea by flinging his axe and claiming the land which emerged (the area between Gokarna in the north to Kanya Kumari in the south) for the Brahmins. Historians such as Sreedhara Menon (1967) are of the opinion that though the legend appears in numerous old literary texts such as Kalidasa's *Raghuvamsha*, it was embellished or modified at some point to facilitate Brahmin dominance in the region. Jeffrey (1976a) contends that this legend was used to reinforce caste-based hierarchies, particularly by the Namboodiri Brahmins to ensure the subservience of the lower castes.

The historical spatial unit of our interest, Travancore, was unified into a large state only by the middle of the eighteenth century. This was carried out by the Venad ruler Marthanda Varma who after having subdued multiple local feuding states and revolts within his own dynasty, consolidated the state into a strong administrative and military power. During the reigns of future Travancore kings, although the kingdom faced multiple setbacks and successes with local as well as foreign powers (particularly the Dutch and the British), Travancore remained a separate political unit till the formation of the state of Kerala in 1956. However, what is significant is that the initial trading partnerships (especially for pepper and other forest products) and small-scale military alliances with the English East India Company gradually effected a significant drain on the financial resources of the kingdom and resulted in administrative subjugation by the British. The transition from strategic ally to political subordinate resulted in a loss of political, military and financial autonomy for Travancore and provided a formal opportunity for the British to dictate the terms of engagement (Varghese 2009). From 1800 onwards, Travancore was largely under the control of a company appointed British Resident. The neighbouring state of Cochin also followed a roughly similar trajectory, but one which had stronger initial relations with the Dutch than the English. Further north, the British-administered province of Malabar, was embroiled not only within the colonial situation, but witnessed a greater degree of local political unrests and small-scale rebellions. Moreover, the region was targeted several times by the Mysore Sultans (Hyder Ali and Tipu Sultan) and bore the repercussions of the Anglo-Mysore wars from which Cochin and Travancore were at least partially shielded. In terms of geographical focus, this study deviates from most contemporary research on this topic by focusing on the internal dynamics of migrations and land transformations within the political unit of erstwhile Travancore. The migrations of Travancoreans to Malabar have been a major subject of interest to scholars, whereas local migrations to the eastern hills of Travancore have received limited attention.

1.5 Summary

Forest fringe landscapes are byproducts of historical as well as ongoing ecological and social impacts. These interlinked components benefit from stand alone examinations to answer specific questions of interest, as well as integrative explorations that demonstrate the dynamic and frequently emergent nature of such systems. The chapters of this study are a first attempt at such an evaluation. While the study is of a preliminary nature, it is hoped that the concepts and methods explored in this exercise are further refined for more comprehensive evaluations of human modified landscapes elsewhere in the tropics.

Chapter 2: Review: Biophysical and socio-political contexts relating to research on conservation in modified landscapes of the developing tropics

2.1 Introduction

Research on biomes reshaped by human activities has been characterised by calls for interdisciplinarity as well as for the revision of conservation biology's scientific and ethical principles (Kareiva and Marvier 2012). Responding to recent calls to incorporate social and ecological elements under a more inclusive 'conservation science' approach (e.g., Kareiva and Marvier 2012) as opposed to a traditional focus on conservation biology, authors with different disciplinary affiliations have debated various avenues for broadening the mandate for conservation research. A holistic approach is also beneficial for conservation practice in the developing tropics, where conservation evaluation frameworks based on ecological principles alone are inadequate in the face of dilemmas concerning human livelihoods. In these regions, a broad range of factors contribute to our understanding of conservation. While some of these are generic and share common links with challenges the world over, others are unique and may align themselves differently in tropical and temperate contexts (e.g. global change impacts tropical and temperate systems differently in terms of community assembly; see Sheldon et al. 2011). These commonalities and differences are not only ecological (e.g. high levels of tropical diversity), but also result from shared socio-political (e.g., North-South differences, agrarian struggles), historical (e.g. colonialism) and cultural (e.g. indigenous hunting, gender roles) contexts whose understanding is central to conservation success.

In the context of this thesis, this review touches upon some important aspects of the dynamics of tropical modified landscapes of which the forest-agriculture fringe forms a part. The aim of the review is to provide an overview of scholarship of frequently occurring ecological, political and social themes that intersect with conservation challenges in modified landscapes in the developing tropics. This includes perspectives and research from multiple disciplines, most of which have been described in detail by scholars in their respective disciplinary literatures. However, for the conservation scientist, this constitutes a fragmented body of work and represents a set of issues that

call for integration while researching multi-faceted research problems. By doing so, this review sets the background for some of the detailed explorations that are carried out in the following chapters. Modified landscapes are characterised by entwined ecological and social histories, and research on these topics have been ongoing for several decades. This ranges from field research on tropical ecology and conservation biology that addresses issues ranging from habitat fragmentation, species responses and the dynamics of ecosystem processes, to an extensive scholarship on a variety of topics ranging from forest and conservation histories, large-scale socio-political processes such as colonialism, neoliberalism and the politics of under-development, food security and agrarian transformations, etc. An understanding of these recurring themes is necessary in order to contextualise the local and regional dynamics. These are progressively contextualised and explored in the following chapters.

This chapter is divided into three broad sections: the first provides a brief overview of tropical land use trajectories (both historical and recent), the second elaborates on a set of recurring as well as emerging themes that are relevant for conservation in the developing tropics, and, the third outlines a set of key imperatives and avenues for investigation to be kept in mind while researching human-modified systems in the developing tropics. It has to be noted that reviews such as this one inevitably tend towards describing regional similarities, and while we can at best describe a few overarching issues, there are distinct regional legacies and perhaps an even greater number of locality specific issues that challenge uniformity and defy homogenisation of any kind. The relative significance and role of each of these issues (whether local or generic) tend to vary with time and place. Therefore, depending on the scale and nature of the conservation context, it is also important to move beyond these generalisations when planning research.

2.2 Tropical land use trajectories

A number of issues linked to tropical deforestation (both historical and current) and changing land use trajectories are relevant for research on modified landscapes. Firstly, a focus on modified landscapes is more pertinent at least in those areas of the tropics where deforestation has run its course or where rates of forest loss have substantially

slowed (Vandermeer and Perfecto 2007). This makes it important to identify those areas where deforestation is ongoing as opposed to areas where large-scale forest loss has run its course or the conversion of primary forest has been successfully stalled. Second, depending on context, deforested areas undergo differential rates of agricultural intensification and types of conversion, some of which are more detrimental than others for biodiversity conservation and ecosystem services. Lastly, following a period of deforestation or degradation, forest regeneration or recovery has occurred in some tropical landscapes (and is a possibility in others) leading to the emergence of novel ecosystems.

With regard to historical anthropogenic alteration of the tropical biome, it is increasingly becoming clear that extensive modification of tropical forests has taken place since pre-historic times. Significant modification of tropical forests has taken place over the past few thousand years. Recent archaeological and palaeoecological evidence shows that many landscapes (including the Brazilian Amazon, the Congo and the Indo Malayan region of Southeast Asia) once thought to be completely untouched by human agency have undergone substantial human modification at different points in history (Denevan 1992; Leach and Mearns 1996; Willis et al. 2004; Shetler 2007). It has been proposed that pre-industrial human impacts were neither passive nor benign, but instead widespread and significant. In some landscapes, native people were keystone predators for millennia, impacting landscapes through hunting, gathering, animal domestication, manipulation by fire and swidden farming (Martin 1967; Simmons 1987; Kay 2007). Pre-industrial urbanism, intensive agriculture and extensive resource use characterised some regions within India, China and the New World well before the advent of European colonialism (Rangarajan 1996a; Heckenberger et al. 2008). As a general pattern, prior to the advent of commodities, large-scale mechanised agriculture and industrial modes of production (both capitalist and socialist), swidden systems with long fallow periods and associated regeneration was the norm in many tropical forests. Other dominant modified systems include selectively logged forests, agroforestry systems, tree plantations (especially monocultures), home gardens and other agricultural land (Simmons 1987). The significance of these patterns for contemporary management is that they not only make it difficult to identify 'pristine' landscapes for conservation, they also allude to a more resilient future (albeit at longer time scales) for tropical forests. These

patterns also lay to rest the myth of a 'pre-colonial golden age' (Pouchepadass 1995) in which indigenous societies purportedly lived in complete harmony with nature.

Though pre-Industrial human manipulations were significant, they were much less dramatic than the centuries of European colonisation and the Industrial Revolution, which witnessed a massive shift in the scale and extent of tropical deforestation (Williams 2007). Colonial domination of the tropics (and some temperate landscapes) was through land expropriation by extermination or exclusion of native people, and by plantation agriculture supported by forced labour (Harris 2004; Wolfe 2006). According to Wolfe (2006, p. 394), the Industrial Revolution, often misleadingly perceived as purely a metropolitan phenomenon, ‘required colonial land and labour to produce its raw materials just as centrally as it required metropolitan factories and an industrial proletariat to process them, whereupon the colonies were again required as a market' (Wolfe 2006). In the hinterlands, the most prominent driver of landscape change during this phase was the development of a 'commodity frontier' characterised by the reorganisation of agriculture through plantation establishment and natural resource extraction (Beinart and Hughes 2007).

Colonialism also exacerbated regional differences leading to devastating famines and associated humanitarian crises in several regions. Humanitarian work carried out with an eye on profit generation and returns on investment included ‘ameliorations’ such as irrigation works that overturned traditionally stable agricultural practices and escalated land degradation. Some of these interventions actually intensified the severity of naturally-occurring droughts in places such as India and China, creating what have been called 'late Victorian holocausts' (Davis 2001). Such 'engines of historical transformation' (Arnold 1991) triggered responses ranging from extreme exploitation and food scarcities to migration, all with consequences for cultivated and forested land. Tropical famines remain a powerful force in public memory, affecting land-use choices today because of continuing fears over food insecurity (Watts 2013). In addition, post-colonial practices also entailed massive land transformations as newly independent governments successfully exploited their peripheral hinterlands (e.g., see Pouchepadass 1995 for India).

Currently, regional patterns of tropical forest loss are highest in South America and Africa with reported losses of 4 and 3.4 m ha per year respectively between 2000 and 2010. Deforestation rates have decreased in Brazil and Indonesia (which have extensive forests and reported the highest net losses in tropical forests during the 1990s). Although the overall figures for Asia show a net gain (primarily as a result of large-scale afforestation rates reported by China), proportional deforestation remains higher in Asia than in Latin America or Africa. Deforestation continues in several countries in South and Southeast Asia. Within this region, annual deforestation during the same period was 0.7 m ha (FAO 2010). Deforestation and modification driven by mechanised agriculture has been greatest in areas such as the 'arc of deforestation' in the Brazilian Amazon which is considered to be the most active frontier in the world in terms of forest loss and fire. The amount of land used for intensive mechanised agriculture increased by more than 3.6 m ha in the Brazilian Amazon between 2001 and 2004. Deforestation for this type of cropland expansion has been correlated to soybean prices indicating that crop production is not just restricted to intensification of agriculture in existing farmland (Morton et al. 2006). Recent research by De Fries et al. (2010) reviewing multiple correlates on forest loss in 41 countries in the humid tropics show a positive relationship with agricultural exports as well as increased urban population growth. These investigations emphasise the importance of non-local, market factors in driving deforestation as well as intensification of agriculture in modified landscapes.

While research on tropical land use change has largely dealt with deforestation and degradation, very little attention has been focused on the regeneration of forests, which has also been taking place at several tropical locations. Termed ‘forest transitions’, these phenomena refer to the recovery of forest that commences following the cessation of a period of deforestation or degradation (which occur as part of a region's initial development) (Mather 1992). Though tropical forest loss and recovery are not comparable in absolute spatial extent, forest transitions have become a recurrent feature of some developing countries, and nevertheless provide significant opportunities for conservation. Deforestation and regeneration of modified lands has also been characterised in terms of differential changes related to lowland and upland topographies (Asner et al. 2009; Rudel et al. 2009). While deforestation of lowland sites for agricultural intensification is

pervasive and a more or less accepted pattern, the proposed pattern of upland depopulation (with respect to human migration) and consequent forest regeneration has been less straightforward to identify or analyse (see Rudel et al. 2009). Asner et al. (2009) report that about 1.2% of the humid tropical biome of Asia, Africa and Latin America has been undergoing some form of long-term secondary growth, 70% of which has been happening in upland environments which are considered marginal for ranching or industrial agricultural enterprises. Regenerating landscapes in tropical uplands may therefore be considered more feasible as opportunities for conservation (Rudel et al. 2009). However, the dynamics of forest transitions are complex and linked heavily to industrialisation, globalisation and associated population migrations (Kull et al. 2007).

A range of arguments have been put forth to explain drivers of tropical deforestation and most of these have consequences for modified landscapes. While causation by any single, overriding factor (e.g. there have been sustained arguments implicating factors such as shifting cultivation and population growth as universal causes) is not supported by empirical evidence, the relationships between multiple causal factors have been difficult to disentangle (Geist and Lambin 2002; Rudel et al. 2009). In their analysis of 152 local-scale tropical studies, Geist and Lambin (2002) identified a variety of agriculture-related proximate causes with regional differences in specific factors. The most frequently reported underlying drivers were economic factors (e.g. growth of markets and cash economies, industrialisation), followed by institutional factors (e.g. poor land tenure arrangements), national policies and remote influences. Population growth as a result of increased fertility (which is often touted as the single most important driver of deforestation) did not figure as a primary factor. Analyses such as these are not only critical for ascertaining regional drivers and agents of change, they also show that the influence of different factors is dynamic and likely to vary with time, place and scale. Analysts of landscape change and degradation, (e.g., Leach and Mearns 1996; Batterbury and Bebbington 1999) point out the significance of examining changes holistically, without which our understanding of landscape change can turn out to be incomplete or even incorrect. Given the diverse and extensive geographies of landscapes, it is important to consider the extent to which factors combine and act as drivers and to contextualise them within the appropriate historical trajectories of political and social changes that

characterise different periods of time.

2.3 Recurring and emerging themes in tropical conservation research

Inferences and insights from tropical ecological research

Research on the response of tropical biodiversity to landscape modification has yielded a few widespread patterns. The most consistent among these is the removal of old growth forests typically accompanied by the loss of habitat specialists in tropical systems (e.g. understory insectivores in bird assemblages, Sekercioglu et al. 2002). However, moving beyond these generalised assumptions of loss has been problematic as actual estimates of loss are scale-dependent and context specific (Gardner et al. 2009). Species loss is likely to have consequences for the structure as well as function of ecological systems. Although functional responses are relatively poorly studied, landscape modification and conversion often result in the loss of specific groups and guilds (seed dispersers, pollinators, species involved in nutrient cycling, etc.) which perform important functional roles (Gilbert 1980). For example, the removal of mammalian seed dispersers by hunting and the loss of avian dispersers as a consequence of fragmentation could result in the restructuring of plant communities (Wright 2003; Peres and Palacios 2007; Arroyo-Rodrĩguez et al. 2009). The loss of pollinators and natural predators is also expected to result not only in ecological consequences for natural systems, but also in the loss of ecosystem services (and associated monetary losses) for agricultural landscapes (Ricketts et al. 2004). Pollination decays (declines) or the breakdown of pollination services are likely to be exacerbated in high diversity systems such as tropical hotspots (Vamosi et al. 2006). There is also growing evidence that the disruption of top-down trophic interactions (especially predator removal) could result in human-induced trophic cascades (e.g. Terborgh et al. 2001; Dunham 2008; Gardner et al. 2009).

Another general pattern that has emerged from research on tropical modified systems is that species persistence is higher in land use types that have greater floristic diversity and structural complexity as opposed to monocultures and landscapes with minimal vegetative cover (Gardner et al. 2009). Modified land uses with the greatest degree of

similarity to their original states as well as those with remnant patches, fragments or elements of forest diversity are likely to support a greater percentage of the species found in tropical forests (Lamb et al. 2005; Scales and Marsden 2008). Examples of viable systems include agroforestry lands with native trees, less severely selectively logged forests, and regenerated swidden plots. (Harvey et al. 2006; Philpot et al. 2008). The amount, type and spatial arrangement of structurally diverse native elements within the matrix are also instrumental in facilitating biological fluxes and connectivity (e.g. movements of species and materials) across the landscape (Tscharntke et al. 2005, 2008). Landscape elements that serve as sources of food (e.g. food plants), breeding or roosting sites (e.g. large canopy trees for arboreal species), and corridors that facilitate movement across patches (e.g. riparian belts) increase the probability of persistence of native species. However, it has to be kept in mind that although there is evidence that individual landscape features (e.g. scattered trees) might have a disproportionate influence on some forms of biodiversity (Fischer et al. 2010), the overall persistence of biodiversity is determined by biological fluxes and ecological functions (e.g. seed dispersal, pollination, predation, etc.) supported by the landscape mosaic (Zimmerer 2000; Gardner et al. 2010).

Until recently, deforestation and habitat loss were regarded as the primary threats to tropical ecosystems. However, with the emergence of climate change as a global challenge, it has become clear that no conservation strategy is likely to succeed without coping with this urgent threat. Hannah and Lovejoy (2011) link several important characteristics of tropical ecosystems that pose significant challenges to conservation. These include the significant degree of global and regional climate regulation carried out by large tropical systems (e.g. the Amazon basin), a poor understanding and remaining uncertainties from palaeo-climatic studies about responses to past climatic variations, uncertainty about the outcome of additional warming during the current (ongoing) inter-glacial period, the important role of precipitation on tropical forest eco-physiology, and the potential cumulative impacts of synergies between climate change and other stressors such as habitat loss and fragmentation.

Our current limited knowledge of the tropics does not capture the full range of complex-

ity or uncertainties about ecosystem responses, making predictions conducive to large errors (under- and over-estimation) with respect to risks and impacts (Corlett 2012). However, despite these uncertainties, a number of results can be inferred. For example, as a general rule, regional impacts are likely to be greater for the tropics than for temperate areas (Woodwell et al. 1998). Within the tropics, these effects tend to be greater for moist forests than for dry forests (Pitman et al. 2000). In modified landscapes, interactions between climate change and other processes such as fragmentation and land use change have potential impacts on meta-populations. Opdam and Wascher (2004) show that in areas where the spatial cohesion of a habitat is below the critical level for meta-population persistence, range shifts (e.g. as a response to climate change) are inhibited. In this context, native elements such as scattered trees will play important bridging roles in migration adaptation (Breed et al. 2011). Tropical ectotherms which live within narrow temperature margins might be more vulnerable (Tewksbury et al. 2008). Colwell et al. (2008) suggest that the tropics which lack a large source pool of species adapted to higher temperatures are also at risk from 'biotic attrition', i.e., depauperation of the lower elevations.

Historical drivers and their current legacies

Historical analyses relating to landscape modification often challenge popular perceptions about causation and the drivers of modification. They also provide an opportunity to analyse multiple discourses, both in terms of dominant articulations as well as marginalised and subaltern viewpoints. More importantly, these analyses enable the identification and exploration of chains of explanation (Blaikie and Brookfield 1987). An analysis of the history and political dynamics of issues surrounding environmental degradation and conservation in the developing world often turns up inter-related processes related to the global asymmetries of power and domination such as colonialism and decolonisation. A period of domination of vast territories on other continents by a few European powers (as per the conventional definition of colonialism) in the past few centuries kick-started a series of processes that can be linked to ongoing global impacts.

The environmental impacts on the tropical developing world in the context of large-

scale processes such as colonialism have received considerable attention (MacKenzie 1988; Grove 1995; Drayton 2000; Beinart and Hughes 2007). However, from the perspective of landscape modification, the most significant change has been the development of a capitalistic commodity growth (Beinart and Hughes 2007) characterised by the reorganisation of agriculture (primarily the introduction of tropical plantation agriculture), changes in forestry and forest governance, the extraction of natural resources, and the widespread proliferation of pastoral enterprises. Many of these activities were transcontinental in scope and can be ultimately linked to the transformation of agriculture, demographics, property rights, institutional change and governance, world trade, markets, consumption patterns, labour, technologies and industrialisation (Murphy 2009).

It is also important to clarify that their influences were not restricted to immediate physical transformations or social modifications, neither were all impacts uniformly negative. Impacts affected both the colonisers as well as the colonised (Said 1994; Drayton 2000). The continuing legacies of these processes is further articulated in the writings of scholars such as Hardt and Negri (2001), Chomsky (2004), and Harvey (2003) who describe not only the hegemonic nature of world powers but also the national strategies of post-colonial governments that exploit their own peripheries. The pattern of internal exploitation was a predominant feature of decolonisation and post-colonial governance in the 20th century. Post-colonial regimes were often equally violent and imperialistic as their colonial predecessors (see e.g. EZLN 2004, outlining the grassroots struggle in Mexico). The legacies of these processes are widespread even today especially in terms of their relevance to contemporary environmental challenges most of which are being played out in modified landscapes. Examples include post-colonial conservation systems and processes that continue to displace or sedentarise people, disallow use and access; forestry practices by states that exert a monopoly over natural resources, commodity exploitation; contemporary hegemonies involving large development projects; as well as current neoliberal links to international markets. In much of the developing world, the memories of colonialism still linger and remain one of the key political experiences through which citizens analyse contemporary threats and processes (Murphy 2009).

Tropical agriculture: commodities, food security and farmland

Recent scholarship emphasises the centrality of contemporary agriculture to ecological stress (Lawrence and McMichael 2012). The overall pattern of agriculture as a proximate cause of most of the world's deforestation holds true in developing tropics, with non-local, market factors and urbanisation driving land-use change and forest loss (De Fries et al. 2010). At the heart of these patterns is neoliberal agricultural globalisation. Neoliberalism encapsulates a set of practices that are characterised by state withdrawal from certain sectors to promote free trade and individual freedoms, and thereby playing an enabling role for greater private sector involvement (Harvey 2005). Although such reforms were initially aimed at markets, analysts point to their widespread impact on non-market spheres resulting in the reconstitution of economic neoliberalism as a political project and ideology (see Tilzey 2006; Castree 2010). For example, from the 1980s, organisations such as the World Bank and the World Trade Organisation (WTO) have combined globalising and neoliberal strategies to dismantle national welfare policies, and change economic and agricultural governance structures in developing economies by facilitating greater integration with external markets (Mohan Rao and Storm 2002; Tilzey 2006).

Agricultural globalisation has engendered multiple impacts. Firstly, in a vast number of cases, tropical cropland expansion is commodity driven (e.g. soybean in the Brazilian Amazon, oil palm in Indonesia, exotic fruit and vegetables in Africa). Crops are prone to abrupt demand shifts due to the emergence of new products, markets and production geographies. International supply chains trading agricultural products (primarily everyday items such as coffee, tea, sugar, textiles, etc.) originating in developing countries and transported via complex routes to end-user markets in the developed world accounted for threats to 30% of species on the IUCN Red List (Lenzen et al. 2012). These commodity chains have typically been characterised by a North-South orientation, i.e. their production was traditionally 'rooted' or profitable in the global South, while their value addition and consumption have been features of the global North (Talbot 2009). More recently, the development of geopolitical power centres and regional alliances have seen associated shifts in trade, financial governance and power resulting in the emergence

of a multipolar world. For example, the emerging economies of the BRIC/S countries (Brazil, Russia, India, China/ South Africa) accounted for 15% of world trade in 2010 with countries such as Russia and China having high global shares and limited environmental safeguards (Purugganan et al. 2014). Alliances such as ASEAN (Association of South East Asian Nations) and development projects such as the Greater Mekong Subregion are also characterised by emerging shifts in trade and power but have found limited engagement from conservationists.

A second, more pervasive impact on modified lands pertains to the politics of food. Commodity trade reforms have replaced '(a rights-based) food sovereignty' (i.e. democratic choice by countries on what to produce, consume and sell) with a '(trade-based) food security' (i.e. where mandatory liberalisation has opened developing country markets to low-priced products facilitated by Northern subsidies) (Lawrence and McMichael 2012). This in turn has decreased self-sufficiency in these regions causing small-holder displacement and indebtedness (Lawrence and McMichael 2012). The global demand for food is expected to increase by 70 to 100% in the next four decades (Godfray et al 2010), causing over one billion people, mostly living in the tropics, to suffer chronic food insecurity (DeFries and Rosenzweig 2010). This is likely to impact land and livelihoods by driving up prices of land, increasing speculation, exacerbating land tenure uncertainties, facilitating land grabs by powerful groups, and promoting socio-cultural inequalities (Lambin and Meyfroidt 2011). The unprecedented investor demand for farmland in Africa from large multinational investors over the past few years is a case in point (Deininger et al. 2011).

However, it is important to point out that industrial agriculture and land grabs also precipitated the emergence of grass-roots initiatives. Such initiatives have attempted to reorient local development pathways towards self-sufficiency and sovereignty, and worked to ensure social equity, environmental justice and the adoption of democratic governance strategies (Escobar 1998; Perfecto et al. 2009). While these social movements (e.g., Zapatista movement – EZLN, The Movement of Landless Rural Workers - MST) emerged in response to specific regional exigencies (e.g. autonomy, land reform), they are now characterised by an increasing exchange of ideas with networks across the

world, the involvement of NGOs, and even engagements with corporate entities. Contemporary groups such as Via Campesina are international networks encompassing over 100 small farmer organisations that work towards their goal of agrarian sovereignty by opposing neoliberal agriculture (Perfecto et al. 2009).

Poverty, politics, development and power

Researchers have analysed developing countries' environmental problems from a variety of angles relating to development economics. While this field has provided a number of critical insights on structural change and economic growth, its scope has not been wide enough, and the developing world's environmental challenges are better understood when viewed through broader analytical lenses such as those of political ecology. The latter, derived from multiple sub-disciplines such as human geography and cultural ecology, has been effective in providing adequate emphasis to situational contexts particularly the socio-political settings that development economics fails to address. For example, drawing on the political ecology approach, Bryant (1997) comments on the emergence of population growth and poverty as the most frequently proposed causes of environmental degradation. The popular perception of poverty in these contexts is the deterministic notion that poverty engenders environmental degradation, that the poor are its main drivers (both as ultimate and proximate causes), and that these challenges affect more than just the developing world (with developing countries assuming a problem-solving role). However, this widespread notion of poverty as 'endemic' or as an 'original state of being' fails to acknowledge that the poverty that is evident in developing countries could be attributed to global political and economic processes in which developed countries have played or continue to play an important part. Such notions fail to attribute the roots of impoverishment to historical exploitative processes such as colonialism, or its continuing legacies. This misreading of the environmental problems of developing countries is very much evident in conservation practice. The mainstream solutions adopted by donor agencies (including the World Bank and the International Monetary Fund) are typically aimed at reducing poverty through the process of economic growth without considering that possibility that poverty could be in fact a symptom of a globalised, capitalist system. There is a lack of emphasis on developed countries'

consumption patterns as is evident even in new strategies such as carbon trading where consumption in the North is maintained at high levels in return for payments to the South. Bryant's analyses (Bryant 1997; Bryant 1998) show that unequal power relations (rich vs. poor, North vs. South, First World vs. Third World, etc.) are central to our understanding of environmental challenges; and that neo-Malthusian arguments at best address proximate (as opposed to ultimate) causes.

Dominant paradigms of conservation

The conservation movement that gained influence during the 20th century was characterised by the establishment of protected areas across the world. Heavily influenced by themes such as wilderness preservation and deep ecology, and driven by historical contingencies such as colonialism, this approach has remained the cornerstone of international conservation strategies (see Guha 1989; Mackenzie 1988; Grove 1995; Drayton 2000; Sarkar 2002). The environmental impacts of colonialism on the tropics have received considerable attention from historians who attribute the creation of the first reserves to imperialist game laws and the perceptions of scarcity induced by commodity extraction (e.g., Crosby 1986; MacKenzie 1988; Grove 1995; Adams 2003; Beinart and Hughes 2007). The roots of the conservation movement can be traced even further back, however, to settler colonialism in temperate North America and Australia. The portrayal of indigenous people as rootless, nomadic, recalcitrant or savage, along with mythologies of 'pristine' landscapes, provided convenient rationalisations for their extermination or exclusion by European-origin settlers (Cronon 1983, 1996; Robin and Griffiths 2004; Wolfe 2006; Kay 2007). In the colonies, such rationalisations initially served as a cover for resource exploitation (or ‘wise use’) and then underpinned the establishment of ‘protected areas’ (PA) (MacKenzie 1988; Grove 1995; Brockington 2002). Grove (1995) argues that 'this new sensitivity [to the limited nature of natural resources] developed, ironically, as a product of the very specific, and ecologically destructive conditions of commercial expansion' of European trading entities in the tropics. Post-colonial conservation has also been highly reminiscent of its colonial precursor. Across the tropics, many conservation systems continue to perpetrate colonial strategies to displace or sedentarise people; disallow use and access; encourage commodity exploitation; facili-

tate large development projects; and promote links to international markets (Huggan and Tiffin 2007).

While conservation via a protected area has had significant benefits (at least over the short-term) for areas that are enclosed, it has had several ecological implications for modified landscapes. An extended focus on protected areas has precluded emphasis on research related to modified systems as well as practical conservation measures aimed at their well-being. Land with a visible human element has been accorded lower priority than what is apparently 'pristine' (see Willis et al. 2004 for a critique of the myth of pristineness) and the same has been reflected in conservation research (with the exception of restoration ecology) (see Lindenmayer 2010). The underlying reluctance to engage with landscapes where human agency is significant and the tendency to consider partially converted habitats as being 'destroyed' (Vandermeer and Perfecto 2007) ignore the reality that these landscapes often hold the key to ecological integrity by facilitating connectivity and supporting ecosystem services (Tscharntke et al. 2005; Gardner et al. 2009). The low priority accorded to landscapes outside protected areas has also resulted in a public perception of these landscapes as spaces where wildlife shouldn't be occurring (Butler 2007).

The practice of conservation has been a politically volatile process in many parts of the developing world. Conservation via exclusionary protected areas, referred to as 'fortresses conservation' (Brockington 2002) has already been questioned as an effective paradigm for conservation in the developing world (Guha 1989; Zimmerer and Young 1998; Chapin 2004; West et al. 2006). Efforts to preserve inviolate spaces entailed the denial of use rights and hunting opportunities to indigenous groups, as well sedentarisation or displacement from their traditional lands (MacKenzie 1988; Grove 1995; Beinart and Hughes 2007; see also Brockington and Igoe 2006; Rangarajan and Shahabuddin 2006). This exclusionary and coercive nature of fortress conservation has resulted in conflicts and social injustices that have been most pronounced in the developing tropics (Lele et al. 2010). Responding to the criticisms of this approach, a number of new inclusive approaches have been initiated in the last few decades that try to address these drawbacks. The first set of alternatives included the Integrated Conservation Develop-

ment Projects (ICDPs) that were initiated during the 1980s by the World Wide Fund for Nature (WWF). Conceptualised, created and implemented in a top-down manner by conservation organisations, ICDPs have been criticised for their lack of understanding of the social and economic aspects of conservation, and for the fact that they did little by way of decentralisation and empowerment of local communities (Hughes and Flintan 2001). However, at the time of their introduction ICDPs were considered a radical divergence from the preservationist approaches of protected areas (Larson et al. 1998) and can be considered as the first set of real alternatives to fortress conservation. Advocacy for increased and meaningful community involvement resulted in the emergence of the concept of community-based conservation (CBC) (that emphasised poverty alleviation) and related conservation initiatives such as enterprise-based conservation, and the creation of community conserved areas (CCAs). In a move away from conventional protected area delineation, the IUCN also amended its categories in the early years of this millennium to include a generally wider class of areas that have a low level of human occupation and the inclusion of traditional practices. It is hoped that CCAs will be a significant step towards decentralised forms of community-based management and the estimated 420 million ha of forests (11% of the world's total area under forests) which are under some form of community-based management is expected to double over the next few years (Kothari 2006).

A number of studies that have looked at the effectiveness of conservation areas managed by communities have shown alternate systems, such as co-management arrangements, to be effective at a number of levels with significant caveats (e.g. Porter-Bolland et al. 2001, Somanathan et al. 2009; Cinner et al. 2012). Lele et al. (2010), who reviewed the literature on alternative conservation initiatives and their governance, suggested that results have been mixed for a variety of reasons. In their words the primary constraint '*is the tenuous and incomplete nature of rights and operational space[s] that are granted to participating communities by the state*'. However, Larson and Dahal (2012) point out that driven by persistent community forestry attempts over the past several years, a transition towards decentralisation is already underway in forest tenure reform which should not be ignored. The effect of forest tenure reform was examined from the perspective of the bundle of rights concept (i.e. access, use, management, exclusion, alienation)

(Schlager and Ostrom 1992). These studies show that despite gaining rights on paper and a transition towards tenure reform, the increases were primarily for use and access and less for management or decision-making. Management is a complex issue, and even when the rights are granted formally communities continue to be obligated to state rules or other external policies, with the ultimate over-riding authority being retained by the state (Larson and Pulhin 2012). They also point to the need for addressing other issues such as time (duration), security (which is particularly problematic in practice), depth of rights, appropriate control, and obligations. Although challenging, these explorations are a first attempt at unravelling the complexity of interventions that support both conservation and livelihoods.

Neoliberal conservation agendas and counter discourses

The intertwined character of political and economic factors had rarely been explicit in early colonial conservation agendas where the need for reserves was articulated in language that stressed scarcity, past pristineness and the natives' inability to manage resources. In recent years, wider capitalist processes have become explicitly embedded within conservation, with the two mutually reinforcing each other (Castree 2003). Contemporary scholarship goes a step further, describing this as a 'conservationist mode of production' or a specific type of capitalist production that not only commodifies nature but also re-envisions its symbolism and reorders its governance to benefit powerful elites and external agents, including Western scientists, donors and tourists, promoting fads such as ecotourism, celebrity conservation and ethical consumption (Brockington and Scholfield 2010). Despite inhabiting incongruent spheres in terms of values, ideologies, and strategies, these processes forged links between unlikely ideological partners, particularly NGOs and private corporations, to facilitate what is now commonly referred to as market environmentalism, green neoliberalism or green capitalism (Igoe & Brockington 2007). This approach argues that capitalist expansion and conservation are not only compatible with each other but are a desirable partnership (Castree 2010). Criticism has been directed at Big International NGOs (BINGOs) for adopting these strategies, leading in turn to a shift in state, civil society, corporate and donor perspectives (Brockington and Duffy 2011).

Instruments like payments for ecosystem services (PES) and related schemes for climate change mitigation (REDD and REDD+) are similar neoliberal strategies. While PES and ecotourism are visible forms of market-based conservation, a more pervasive 'hybrid-neoliberalism' (McCarthy 2005) is taking shape. Dressler and Roth (2011) call this '*the bridging of free-market enterprise and civil society ideals with community-based conservation*' which has shifted community-based conservation increasingly towards market-oriented solutions. Commodification, intensification of agriculture, privatisation of property and changing social relations are key outcomes in regions like Southeast Asia, leading to large-scale land transitions (forest to non-forest, rural to urban, agrarian to industrial, commons to private ownership). According to Dressler and Roth (2011), '*landscapes once peripheral to market activity are now, at a very fast pace, being governed through various local, regional and global market processes*'.

For developing countries, the most pressing concern is that such strategies cause extensive dependence on global markets, increasing disparities in wealth and consumption, overturning long-standing traditional practices, and disrupting deeply rooted cultural norms. Critics argue that by adopting as desirable solutions the very structures that create environmental challenges, neoliberal conservation '*contributes to [a] wider systemic failure of mainstream ideas and "sustainable development"*' (Büscher et al. 2012). NGOs, which act as the primary vehicles for such conservation, could be held guilty of legitimising and reinforcing (an apparently benign) capitalism (Brockington & Scholfield 2010). On the whole, Harvey's (2005) criticism of the development of neoliberalism as '*a decentred and unstable evolutionary process characterised by uneven geographical developments*' holds true. Alternate conceptualisations could instead be offered up from approaches calling for the critical examination of Northern consumption patterns, subsidies, etc. which have been put forward by progressive Southern NGOs or those involving territorial and cultural autonomy along with the local control over natural resources as demanded by social movements (Escobar 1998). While opposition to globalising strategies like industrial agriculture and free trade has a long history, their explicit linkages to biodiversity conservation have been of a more recent nature. Yet, they have been immensely effective in countries like Brazil where the whole-sale development of Amazonia was opposed by grass-roots initiatives such as the MST (Wright and Wolford

2003).

Cultural and non-material influences

Peoples' perceptions and knowledge about nature and their cultural involvements with the environment play a significant role in addressing all aspects of conservation. This involves decisions and choices about what to preserve, where to plan interventions as well as the adoption of specific methodologies, strategies and goals. Cultural analyses, or the analysis of beliefs, perceptions and ideas about conservation, have been limited in most mainstream conservation literature. The practice of conservation is also essentially a social and political process that involves significant engagements with human organisational process to bring about social actions aimed towards nature management and protection (Wilshusen et al. 2002; Mascia et al. 2003). Bringing about social action involves an understanding not only of conventional ecological and socio-economic dimensions but also of the non-material and unarticulated aspects of human-environment relations (Head et al. 2005). These include a wide range of perceptions, beliefs, practices and rituals that can be grouped under the broad umbrella of culture and lie on the fringes of most conservation research.

The analysis of culture is an important requirement for conservation in modified landscapes of the developing world. MacDonald (2004) cites important reasons for this. Understanding culture provides a more complete way of understanding nature, and has been particularly useful in changing the stereotypical images of developing countries as being only interested in subsistence and development to that of nations with rich bio-cultural diversity and history. For example, the loss of vernacular languages, which are relevant from the perspective of bio-cultural diversity (Harmon and Maffi 2002), plays a major role in the marginalisation of communities, exclusion and powerlessness, and ultimately leads to their marginalisation within the conservation arena. Additionally, the examination of cultural aspects provides insights into the way conservation has been historically embedded in developing world scenarios and has important pointers for future policy and management. Finally, culture is an issue which is increasingly finding a place on the conservation agenda as a result of empowerment of those groups which

have been historically marginalised under various forms of subjugation. Their questions revolve around correcting historical injustices, claims to ways of life and traditional practices.

Society and culture in the tropics has been researched from a variety of perspectives including (but not limited to) those of place, memory, movement, resistance, ethnicity, gender, identities and representation. To cite an example, one of the defining features of the 20th century social and political upheavals involved the movements or the migration of a large number of people. The profiles of these population flows were varied (voluntary, ethnic, forced, etc.) as were their driving forces (e.g. wars, famine, agricultural reform, conservation.). Migrant communities were not only instrumental in bringing about physical transformations to the landscapes they left and occupied, they also brought with them knowledge, experiences and memories which are retained in the form of rituals and practices. Even further, the cultural and non-material aspects of place and locality not only include the exploration of practical and ritualistic contexts that have brought about neighbourhoods and settler identities, but also their role in the generation of wider, dynamic contexts and their shifting positions within regional and global milieus (Massey 1994; Appadurai 1996). These issues have been explored in multiple contexts (e.g., in Amazonia by Raffles 2002; among Australian aboriginal communities by Goodall and Cadzow 2009), and as Escobar (2001) points out, go a long way towards understanding the role of locality and the links between place, culture and livelihoods in shaping (and continuing to shape) the landscape and perceptions as they stand today.

A cultural analysis of resistance, conflict and violence is also pertinent in those areas of the tropics where memories of colonialism, disenfranchisement and marginalisation still linger. The cultural and psychological impacts of colonialism resulted in the development of 'cultural nationalism', which continues to inspire struggles for cultural as well as political autonomy (for the development of this idea, see Fanon 1952, 1961). Furthermore, these strategies are still evident in the context of conservation, which has witnessed local resistance to state conservation policies as well as opposition to conservationists. Brockington and Igoe (2006) explain resistance in the following manner: '*Beyond material loss to livelihoods or dwellings, protesters fight their symbolic oblit-*

eration from the landscape – their removal from its history, memory and representation ...Other groups protest their loss of power and control over their environments, the interference of the conservation regulations into their lives in ways over which they had little control ... Else they protest the interference of different value systems into local economies, the commodification of wildlife and nature into things which tourists can purchase, but which locals can then no longer afford ....'. However, as Peluso and Watts (2001) point out, violence fits awkwardly within the environmental discourses, and environmental violence also tends to mask other forms of social struggle (Peluso and Watts 2001). As Bryant (Bryant 1997) points out, understanding power by a sole reliance on material practices is incomplete without considering the unarticulated, non-material aspects of resistance.

2.4 Revising research and conservation paradigms

In the above sections, a set of critical themes relating to conservation in modified landscapes has been summarised. This analysis shows that whereas long-term biological research in the tropics points to a set of ecological impacts that can be generalised broadly, large-scale historical trajectories have resulted in influences that are encountered repeatedly in these regions, and lead directly to impacts on social and economic power relations. Conservation in these landscapes is contingent on negotiating these power differentials and by achieving a balance between ecological and social objectives. Keeping these ideas in mind, the concluding section of this chapter attempts to outline a set of key imperatives and approaches that could be useful for researching landscapes which have human organisational complexities. The first relates to devising ways to generate cost-effective ecological and social predictions in data-deficient, uncertain systems, and in understanding these systems in the context of political dimensions, underdevelopment, resistance and differential ethical standards. The second briefly describes approaches that could bridge disciplines effectively and bring back specificity and context, which are complementary, yet necessary, elements to generic explorations.

Key directions

Incomplete knowledge: In the developing tropics, data on biological diversity as well as socio-economic parameters are often likely to be incomplete, complex, biased, and plagued by uncertainty. The challenges related to ecological data collection and analysis are exacerbated by the fact that tropical systems are assembled differently. As evidenced by the latitudinal gradient in species diversity, high diversity is a hallmark of the tropics (at least for a significant number of taxa). In most tropical hotspots, diversity and endemism go hand-in-hand, resulting in a large number of species with restricted distributions. In these systems, constraints of time and money have meant that research effort is also restricted to a few species and a few well-studied locations. Studies have also been confined to occupancy studies (that fail to take into account species abundance) which are uncertain proxies of species viability. Research outputs from tropical systems are characterised by publications emanating from a few well-studied locations, with research findings transferred and extrapolated to other sites (Gardner et al. 2009). Similarly, social research in these regions has also been hobbled by a lack of resources and data, inadequate problem formulation and attention to feedbacks between conservation and social-ecological systems (e.g. see Ostrom and Cox 2010; Miller et al. 2012). Tropical conservation research therefore remains to gain a great deal from cost-effective, innovative designs that circumvent costly data gathering to yield better predictions and modeling results (Fielding and Bell 1997, Grantham et al. 2009). Potential innovative directions for this type of research include explorations into prioritisations based on triage-based resource allocations, heuristic decision-making, networks and systems-based approaches, etc. (e.g. Gigerenzer et al. 1999; Gigerenzer and Selten 2001; Bottrill et al. 2008).

Embracing politics: Recognising the political dimensions of conservation processes is not a new suggestion, but it is often avoided by cautious scientific researchers in a bid to remain apolitical. Yet as the literature cited here argues, a desirable direction for applied research and conservation interventions in modified landscapes is to view science and politics as interlocking elements of coupled human-environment systems. In modified landscapes, characterised as they are by high levels of human-nature interactions, con-

servation research calls for an *understanding* of relevant social and historical contexts, regardless of whether or how conservation scientists deal with advocacy. Echoing Forsyth (2003), this would require the adoption of an '*analytical approach that is biophysically grounded yet conscious of social and political constructions*'. This means examining science to understand an issue but also to explore how scientific questions and results have emerged and been used politically by different interest groups. Krishna's (2009) observations on post-colonial resistance provide a valuable example. He points out that globalisation and modernisation, which draw on ideals of scientific rationality and equity by championing individualism and free markets, seem to depoliticise markets. At the same time, colonial histories and persistent popular memories of resulting inequalities lead directly to resistance against these forms of markets and relations. The political legacies of twenty-first century colonial and postcolonial contexts are encountered as much in conservation as they are in day-to-day economic and political domains. These themes could therefore serve as important axes along which conservation is understood in modified landscapes.

Rethinking underdevelopment: Conservation and development are often attempted in tandem without considering unequal power relations generated by socio-political processes. An example is the widely-held Neo-Malthusian perception of poverty as 'endemic' or as an 'original state of being', brought about by uncontrolled tropical population growth. This view fails to acknowledge the links between poverty and historical exploitation and under-development in many developing countries (Rodney 1973; Escobar 1995; Bryant 1998; Perfecto et al 2009). Such a misreading is reflected even in the solutions adopted by international financial institutions that typically promote poverty reduction by imposing economic growth instruments and technological fixes without considering that poverty could be a symptom of a globalised, capitalist system (Bryant 1998). Fundamental, democratic changes that address to change these systems of domination and exploitation rarely figure in such strategies. Conservation science too has been characterised by a simplistic engagement with these issues. A case in point is the controversial study by Wright and Muller-Landau (2006) which problematises the correspondence between forest cover and human densities to conclude that: '*... humans living in rural settings have the greatest impact on extant forest area in the tropics....*'

and that, '*a strategy to preserve tropical biodiversity might include policies to improve conditions in tropical urban settings to hasten urbanization and preemptive conservation efforts…*'. The focus on local people as culprits and increased urbanisation as a solution reflect a poor understanding of the system and merely treats the symptoms. It distracts attention from investigating underlying causes for high population or high levels of extraction or the global markets for extracted resources (Kaimowitz and Angelsen 1988).

Understanding resistance to conservation: The most visible social consequence of unequal power relations manifested in conservation is resistance. Resistance, conflict and violence are not only relevant in the context of protected areas, but also pertinent in those areas where memories of colonialism and its attendant impacts like dispossession and marginalisation persist (Neumann 1998). Histories of colonial contexts, typified by external control, are therefore likely to predispose communities towards resistance to conservation. This opposition may take many forms: from subtle, everyday, informal and individual resistances (Scott 1985) to organised social movements, open rebellions, 'individual and collective, material and symbolic' resistance (Holmes 2007) and ecological nationalisms (Cederlöf and Sivaramakrishnan 2006). In modified landscapes, similar sentiments could result in widespread opposition to conservation initiatives, manifesting as opposition to capitalist expansion, or to real or perceived inequities where marginalised groups bear inordinate costs, receive inadequate share of benefits, or are excluded from decision-making (Peluso & Watts 2001; Büscher et al. 2012). A related issue is that of continuing elite appropriation. In almost all the themes considered here, ranging from resource grab, to conservation research, profits, knowledge and media coverage, the balance of power is tilted in favour of powerful elite groups, whether local or external.

Conservation ethics for modified landscapes: A spectrum of ethical undertones can be inferred from conservation activities over the years, ranging from imperialist designs aimed towards land appropriation and human exclusion to honest efforts to protect species, ecosystems and livelihoods. In much of the recent protectionist writings (e.g. Cafaro & Primack 2014), conservation is depicted exclusively as a moral endeavour devoid of its social and political antecedents (Carruthers 1989; Neumann 1992). Char-

acterising conservation motivations as purely ethical ignores the underlying politics of historical and contemporary conservation engagements, and their heavy dependence on context (Guha 1989; Wilshusen et al. 2002). Similarly, calls to halt species extinctions as a universal moral responsibility are questionable on several levels as ethical norms vary within and between individuals, societies and contexts. Guha (1989) and Brockington (2004) have critiqued the ethical standpoints of radical as well as 'Third World' environmentalisms. For modified landscapes in particular, caution is needed in adopting exclusivist ideologies which are purely bio-centric or anthropocentric. Instead an inclusive, pluralistic ethic that encompasses a continuum of human values, embedded within cultural and environmental contexts, is more desirable.

Bringing back specificity and context

Avoiding oversimplification: Though a big picture exploration provides a general political ecological background for tropical modified landscapes, major differences emerge from distinct regional and local legacies whose significance and impact tend to vary with time and place. It is therefore essential to avoid oversimplification and to examine differences and particularities where necessary. For example, different colonial entities were instrumental in creating distinct post-independence legacies of environmental and social restructuring. Nor can every development within a region be attributed to colonialism. Additionally, outside political pressures may not be the most important catalysts of change in every conservation context; instead, local drivers may take precedence. Ideal research methodologies therefore encompass human-environment relations across scales and incorporate elements of both generality and specificity without becoming prisoners of either. Understanding these issues in parts or whole is nevertheless challenging given the lack of mutual understanding by disciplinary researchers, therefore the following section briefly reviews two promising avenues of research.

Place-centred examinations: The concept of 'place' directs attention to the interactions between the physical and biological materiality of sites, and the human cultural activity which attributes and consolidates meanings to those material attributes (Cresswell 2004). Attention to place provides a critical complementary understanding to the gen-

eralisation and the 'denial of localisation' (Escobar 2001) that typically characterises big-picture explorations. In other words, conservation will benefit from juxtaposing two approaches. First, it should draw on widely applicable, scientifically-derived generic overviews. Simultaneously, it needs smaller scale, focused studies which are tied to conservation practice as well as recognising the qualities of specific environments and the ways people attribute and sustain meanings for those areas as 'places'. At the same time, it is also critical to examine the more fluid notions of place-making such as those in the context of contemporary global situations of migration and displacement where places play a role in the generation of memory, choices and aspirations of such groups. For instance, diasporic memories of place could be viewed in terms of migration which then becomes the essential condition of memory (Creet and Kitzman 2010). The concept of place or place-making (whether physically grounded or not) could therefore serve as the basic platform for exploration of physical transformations of the landscape as well as the space for a deeper examination of human-nature interactions that are difficult to measure using conventional examinations.

Bridging disciplines: Integrated methodological frameworks that incorporate multiple disciplinary and theoretical aspects can also be used for understanding complex conservation problems. Cross-disciplinary understandings are necessary because many causes of environmental dilemmas are non-local and lie outside the realm of conventional conservation (e.g. perverse environmental subsidies). Typically, conservation professionals come from different disciplines and it is unreasonable to assume a perfect understanding of both ecological and social research concepts. For those who can overcome the shackles of exclusively positivist or relativist thinking, established concepts such as progressive contextualisation (Vayda 1983) offer viable directions for initiating and exploring novel research. Such procedures encourage researchers to start out with open questions and multiple working hypotheses (as opposed to a predetermined theoretical framework; Chamberlin 1890), and to move progressively outward or inward in space and enquiry, using methods relevant to the emerging questions, which may range across both quantitative precision and social theory. Such methodological frameworks could eventually lead to more detailed understandings of diverse disciplinary scholarship. However, encouraging progressive contextualisation does not imply or promote an atheoretical

approach. Instead, progressive contextualisation can widen the process of investigative practice in the initial stages of a research enquiry which would then (on comparative analysis) point to the existence of persistent patterns and their theoretical underpinnings that are relevant to the particular context or region that is being evaluated.

2.5 Summary

This chapter summarises key themes from environmental research and discourses that are of significance in modified landscapes in the developing tropics. Conservation-focused research in landscapes such as forest-agriculture boundaries needs to take into account a number of themes that have been elaborated in the above sections. Along with ecological explorations, an understanding of the complex legacies of exploitation and social upheaval that underlie transformations of tropical landscapes is critical, because failing to incorporate the complexity of causal factors brings the risk of viewing these problems too simply, leading to unsuccessful attempts to contain proximate factors (or symptoms) with little impact on ultimate processes. Conservation science as a whole could therefore benefit from an expansion of its scope to incorporate scholarship from the recent convergence of interests in environmentalism across a number of disciplines. This would result in more nuanced understandings of conservation challenges that could in turn lead to the development of socially just solutions that are not counterproductive to conservation in the long run.

Chapter 3: Assessing potential levels of biodiversity in tropical modified systems: a case study using mammals

3.1 Introduction

The impact of human modification of forests is a primary research focus in tropical conservation biology, and its understanding serves as the necessary ecological background to conservation planning. In these regions, the spatial as well as temporal patterns in biological diversity are the consequence of a broad range of ecological and anthropogenic factors, both historical and contemporary (Gardner et al. 2009). Land use transformations along the forest fringe represent a changed set of circumstances for species and ecosystems. Ecological communities are altered in the composition of species that can persist in a particular landscape as well as in terms of the structure and function of food webs and other ecological interactions. The scholarship on tropical habitat modification demonstrates that commodity and subsistence land uses placed along a modification gradient show a diversity of species responses to habitat alteration. However, our understanding of these patterns is severely constrained by a deficit of information on the status of biological diversity in modified land uses, especially in rural areas (Chazdon et al. 2009; Gardner et al. 2009).

This deficit in knowledge is in large part a consequence of the nature of tropical ecological explorations to date. Tropical datasets are characterised by incompleteness and uncertainty even for well-studied taxonomic groups and relatively better-researched geographical regions (Gardner et al. 2009). Research in these regions has typically focused on conventional, data and effort-intensive approaches often involving costly surveys and complex analyses. Although these studies have been the cornerstone of our existing understanding of ecological patterns, the feasibility of this type of research needs to be evaluated against the vast diversity of tropical species and land use types. Understanding the tradeoffs involved with respect to conservation action is also critical, because lack of sufficient information is a frequently attributed reason for inadequate conservation strategising and policy development. When compounded by practical limitations such as funding constraints, such circumstances result in significantly delayed

action on the ground (Grantham et al. 2009). This chapter analyses species' responses to habitat modification for two reasons. Firstly, an understanding of species-habitat relationships in modified landscapes along the fringe constitute the building blocks of the interdisciplinary exercise that is attempted in the last chapter, i.e., identifying what is present in these landscapes so that conservation planning can be carried out. Second, by experimenting with a set of non-traditional modeling exercises, this chapter explores the possibility of using simpler data structures and inference mechanisms for generating robust models of species presence along the tropical forest fringe. In other words, the latter exercise attempts to understand habitat suitability for species by moving away from complex traditional modeling in order to develop simple, good enough models that can be quickly applied across larger suites of tropical species complexes.

3.2 Concepts and justification

To overcome dependence on detailed data, a number of studies have explored the effect of different levels of data availability and information gain on conservation strategies such as reserve selection (e.g. Gaston and Rodrigues 2003; Gladstone and Davis 2003; Grantham et al. 2009). However, the examination of similar attributes at the species-level (or that of meaningful functional groups and guilds) has been limited due to theoretical, methodological and logistical barriers. For instance, though species' responses to habitat modification remain one of the most frequently researched topics in conservation science, challenges still abound in the development of cost-effective, simple models of habitat suitability (Martin et al. 2005). Tropical modified landscapes are particularly problematic in this context as the large numbers of species, limited information on each of them and the emergence of novel ecosystems impose multiple constraints on the compilation of comprehensive datasets (Gardner et al. 2009). Evaluating the efficacy of existing information and expertise, and the use of innovative strategies that circumvent complex data collection and yet have predictive value for conservation, is therefore, emerging as a profitable area of research in this field (Fielding and Bell 1997; Grantham et al. 2009). In this chapter, an effort is made in this direction.

Among the variety of approaches that are now available to address these types of issues Bayesian Networks (BNs) or Bayesian Belief Networks (BBNs) (Pearl 1988) are useful for describing dependencies (causal or otherwise) between variables in terms of probabilistic relationships. BNs are increasingly finding application on account of their cost effectiveness, their flexibility in combining different forms of prior knowledge and data, and their robustness to imperfect knowledge (Jensen and Nielsen 2007). Their intuitive appeal stems from the powerful insights attained from the encoding of probabilistic data within simple graphical structures and the calculation of conditional dependencies based on evidential reasoning. In other words, BNs are graphical representations of our understanding of relationships between different variables (represented as nodes), and connected by arcs and links that represent probabilistic dependence or independence (beliefs) between them (Pearl 1988). The combination of elements of probability and graph theory with statistical and modern computational advances has made them popular tools in several disciplinary fields including ecology. Despite their attractive attributes, however, the drawback of traditional BNs is that they call for a large quantity of data which has to be parameterised as conditional probability tables, which in turn is likely to force the incorporation of imprecise and often unrealistic information into the models (Pradhan et al. 1986; Parsons 2001; Drużdżel 2009). The inherent complexity and multi-dimensionality associated with some large systems also make some of these models computationally intractable (Gigerenzer et al. 1999). At the same time, research also seems to suggest that model diagnostics work adequately even in the absence of precise quantification; in other words, even highly imprecise input probabilities are unlikely to undermine the diagnostic potential of the network, provided they approximate a robust structure (Pradhan et al. 1986). Building on these insights, a number of variants of these models such as naïve Bayes models and qualitative probabilistic networks (QPNs) have been explored by researchers in the fields of machine learning and artificial intelligence.

The application of BNs in environmental research has been largely in the fields of environmental decision-making and species-environment relationships. The latter topic has received attention particularly in the context of habitat suitability modeling and species distribution models (e.g. Marcot et al. 2001; Smith et al. 2007). Following calls for simplification and the need for more flexibility towards input data types, habitat suit-

ability predictions in recent years have benefited greatly even with the use of simpler, computationally efficient BN structures such as naïve Bayes (NB) and tree-augmented networks (TAN) (Friedman et al. 1997). These offer a probabilistic alternative to frequentist methods such as logistic regression which are typically used to model such relationships (Mitchell 2015). The first of the alternative models discussed above, naïve Bayes (NB), links target variables to all environmental variables and the second, the tree-augmented network (TAN), performs structural learning by including dependencies between correlated variables. Both have been found to be robust in the face of simple data and surrogate variables which are easier to obtain (Aguilera et al. 2010; Lockett 2012; Altartouri and Jolma 2013). In general, despite their simplicity and underlying independence assumptions, naïve Bayes models have shown excellent performance and effectiveness not only in clustering and classification, but also for general probability estimation which has been the forte of traditional Bayesian networks. However, in the latter, independence is context specific and model building is complex and costly (Cerquides and de Màntaras 2003; Lowd and Domingos 2005). NB, on the other hand, brings such networks back from the world of complexity (epitomised by the traditional BN) into the realm of heuristics or simple analytical rules and structures that utilise less information but are nevertheless robust in their predictive capacity given an uncertain world (Gigerenzer and Brighton 2009).

To build on this analysis, this chapter uses insights from the study of fast and frugal heuristics (Gigerenzer and Goldstein 1996). This field relies on the use of heuristics or simple rules of thumb, and frugal methodologies that are increasingly being used to derive insights for complex scenarios. Countering the common proclivity for turning to complex solutions for complex systems, simple heuristic algorithms such as 'fast and frugal', 'take-the-best' and 'one good reason' fall within the framework of 'satisficing' approaches that neither maximise nor optimise, but nevertheless routinely outperform these complex optimising calculations under conditions of uncertainty (Gigerenzer and Goldstein 1996; Gigerenzer 2007). Satisficing, a conjugate of sufficing and satisfying was proposed by Simon (1955) to characterise algorithms that perform robustly under conditions of limited data, time and computational capacities. In traditional analyses, such heuristic algorithms have been utilised by researchers to counter situations of data

deficiency, cognitive limitations or computational intractability, but recent research in the field challenges these assumptions by showing that in many situations, more information or complex computation can in fact decrease accuracy (Gigerenzer and Brighton 2009). In the field of ecology and conservation, heuristic solutions have found vast exploration in animal behaviour and reserve selection exercises but rarely in studies relating to species habitat relationships.

For data deficient systems, both Bayesian networks as well as frugal heuristics are amenable to integration. They also offer the additional advantage of integration with expert elicitation frameworks. These features give us the opportunity to ameliorate the drawbacks of one method (here, the high level of data requirements for traditional BNs) through improved by inputs from the other (frugal heuristics) via the development of simple probabilistic networks such as naïve Bayes. In the ecological sciences, while BNs have been used for species modeling, there has been only limited evaluation of heuristic algorithms in the study of species-habitat relationships. In the absence of field studies that address every species and its habitat in detail, researchers have often relied on expert judgement and published research to understand and synthesise knowledge about natural systems. Both these sources of information lend themselves to Bayesian frameworks in the form of informative priors (Martin et al. 2005) and to frugal heuristics in terms of inferences, judgements and other forms of expressions within cognitive repertoires (Marewski et al. 2010). Moreover, though individual experiential knowledge may be partial and imprecise, collective knowledge, as evidenced through concepts such as 'wisdom of crowds' (first illustrated by the statistician Francis Galton in 1906) and nature-inspired computing methodologies such as swarm intelligence (Beni and Wang 1989) are increasingly applied in a variety of fields such as biological and ecological modeling, military and space applications, weather forecasting and so on. The former concept is based on the underlying assumption that an aggregate of potential solutions supplied by individuals perform as well as or even better in comparison to individual solutions (as it reduces the idiosyncratic noise associated with each individual judgement) (Surowiecki 2004; Yi et al. 2012). The latter points to the efficacy of simple rules and pathways in arriving at fairly realistic approximations of emergent complexity and the selection of efficient pathways, as is evident from the patterns offered by natural col-

lectives such as those of ant and bee colonies, schools of fish, etc. Together, these concepts explore 'the emergent collective intelligence of groups of simple agents' and apply them in modeling complex behaviours and patterns; they are also useful in eliciting solutions within data mining approaches (Martens et al. 2011). Moreover, as Gigerenzer and Brighton (2009) demonstrate, simple heuristics derived as part of the human mind's cognitive inability to process complex information are in fact beneficial and are often translated in the form of more accurate results. Expert elicitation is therefore not only a method to follow in order to address data deficiency or limitations in our understanding of complex systems, but an emerging field of study that showcases the ability of simple heuristics to perform better than complex procedures under scenarios of uncertainty (Gigerenzer and Brighton 2009).

In this study, some of these ideas are evaluated from the perspective of the persistence of mammals in forest-agriculture fringe landscapes of the Western Ghats. Formal research in ecology and conservation biology in India is now several decades old, and research effort, though distributed across the country, is hardly even, with some regions receiving inordinately more attention than others, both in terms of the number of species and ecosystems studied as well as in terms of the number of field biologists researching them. In relative terms, considerable research effort has been expended on the Western Ghats on account of it being one of the 'hottest' global biodiversity hotspots as well as a critical ecosystem and ecoregion. As the most extensively researched biogeographic zone within India, the Western Ghats, therefore, offer a unique opportunity to evaluate research in terms of available published information and expert knowledge of species and their habitats, and to capture the same in making predictions that are relevant for applied conservation science. However, despite extensive research, it is unclear what kind of general patterns can be deduced or how this information can be effectively utilised and synthesised for informing conservation interventions in the region, especially with respect to issues surrounding ongoing habitat modification. These are important not only for resource management and spatial planning decisions for traditional land use systems, but also for novel ecosystems that incorporate a variety of new cash crops and subsistence agricultural land uses that continue to transform the forest-fringe and encompass within them significant levels of mammalian and other biodiversity. These ecosystems

are also increasingly viewed as potential areas for biodiversity conservation as protected area expansion is no longer a feasible option in this region.

This study attempts the construction of a predictive framework for understanding the potential suitability of different land use types for the persistence of mammal species (the same method can be applied to other taxa as well). The study follows the broad conceptual foundations of species distribution and habitat suitability explorations under conditions of data scarcity which have characterised much of tropical ecology research (Elith and Leathwick 2009; Franklin 2009). As pointed out by Manly et al. (2002) and Franklin (2009), the concept of habitat suitability is closely related to that of a resource selection function (RSF) which is defined as any function that is proportional to the probability of habitat use by an organism. A species distribution model (SDM) can be said to predict the likelihood of a species being present at a location (defined as the probability of species presence) if the RSF is proportional to the probability of its use (Franklin 2009).

In this study, past research outputs, expert elicitation and frugal sets are used to predict probabilities of species presence in different land use types. The prediction accuracies of different models are compared and an attempt is made to identify a small but powerful suite of habitat indicators for each species. As pointed out by Hamilton et al. (2015), although such exercises omit factors such as population dynamics, interactions between species, etc., they are nevertheless useful in a variety of urgent conservation contexts that call for quick, cost-effective approximations of knowledge. In this study, the results are integrated into a simple network structure to develop a predictive model that incorporates the positive features of a BN approach and frugal variable selection (information from lexicographic/ tallying models are used as building blocks for the naïve Bayes model, see Martignon et al. 2008). The objective, therefore, is to make efficient and methodologically uncomplicated use of prior knowledge, both in terms of using existing information and expertise to develop a widely applicable set of conservation tools.

3.3 Methods

Dataset construction

Data collection was backgrounded by the assumption that optimal conditions for species can be described in terms of structural and compositional habitat variables as well as various states of management inputs that can be recorded from the different modified land use types found within the study area. An initial set of 48 non-volant mammals (Appendix A) were shortlisted for study. Fifteen different modified land use types ranging from commodity monoculture to subsistence agriculture were selected for evaluation. These range from pure commodity monocultures such as rubber, tea and coffee to land uses such as home gardens, plantations of cardamom, shade coffee, etc. that still contained a significant amount of native vegetation components. The dataset incorporated three main components. The first utilised probabilities elicited from experts to provide an average measure of habitat suitability (quantified as a potential probability of occurrence) of each mammal species in each modified land use type. The second component of the dataset was a representative matrix of habitat attributes for each of the different types of land uses that were selected for this study. The third component comprised different suites of predictor variables (of species occurrence) as ranked by experts, published literature, combined expert and literature-based rankings, and frugal sets based on cue validities (this is explained later in this section). Figure 3.1 outlines a step by step illustration of the data collection and analysis procedures in this chapter.

For eliciting probabilities of species in different land use types, the experts selected were fourteen individuals with medium to long-term field experience in the Western Ghats who were approached to provide information for the study. Most of these individuals have carried out primary research on mammal species in the region or have extensive field experience in the Western Ghats. The researcher explained the objectives of the study and methods of data collection to each of these individuals through face to face meetings or through telephone conversations. All the experts were also provided with a document outlining the study and instructions. Experts used their existing knowledge of the natural history and habitat preferences of a species to provide a single

point estimate (i.e. a probability of occurrence) of 48 species in each of the 15 selected land use types (Step 1 in Figure 3.1). Experts were also asked for a self-evaluation of their level of confidence/ uncertainty regarding their own assessment of this value (See sample expert evaluation form in Appendix B). Probability estimates provided by the experts were then averaged for each species in each land use type. In addition to the full contingent of records, a smaller subset of cases with a low coefficient of variation (CV, calculated as the ratio of the standard deviation to the mean; low CV indicated high expert congruence) was also identified for further analysis.

A suite of 28 habitat parameters or discrete categorical variables (with values ranging from 0 to 3) were used to characterise each major land use type found in the study region (Step 2 in Figure 3.1; see Appendix C for a list of parameters). These habitat attributes were shortlisted and categorised from a review of the literature. This review identified habitat characteristics of different agricultural systems and mammalian responses to habitat modification in the tropics (Appendix D). Additionally, many of these land use parameters related to either field observations that were easily discernible visually (e.g. canopy presence) or routinely measured during fieldwork in tropical ecology (e.g. basal area). The final suite of habitat variables included key correlates such as canopy cover, basal area, foliage height diversity, management inputs (e.g. pesticide, fertiliser inputs vs. organic) and other cropping features (e.g. monocropping vs. polyculture, traditional vs. intensive agriculture, etc.). A set of habitat properties that incorporated elements of structural, compositional and configurational heterogeneity was also included for each land use type. Within these groups of local level habitat attributes, some categories (e.g. habitat structure) have been proposed to be more significant for mammalian persistence than others (e.g. composition) (Garden et al. 2007). The ideas proposed in Duelli's (1997) 'mosaic concept' which relates to 'habitat variability' and 'habitat heterogeneity' per unit area and explored at the landscape level for agri-forest landscapes by Fahrig et al (2011) formed the conceptual basis for this exercise. Recent studies also support environmental heterogeneity as a universal driver of species richness across biomes, taxa and scale (Stein et al. 2014).

Step 1

Experts estimate potential probability of presence of species in each land use type

Data

48 species
14 experts
15 land use types
(e.g. coffee, rubber, tea, cardamom)

Step 2

Identify and categorise the state of habitat variables for each land use type

Data

15 land use types
28 candidate cues/ habitat variables
(e.g. canopy cover, pesticide inputs, tree height)

Step 3

Experts estimate potential probability of presence of species in each land use type

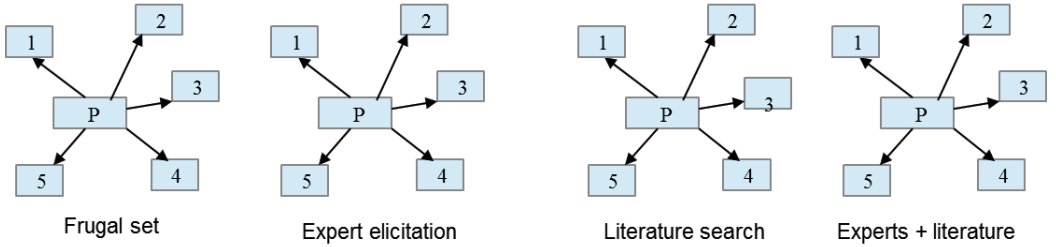
Rank	1) Cue validities (Frugal set)	2) Expert elicitation	3) Literature search	4) Experts + literature
1				
2				
3				
4				
5				

Step 4

Experts estimate potential probability of presence of species in each land use type

Data

Mean probability of presence (P) – Step 1
Values of candidate cues – Step 2
Top 5 key variables selected
by each method – Step 3



Step 5

Experts estimate potential probability of presence of species in each land use type

Figure 3.1 A roadmap outlining construction of dataset and models for predicting species presence in modified landscapes

The shortlisting of key variables as ranked by literature search, expert and frugal methods was then carried out using the same representative matrix of 28 land use attributes (Step 3 in Figure 3.1). For identifying variables from published information, habitat relationships were inferred from 75 different studies on mammalian species, most of which were carried out in the Western Ghats (Appendix D). A few studies from Sri Lanka (which forms a part of the same global biodiversity hotspot) and tropical South East Asia were also included for a few species to overcome basic data deficiency. The directionality as well as strength of influence of key variables was recorded. A simple rank and tally scheme was used to select 5 key variables of significance for each species. Experts were provided with the representative matrix of the 28 land use attributes (described earlier) and were asked to rank the key predictors for each species, on the basis of their own mental pictures of species-habitat relationships (a sample expert elicitation protocol is provided in Appendix E). In this exercise, experts used their knowledge to classify individual structural and compositional habitat variables as having positive, negative or neutral influence on the species in question (see Fahrig et al 2011 for the development of this type of classification). Experts were also asked to provide a weighted score ranging between 1 and 3 for each predictor variable and were also given the option of specifying non-linear responses for different categorical states. Weighted scores and information on non-linear responses were not used for this study, but reserved for a later analysis. The experts selected for this study were individuals who were accustomed to thinking in terms of the same sets of variables and habitats for their own studies, and these questions were therefore meaningful to them. A combined list of predictor variables for each species based on overlapping key variables, derived from the literature search and expert judgement, was also developed to explore the possibility of a more powerful set of variables. For both expert derived and combined sets, the top 5 variables for each species were used for model construction and comparisons.

From the list of 28 candidate cues provided in the representative matrix, a small suite of 'frugal' cues were selected according to their perceived validities or weights, following an approximate 'take the best' (TTB) strategy outlined by Gigerenzer et al (1999, p.81.). This strategy works best in situations when the cue/ variable with the highest validity has a higher weight than that of all other cues combined. The concept of cue validi-

ty (Beach 1964) relates to the ability of a cue to discriminate between categories. For example, the high value of one of the variables (e.g. high canopy contiguity) from the representative matrix might be the most efficient discriminator of the presence of highly arboreal mammals in different land uses. However, perfect discrimination was not a requirement (and in most cases, the cues are not entirely non compensatory), and the goal was to pick the best set of discriminatory variables. In other words those variables with the highest cue validities were selected, where cue validity is the number of correct inferences divided by the sum of the number of correct and incorrect inferences made using that cue alone (see Czerlinski et al. 1999, p. 101). In this study, a decision was made by the researcher to utilise 5 cues (i.e., the exercise has been to select best set of cues) instead of the single most valid cue, and to ignore the remaining cues. A selection of five habitat variables can be considered to be a frugal ordering when viewed against the 28 variables that were available for the study. Such an ordering ignores dependencies or correlations between variables (Czerlinski et al. 1999; Martignon and Hoffrage 1999). This process basically narrowed down on predictor variables for probability of occurrence of species as well as in exploring a satisficing algorithm along the lines of 'fast and frugal', 'take the best' algorithm as suggested by Gigerenzer (Gigerenzer 1996). A satisficing algorithm as proposed by Simon (1955) differs in its focus on finding a good enough or robust solution as opposed to an optimising/ maximising or perfect solution (Gigerenzer and Brighton 2009).

Model structure and parameterisation

For comparing the performance of frugal cues, expert and publication derived variables, naïve Bayes networks were constructed (Step 4 in Figure 3.1). A naïve Bayes network is a simple form of a Bayesian network. A typical Bayesian network consists of a graphical model or structure and a set of probabilities or parameters that are quantified and encoded within this structure to indicate the strength of interrelationships. Model structure relates to the graphical representation of the relationship between a response variable and various predictor variables. This structure can be manual one prescribed by a modeler, an automated one that is learnt by a particular software or can be a hybrid one which uses a combination of manual and automated methods. Model parameterisation

involves the population of the networks by conditional probability tables which are in turn based on the quantification of the strengths of the relationships between variables obtained from available data, expert elicitation, etc. The models in this study were parameterised based on information derived from frugal sets, expert judgement, past studies and combined expert and literature based sets.

Two simple BN models, naïve Bayes (NB) and tree augmented naïve Bayes (TAN) structures are typically adopted to represent (and predict) the occurrences of different species and groups in different land use types.
NB models are simple structures that classify or predict a target variable by capturing only its direct correlation to each predictor variable without taking into consideration the relationships between predictors. In other words, they assume a strong conditional independence between predictor variables (in this case, structural, compositional and management variables) given the target variable (probability of occurrence of a species), calling for the specification of only a few parameters. This makes such models particularly amenable to sparse datasets. Although in real world scenarios of species-habitat relationships, synergistic relationships between predictor variables are rarely independent, NB algorithms have been proven to be surprisingly effective in predictions, resulting in their emerging utility for predictions in this field (Aguilera et al. 2010; Guo and Liu 2010; Lockett 2012; Altartouri and Jolma 2013). TAN models differ from NB by going a step further in overcoming assumptions of independence between predictor variables. The TAN algorithm is a structure learning technique that develops the model structure by taking into account the correlations between different variables and attempts to improve the NB model's accuracy (Friedman 1997). However, in many cases, NB and TAN models give similar results. This study experimented with both models. Since both models provided similar results, NB models were selected on account of their greater inherent simplicity. While NB models have been used extensively for classification and clustering, they have been underutilised as models for probability estimation despite their accuracy, simplicity and efficiency (Lowd and Domingos 2005).

The parameterisation component of these models can be divided into two component parts, the first of which involves the development of a scoring function, and the second

involves the development of a structuring algorithm that optimises the scoring function. Parameter estimation is typically carried out using frequentist approaches such as the maximum likelihood estimator (MLE) or Bayesian Network scoring metrics (e.g. BDe, K2, GU). Optimal structures are arrived at using algorithms such NB, TAN, etc. for simple networks (see Kayaalp and Cooper 2002). In this study the latter scoring metrics (primarily BDe and K2) were used for structure learning. NB classifiers are advantageous not only in predictions and forecasting, but also in providing estimated probabilities for different possible outcomes (i.e., set valued outcomes) for different classes when there is ambiguity in the data.

An explanation of the formalisation and notation of a basic example of an NB model is pertinent here. NB models are simplistic Bayesian networks in which all variables have a single parent, given which, they are considered mutually independent (Lowd and Domingos 2005). Since NB is based on the conditional probability model, the Bayes Rule provides us with a method of updating our beliefs about an event (here A) given that we have information about another event (here B). In this context,

P(A) is called the *prior* probability of A,
P(A/B) is called the *posterior* probability of A given B, and,
P(B/A) is called the *likelihood* of A given B

Bayes Rule for two events can be written as:

$$P(A/B) = \frac{P(B/A).P(A)}{P(B)}$$

Alternately, using Bayesian probability terminology, the same can be written as:

$$\text{posterior} = \frac{\text{likelihood.prior}}{\text{evidence}}$$

For computations, this formula can be rewritten as the chain rule for two events:

$P(AB) = P(A/B).\ P(B)$

The chain rule helps us to calculate the probability of both A and B when we know the probability of A/B and the probability of B. In other words, the conditional probability of A/B and the probability of B are used to find the unconditional probability that both events A and B occurred.

The following is a simple worked example which is provided to understand the notation, formalisation and computation of a basic calculation involving NB. Table 3.1a shows a simple hypothetical dataset consisting of 8 records (in 8 different land use types) of presence and absence of Species X and corresponding records of some habitat attributes and management inputs. For example, P(Species = Present) = .625 denotes that the species was present in 5 out of 8 land use types, and absent in 3 out of 8 land use types. Table 3.1b lists the conditional probabilities on target attribute Species X. In addition to building a probabilistic model and network based on the dataset, a naïve Bayes approach helps in the calculation of likelihoods of presence or absence of a species given a set of new examinations.

Table 3.1: Sample calculation involving naïve Bayes classifier

a) Hypotheical dataset for species X

Land use type	**Species X**	**Canopy cover**	**Tree density**	**Human disturbance**	**Pesticide input**
A	Absent	High	Low	Medium	Present
B	Present	High	High	Low	Absent
C	Present	High	Low	High	Present
D	Present	Low	High	Medium	Present
E	Absent	Low	Low	Low	Absent
F	Present	Low	High	High	Present
G	Absent	Low	High	High	Absent
H	Present	High	High	Medium	Present

b) Conditional probabilities on target attribute

Conditional probabilities on target attribute Species X	
P(Species = Present) = .625	P(Species = Absent) = .375
P(Canopy cover = High/ Species = Present) = .600	P(Canopy cover = High/ Species = Absent) = .333
P(Canopy cover = Low/ Species = Present) = .400	P(Canopy cover = Low/ Species = Absent) = .666
P(Tree density = High/ Species = Present) = .800	P(Tree density = High/ Species = Absent) = .333
P(Tree density = Low/ Species = Present) = .200	P(Tree density = Low/ Species = Absent) = .666
P(Human disturbance = Medium/ Species = Present) = .600	P(Human disturbance = Medium/ Species = Absent) = .333
P(Human disturbance = Low/ Species = Present) = 0.00	P(Human disturbance = Low/ Species = Absent) = .333
P(Human disturbance = High/ Species = Present) = .400	P(Human disturbance = High/ Species = Absent) = .3333
P(Pesticide input = Present/ Species = Present) = .800	P(Pesticide input = Present/ Species = Absent) = .333
P(Pesticide input = Absent/ Species = Present) = .200	P(Pesticide input = Absent/ Species = Absent) = .666

For example, the likelihood of species X being Present and Absent respectively given a set of observations (Canopy cover is High, Tree density is Low, Human disturbance is Medium and Pesticide inputs are Absent) can be calculated by computing and comparing:

Likelihood P(Species = Present) P(Canopy cover = High/ Species = Present) P(Tree density = Low/ Species = Present) P(Human disturbance = Medium/ Species = Present) P(Pesticide input = Absent/Species = Present)

(0.625) (0.6) (0.2) (0.4) (0.2) = .006

vs

Likelihood P(Species = Absent) P(Canopy cover = H/ Species = Absent) P(Tree density = Low/ Species = Absent) P(Human disturbance = Medium/ Species = Absent) P(Pesticide input = Absent/ Species = Absent)

(0.375) (0.333) (0.666) (0.333) (0.666) = .0185

In this study, model construction and analysis was carried out using GeNIe (Graphical Network Interface), which is a graphical model construction tool provided by the Decision Systems Laboratory, Pittsburgh. GeNIe serves as a graphical interface to SMILE (Structural Modelling, Inference Engine), a Bayesian inference engine that implements graphical decision-theoretic models which are directly amenable to inclusion in intelligent systems (for more details, see https://dslpitt.org/genie/index.php/about).

Model validation

Validation frameworks for BNs can be very complex, depending on individual components such as structure confidence (e.g., number or choice of nodes), discretisation confidence (the allocation of information for different variables into classes), and parameterisation confidence (the treatment of values elicited from experts or other sources), all of which could contribute to model behaviour confidence and overall confidence in the model (Pitchforth and Mengersen 2013). While components such as structure confidence, discretisation confidence and parameterisation confidence were more or less similar across the different models that were compared for this study, the overall confidence in the predictions of the model and the robustness of the results were of greatest relevance. In species-habitat models, the efficacy of models that predict the presence or absence of species in different habitats are typically judged in terms of the number of correct predictions (Fielding and Bell 1997). However, as was the case with the current study, BNs are typically constructed using limited data, leaving little room for traditional model evaluation methods. In this study, the small number of cases for each species made the division of data into calibration (training) and validation (test) datasets untenable. The absence of actual field observations on species also made validation problematic. As predictions based only on the test dataset are likely to result in exaggerated predictive accuracies, the issue was addressed by using different cross-validation approaches that partition data into complementary subsets and validating across them. Cross-validation approaches typically evaluate the ability of a model to generalise to an independent dataset and limits problems such as overfitting. In this study leave-one-out

cross-validation (LOOCV) and k-fold cross validations were carried out for species and groups respectively Step 4 in Figure 3.1. The former made more efficient use of small datasets by omitting only a single case during each reclassification, while the k-fold cross validation was more appropriate for pooled data on groups. These techniques have been used by other studies in the context of small datasets (e.g. Kong et al. 2013).

The dataset

Of the 14 field researchers (experts) who were approached during the elicitation process, 12 individuals provided information on species that were known to them. A list of 48 non-volant mammal species was provided to field researchers familiar with the Western Ghats. Large carnivores with obligate dependence on wild prey availability such as the tiger (*Panthera tigris*), leopard (*Panthera pardus*) and wild dog (*Cuon alpinus*) were excluded from this analysis. Expert inputs varied across species. Groups such as murid rodents and insectivores (Soricidae) received very few expert scores due to poor familiarity with species-habitat relationships and taxonomic uncertainty. Hence, these species were excluded from the present analysis. Experts were able to provide information sufficient for basic model building for 30 species of which 25 were used for model building that included comparisons with published literature. Five species were omitted from the combined analysis as there was insufficient information from published studies to build comparative models.

The potential probability of presence of a species in a land use type was derived by averaging the probabilities provided by experts for that particular land use. In the absence of actual field data on the majority of species in the region, predicted probabilities averaged across expert elicitations provided the best analogue to the suitability of different land use types for different species. Predicted probabilities were also classified on the basis of CV values in each land use type for detailed analyses of some species. Self-estimation of their own level of confidence in their judgement by the experts enabled further segregation of the data set based on high and low levels of confidence.

From the list of 28 habitat attributes which were recorded for this study, five key habitat

attributes of significance to each species were shortlisted using three methods. Simple rank and tally exercises were used to identify key attributes based on published literature and expert opinion respectively. The two were evaluated together to develop a third, combined (i.e., overlapping) suite of attributes based on both expert opinion and literature. A fourth set of attributes, referred to as a 'frugal set' was based on ranked cue validities for each species (this is explained in detail in the methods section). While identifying key attributes on the basis of cue validities was not exact (i.e., there were few cases where cues discriminated perfectly), the last set also served as a benchmark set against which the other three datasets could be compared. As mentioned before, figure 3.1 outlines the steps that were followed for data collection and analysis in this chapter.

3.4 Results

Models of a sample species

For each species, five separate NB models were constructed and compared. The class variable (probability of occurrence of species in a land use type) remained constant, against which the conditional probabilities relating to habitat attributes were modeled. Each model comprised different subsets of habitat attributes selected on the basis of different methods (i.e., all variables, frugal, expert-derived, literature-derived, and expert+literature derived variables). Figure 3.2 depicts the basic naïve Bayes model (incorporating all habitat attributes) for the brown palm civet (*Paradoxurus jerdoni*), a Western Ghats endemic. Figure 3.3 compares the four models constructed by using different suites of key variables. For this species, the most accurate classification of the test dataset was derived from the frugal set of habitat attributes that included presence of understory, presence of *Ficus* sp., tree density, presence of bamboo and reeds and intensity of cultivation. The attributes ranked on the basis of expert elicitation and publication included canopy features such as cover, contiguity and height, native canopy, native tree cover, fruiting trees and lianas and climbers. The latter models showed a greater degree of overlap in predictor variables, but yielded lower prediction accuracies than the frugal set. However, the differences in predictions between the four models (across categories

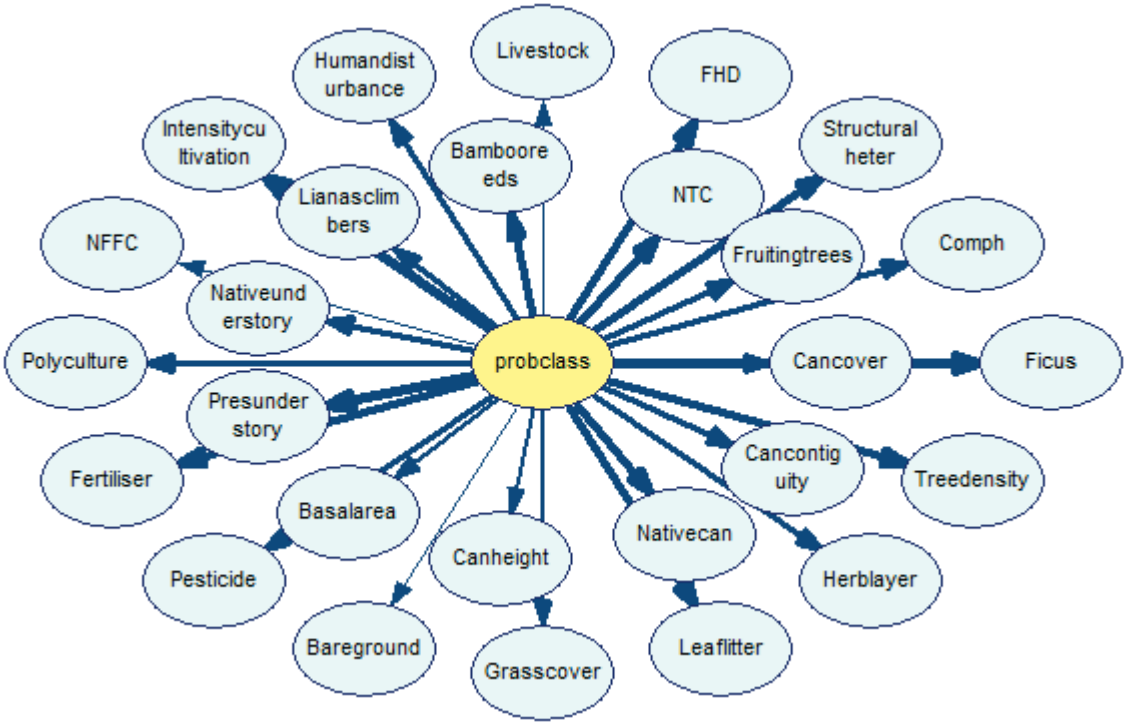
- high, medium, low, and very low) were not significant upon testing, indicating that all four models arrived at similar predictions by following slightly and in the case of the frugal set, a considerably different suite of predictors.

The validity of models is best evaluated with actual field data, but in this case, the absence of reliable field observations (which is a common reason why BNs are adopted as a model building strategy in the first place) prevented this form of testing. At the same time, predictions based on the same test dataset alone are likely to result in the overestimation of true predictive accuracy. Therefore, a leave-one-out cross validation (LOOCV) exercise that evaluates how the model would generalise to an independent dataset was adopted. As evidenced in the case of the sample species, the brown palm civet (Figures 3.2 and 3.3), prediction accuracies are considerably lower with cross-validation. However, the decline in prediction accuracies is relatively lower for the frugal set. For the sample species, the prediction accuracy for the model declined from 87.5% to 75%. For the other three models (Figure 3.3), the prediction accuracies showed a marked decline from 81.25% to 50% and 56.25%.

The best model (frugal set) for the sample species, the brown palm civet was used to compare predictions across forest with a contrasting land use type (tea) (Figure 3.4). The NB model was constructed with 5 key variables identified using cue validities (i.e., the frugal set) including tree density, intensity of cultivation, the presence of *Ficus*, understory, bamboo and reeds. Forests were the most suitable landscapes for this species (i.e., in the figure for forests, probability of occurrence is shown as high). Tea gardens which differ the most in terms of structure and composition were the least hospitable habitats. Visual interpretation of this network shows these model predictions to be in line with available ecological information on this species.

Comparisons across species

Model comparisons were carried out for 25 species. The highest prediction accuracies of non-cross validated datasets were more or less evenly distributed across models using frugal, expert and literature derived sets of variables and lower for the models derived



Model validation – test only

Overall accuracy = 0.875 (14/16)

high = 1.00 (1/1)
low = 0.89 (8/9)
medium = 0.80 (4/5)
very low = 1.00 (1/1)

Model validation – leave one out cross-validation

Overall accuracy = 0.6875 (11/16)

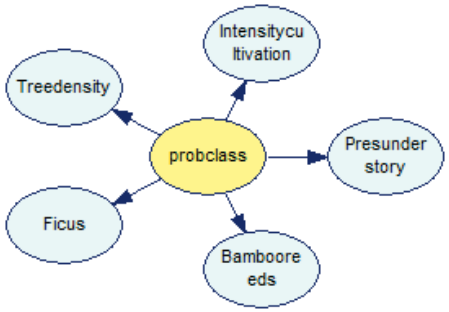
high = 1.00 (1/1)
low = 0.67 (6/9)
medium = 0.80 (4/5)
very low = 0.00 (0/1)

The thickness of the arcs indicates the strength of influence of each habitat attribute

Variable codes are provided in Appendix C

Figure 3.2: Brown palm civet: naïve Bayes model with all habitat attributes

from pooled expert and literature derived set of variables. Table 3.2 shows that the models based on the frugal set had the best prediction accuracies for 12 species, the expert, literature and combined models recorded highest accuracies for 13, 11 and 5 species respectively. A considerable degree of overlap in prediction accuracies was recorded. For 12 species, more than one model performed equally well in terms of prediction accuracy. To cite an example, for the wild boar (*Sus scrofa*), the model derived from expert ranked variables performed equally well as the frugal model. When cross validated datasets were compared, species models constructed from frugal sets accounted for the greatest prediction accuracies (Table 3.2). These had the highest prediction accuracies for 18 species, whereas models constructed from expert elicitation, published literature



Frugal set

Model validation – test only

All classes = 0.88 (14/16)

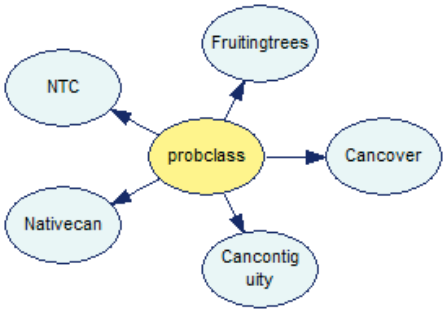
high = 1/1
low = 9/9
medium = 4/5
very low = 0/1

Model validation – leave one out cross-validation

All classes = 0.75 (12/16)

high = 1/1
low = 7/9
medium = 4/5
very low = 0/1

Exact contingency table test, sum of probabilities of 'unusual' tables, p = 1.00



Expert elicitation

Model validation – test only

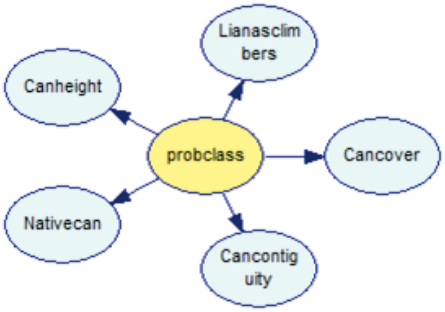
All classes = 0.81 (13/16)

high = 1/1
low = 9/9
medium = 3/5
very low = 0/1

Model validation – leave one out cross-validation

All classes = 0.56 (9/16)

high = 0/1
low = 6/9
medium = 3/5
very low = 0/1



Literature search

Model validation – test only

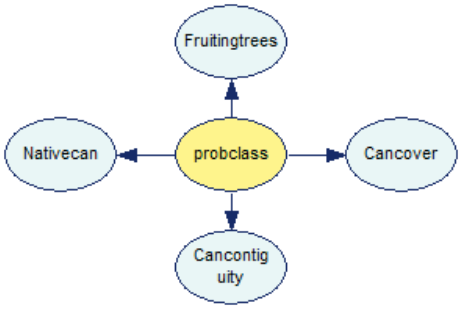
All classes = 0.81 (13/16)

high = 1/1
low = 7/9
medium = 4/5
very low = 1/1

Model validation – leave one out cross-validation

All classes = 0.50 (8/16)

high = 0/1
low = 6/9
medium = 2/5
very low = 0/1



Experts + Literature*

Model validation – test only

All classes = 0.81 (13/16)

high = 1/1
low = 9/9
medium = 3/5
very low = 0/1

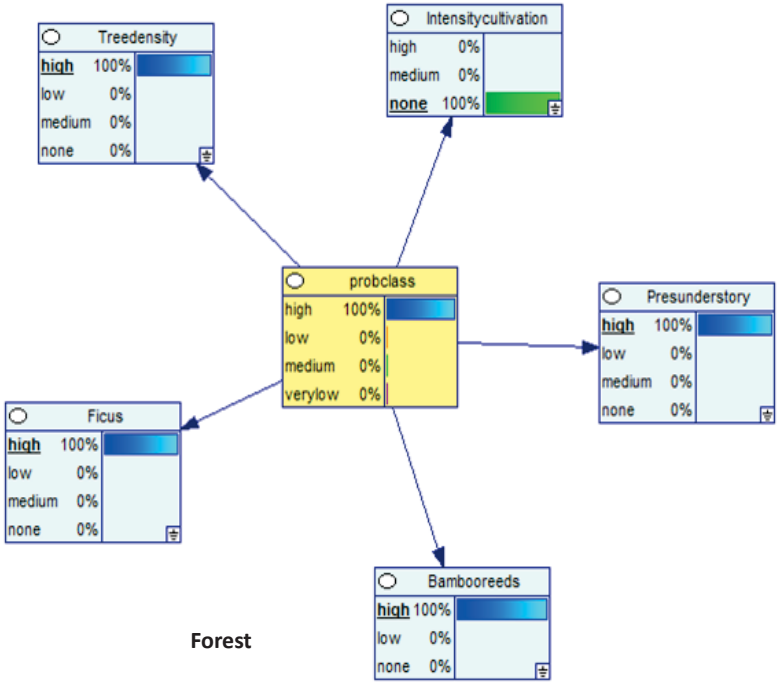
Model validation – leave one out cross-validation

All classes = 0.56 (9/16)

high = 0/1
low = 6/9
medium = 3/5
very low = 0/1

* Only 4 overlapping variables were recorded for this category

Figure 3.3: Brown palm civet: naïve Bayes model with key habitat attributes. Each figure shows the key variables identified by a particular selection process (e.g. frugal methodologies, expert elicitation). Model validation accuracies are highest for frugal sets for both test and cross-validated datasets.

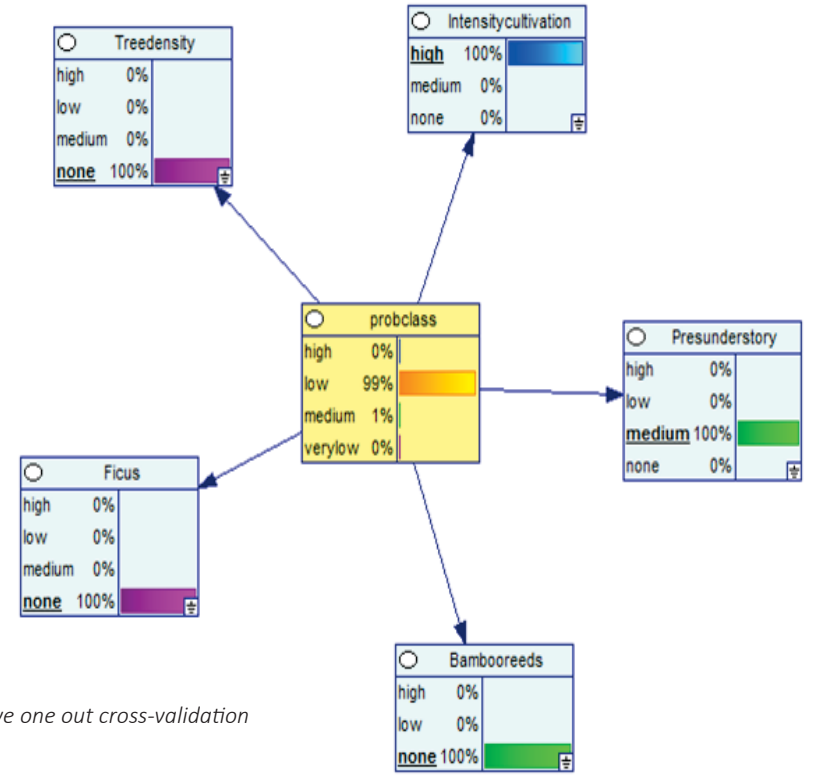


Forest

Model validation – test only

All classes = 0.86 (14/16)

high = 1 (1/1)
low = 1 (9/9)
medium = 0.8 (4/5)
verylow = 0 (0/1)



Tea

Model validation – leave one out cross-validation

All classes = 0.75 (12/16)

high = 1 (1/1)
low = 0.777778 (7/9)
medium = 0.8 (4/5)
verylow = 0 (0/1)

Figure 3.4: Brown palm civet: naïve Bayes model (frugal set) for forest and tea plantation. Forests and tea gardens have contrasting habitat structure and composition. When this is incorporated into the model, the probability of occurrence class (probclass) for this species is 'High' for forest and 'None' for tea.

Table 3.2: Model comparisons across species

No.	Species	Frugal V test	Expert V test	Lit V test	Exp+Lit V test	Frugal V LOOCV	Expert V LOOCV	Lit V LOOCV	Exp+Lit V LOOCV	p (Exact test)$	Significance #
1	Barking deer	**0.8**	0.6667	0.6667	0.6667	**0.6667**	0.4	0.4	0.4	1	**
2	Bonnet macaque	0.875	**0.9375**	0.875	0.875	**0.875**	0.625	0.624	0.625	0.239	
3	Brown mongoose	**0.875**	0.8125	**0.875**	0.8125	**0.75**	0.5	0.4375	0.5	0.913	*
4	Common palm civet	0.9375	**1**	**1**	0.9375	**0.9375**	**0.9375**	**0.9375**	0.625	0.569	
5	Gaur	0.9375	**1**	0.9375	0.9375	0.625	**0.875**	0.6875	0.6875	0.912	*
6	Indian giant squirrel	0.75	0.75	**0.8125**	0.75	0.3125	**0.375**	**0.375**	**0.375**	0.223	
7	Lion-tailed macaque	0.87	**0.9375**	**0.9375**	**0.9375**	**0.625**	0.5625	0.375	0.5625	1	**
8	Malabar spiny dormouse	0.8125	**0.9375**	0.8125	0.875	**0.5625**	0.5	**0.5625**	0.5	1	**
9	Mouse deer	0.75	0.875	**0.9375**	0.875	0.5	0.625	**0.75**	0.625	1	**
10	Nilgiri langur	**0.9375**	0.8125	0.8125	0.8125	**0.5625**	0.5	0.3125	0.375	1	**
11	Ruddy mongoose	**1**	0.875	0.9375	0.875	**0.875**	0.625	0.625	0.75	0.239	
12	Slender loris	0.75	**0.8125**	**0.8125**	0.75	0.625	0.5	**0.6875**	0.625	0.99	**
13	Small Indian civet	**1**	**1**	0.875	0.9375	**0.9375**	0.8125	0.75	0.8125	1	**
14	Travancore flying squirrel	**0.9375**	**0.9375**	0.8125	0.75	**0.875**	0.8125	0.5625	0.625	0.99	**
15	Wild boar	**0.9375**	**0.9375**	**0.9375**	**0.9375**	**0.875**	**0.875**	0.75	0.6875	0.88	
16	Jungle cat	**0.9375**	**0.9375**	**0.9375**	**0.9375**	0.875	0.625	**0.9375**	0.625	0.58	
17	Leopard cat	0.875	**0.9375**	0.75	**1**	**0.8125**	0.6875	0.375	**0.8125**	0.81	
18	Rusty-spotted cat	**0.8125**	0.75	0.75	0.6875	**0.8125**	0.1875	0.1875	0.3125	1	**
19	Sloth bear	**0.9375**	**0.875**	**0.9375**	0.875	0.75	0.6875	0.75	**0.8125**	1	**
20	Golden jackal	0.8125	0.875	0.8125	**0.875**	0.6875	**0.8125**	0.625	0.6875	0.978	**
21	Asian elephant	0.8125	0.8125	**0.9375**	0.8125	**0.75**	0.375	0.5625	0.625	0.962	**
22	Brown palm civet	**0.875**	0.8125	0.8125	0.8125	**0.75**	0.5625	0.5	0.5625	1	**
23	Indian flying squirrel	0.6875	0.75	**0.8125**	0.625	**0.3125**	**0.3125**	**0.3125**	**0.3125**	1	**
24	Indian porcupine	**0.9375**	0.75	0.8125	0.8125	**0.8125**	0.5	0.4375	0.375	0.817	
25	Sambar	0.8125	**0.9375**	0.8125	0.8125	**0.75**	0.5625	0.625	0.6875	0.98	**
	No of cases of maximum	**12**	**13**	**11**	**5**	**18**	**6**	**6**	**3**		
	predictive accuracy X' =	0.8668	0.869168	0.856668	0.839168	0.716668	0.5935	0.56596	0.5835		

Overall performance of models: difference between test and cross validated sets
∑ (All variables test – All variables LOOCV) = 7.5875, X' = .3035
∑ (Frugal V test – Frugal V LOOCV) = 3.7533,* X' = .1501@
∑ (Expert V test – Expert V LOOCV) = 6.8917, X' = .2756
∑ (Lit V test – Lit V LOOCV) = 7.2677, X' = .2907
∑ (Combined Exp+Lit V test – Combined Exp+Lit V LOOCV) = 6.3917, X' = ..4954

$: p(Exact test) refers to the results of an exact contingency table test
#: levels of significance (*.10, **.05) are only indicative
@: lowest value

Note: V denotes, top 5 variables. The first set of model comparisons (left panel) are for non cross-validated sets. The second set of model comparisons (right panel) are for cross-validated sets. Accuracy values in bold font represent the model with the best prediction accuracy for each species. For test sets, models with best accuracies are distributed across frugal, expert and literature derived suites of variables. For cross-validated sets, the frugal sets provided the best accuracies.

and combined methodologies accounted for only 6, 6, and 3 species respectively. Average prediction accuracies for models based on the frugal sets were about 12%, 15%, and 13% greater than models derived from expert-derived variables, literature-derived variables and combined and expert models respectively. However, the absolute differences in accuracy so as to bring about a shift in allocation in a particular category were low for most species. A comparison of expected predictions across occurrence categories (high, medium, low, etc.) points to significantly different predictions between models for only 9 out of the 25 species that were modeled. When compared across species, three key attributes stood out as the primary contributors to the frugal set: the presence of *Ficus* species (22 species), tree density (19 species) and the presence of understory (18 species) in a land use type. Attributes such as native tree cover (12 species) and intensity of cultivation (10 species) were also selected as having high cue validities for several species.

The loss in accuracy with cross validation (i.e., the difference between non cross validated and cross validated datasets) was also explored across models. These values were lowest for the frugal models as opposed to the other three models indicating a greater degree of robustness in predictive capacities (Table 3.2). Variability in estimated probabilities for species in different land use types has been a concern for this type of analysis. Different estimates of probability could arise from actual variability on the ground, as well as from a lack of familiarity that an expert has with a species or a landscape.

A small subset of 5 species was also evaluated in greater detail. For this subset, separate models were also constructed for those cases with a low CV in probabilities (when averaged across land use types). As expected, there was significant improvement in model prediction accuracies for all species when datasets were reduced to cases with low CV values. Results for the models based on the frugal sets for the 5 species are provided in Table 3.3 However, in the current analysis, the small size of the dataset also resulted in a reduction in the number of land use types for which the predictions could be made. At the same time, the analysis shows that these models could be improved with larger sample sizes. This modeling exercise shows that although for some species, expert opinion or published literature produced the best model, the models created from frugal sets

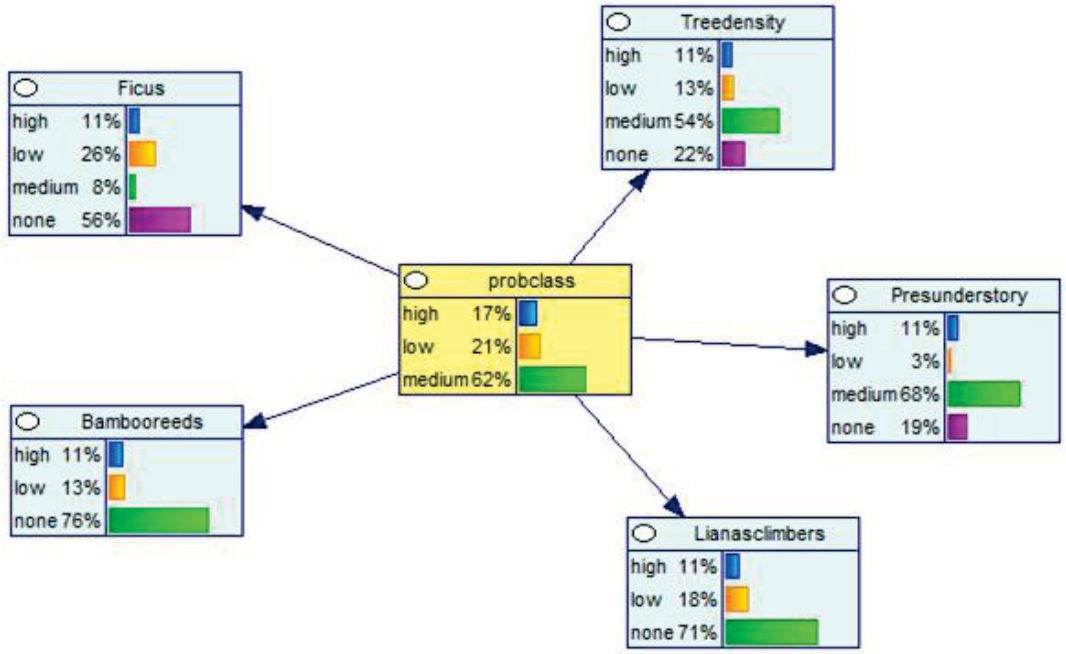
were generally superior.

Table 3.3: Prediction accuracies for 5 species

Dataset	Brown palm civet	Indian flying squirrel	Indian crested porcupine	Sambar	Asian elephant
	Non cross-validated dataset				
Frugal set (all values) – test model	0.88	0.69	0.94	0.81	0.81
Frugal set (low CV values) – test model	1.00	1.00	1.00	1.00	0.90
	Cross-validated dataset				
Frugal set (all values)	0.75	0.31	0.81	0.75	0.75
Frugal set (low CV values)	0.83	0.71	0.92	1.00	0.80

Models for groups

NB models were also constructed for a group of species of interest to explore model dynamics when species were pooled. In this case, a combined model for ungulates was constructed using estimated values for species classified within this group. Although not strictly classified under ungulates, the Asian elephant was also considered as part of this group for the current study (on account of historical evolutionary classifications). A naïve Bayes model constructed with the frugal set for all records accurately classified about 63% of the cases, whereas the same model constructed on the basis of records with a low CV value improved the predictions to 71% (Figure 3.5). A 4-fold cross validation resulted in reduced prediction accuracies for both cases. In Figure 3.6, the frugal model for low CV cases is used to predict the presence of ungulates in forest and rubber landscapes. The differences in key structural and compositional attributes as identified by cue validities result in different predictions for ungulates. The models show that forests that have typically high values for variables such as tree density, understory, etc. are likely to be more hospitable to ungulates. Rubber plantations on the other hand with differing values for these variables (especially understory attributes) are likely to be less attractive to ungulates. However, in the latter case, the classifier deals with instances that are hard to classify by providing set-valued classifications, i.e., moderate probabilities for ungulates has been recorded as the most likely outcome, and low values as the less probable outcome. Within category predictions for ungulates were similar for both sets of models.



Entire dataset *Dataset with low CV records*

Model validation – test only

All classes = 0.64 (61/96)

high = 0.5 (5/10)
low = 0.736842 (28/38)
medium = 0.583333 (28/48)

All classes = 0.72 (42/59)

high = 0.5 (5/10)
low = 0.166667 (2/12)
medium = 0.945946 (35/37)

Model validation – k-fold cross-validation

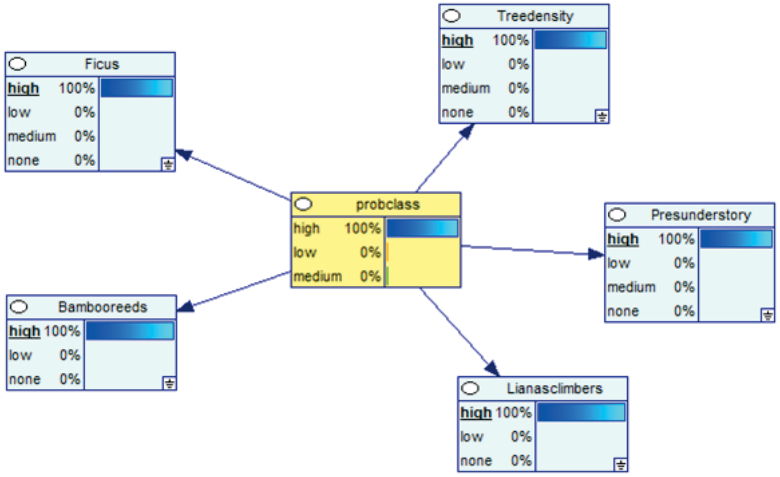
All classes = 0.53 (50/96)

high = 0.5 (5/10)
low = 0.421053 (16/38)
medium = 0.604167 (29/48)

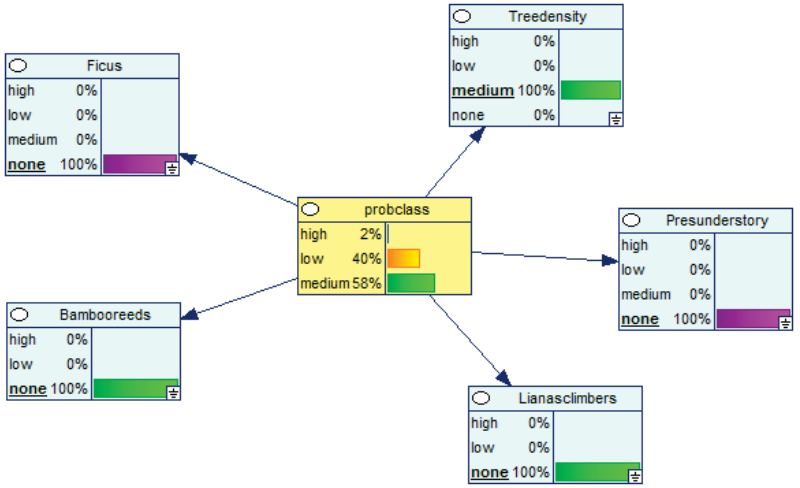
All classes = 0.56 (33/59)

high = 0.5 (5/10)
low = 0.166667 (2/12)
medium = 0.702703 (26/37)

Figure 3.5: Ungulates: comparing naïve Bayes models for datasets with different coefficients of variation (CV). The low CV dataset was comprised by records that showed a high degree of congruence between the judgements of different experts.



Forest



Rubber

Model validation – test only

All classes = 0.71 (42/59)

high = 0.5 (5/10)

low = 0.166667 (2/12)

medium = 0.945946 (35/37)

All classes = 0.71 (42/59)

high = 0.5 (5/10)

low = 0.166667 (2/12)

medium = 0.945946 (35/37)

Model validation – k-fold cross-validation

All classes = 0.59 (35/59)

high = 0.5 (5/10)

low = 0.25 (3/12)

medium = 0.72973 (27/37)

All classes = 0.61 (36/59)

high = 0.5 (5/10)

low = 0.25 (3/12)

medium = 0.756757 (28/37

Figure 3.6: Ungulates : comparing naïve Bayes models for forest and rubber plantation. The variables derived from the frugal methodology (i.e. the best performing set) was used to derive potential probabilities in forest and rubber plantations. Forests which have high values of the variables were likely to have a greater probability of presence for this group of species.

3.5 Discussion

Models with the greatest degree of prediction accuracy varied for individual species but the four BN models were on the whole comparable with each other. For non cross validated data, expert and literature derived models and frugal models performed equally, predicting 83-87% of cases correctly. The advantage of the frugal models was their robustness. Czerlinski et al. (1999) define a robust strategy as one that performs more accurately with new data, as in the case of cross validation. In overall terms, frugal sets had the greatest prediction accuracy in cross validation and on average predicted over 70% of cases correctly whereas the other methods correctly predicted 56-60% of cases. Frugal models recorded better prediction accuracies for most species, performing on average 12-15% better than the other sets of models. This roughly corresponds to the results of previous comparisons in literature. For instance, in medical psychology, Grove et al. (2000) reported mechanical prediction techniques to be approximately 10% more accurate than clinical (expert) judgement.

Frugal sets also returned the smallest difference in prediction accuracies between test and cross-validated datasets. This low error rate also indicates a higher level of robustness and repeatability for this group of models than for alternately hypothesised expert or literature derived models. Frugal models also have the additional advantage of being able to perform classification without requiring an exhaustive compilation of all remaining variables. The calculation of cue validities on which the identification of key variables are of the simplest nature involving counts and ratios (Laskey and Martignon 2014). In other words, cue validity can be calculated as just the conditional probability that a case falls in a particular category given a cue. However, the general congruence among models indicates that regardless of the method by which key variables were chosen, for the majority of species, the NB modeling framework successfully predicted similar outcomes for different categories of occurrence.

When viewed in terms of species identities, the least level of congruence among predictions were for generalist species such as the bonnet macaque, the Indian giant squirrel, common palm civet, wild boar, etc. Poor categorical definitions between land uses

(many generalists are widely distributed across land use types), or actual variations in the generality of species could be the reason for this outcome. Similarly, models for small felids such as the jungle cat, leopard cat and rusty-spotted cat showed a comparatively lower degree of congruence, possibly indicating the role of unmodeled factors such as prey availability. The naïve Bayes networks constructed for a group of species (in this case, ungulates + elephant) showed moderate predictive accuracies.

A limited overlap between predictors identified as the frugal set and those ranked highly by experts and published literature is an important finding of this study. Models built from frugal sets were more accurate followed by those built from variable groupings based on ranking by experts. It has also been suggested that informants and experts are often adept at picking out individual cues, and even tend to act like naïve Bayesians by assuming independence of the selected cues (Martignon and Laskey 1999). One of the reasons for this lack of congruence between the two sets could be due to the high degree of correlation between attributes selected for this study. Experts typically selected attributes of ecological and functional nature directly significant to a species, whereas the frugal set selection process tended to identify attributes with the greatest cue validity regardless of its ecological significance to the species. The latter attributes were often correlated with those with functional significance selected by the experts. For example in the case of the sample species, the brown palm civet, experts identified the presence of fruiting trees and various canopy-related attributes as being most significant, whereas the frugal search revealed tree density (which is correlated to canopy parameters) to be more capable of discriminating between classes. This could be the reason why models based on expert opinion, published information and pooled variables (expert and published information) produced similar, albeit less accurate results than the frugal set.

A comparison with the wider literature on expert judgement versus mechanical/statistical prediction is also appropriate here. The results obtained here are in general agreement with the extensive literature on clinical versus mechanical prediction in medical and psychological studies. In such studies, statistical/ algorithmic models have been shown not only to outperform models based on clinical judgement made by experts, but also are more robust in terms of their replicability and generalisation to new data (Meehl

1954; Grove et al. 2000). At the same time, as discussed earlier, the superior performance of the frugal models hardly invalidated the significance of expert judgement. In this study, expert judgement performed close enough in terms of predictive capacities. The two can be used in a complementary manner with the former being useful in identifying conditions and environments where expert intuitive judgement can be successful (Katsikopoulos et al. 2008). In general, expert judgement and information from past literature are also critically important in scenarios where experts have access to more data (which may not be amenable to algorithmic modeling) or in outlier situations where frugal models have poor predictive accuracy. Expert elicitation lends itself to easy integration within a Bayesian framework for the development of habitat benchmarks (e.g. Low Choy et al. 2001on vegetation benchmarking). Expert elicitation is also considered to be more naturally suited to Bayesian models as this information captures prior knowledge or the prior probability distribution or what is already known about a certain set of variables (Kuhnert et al. 2010).

Although only prediction validity was formally tested during this exercise, the BN models constructed during the course of this analysis appear to adhere to several axes of validity suggested under testing frameworks for BNs (Pitchforth and Mengeresen 2013). For instance, these models incorporate a high degree of nomological, face and content validities that relate to the structure, predictions, discretisation, parameterisation, etc. of models. In other words, the overall behaviour of these models fits well within the known domain of the wider literature and expert understandings on species-habitat relationships.

In environmental and species modeling, classifiers such as naïve Bayes use the observed relationship between a set of attributes and a variable of interest to predict or classify species occurrence. The naïve Bayes networks developed for species and groups are the first attempt at this form of modeling for the Western Ghats. While traditional Bayesian networks are being used extensively in species distribution modeling, the shift to simpler models, such as the utilisation of naïve Bayes models (typically used for clustering and classification) for probabilistic modeling and inference has so far been limited to a few recent studies globally (e.g. Aguilera et al. 2010; Lockett 2012; Altartouri and

Jolma 2013). The current data analysis was also limited to naïve Bayes models and their construction based on simple categorical predictor variables. Comparisons with other statistical techniques (e.g. logistic regression, classification trees, etc.) and further exploratory analysis into combination methods for expert-elicited and published data also remain to be carried out. Caveats of this study include the lack of adequate field data to test model predictions. Even in cases where some amount of field data is available, it has to be kept in mind that habitat occupancy and habitat suitability are often not synonymous with each other. The practical application of these models can be further improved when other predictive factors such as landscape attributes (e.g., matrix characteristics, distance to forest, etc.) are included to understand actual occupancy patterns, and when the models are integrated with geographical information systems to make them spatially explicit. With respect to the current study, there is also ample scope for improvement by refining the models themselves, incorporating factors such as expert bias and levels of confidence, and integrating decision-making components into the models.

3.6 Conclusion

Given the urgency of the tropical biodiversity crisis and the lack of adequate research effort, funding shortfalls, and logistical constraints, gathering large quantities of data on every species is a near impossibility in tropical hotspots. Therefore, deviating from the typical calls for more detailed research on species to inform planning, this study looks at the alternative perspective of using existing information and innovative frameworks for finding good enough predictive models. More critically, this also means the adoption of perspectives and techniques that aim for *generalisation* (i.e., *prediction* which typically uses a few key variables) instead of *fitting* (e.g. computationally complex strategies such as regression) which involves all available information (Gigerenzer and Todd 1999). The move away from the restricting assumptions of parametric approaches has paved the way for the exploration of machine learning approaches that perform reasonably accurate model construction and classification even with easy to obtain surrogate variables (Garzon et al. 2006; Altartourie and Jolma 2013). BNs are among the most appropriate frameworks that can deal with data relating to expert systems and are also amenable to integration with other systems. NB networks have simpler structures than traditional

BNs and are known to be efficient for classification and prediction.

The models developed in this study are of a preliminary nature and need improvement along several fronts. At the same time, these could be considered as contributing to an increasing series of explorations that are beginning to step away from an inordinate dependence on traditional frameworks for analysing species-environmental relationships, and venture towards tackling real world conservation challenges with simpler techniques and good enough inferences. Ecology's extreme and almost ritualistic dependence on statistical techniques such as regressions and fixed levels of significance, could be equated with an Einstellung (set) effect, or a cognitive trap which occurs when the continuing fixation with a discipline's favoured (and often hegemonic) theories prevent the exploration of alternative avenues of enquiry or the adoption more appropriate solutions (Gigerenzer 2004; Bililać et al. 2008). Ecological analysis and conservation planning could therefore benefit from recent research exploring some of these issues which move beyond conventionally accepted frameworks, and which underscore the need for simpler statistical routines and frugal methods where appropriate.

The results of this study form the ecological basis of the integrative exercise which is carried out in Chapter 5. Species-habitat relationships for species involved in crop-raiding are used to inform several parts of the qualitative probabilistic network that has been developed to problematise conservation conflict along the fringe.

Chapter 4: Linking historical contexts with conservation: stakeholder engagements with place, experience and conservation conflict[6]

4.1 The context

Planning conservation interventions requires an adequate knowledge of biodiversity presence and persistence as well as an understanding of the social factors that make conservation scenarios complex and unique. This chapter attempts a necessary complement to the ecological analyses (carried out in the previous chapter) by tracing the attendant social and political contexts that inform conservation challenges along the forest fringe in the study region. This is done by tracing the historical trajectories of both agrarian transformation as well as forest histories and environmental protection. To develop such a geographically explicit perspective, an analysis of place – as viewed, constructed and contested by different stakeholder groups in this region – is attempted. A multi-scale exploration of political ecological factors relating to local and external influences that catalysed forest transformations is carried out. An analysis of place-based sentiments and embodiments that explain how people perceive their own identities and aspirations is also attempted. Together, these analyses encompass a set of perspectives that seldom find a voice in conventional conservation frameworks.

The aims of the present study are twofold. Firstly, such an exercise is used to narrow down and identify the key points of entry into this system especially in the context of conservation conflict, which is a pervasive issue in the region. Some of these entry points are relevant not only to similar locations within the Western Ghats, but are also generalisable elsewhere to situations of contestations and conflict. Second, the results from this investigation are used to construct a network of interacting influences and analysed in the chapter that attempts to integrate the different components of this research.

6 The following chapter is an abridged version of a comprehensive analysis included in the thesis as Annexure 1. The latter incorporates expanded versions of all the themes discussed in this chapter including a detailed methodology and a more extensive phenomenological analysis stemming from oral histories and accounts from vernacular literature. **In its current form, this chapter focuses primarily on the structural exploration of the historical and contemporary co texts and provides the necessary background for the integrative analysis presented in chapter 5.**Detailed descriptions of methods and concepts, excerpts from oral history accounts, and key anecdotes that constitute a more comprehensive analysis of place-making have been included in the complete version (Annexure 1).

In the current study, which addresses a forest-fringe landscape in the Ranni Forest Division located in central Kerala, human activities, primarily agricultural expansion, have resulted in a forest-agriculture matrix significant for both local livelihoods and biodiversity persistence. Historically, the fringe itself has been a mobile entity, one that has been constantly shifting, expanding outwards into habitation during periods of conflict with wild animals, and retreating inwards into the forests as populations and cultivation expanded. Although there have been previously documented transformations of significance, the dynamics of settlement that are critical to the present study begin with the late 1940s. An extensive period of food grain shortage leading up to and following World War II and India's independence from British colonial rule saw the influx of marginal farmers and landless migrants from the plains of Central Travancore (*Thiruvithamkur*, Mal.) to its plentiful forests. This migration – which was prompted by calls from the Travancore government (which was under the de facto rule of the British colonial regime) and then the independent Indian government to clear forest and cultivate rice – was a widespread one that continued for several decades. Settler colonies became a typical feature of many forested districts in the Western Ghats. Though initially drawn from different regional, caste and community denominations, a unique settler identity and livelihood ethic emerged, fostered by common experiences and obstacles which the migrants surmounted as a group. During this period, the Forest Department which emerged as the custodian of these lands persuaded some settlers to move elsewhere. Those who remained were given title deeds with numerous restrictions. In recent decades, protectionist legislation and conservationist lobbying have resulted in a situation of protracted externalised conflict involving at least some groups of stakeholders (such as the settlers and the Forest Department) as well as a more latent, yet exploitative situation that has marginalised other groups such as the forest-dwelling communities.

Post-Independence forest protection resulted in a more stable forest fringe, characterised on either side by communities perched on the margin, intermittently mingling and blurring edges. Each group has its own history of displacement and marginalisation: impoverished settlers displacing forest-dwelling communities, who, in turn were exploited, sedentarised, mainstreamed and museumised at various points of time. Different stakeholder groups are themselves complex, heterogenous entities that have evolved

under changing historical premises, and have their own set of physical and mental constructs/ ideologies which remain poorly visible to other groups and there has been poor reconciliation between these differing viewpoints. At the same time, as noted by several scholars (Baviskar 1997; Nygren 1999; Krishnan 2009) research and conservation interests often tend to be one-sided, often privileging indigenous views and a exhibiting a parallel disregard for groups such as migrant settlers. In this context, much of contemporary conflict is centred around settler engagements with forests and agriculture. This study is an attempt at a more holistic approach towards understanding some of these viewpoints from the perspective of several groups. This study also differs from previous regional research in its geographical focus. Most of the work on this subject till date in Kerala has focused on Travancorean migrations northwards into Malabar, a different geopolitical unit with a distinct social hierarchy, agrarian history, and external influences (e.g. the Anglo-Mysore wars). Focusing on migrations within Travancore itself, this work provides a comparison to the investigations of migrations in Malabar. While Travancorean settlers were the major force of transformations in both places, their engagements on arrival were with different groups of people already occupying the land. In Malabar, their initial engagements were with a different set of agrestic and forest-dwelling communities (grouped in recent times under *adivasi*[7] and *dalit*[8] identities) and were often negotiated through land acquisition facilitated by already existing *jenmi* (hereditary) landlords. In Travancore, settler engagements were primarily with forest-dwelling communities, and the absence of a *jenmi* class entailed a set of engagements devoid of this mediation.

This chapter is divided into eight key sections. The introductory section problematises the context and explains the structure of this chapter. The third section outlines the methods and data formats used along with a brief justification of the methodological and conceptual issues that are utilised for this study. The third section attempts to provide a wider background to the extra-local influences and large-scale processes such as

7 *Adivasi*, is a generic a term that is commonly used to denote a heterogeneous group of tribal and ethnic populations distributed throughout India. This appellation can be literally translated as 'original/ first inhabitant' and is used to refer to the indigenous pre-Aryan inhabitants of India. However, problems also arise with respect to generalised categorisations such as indigenous and aboriginal especially in the case of India where clear distinctions are absent. For more details, see Agrawal 1995; Baviskar 2005; Sundar 2005.

8 *Dalit* is an umbrella term and self-chosen appellation for the former Hindu untouchable castes.

colonialism that have had a bearing on the dynamics of this region. Sections four, five and six deal with the stakeholder perspectives relating to the region. Drawn from both etic and emic approaches, the aim is to arrive at the perspectives of different groups of stakeholders (external actors and ideologies such as those of the forest department and conservationists; forest dwellers; and, settlers) of their own contexts, as well as their impressions of other groups. The insights from these analyses, identified as points of entry are outlined in the seventh section. The last section is a short concluding paragraph that summarises key points.

4.2 Methods and concepts

Conservation scenarios along the forest fringe are often tied up in the contrasting dynamics of agrarian transformations on one side of the boundary and forestry histories on the other. Simultaneous explorations of these aspects are rarely attempted by researchers due to their training and disciplinary histories. In trying to bring about a concurrent evaluation, this research attempts to blend key thematic elements adopted from several disciplines (such as human and cultural geography, political ecology, sociology and anthropology) and to unite them under a historical framework. In other words, as opposed to disciplinary and methodological rigidity which is the norm in academic practice, this study adopts a fluid focus of enquiry. In adopting this form of research, this study depends on both primary and secondary data as well as different data formats including oral histories, colonial reports, memoirs, and literary fiction. The methodological approaches and conceptual trajectories that are of relevance to this research are explained in this section.

Insights into communities: insider and outsider view points

The issues explored in this chapter are addressed within a narrative that traces the history of the forest fringe landscape and articulated by analysing the perspectives (discursive and non-discursive, representational and non-representational; Thrift 2008) of different stakeholder groups and their differing links with place. A significant part of this narrative exploration draws on ‘etic’ (or ‘outsider’) material for all three groups but

also highlights the perspectives of the settler community using a complementary 'emic' or 'insider' approach (Headland 1990; Morris et al. 1999; Roy and Banerjee 2012). This dual research approach was adopted in order to gain a more nuanced understanding of the marginalised settler community. Settlers are the largest stakeholder group in the agricultural landholdings along the fringe, and have been at the centre of contemporary disputes involving conservation. Their viewpoints and personal accounts provide the necessary 'hidden transcripts' (Scott 1990) which act as counter-narratives to official histories and conservationists' commentaries. As the overall goal of this approach is to identify local level 'entry points' that would help resolve the ongoing situation of conflict, insider viewpoints are a critically important arsenal of information. In other words, importance is given to oral histories and personal accounts (as opposed to archival or other forms of data), as the focus is not on compiling an absolute history of this landscape, but rather on understanding how a marginalised group perceives its own history and progress within a landscape. These perceptions, aspirations and predispositions are reflected in individual and collective histories, and subaltern perspectives, that have the potential to provide insights for conflict resolution.

Keeping these conceptual issues in mind, a series of interviews were carried out with first and second generation members of the settler community[9]. First generation settlers who arrived at the fringe between the early 1940s and 1965 were approached to provide information as were second generation settlers who were still living in this landscape. These individuals were contacted via an approximation of a snowball/ referral sampling method whereby informants provided information as well as details of acquaintances who could be contacted for this purpose. Approximately 18 detailed oral histories were recorded in this fashion. A series of open-ended questions were addressed to them. These included their experiences of poverty and marginalisation in their native villages, their arrival and settlement at the fringe, agricultural practices, conflict with wildlife, etc. An additional 23 interviews were provided by key informants who were in many instances settlers. Open-ended as well as semi-structured interviews were also carried out with key informants who provided information on selected aspects of contemporary significance in the landscape.

9 Interviews with human subjects in this study are covered under an ethics approval UTS HREC 2012 183A.

Information relating to other stakeholder groups such as *adivasi* communities living in the forest and other actors such as the Forest Department and conservationists has been based on fewer direct insights. Sources for these included a vast colonial literature in the form of European missionary, forester and planter accounts; scholarship representing the twentieth century anthropological focus on local communities; and the considerable post-colonial scholarship addressing the wider socio-economic and political issues relating to the social and ecological transformations of Kerala. Though the reliance on secondary sources of information introduces a different set of biases (e.g. negative stereotyping of forest-dwelling communities by missionaries, colonial foresters and administrative officers; cultural stereotyping by anthropologists, etc.), they nevertheless contain many valuable insights, and the disadvantages of this type of information are mostly outweighed by their strengths. In other words, these sources reveal particular constructed discourses on *adivasi* groups and lowland communities that are replete with stereotypes, but a deconstruction of these texts make them useful historical sources. This information is therefore treated with caution and used critically within its own context. Primary data collection involving *adivasi* communities was not carried out as there are numerous communities (e.g. Hill Pandaram, Mala Vedar, Ulladan, Urali, Mala Arayan (Malavel/dan), Mala Adiyan, Vettavan, Kani, etc.). Additionally, the predominant community in the study area, the Hill Pandaram is a nomadic group that is reluctant to communicate. Understanding these communities through primary data collection engagements would have required long-term ethnographies. Therefore, greater emphasis was laid on historical accounts, reports and memoirs and published anthropological research to inform this study.

Political ecology, power, habitus and memory

The first broad set of topics that will be explored in this study relates to those of political ecology and associated sub disciplines. These attempt to trace the connectivity of events and processes via ‘chains of explanations’ (Blaikie and Brookfield 1987), ‘webs of relation’ (Rocheleau 2008) and ‘rooted networks’ (Rocheleau 2011) from a regional perspective in understanding conflicts over resources (and their linkages with unequal power relations) and narrows them down via subsequent links to the landscape

level. In other words, such evaluations help in identifying key influences that operate outside the immediate bounds of local systems, which are the typical units of study focus (Robbins 2012). For the developing world, responding to the apolitical proposals of neo-Malthusian theorists who tend to consider poverty and underdevelopment as endemic to certain geographical regions, political ecological research has been instrumental in clarifying the role of large-scale processes such as colonialism in generating Third World inequalities and power differentials (Escobar 1995; Byrant 1998). Elements of the methodologically fluid 'progressive contextualisation' (Vayda 1983) and 'chains of explanation' (Blaikie and Brookfield 1987) approaches are then used to construct a structural visualisation of interacting events and themes along multiple temporal and spatial scales. These analyses have been informed by scholarship arising from several disciplinary streams (e.g., political ecology, landscape studies, cultural geography and anthropology) that integrate the dynamics of land, society and place, and the embedded power differentials within them. Together, they examine not only the social-ecological transformations (e.g. labour, production-consumption landscapes, etc.), more recent work has also targeted various non-material, non-discursive and non-representational aspects of human-environment relationships (e.g. belonging and exclusion, social identities, struggles over meanings, etc.)[10]. Using the approaches outlined above, a structural visualisation of the various interconnected events and processes affecting the forest fringe was carried out. These include a number of local as well as extra-local events and processes that impacted the fringe over the years as well as the contemporary drivers of change as understood through a political ecological lens.

In addition to structure, it is also necessary to understand ways of analysing theories of power as well as questions related to practice, embodiment and memory. These are critical elements that could inform the emerging academic focus on the local, especially themes related to the analytics of place and landscape (Grenier and Sakdapolrak 2013). To adopt as overarching frameworks for these types of analyses, the sociological theories of Pierre Bourdieu, Michel Foucault, Jean Baudrillard are useful as they examine the micro-politics of power. Bourdieu's empirically informed theory is considered most

10 Examples of this type of work include Hecht and Cockburn (1990), Fairhead and Leach (1996), (Neumann 1998), Raffles (2002) and Ogden (2008).

appropriate, as, in addition to being grounded in insights from traditional juridical-political theories of power (e.g. those articulated by Marx and Weber) that attribute the dominant role to economic capital, it also takes into account the potential significance of additional forms of power: cultural, social, symbolic (Navarro 2006). Insights relating to what Bourdieu terms 'misrecognition' (similar to Marx's 'false consciousness') are significant in understanding the passive subordination that is often embedded in such contestations (Bourdieu and Passeron 1977). In this study, misrecognition is one (though not the only) way of viewing contemporary forest-dweller and *adivasi* articulations related to land. Though explicit articulated ties to land were not a part of their past social repertoires, in the contemporary period, many *adivasi* groups are compelled to construct new discourses and representations that signify their long-term ties to land and promote their image as 'noble savages'. By doing so, they passively conform to the dominant social order. The politics of power and marginalisation can also be read in the early histories of subjugation of forest peoples as well as in the histories of colonial and post-colonial plantation agriculture and forestry which removed and sedentarised forest dwellers while at the same time ushering in migrants from the plains.

'Habitus', is also a significant concept to be explored while studying the activities of communities in landscapes, particularly in terms of their differential responses to situations. Drawing upon previous conceptual work on this topic, Bourdieu defines habitus (Bourdieu 1990 [1980], p.54) as a product of history, that, '*... ensures the active presence of past experiences,...*'. Habitus signifies that each group of people has its own individual and collective memories borne out of past experiences, which can be linked to current attitudes and choices. This concept is therefore useful for understanding both embodiment in people with long-term relationships with place (such as forest-dwelling communities) as well as in understanding how incoming migrant groups (such as settlers) make sense of both the displacement from their native villages and the novelty of their destinations[11]. Along with habitus, the role of memory in explaining how individuals and groups of people relate to their past and construct their identities and contestations have increasingly been the focus of research especially in relation to current

11 The concept of habitus has been researched extensively by several authors (e.g., Ingold 2000; Casey 2001 a,b; Wacquant 2005, 2011; Sanchez Garcia and Spencer 2013).

engagements with situations of conflict (Creet and Kitzman 2010; Tint 2010). Phillips (2004) points to the distinction made by Halbwachs ((1992, [1941,1952])) between history and memory as opposing ways of recalling the past. Unlike history, or the popular perception of it as something fixed and unchanging (i.e., 'a singular authoritative history'), memory (or multiple memories) remains in a constant state of flux, changing according to the need of the times, and as something that is open to manipulation, revision, remembering and forgetting[12]. Moreover, memory plays a key role in the contexts of traumatic events such as migration and displacement, whether voluntary or forced (Creet and Kitzman 2010). The concept of translocality or the processes that result in entanglements, interrelationships and frictions between places, can also be used to understand the linkages between mobility, locality, migration and memory. Translocality has provided a variety of perspectives for analysis of these issues but has been defined in different ways by different scholars (Grenier and Sakdapolrak 2013). In this study an exploration of translocality is carried out without reliance on a strict definition, but as a generic concept that helps in the exploration of mobility and place at local and regional scales. Conceptual elements utilised for this purpose include the concept of 'multilocality' (Rodman 1992) as well as the material, symbolic and imaginative notions of translocality as has been analysed by Appadurai (1988a,b), Rodman and Massey (1994).

Memory forms a critical axis of enquiry for this study as it provides a way to understand how different groups of people view their own history and link it to the present. The articulated memories of settler communities who have undergone displacement with multiple traumatic experiences not only explain their contemporary choices, but also serve as a window to their future aspirations and expectations of place. The analysis of individual, social and collective memories are useful in understanding how much or in what ways they deviate from official and formal histories which are often regarded as absolute truths. Memory among forest dwelling groups (though analysed from partly biographical secondary sources) still offers insights into exploitation, marginalisation and loss. Stakeholder memories and perspectives serve as the 'hidden transcripts' (Scott 1990) and counter-narratives based on which the actions of a marginalised community can be analysed. In summary, this research explores the ongoing tension between habi-

12 See also Davis and Starn (1989), Nora (1989), and Kotre (1996).

tus and memory, which can be regarded as opposing forces. Habitus, or the creation of lasting dispositions on the basis of past experiences can be considered as a way in which the past shapes the present. Memory on the other hand, offers a dual perspective, and a constantly evolving one at that: of past experiences shaping perceptions and aspirations, as well as that of the present playing a role in how the past is selectively viewed or remembered. Both aspects are critical for assessing contemporary and future scenarios.

The critical links that both habitus and memory have with places and landscapes call for a more thorough evaluation of how these latter entities have been dealt with by different research frameworks. Reflecting contemporary situations such as migration and displacement, indigenous and environmental conflicts, contestations and power struggles have become the central preoccupation within phenomenological research which analyses personal experiences and interpretations (Feld and Basso; Stewart and Strathern 2003). In this context, Stewart and Strathern (2003) consider landscape as a vital concept that integrates the 'materialist' and the 'symbolic', in other words, uniting politics and economics with cultural meanings. In terms of identity, these authors identify the interplay of two crucial elements – notions of memory and notions of place embedded within a landscape, and how '*perceptions of and values attached to landscapes encode values and fix memories to places that become sites of historical identity (p.1)*'[13]. They show that positioning related to the senses of identity (e.g., local, regional, national) is routinely manifested in local/ landscape histories that are incorporated in folk tales, ballads, oral histories, ritual and artistic representations. Caftanzoglou (2001) points to the continuous efforts of local groups at reinforcing, constructing and defending their bonds to place through displays of rootedness and belonging, boundedness, and senses of place.

This study benefits from a phenomenological focus as it offers opportunities for bringing together both materialist as well as cultural and symbolic features and their links to place among settler groups. Their perceptions and memories of trauma, migration and

13 Whether relating to the diasporic memory of Jewish communities scattered across the world (and their labeling as 'peoples of memory') (Nora 1989, p.8) or of recent émigrés to Australia 'being in two places at once' (Byrne et al 2010), place and memory are intimately related. In fact, recent research (e.g., Creet and Kitzman 2010) argues for migration (as opposed to location) as the essential condition of memory.

re-establishment are tied to the emergence of a settler identity as are their material and cultural choices that are embedded within landscapes. The exploration of habitus and memory therefore forms a central part of this exercise. It is by exploring these aspects that the links between historical and contemporary events and processes are established in this study.

Critiques

There are many ways of seeing and understanding landscapes and the relationships between land and people. These could be differences based on the perspective or the identity of the person/s viewing, exploring or recalling the nature of a landscape[14]. Ethnographic enquiry itself has a transformative element to it as ethnographers understand their study systems better or as they go into more detail about a particular aspect of study. Ethnographic outputs and generalisations, i.e., the transmutation of individual voices into a shared narrative, also often betray the imposition of the researcher's viewpoint, which is in turn influenced by prior training, influences of prior research and cultural backgrounds of the researcher (Appadurai 1988a; Rodman 1992; Feld and Basso 1996). Appadurai (1988a) points out that this 'double ventriloquism' therefore makes it difficult to figure out who is really speaking from where and who for whom, thereby privileging the voices of those in positions of power (see also Haraway 1991; Rodman 1992; Feld and Basso 1996)[15]. The reliance on simplistic metonymic representations inappropriately signaling selected modalities or perfunctory essentialisms for places are also common (see Fernandez 1988). Similarly, an Euro-American panopticon (Brunton-Ernst 2012) whereby predominantly European and American researchers examine other regions as a one-way system has been a characteristic feature of ethnographical research in general (Appadurai 1988a; Bird-David 2008).

14 For example, Raffles (2002, p.68) exploring the Amazonian settlement of Igarape Guariba through the eyes of various protagonists recounts, *'as different claims on nature proliferate, so different Guaribas come into view*'. (Other examples include Carter 1987; Bender and Winer 2001; O'Sullivan 2001; and Strathern and Stewart 2001).

15 According to Appadurai (1988a), ethnography reflects the ' *circumstantial encounter of the voluntarily displaced anthropologist and the involuntarily localized "other."* '

In this context, Rodman's (1992) critique of place studies in anthropology and geography is critical in identifying ways forward. She comments on the significance of taking into account diversities of place and voice ('multilocality' and 'multivocality') by pointing out that '*... places, like voices, are local and multiple. For each inhabitant, a place has a unique reality, one in which meaning is shared with other people and places*.' She also cautions that the totalised anthropological voices are in themselves problematic because they are not lived experiences. And their definitions of place are often privileged in comparison to those of their research subjects whose views become peripheral in light of the generalising narrative of the anthropologist.

This study attempts to frame analyses along several paths while at the same time keeping in mind the biases and cautions summarised in the preceding paragraphs. As many of the insights from this work are based on oral histories and perceptions, every effort is made to convey these in an ethically appropriate manner. The annexure which details this component of the study makes a special effort to make some of these diverse voices heard. In this document, many settler perspectives are provided verbatim for the reader to get a better understanding. Hopefully this results in avoiding the pitfalls of a totalised anthropological voice/ homogenising discourse to some extent.

4.3 Looking Back: A Wider Perspective on Social and Ecological Transformations in Travancore

This section attempts to provide the necessary background for the analyses attempted in the sections on stakeholder engagements with place along a forest margin in Central Travancore. Local ecologies and economies are typically enmeshed in extra-local and top-down contexts where the '*balance of causal factors constantly shifts over time and geographical space*' (Blaikie 1989, p. 35). In articulating these chains of explanations, it is therefore important to understand not only the immediate environmental issues at work in a locality but also situate them within wider frames of socio-political and cultural influences (Blaikie 1989). In this study, we find that large-scale forest transformations in Travancore were to a great extent, the result of influences from outside the region, perhaps for millennia, but more extensively from at least the beginning of

the colonial period. There were several critical junctures of increased demand which resulted in the escalation of extraction as well as potential occupational shifts and relocations among people as a response towards utilising new opportunities in the hill forests. While the demand for forest products from the Roman period onwards placed Travancore firmly on the global maritime trade map, the region's identity as the primary hinterland for spices and other exotic forest products was one of the key reasons for the arrival and tussles over territory by European colonial powers. Colonial influences were instrumental in the development of socio-economic transformations as well as the introduction of agrarian capitalism through commodity growth, improvement projects, forestry and eventually through the implementation of conservation laws. Colonialism interacted with local conditions to produce scenarios that were at once generic and idiosyncratic (e.g. see Sivaramakrishnan, 2000 for understanding the impacts of 'central direction' vs 'local autonomy' in colonial forestry) but in either case, primarily characterised by connectivity and interaction between regional and local scales. These changes were not just purely ecological, political or economic. Cultural changes too marked nearly every phase of transformation in this region. These issues are explored thematically in this section[16].

The forest and plains as connected spaces: upland-lowland exchange

The forests of the Western Ghats have a long history of human occupation, with the first human influences being recorded as early as the Palaeolithic or Old Stone Age (12,000 yrs BP) and the transitions from hunter gatherers to food growers occurring during the Mesolithic Period or Middle Stone Age (12,000 – 5000 yrs BP) (Subash Chandran 1997). However, as is true for much of South Asia, hunting and gathering still remain an enduring and resilient tradition among some forest communities of the Western Ghats. Archaeological evidence, references in early travel accounts, and literary epics show that these forests and their bountiful produce were known to traders since several centuries before the beginning of the Common Era (Morris 1986; Tomber et al

16 These themes derive extensively from previous scholarly research which is backed by comprhensive analyses of archival records, reports and primary data. The analysis in this section is therefore significantly informed by past work at the regional scale on forest histories (Bourdillon 1893; Morrison 2002, 2008), socio-economic change (Rammohan 1996), agrarian capitalism (e.g. Baak 1997, Varghese 2009), and conservation trajectories (Amruth 2009).

2009). The Tamil literary epics of the Sangam period also point to the practice of upland agriculture was also practiced by a numerous forest-dweller communities. In a manner of upland-lowland exchange, timber, ivory, cardamom, pepper, ginger, turmeric, meat, honey, wax, myrobalan (*Terminalia chebula* and *T. bellirica*), dammar resin (*kundiruk-kam*, Mal.; *Canarium strictum*), sandalwood and a variety of other forest products were collected and bartered by 'hillmen' and some lowland agriculturalists for many centuries as part of a flourishing Indian Ocean as well as intra-Indian trade (e.g. Hockings 1980,1985; Morrison 2005; Kusuman 1973).

In return for forest produce, tribal people (referred to in colonial literature as 'hillmen') typically received a few lowland products: food staples such as salt and rice, cloth and iron implements (Morrison 2002). Groups involved in this form of exchange have been classified as 'forager-traders' by Morrison and Junker (2002). Despite, their so called backwardness, most anthropological enquiries have stressed the specialised knowledge of the hill tribes, their role as key participants in the collection of forest produce, and hence of their indirect participation in the wider regional and even international economies (Morrison 2002, 2005). Hillmen communities frequently allied themselves with local chiefs and rulers, assisting in the trapping of elephants, and in the collection of ivory and forest produce, all of which were significant activities (Bourdillon 1893; Morris 1982). In this context, Morris (1982) reiterates a widely shared view among researchers, that these hill communities '*have never been isolated from the wider culture...*' and that their '*...trading relationships, either of a symbiotic kind or organised through a contractual system, have long been in existence*'.

In addition to the Roman period, Morrison (2002) suggests the possibility of several other critical junctures which could have not only prompted lowland groups to relocate but also facilitated further specialisation among upland groups. The colonial period was particularly instrumental in terms of the scale of activities. Access to spices was the driver of colonialism as well as the cause of conflicts between colonial powers (Portuguese, the Dutch, the Danes, the French and the British) themselves. Colonial demands eventually culminated in changes in strategies of collection and production (e.g. cultivation of pepper, ginger, cardamom, etc.), the emergence of 'secondary traders' and

contractual systems with relationships of indebtedness and domination of forager-traders. By the sixteenth century, low-land political economies had already effected transformations of up-land political ecologies in the form of cultivation, cultural exchanges and occupational changes (Morrison 2008).What we see therefore are often, intimate (yet largely invisible) links between upland and lowland communities that are imposed in the process of exchange and interaction. Forager-traders, rather than being marginal players, were the key (albeit invisible) partners in many of these trading networks, and central to the colonial process.

From trade to forestry: colonial use of forests

The early colonial period was ridden with tussles over land and shifting local allegiances and alliances between competing feudal states supported by various colonial entities. However, it was the British who managed to overturn the initial fragile monopolies and were eventually the most successful, especially in their dealings with Travancore (Baak 1997). For key products like pepper, cardamom and timber, trade was tied to explicit colonial monopolies that were acquired by the English East India Company (EIC) from local kingdoms as protection fees to repel annexation attempts by neighbouring kingdoms or by other colonial powers (Baak 1997).

The trajectory of British involvement is particularly relevant for Travancore. The EIC's engagement in Travancore which began in 1644 with a modest trading post, expanded to the provision of protection services to the Venad ruler. This included the subjugation of opposing feudal chiefs and support to a newly consolidated Travancore in its efforts to repel attacks from the Mysore sultans. Eventually these resulted in numerous one-sided treaties of '*perpetual friendship and alliance*' by which the Company assumed the '*tiresome responsibility*' of protecting Travancore, while at the same time undermined its sovereignty and drained its resources through the imposition of unfair monopolies in pepper (Varghese 2009, p. 8). These treaties presaged a series of crises for the Travancore administration culminating in excessive taxation of its subjects and further fiscal indebtedness for the monarch. Eventually, a focus towards agricultural production and the impetus on generating other forms of revenue from land, especially forests was em-

phasised. The latter part of the colonial period also saw the transfer of EIC lands to the British Crown in 1858 (Amruth 2009).

During the early part of the nineteenth century, timber demands for imperial expansion (especially ship-building) necessitated the incorporation several hardwood timbers on a large scale into colonial forestry monopolies (Mann 2001). Timber surveys were initiated, and state monopolies on teak, rosewood, *anjili* (*Artocarpus hirsutus*) and other hardwoods were imposed by the mid-1800s (Amruth 2009). These in turn led to declines in hardwood species (Ravi Kumar n.d.; Mann 2001). Ironically, though overexploitation of timber was largely a product of imperialist expansion and associated forest policies, to resolve the problem, colonial forestry justified hegemonic control and sought to restrict a wide variety of local usage arrangements and subsistence practices (such as shifting cultivation which destroyed timber). Part of this included a colonial rhetoric which projected the colonisers as racially superior, and eventually resulted in a '*British imposed scientific and moral hegemony*' over native forest management (Ravi Kumar n.d., p. 125). For instance, Ward and Conner (1816) bemoan a poorly utilised Travancore landscape with its thin strips of habitation along the coast with its inhabitants lazy and indolent with respect to agricultural ambition and helpless against the constant attacks by wildlife and infringements by the wilderness. This denigration of native peoples and their relationships with places reflect their own metonymic, objectified views about the Orient (Cohn 1996) and a gross misreading of pre-colonial human-environment relationships in the tropics[17]. Under this new era of governmentalisation of forests, the knowledge-power nexus between scientific forestry discourses and imperial needs led to a state-imposed, top-down disciplining that suppressed local, subsistence-centred views of place and instead encouraged production forestry and revenue extraction (Agrawal 2005; Sivaramakrishnan 2008, for Travancore, see Amruth 2009). A process of territorialisation accompanied these developments resulting in the categorisation and formalisation of land into forest and non-forest, and the demarcation of 'reserved forests' for production forestry (Varghese 2009).

17 Hecht and Cockburn (1990) point out similar narratives for tropical Amazonia.

Agrarian capitalism and associated interventions: colonial transitions and impacts due to plantations

As a corollary to revenue generation from forests, the latter half of the colonial period witnessed a concerted focus on capitalistic agriculture. Plantations were initiated in the mid-1860s. The crops that were selected and the trajectories of growth were catalysed by available markets, world events, European investment potential, gluts in production, scarcities due to disease and climatic exigencies (Baak 1997). Plantation activities attained centre stage as the perception of Travancore as a land of plentiful resources shifted to accommodate increasing colonial preoccupations with new notions of economic progress in the form of capitalistic production, revenue generation and eventually scarcity (Edney 1997). In Travancore, almost all colonial officers echoed these sentiments, surveying the forests with one eye on game and the other on profits (e.g. Munro 1880). Foresters such as Bourdillon (1893) paid extensive attention to accessibility, the potential for cart road development and procurement of labour, and the prevalence of diseases such as malaria[18].

Coffee, the first plantation crop, was welcomed into the region by means of free and low-priced government grants of over 39,400 acres of virgin forest to European planters and some local planters of high status (Lovatt and de Jong 1993; Baak 1997; Rejimon 2000). However, with the coffee industry beset by disease and a fall in prices due to a glut (in the form of cheaper Brazilian imports) resulted in the abandonment of most estates excepting those situated on exceptionally fertile ground. Cinchona and tea were then attempted with the latter rapidly growing to be the primary commodity in the region by the 1890s. Rubber cultivation was also experimented in Travancore from the late 1800s. Unlike other plantation sectors in which indigenous control came only after Independence, by the 1930s (partly aided by the Great Depression which made many Europeans sell their rubber estates), native Travancoreans (especially Syrian Christians) controlled more acreage, owned more plantations and had better performing estates. Rubber benefited greatly as demand spiked during the Second World War, and then again as the war ended, independent India's growth and development offered new mar-

18 As a consequence of the poor accessibility and soil conditions, Bourdillon gave Rani FD a poor score resulting in the region eventually getting a reprieve from plantation activities.

kets for this commodity (Baak 1997; Varghese 2009).

As Baak's (1997) extensive analysis demonstrates, plantation development in Travancore entailed a series of significant, far-reaching changes for land and society. Firstly, shifts in crops resulted in changes in geographical focus at a regional scale. Coffee plantation was initiated in the southern areas of Travancore followed by areas in Central Travancore. Tea witnessed growth in the central and northern parts of Travancore, its influence trickled southwards taking with it forest clearing, associated infrastructure development and labour. Rubber found its niche in areas within the Central Travancore region placing the Syrian Christians who dominated the region in a doubly advantageous geographical situation. Shifts from coffee to tea and rubber also meant an influx of people into the hills with transformations in land ownership patterns, infrastructural change such as road building, and shifts in labour[19]. Rubber also transitioned to suit smallholder agriculture. Across the board, plantation agriculture was responsible for extensive encroachment and diversion of forest land. In the early period, concessions abounded and most of these were secured by the European planter-missionary-forester nexus that actively kept native planters out of business (Kooiman 1989). During the first half of the twentieth century, when anti-colonial sentiments peaked, this advantage was wrested by indigenous planters, particularly the Syrian Christians. In the post-Independence period, the group referred to by Baak (1997) as the 'Syrian Christian planting elite' successfully lobbied to halt the process of land reform (especially redistribution of land to economically disadvantaged classes) initiated by the ruling Communist government using their political influence with the Congress party at the centre. In summary, the extensive focus on commodity agriculture had a negative influence not only on forests, but also on the growth of food staples such as paddy (Baak 1997). Grain production faltered and eventually contributed to food shortages and to the migrations of people into the forests of Travancore and Malabar.

19 For a review of the dynamics of labour, see Baak 1997. In their analysis of commodity lan scapes in the Western Ghats, Robbins et al. (2015) point to the dynamics of labour as a critical (yet poorly explored) driver of contemporary decision-making related to agroforestry. A detailed scholarship on demography and migrations are also available for Kerala (e.g. Zachariah and Irudaya Rajan 2005, 2007).

The emergence of conservation

As emphasised by Rangarajan (1998), the colonial period can be characterised by the emergence of state level policies in India that targeted the extermination of numerous problem species and those encouraging the protection of some species of game. The British with their own histories of hunting, extermination, and selective preservation of wildlife were instrumental in this reordering of priorities. A 'broadly negative attitude to carnivores' resulted in systematic campaigns against 'dangerous beasts' (tiger, leopard, wolf, etc.) and vermin which abounded in India (Rangarajan 1998). The situation in Travancore was similar to that of the rest of British India. Wildlife had an emphatic presence in the region. '*The 'village' and the 'forest' were fluid entities and the dividing line was not sharp*' resulting in incursions from both sides Rangarajan (1998, p. 268). In Travancore, the disarming of local populations at several points made it difficult for local communities to live in areas of conflict. During such phases, the government, hobbled by the lack of agricultural production, attempted to entice people back into the forest fringe by providing concessions, and armed protection, and announcing bounties on man eaters and crop-raiding species (see Bourdillon 1893; Amruth 2009).

In Travancore, aided by a trickling in of ideas from other parts of India and the rest of the empire, protectionist attitudes to species in the colonial period began with the game associations[20] in the region that preserved animals to support elite hunting (as opposed to hunting for subsistence, which was frowned upon). While the great majority of subsistence hunters (the forest-dwelling tribes) were powerless to protest, this re-casting of attitudes and territories generated opposition even within a section of the colonial planting community which considered species such as elephants and sambar as pests. In 1869, the state prohibited the killing of wild elephants which were an important source of revenue (from ivory and elephant labour). Sometimes, tensions between trigger happy planters and the government and game associations escalated. At other times, elephant capture with hunting tribes such as the Urali and sport hunting by colonial officials and European planters all segued into a single event. Further, as elephant killings were abolished and the law more strictly implemented, planters sometimes turned to

20 The first such association to be established was the Game Preservation Association of the High Ranges in 1928.

rogues for sport (Bourdillon 1893; Thurston 1901; Amruth 2009).

Following a parallel course with the colonial policies of British India which were edging towards a greater degree of protection for wildlife, the game associations in Travancore too increasingly focused on the preservation of game. The trajectory of development of Travancore's first game sanctuary and national park is illustrative of this process. In the late 1800s, the areas surrounding the Periyar Lake was demarcated as a royal hunting preserve. In 1899, this area was constituted as the Periyar Lake Reserve where hunting and preservation continued hand in hand, though increasing strictures were imposed on subsistence hunting and fishing and the utilisation of forests in these areas. In 1934, the Nellikkampatty Game Sanctuary was established here. The early 1940s saw the separation of the Game Department from the Forest Department. The decision was taken to disallow human intrusions into the area, and hillmen communities living within the sanctuary were moved to its fringes. The area was consolidated again as the (much larger) Periyar Wildlife Sanctuary in 1950. The next series of developments took place after Indian Independence with the implementation of the Wildlife (Protection) Act in 1972. Following the launch of Project Tiger (in 1973), the reserve was re-notified as the Periyar Tiger Reserve (PTR) in 1978. In 1982, PTR was also notified as a National Park. The latter two moves entailed a series of strict formulations in terms of access to forests, signaling a strong division between areas that are inviolate and surrounding spaces which have human activities. In 2007, the park was again expanded by incorporating 148 sq. km of Goodrickal Range of Ranni FD into PTR.

Early transformations in Travancore and the making of migrants

Till the middle of the nineteenth century, Travancore was a kingdom characterised by a complex social structure dominated by caste-Hindus. The high caste groups included the Namboodiri Brahmins, followed by the Kshatriya and Nair communities. These were the primary land-owning communities, whose vast properties were tended by low-caste, untouchable and slave groups such as the Izhava, Chanar, Paraya, and the Pulaya. The Syrian Christian communities were largely excluded from the primary caste dynamics as were most of the forest-dwelling communities but both groups faced distinct advan-

tages and disadvantages. As Travancore was a traditional Hindu kingdom, high caste groups wielded enormous power over their ritual inferiors. Caste was also deeply tied with the mobility of groups with the higher castes endowed with greater freedoms of movement (Jeffrey 1976b). Miller (1954) writing with reference to Malabar confirms that a rigid caste system and territorial segmentation served to maintain both hierarchy and interdependence between castes.

By the middle of the nineteenth century, Travancore which was largely under the de facto governance of the British began witnessing a series of socio-political transformations that gradually brought people belonging to different religions and castes on a more or less equal footing (Jeffrey 1976a). These resulted in a number of interrelated transformations in land tenure, agriculture and forestry, as well as socio-economic and demographic shifts, and changes within the kingdom's judicial, educational and cultural institutions. The changes brought about during this period were grounded in reforms that facilitated colonial strategies for administrative control as well as that for the introduction of agrarian capitalism as a way to generate revenue for the empire. The most significant event during this phase of the colonial era was the 'Pattom Proclamation' of 1865, which conferred full ownership rights on the tenants, making a significant portion of cultivable land in Travancore an alienable commodity. A large number of Syrian Christian tenants who were cultivating for absentee landlords found themselves as land owners (Jeffrey 1976a). In addition to providing tenant farmers with secure ownership, it made land a marketable commodity. Adding another angle to the events leading to settler migrations is the long-standing question of food security in Kerala. Owing to limited cultivable land and high population densities, Travancore-Cochin was already a deficit region for rice production for many decades starting with the 1850s. Cultivation in the lowlands had declined (since paddy was taxed heavily), the cultivation of hill rice which lowland settlers too practiced as shifting cultivation and was of considerable acreage had also given way to commercial agriculture (Varghese 2009). Rice was imported from Bengal as early as the 1850s and by the end of the 19th century, Travancore had become a net importer of rice, with the primary imports being sourced from Burma and Siam (Thailand) (Menon 1878; Joseph 1988).

The factors mentioned above – most notably state-induced changes - can be seen as instrumental in the creation of a transformational nexus between the fictitious commodities of land, labour and capital (as suggested by Polanyi 1944) and providing stimulus for the '*transformation of an immobile subsistent peasantry into a mobile, commercialised cultivator class*' (Joseph 1988). This transformation which occurred in Travancore in the first part of the 20th century prompted the first wave of migrations to Malabar. Travancorean peasantry, took advantage of their new rights to sell their small plots of land, which on account of being located in highly populated, yet cultivable areas, fetched considerable prices. At the same time, this enabled them to obtain larger, inexpensive plots of land in Malabar, which was still firmly entrenched in traditional land management and caste systems. Though these migrations were characterised by a new class of peasants, the inertia imposed by the stranglehold of the caste system was still evident in the fact that Syrian Christians, who were excluded from this social structure formed the majority of the migrants (see (Varghese 2006, 2007, 2009; Devika and Varghese 2011 for details).

War and food shortage in Central Travancore: catalysts for migration of marginalised communities

The first phase of the migrations to Malabar by the Syrian Christians showed that the cultivation of forests was possible (although it was a difficult process and in many cases, success was achieved after many setbacks) (Rejimon 2000). The next phase of the migrations from Travancore was different in composition and motivation. Some people moved northward again into Malabar but others moved more locally, between districts within Travancore, sometimes referred to as ‘proximate’ migrations. These took place in the middle decades of the 1900s. While the first wave of migration, which had focussed on the colonisation of Malabar by Travancorean migrants, has been termed variously as 'land hunger' (Sivanadan et al. 1996), 'land rush' (Münster and Münster 2012), the second major phase of migrations was a combination of distress migrations and profit-oriented moves. Marginalised and landless farmers as well as some capitalist agriculturalists moved to areas such as the Cardamom Hills, the High Ranges and also to areas surrounding the Ranni and Achenkovil forests. The driving force for this migration was

a period of severe economic hardships brought about by the Great Depression during the 1930s followed by food shortages in the early years of the 1940s. This was compounded by the effects of World War II (Varghese 2009). Although the 1943 famine in Bengal is best known, there were shortages in many other parts of India. Between 1941 and 1944, rice imports to Travancore, for example, were held up due to the 1943 Bengal famine and the Japanese occupation of Burma, Travancore's primary suppliers of rice. The impact on the densely settled populations of Travancore and Cochin were severe food shortages. These impacts were further accentuated by localised droughts, flooding and cholera epidemics (Sivaswamy 1945).

To combat the food crisis, the Grow More Food Campaigns (under the recommendation of the Food Grains Policy Committee) were initiated in 1942 by the colonial Government of India and the various Provincial and State governments (Knight 1954). Two forms of agrarian expansion were undertaken in Central Travancore. The first focused on reclamation and backwater paddy cultivation in the Kuttanad plains, and the second targeted forest clearance in the Ghats (Thomas 2002). While this practice was long-frowned upon by the Forest Department, agrarian expansion even at the cost of forests (which were already under protection) was morally justified given the situation for which there were no viable alternatives. Waves of migration continued for a number of years from the 1940s through to the 1960s. Although the major livelihood crises had been overcome, agricultural development and food security reverberated in the developmental ethic of a newly independent India. This line of thought is evident in both regional and national developmental literature of all of the major political parties. The Syrian Christians who led this exodus were made examples of as patriotic and hard-working, progressive farmers (*purogamana karshakan*, Mal. Sing.). E.M.S. Namboodiripad, the stalwart of the communist party, called for a pledge from people not to leave even an inch of land uncultivated (Varghese 2009). Others made very strong demands for all possible support to the hardy migrants who were conquering the wilderness under extremely hostile conditions including rampant malaria and the continuous onslaught of wild animals (Varghese 2009). Although this was done largely with the Malabar migrants in mind, the same stood true for the people seen as pioneering migrants in other areas in the Western Ghats such as Ranni. The migrants were labelled

'national assets' in need of '*every kind of encouragement and assistance in the great battle they are waging against nature for the agricultural development of the country*' (Varghese 2009). In the early years of the migrations, with almost a third of Kerala classified as forests, it was morally difficult for the FD to restrict access as forests seemed the perfect solution and safety outlet against an ongoing humanitarian crisis. A permissive approach to settlements continued till about the early 1950s. However, with the end of the Grow More Food Campaign in 1952-53, the now-independent government began to look at settlements and encroachments in an unfavourable light. Tussles ensued between the Forest Department, the Revenue Department and the settlers, who were in some cases supported by political parties. Rejimon (2000) describes the process in the High Ranges as a repeated cycle of encroachment by settlers, attempts at eviction by the Forest Department, public outcry and eventual regularisation in many places.

4.4 External Actors and Influences: Shaping Capitalism and Conservation

While local forest dwelling communities who lived in the Ranni region, and migrants who arrived there to establish settler livelihoods were instrumental in the transformation of the forest fringe, a diverse array of actors were already entrenched in the dynamics of this region by way of their involvement in various capacities largely synonymous with top-down institutional control. These included traders, forestry operators, administrative bureaucrats and other officials as well as conservationists who brought about a sea change in the way forests and wildlife are viewed today. Some, like the colonial officials and administrators, were outsiders, while others such as local forestry operators, traders and village officials came from the communities in the plains. Together, they were instrumental in imposing a set of ideas (e.g., agrarian capitalism, conservation) that were largely alien concepts in the hills. Under the machinations of this changing group of actors and ideas, place-making assumed new meanings for the colonists, forests began to be valued differently, forest-dwelling communities were displaced and relocated to create 'pristine' spaces, and conflicts arose between groups of people with differing motivations. In this region, these external influences took shape in the form of

the globalising impacts of capitalism and conservation.[21]

Changing values of place: conversion of lived places to sites of capitalist extraction

In the areas around Ranni FD, the large-scale physical transformation of the landscape was linked first with the demand for timber which catalysed the colonial reconstitution of the idea of forests. Surveys, which were one of the instruments of colonial knowledge gathering, were carried out in the Ranni catchment (Pamba river catchment) in the early 1800s by Ward and Conner, and towards the end of that century by Bourdillon (1893). Retracing the steps of the previous surveyors, Bourdillon combed the minor tributaries of the river and viewed the forest primarily in terms of its volume and quality of timber, and the infrastructure required for extraction. His first preference was for teak which was most valuable, but systematic recording of other species that could be extracted in the future were also made by the surveyor. Though according to him, the landscape was eminently suitable for teak, he found few trees of large girth since these forests were under extraction for a long period of time. Bourdillon (1893) proposed the 'worthless' land constituted by Ranni and Achenkovil rivers' interior moist forests to be included in a reserve (of about 300 square miles) for future use.

Bourdillon, despite his conscientiousness to his profession, displayed what had by then become typical, a colonial derision towards hill cultivation and associated practices such as girdling of trees and burning. He felt that in the Ranni region, local Indian officials who comprised the lower-rung of the forestry staff were tardy in their approach to stopping these local activities. In other words, hill cultivation, a subsistence practice (although in a number of cases, extra grain was shipped down to the plains for sale) was soon betrayed by the European forestry official's fondness for timber. In fact, despite being an exemplary botanist himself, he complains against the diversity of the forest trees, many of which were not of any use. In this sense, the forestry department was instrumental in the forests being reconstituted and perceived as reservoirs of timber and little

21 The impact of some of these influences at the landscape scale can be examined using surveys reports and other relevant literature on Ranni Forest Division and surrounding areas in Central Travancore. The number of direct sources for this region is fewer, but key documents, such as the reports prepared by Ward and Conner (1816) and Bourdillon (1893) are a direct window to the aspirations that colonial forestry engendered for far flung places in the Ghats.

else. Foresters valued land differently, along silvicultural lines: in terms of the presence of timber species, standing volumes of timber, maximum sustainable yields, etc. Here Whitehead's (2002, p.1363) perspective of the dichotomy between '*local senses of place*' and '*...abstract conceptions of place, the latter being rooted in Western legal and economic and scientific constructs*' is a useful way to understand how the identity and value of forests changed. By viewing forested land in this way, colonial foresters were the first to bring about a shift in perspective which in later years found ready acceptance in other circles.

Eventually, the 'improvement' strategies adopted by Indian forestry were reflected in this landscape. Forest plantations were established here that were geared towards the exclusive production of timber. The Konni Forest Division (which at the point also constituted the Ranni region) was the first site in Central Travancore to be selected for '*taungya*' cultivation of teak. This hybrid form of traditional and 'scientific' silvicultural practices of the time was imported from colonial forestry experiments in Bengal, Assam and Burma, and depended on local labour for maintaining the plantation in its early years. Local people were allowed to cultivate crops within plantations in exchange for initial services rendered in clearing and burning as well as performing the necessary maintenance activities for the teak saplings. While *taungya* failed in numerous other parts of Travancore, the abolition of hill cultivation and a population of impoverished peasants desperate for land rendered this practice a productive strategy in this area.

Plantation agriculture which followed a parallel pathway to colonial forestry was the other major extractive activity that catered to far away markets. In terms of landscape transformation, this form of agriculture was much more ecologically harmful than forestry activities, as the majority of plantation crops were grown as monocultures on clear-felled land. Plantation agriculture also entailed significant changes to property ownership, labour, socio-economic and demographic changes, and food security. Plantations also made land and labour susceptible to overseas market situations and policies. In contrast to neighbouring areas, large-scale plantation activities were of a restricted nature as Ranni's topography (particularly steep slopes) was not conducive to this form of agriculture. Here land and geography were two-way processes that shaped human

settlement in this region. Interestingly, European missionary influences (which typically went hand in hand with planting) in this region were also of a limited nature perhaps due to the lack requirement for labour (who were liberated from the confines of the restrictive caste system by missionary efforts). Eventually, the impacts of plantation agriculture trickled in. Rubber cultivation which started under a large plantation model soon became an attractive option for smallholders in the region in the latter half of the 20th Century. The migrant settlers who moved in during the period of food shortage benefited immensely from this crop. Smallholder plots, despite their focus on both rubber and agricultural crops (a great deal of which are lost to crop depredation by wildlife) are susceptible to the vagaries of external rubber prices. The introduction of rubber has been both boon and bane, drawing in large amounts of revenues during periods of high economic growth and sending local economies into a tailspin during the bust years.

On the whole, the impacts of extractive capitalist agriculture in the late colonial period resulted in an erasure of place and locality at least in terms of what was locally pertinent and considered as significant by local communities. The legacy of imperial demands of the earlier colonial era was also reflected in a shifting focus from forest produce to timber and ultimately commodity agriculture. Land came to be valued less in terms of its subsistence and small-scale trade values and more in terms of potential for timber and agricultural productivity. Commodity agriculture in the form of monoculture plantations (once the mainstay of large holdings) pervasively took over small-holder mixed plots in some places, dismantling an already precarious food production system. While the extreme impacts of neoliberal agriculture in terms of the boom and bust commodity economies have been more acute in the Wayanad region of Malabar (Münster and Münster 2012), the ecologies of highland Central Travancore with its sub-optimal soils and inaccessible slopes sheltered the region from an excessive dependence on these crops (with the exception of rubber).

Conservation and control: the making landscapes of conflict

The initiation of the wildlife preservation and conservation movements signified yet another shift in the way places are perceived, valued and enclosed. On the one hand,

preservation exercises centred on charismatic species such as the tiger and elephant required an evaluation of numbers, densities, and habitat parameters (not to mention different management strategies), other valuations aimed at prioritising areas based on the number of species, endemics, or levels of threat (e.g. hotspots) or the potential of landscapes to provide significant ecosystem services and to serve as source locations for re-colonisations of species. Like in forestry and commodity operations, a number of abstract parameters and measurements came to be of relevance. Following Whitehead's (2002) analysis, places are converted into abstract spaces or the creation of spaces without people, their histories, culture or politics. As in the case of the Periyar Tiger Reserve adjoining Ranni, the establishment of protected areas not only resulted in different forms of enclosure and management, but also engendered a different perspective of the landscape outside the reserve. The lower priority accorded to areas outside reserved spaces and the protection accorded to animals within reserves has resulted in a perception of modified landscapes as those where wildlife shouldn't be occurring. In a pattern that is common to other areas, the delineation of protected areas, therefore resulted in changed social expectations of acceptable and deviant behaviour both for wildlife as well as people (Gieryn 2000; Jacoby 2001; Williams et al. 2013).

As emphasised by Rangarajan (1998), the Indian context leading up to the era of conservation has been one of protracted conflict and systematic eradication of dangerous animals or species that were problematic in other ways. The conservation era too has been a primarily top-down exercise whereby colonial administrations or environmentalist interventions imposed restrictions on local engagements that involved hunting or extermination of wildlife. In this sense, the trajectories in Central Travancore have been similar to the larger regional and national contexts. This is well illustrated in historical records from regions in and around Ranni which report numerous instances of problematic conflict involving crop-raiding elephants and man-eating tigers (e.g. Mateer 1883; Bourdillon 1893; see Amruth 2009 for more details). However, with the passage of time, restrictions emerged on the utilisation of species for subsistence as well as against the extermination of valuable species such as elephants. Since the imposition of legislation has been hardly context specific, pockets of conflict remained where extermination of problematic wildlife was not legally possible. The widespread colonial legacy of first

exterminating problem species and then turning them into 'ownerless, priceless assets protected by law' (Butler 2007) has been problematic. As evidenced by the contemporary situation in Ranni, protection to crop-raiding species such as wild boar have resulted in significant increases in animal numbers and incidents of conflict. The prevalent local ethic in these situations, i.e. one of eradication and hunting of animals is overruled by that of Forest Department officials, urban conservationists and animal rights activists who are less empathetic to the travails of forest fringe dwellers, and lack lived experiences in such systems. For many urban-dwellers and conservationists, forests and parks provide short term experiences in the form of tourism and wild life safaris, field trips, etc. whereas local communities pay the price in terms of animal attacks on crops and livestock, direct attacks, opportunity costs, etc. Such situations signify contestations between local and urban views of place that are not only prevalent in the Indian context, but are widespread globally and signify the power of top-down control exerted by powerful lobbies. Here, one is reminded of the opening line of Neumann's (1998, p.1) '*Imposing Wilderness: ...*', in which an expatriate official from an influential, international conservation organisation exclaims, "*This is the way Africa* should *look*" as he stands in the middle of one of the region's national parks from which people have been expelled. Neumann's interrogation of the situation, '*...who decides what Africa "should" look like? Where and how have ideas of the pleasing African landscape been constructed? What does this landscape vision mean for African peasants and pastoralists living and labouring there? To what degree and in what ways do they resist this vision?*' is as relevant here as it is in Africa. While in the contemporary scenario, expatriate conservationists may not be the prominent voices (although their opinions are nevertheless part of international assessments that have put the global spotlight on the Western Ghats), the Indian conservationist, with his urban upbringing, Western education and non-consumptionist view of nature, plays this role admirably well.

Similarly, access and control are equally important aspects relating to the generation of conflicts between the conservation lobby and local communities. While entry and extraction are largely prohibited for local communities living on the fringe, parks routinely allow high end ecotourists to visit. Ecotourism can be interpreted as a form of elite control of land and resources. The trajectory of park development itself has been one

of increasing control and exercising of power. As is evident in the case of the Periyar National Park which shares a boundary with Ranni, the exclusion of people and the denial of rights was a multi-step process[22]. With each new legislation or notification of the park – from a mere game reserve to one of Project Tiger's success stories and India's premier national parks that provided attractions to lakhs of tourists and nature lovers – local communities lost out by way of access and usufruct rights, prohibition of activities, greater costs in terms of crop damage and loss of cattle, etc.

To summarise, although human activities in the pre-migration era are rarely recalled within contemporary frames of memory, archaeological records and historical reports abound of human use of the region over millennia. It is in this light that the ideologies backgrounding the creation of a more recent dichotomy between human occupied and exclusionary landscape becomes interesting. The segregation between people and forests in this region has been provoked by a specific set of ideologies brought in from the plains, from far away places and from urban centres: those of the planting elite, the forest department and more recently conservationists. The colonial elite as well as post-colonial forestry administrations, and planters were instrumental in bringing about this gradual segregation and ushering in their ideas of commodity agriculture and other capitalist activities that looked to generate revenues from the forests. In recent times, this segregation has been further cemented by the current protectionist rhetoric imposed by the influential conservation lobby who favours the preservation of the forests exclusively for biodiversity protection. Albeit for differing purposes, both groups favour/ed an ideology of the removal or displacement of people (or at least certain groups of people) from forests. As the cumulative effect of these exclusionary ideologies, there has been a material as well as symbolic transformation of productive forests into pristine spaces. In this sense, there has been a break with long-term (and in some cases, centuries old) lived experiences of place, memories, identities, oral and occupational traditions that have accompanied this separation. On the other hand, with the influx of settlers into the forested areas of Travancore from the mid 1900s onwards, there was yet another articulation and creation of forest-centred experiences, memories, identities, etc., this time of

22 However, Periyar, being a more high profile PA had stricter policies of exclusion. Ranni, on the other hand did not exclude local communities completely. Groups such as the Hill Pandaram still use this landscape.

different kind altogether. Here, settlers shaped by their histories and experiences of the cultivated plains refocused their ideologies and expectations as they came into contact with the forest and its occupants.

4.5 Forest Dwellers

The Western Ghats have a long history of human occupation. Settled or itinerant, hunter-gatherer, forager-trader, or agriculturalist, human communities still living in the forested landscapes have been categorised under the recent, generic appellation, '*adivasi*'[23]. They have in common between them longstanding histories of interaction with the region's forests and their eventual alienation by outsider agendas. Dispossession and dislocation of tribal communities figured prominently both in the strategies of colonial planters and other agricultural capitalists, as well as in colonial and post-colonial forestry and conservation strategies. Although development and conservation are characterised by conflicting agendas, forest-dwelling groups have been adversely impacted by both. As suggested by Steur (2011) in the case of Wayanad, structural transformations characterising the age of late capitalism, i.e., the shift from expanded reproduction to accumulation by dispossession (Harvey 2003, 2004) played out significantly in this region as well.

This section traces a history of forest-dweller engagements and perspectives in the Western Ghats, particularly, in the areas in and around the Ranni Forest Division in the Central Travancore region. By developing a narrative of place centred on forest communities, the main focus of this exercise is to develop additional understandings of other groups of people in the Western Ghats. Detailed explorations of *adivasi* community histories or perspectives were not carried out as there are numerous communities (e.g. Hill Pandaram, Mala Vedar, Ulladan, Urali, Mala Arayan (Malavel/dan), Mala Adiyan, Vettavan, Kani, etc.) and also due to the fact that the predominant community in the study area, the Hill Pandaram is an itinerant group that is reluctant to communicate. In terms of research effort, a long-term ethnography of this community would need to be conducted to evince the level of detail comparable to that of the settler study. As a con-

23 See footnotes 7 and 8.

sequence, greater emphasis has been placed on published ethnographic research, historical accounts and reports by planters, missionaries and government personnel, settler oral histories, and literary fiction to get an approximate understanding of this context[24].

Forests as non-pristine, lived spaces: differing ties to land

The recent focus on exclusionary conservation along with colonial and post-Independence enclosure strategies have somewhat obliterated the notion of the Ghats as a peopled landscape and replaced it with that of a protected pristine zone at least in popular perception. As one delves into past records of the region, a different history emerges. Literary texts, archaeological evidence and historical records point to specific locations along the Pamba (Ranni River, River Baris to the Romans) and Periyar rivers as a key source of upland products and their trade by hill tribes (sources include the Silappatikaram, *Periplus*, the accounts of Pliny and Ptolemy, and also the Tamil bardic poetry of the Sangam period). In the Ranni landscape, numerous urn and cist burial sites, megalithic dolmens (Krishna Iyer 1941) and ruins in the forest signify an even longer history of human habitation dating back to at least the Neolithic period (Krishna Iyer 1941). The romantic poetry of the Sangam age refers to forest dweller engagements in the 'elephant-forests of Ay'[25] Missionary accounts and surveys of the colonial period report ruins and extant settlements, and the presence of various groups of people, some practicing settled agriculture or shifting cultivation, others itinerant and without fixed dwelling places or settlements (Ward and Conner 1816; Mateer 1883; Bourdillon 1893). From the Ranni region, several colonies of hillmen were reported, including the Hill Pandaram, the Malayadiyar/ the Kuravar, the Valens, the Mala Arayar, etc. During later years, anthropologists (D'Penha 1902; Morris 1986) too were curious about the hillmen, and especially so about the enigmatic, forest-dwelling, Hill Pandaram, for whom the Ranni and Achenkovil forests formed the centre of their loosely defined territory. Their accounts show that the forest-communities occupying the Ranni region, when placed

24 In this regard, two publications are of significance. The first is a detailed ethnographic study by Morris (1986). His work titled, 'Forest Traders: A Socio-Economic Study of the Hill Pandaram' remains the only ethnographic study on this enigmatic community. 'Kocharethi (The Araya Woman)', a fictional account that encapsulates the exploitation of the Mala Arayar during the colonial period and the Travancore migrations, is a novel by Narayan, an adivasi writer from Kerala.

25 Paranar, *Kurinji Thinai, Akanānūru* 152.

along a continuum, ranged from hunter-gatherers to agriculturalists. These groups were defined by a variety of occupational specialisations, dwelling patterns, and social relations, all of which had import for place-making and ties to land.

Firstly, forest-dependent groups operate based on a different set of criteria that are tied up with safety, subsistence, and trade. As inhabitants of an elephant landscape, knowledge of safe locations of habitation and cultivation was of paramount importance in the landscape for all these groups (Mateer 1893; Morris 1986). Spatial knowledge relating to subsistence and trade-related activities is also a key component of place-based knowledge of forest-dwelling communities. Consequences of past ill treatment, harassment, and exploitation are also reflected in their choice of hidden, unobtrusive camps for groups such as the Hill Pandaram (Morris 1986). On the whole, the spatial relationships and mental maps of forest-dwelling communities are bound to be invisible to and distinctly different from that of settler groups whose primary focus was agriculture. Some forest dwelling groups such as the Mala Arayar, the Mannans and the Paliyans actively made places within the forest by means of cultivation, sacred spaces or associated rituals. Others such as the Hill Pandaram with their lack of cultivation and un-iconic worship give little away to outsiders as the places that are significant to them are rarely visually prominent. For many forest peoples, movement through the landscape is primarily achieved on foot, which in turn projects a different image of the landscape than is visible to people whose mobility is attained through vehicular travel. They tend to read the landscape differently, almost with a different language entirely, and developed as a consequence of their subsistence requirements, exchange opportunities and necessities related to lifestyle.

The above descriptions show that contrary to what a lot of conservationists believe, the Ranni landscape, like the rest of the Ghats, had its complement of forest-dwelling communities[26]. A diversity of occupations ranging from cultivation to hunting encompassed different spheres of knowledge and ties to land. A great deal of these were obliterated

26 Note that although these tribal communities are found in the Ranni area, the actual observations by Mateer, Baker, etc. were on the same groups located either further north or south. European influences, with the exception of visits by surveyors and foresters, were fewer in Ranni compared to the neighbouring hills. Missionary influences in this region were particularly limited. In the absence of plantation opportunities, saving souls was perhaps not a lucrative venture after all.

during the colonial and post-Independence periods due to misconceptions about their ways of life. This was further compounded by exploitative land grabbing strategies of incoming plains peoples. Interestingly, given the present appearance of the forest, this also shows how quickly a monsoonal evergreen forest, once it is enclosed, can mask signs of abandoned habitation and cultivation and revert to thick forest giving itself it an impression of pristineness.

Forests as refuge/ familiar places

The lack of overt, articulated or discursive links to place or land among some communities, however, does not mean that their relationship to land and the forest is non-existent or irrelevant. On the contrary, the fact that the Hill Pandaram retreat to the forest to avoid agriculturalists from the plains or the forest officials speak volumes about their ties to land and forests. From the colonial period onwards, their nomadic lifestyle (in stark contrast to that of sedentary cultivators) has been painted in a negative light and associated with racial inferiority and as a recipe for destitution and environmental degradation (Cronon 1983 shows the same for New England). As Tuan (1977) argues, rootedness and formal ties to land which seem natural to sedentary agriculturalists are not the only forms of place attachment. However, in this scenario both the Forest Department as well as the settlers consider certain *adivasi* groups as placeless, resulting in a great deal of land appropriation. For the Hill Pandaram, forests as refuge resonates well with Relph's (1976) concepts of insideness and outsideness, the former relating to a feeling of safety, security, and lack of stress that a person feels in a familiar place such as home, whereas outsideness relates to alienation and insecurity about a place.

When viewed from this perspective, for the forest dweller, the forest is the familiar landscape, and the cleared landscape/ village is the one which is fraught with dangers and vulnerability. This is reflected in an interesting dualism which groups such as the Hill Pandaram exhibit in engagements with the forest and village. Morris (1982) refers to this duality when he describes the Hill Pandaram as being ill at ease and sullen when seen outside the forest, but perfectly cordial when inside, indicating their level of comfort with the surroundings. When visiting villages, community members take

measures to dress like villagers (wearing more clothes than in the forest, wearing clean clothes, oiling and tying up their hair, women wearing saffron bindhis like women of the village), using respectful salutations and other normative rituals while greeting people (as opposed to a lack of greeting in within their own camps), etc. According to Morris (1982, p. 47) women dress in a more feminine fashion when setting out for a village as opposed to their attire in the forest which is similar to that of men, and plays the servile, reticent role expected of village women. This is different from the more egalitarian engagement between men and women in the forest camps. According to Morris (1982, p. 50), '*...outside this setting (the village), the external symbols of the wider Hindu society are discarded, and normal behaviour follows a pattern*' and ' *... characterised particularly by tolerance of sexual relations between close kin, loose social ties and a stress on symmetrical relationships. To the Hill Pandaram, even those who are to some degree enmeshed in activities outside it, the forest offers hope, security and a place of refuge from exploitation.*' This exploitation and ridicule that they face is due to the exaggeration of these distinguishing features by plains people and hence the negative stereotyping of the community as a whole.

It is also important to consider the role of forests as refuges since historical times. A number of the hill tribes claim to be descendant from groups in the plains. Many communities speak a mixture of Tamil and Malayalam, indicating mobility across the ridge. Potential descent from caste communities could also be considered possible as communities have hierarchies among them; taboos exist against eating beef reminiscent of some caste communities. Historically, some forest-dwelling groups were considered above lower castes in the plains and did not fall under the strict distance pollution framework when they encountered plainspeople. The fact that many groups do not articulate strong links to place, could be because of historical mobility. Their lack of articulation and reticence to engage, itself, could be a remnant function of their probable status as refugees who fled to the forest during times of oppression. The latter are reflected in numerous stories relating to the Mala Arayar, Kurumar, Mannan, Muduvan, Urali and even the Hill Pandaram (e.g. D'Penha 1902; Morris 1986).

Marginalisation

As mentioned before, the marginalisation of tribal people, especially the hill tribes, is not a new phenomenon. Over many centuries, the exchange system of these groups was always one of unequal power relations, with lowland agriculturalists, contractors, or the state functioning in an exploitative manner. And as Morris (1986) demonstrates, citing the Tamil epic Silappatikaram, even during first few centuries C.E, there is mention of tributes being extracted from local tribal communities in this region. Rev. Samuel Mateer, a Protestant missionary in Travancore noted for his accounts of the native people in the late 1800s recounts that groups such as the Kanikkar were exploited by just about anybody who had the opportunity. However, being a Christian missionary himself, Mateer does not view his own role in the attempted conversions of the hill tribes as problematic.

Colonialism entailed a more aggressive exploitation and ushered in a period of stricter controls, culminating in what can be termed the governmentalisation of the forest and the subsequent marginalisation and displacement of hill peoples. Governmentalisation brought an army of outsiders and external influences into the hills. The activities of tribal communities were seen as being actively harmful to forests (Rejimon 2000; Philip 2004), especially shifting cultivation that involved girdling or burning of timber trees. Bourdillon's (1893) concern about the prevalence of these practices in Ranni was one of the reasons for the creation of the reserve in this region. In the early 20th century, forest-dwelling communities such as the Hill Pandaram were paternalistically designated 'wards' of the Forest Department and brought under a new legislation, the 'Treatment and Management of Hillmen Rules, 1911'. Traditional hill produce collection systems were dismantled to be systematised under leases to merchant contractors, who further exploited these communities and exacerbated indebtedness. In post-Independence India, many of the forest-based groups such as the Hill Pandaram were brought in charge of the Harijan Welfare Department, which in turn attempted to sedentarise these groups and promote agriculture through 'colonisation schemes'. Though largely unsuccessful, such interventions were still detrimental to these groups. The ownership of land and the rights to collect were curbed once the state took over the forest and ushered in a forest

department with its 'space-based world-views' incorporating utilitarian logic and commercial exploitation and reconfiguring the hill tribes' access to places in what Whitehead (2002, 2003) terms 'spatial and cultural erasure'.

When the migrants arrived in the hills bringing with them an expanding agrarian frontier, some of these battles over forest land had occurred and forest dwelling groups were already wary of these incursions. Migrants, itinerant traders and contractors all appropriated land both by subtle forms of appropriation such as creating indebtedness, trickery and falsification of land records, as well as by acquisition by more violent means in some places. While the latter from of land grabs were more prominent in the Malabar region, Travancore also witnessed its own forms of exploitation. While these events have been poorly explored in academic scholarship, they have been the subject of recent literary fiction. For example, Narayan's *Kocharethi* (*The Araya Woman*, 1998) explores the travails of the Mala Araya community during the period immediately before the arrival of the settlers. This work makes frequent references to exploitation in the hills in the early phase and much of this involved the creation of indebtedness and the transfer of land to clear debts which were often fictitious. In Central Travancore, plantation owners had appropriated a great deal of land suitable for tea, cardamom and most significantly rubber. Migrants were encouraged to clear forests in what were considered marginal areas, and support from the government amplified the power of settler communities. The signs of existing exploitation were already evident as settlers describe the initial hesitation and fear among *adivasi* communities to interact with them. Moreover, in the light of the numerous dispossessions that already took place, there seems to have been a powerlessness on the part of *adivasi* groups and an internalised futility in their attempts to defend their land or offer resistance in any way.

From forest-traders to adivasis*:* adivasi *resurgence and the centrality of land and forests*

In Kerala, the persistence of colonial patterns of land management in forest conservation and plantation ownership in the hills, as well as the dynamics of socio-economic and political conditions that impacted agricultural landscapes of the plains, have been at the root of the high levels of landlessness among marginalised groups (especially those

belonging to the agrestic-serf communities). Land or (to put it more accurately) landlessness, has been a central issue for these communities with much of their experiences with land being more strongly situated in the agrarian histories and caste politics of the plains. However, with the clubbing of diverse communities under the umbrella of the post-Independence *adivasi*[27] movement, forest-dwelling communities who have historically had different engagements with land, and underwent distinctive forms of dispossession, are viewed in the same way.

In the land conflicts that have been playing out in the state during the past few decades, reconstructions of place-based imaginations alluding to their alienation from native lands play an important role in *adivasi* articulations. Deep ties to land and forests are alluded to whether the community in question was primarily forest-based or not. Here, reconstructions of place-based indigeneities and tribal self-portrayals assuming the 'noble savage' identity also reflect the recent engagements with power to which *adivasi* groups are subject. Misrecognition forces the use of such arguments to counter powerful agents such as the state and environmental activists who have projected negative stereotypes with respect to their relationships with nature. As Steur (Steur 2011) cautions, '*when organic indigeneism becomes inflated by elite eco-indigeneist exaggerations of indigenous harmony with nature, it becomes particularly problematic*'. Romanticist portrayals are particularly easy targets to debunk for opponents from the conservationists lobbies that support exclusionary policies. More significantly, in terms of articulations relating to the politics of land and place, we are again in a situation where the demands of a dominant group (communities that have been under agrestic servitude) though entirely legitimate considering their historical marginalisation, often overpower those of minority groups (forest-dwellers). This prevalence of hegemonic articulation within indigenous movements typically hides subaltern ideological viewpoints and alternative forms of indigenism (Steur 2011) to which groups such as forest dwellers subscribe.

27 Within India, there is the lack of a distinguishable category of people who can be recognisable *adivasi*, a term that can be literally translated as ‘original/ first inhabitant’. For more details, see Agrawal 1995, Sundar 2005, Baviskar 2005a. Problems also arise with respect to generalised categorisations such as indigenous and aboriginal especially in the case of India.

In many cases, these result in the creation of monolithic identities (Kjosavik and Shanmugaratnam 2007). Kjosavik (2006) points out that Stuart Hall's (1990, 1996; see also Li 2000) analyses of collective identities as 'articulated positioning' are useful in understanding the theoretical and tactical dimensions of land struggles by *adivasi* communities. Such identities are often articulated to transform groups into a social force and to achieve political ends but are often re-articulated depending on context and necessity. In the case of Kerala, Kjosavik (2006) argues that the initial projection of *adivasis* as a monolithic category could be interpreted in terms of the advantages it would confer them in negotiating with the state, settlers and society in general.

In the Ranni landscape as well as for much of the Travancore region, explicit articulations of place-based identities as well as associated political upheavals have been less numerous than in Wayanad. Land, identity and place are finding voice in some of the struggles that are being spearheaded by agricultural serfs in some parts of the wider region (e.g. Chengara). In response to the consequences of large-scale ecological assessments such as the move to declare World Heritage Sites in the region, while a few of the forest-communities have teamed up with low-land scheduled caste communities to voice their opposition, many groups remain outside the network. The reasons behind this reticence remain unclear but can be speculated upon. On the one hand, *adivasi* groups belonging to the highly oppressed agrarian serf communities were fewer (Malabar had much higher levels of historical marginalisation of *adivasi* groups) with a large number of settler interactions being with the forest-dwelling communities such as the Hill Pandaram who are non-confrontational by nature. Their primary strategy of avoidance of conflict was aided by their itinerant lifestyles. On the other, it could be because the majority of the migrants themselves were impoverished smallholders as opposed to the archetypal land-grabbing frontier capitalist who moved to Malabar. By moving in small bands and making several temporary forays before settling down, the former also followed a strategy of migration that was of a less aggressive and of a more incremental nature as opposed to the sudden upheavals that migrants brought about in the Malabar landscape. These could explain the fact that in the Ranni landscape, forest-dweller interactions between forest communities and pioneer settlers were perhaps less violent and even exchange-centred during the initial phases. While these interactions were still no

doubt exploitative and favoured the settlers, the overall relationship was distinctly less violent, at least in comparison to the Malabar experience.

4.6 Settlers

Migrant settlers and their transformations of land are important elements of forest fringe dynamics in the Western Ghats. A significant portion of the deforestation in these areas in Kerala can be attributed to an unprecedented series of migrations from the plains of Travancore to a number of areas in the hills. These migrations took place in waves between the 1920s and the 1960s (Joseph 1988). The most prominent among these were the migrations to the Malabar region which occurred in two distinct phases: the initial (pre-1940) migrations comprised largely of agricultural capitalists, and a second wave of predominantly distress migrations which coincided with the years of the Second World War and the years leading up to Indian Independence. Even though Malabar was a primary destination during both phases, a number of migrations from areas within Travancore also took place. Together these comprise a distinct form of agricultural capitalism in India, as in contrast to the rest of the country where this process was driven by agrarian elites, the major players in the migrations in Kerala were marginalised peasants (Joseph 1988). Although this study focuses on the consequences of the latter series of migrations which have received limited attention, an overall understanding of the dynamics of both series of events is important as the initial migrations to Malabar set the stage, catalysing future movements of people.

This section addresses the settler influx into the eastern hills (specifically Ranni Forest Division) and the social dynamics of deforestation and agricultural expansion that accompanied it. A background of the larger-scale (and sometimes extraneous) socio-political factors that impacted the erstwhile kingdom of Travancore state has already been outlined in previous sections of this chapter. This section begins with an account of the local migrations, followed by the transformations of forests to agricultural lands and homesteads and the consequences of these movements in settler landscapes in Travancore. The central conceptual focus of this exploration is to understand settler perspectives on place and the role of migration and memory in generating contemporary atti-

tudes to conservation and environmental justice. Data drawn from several sources such as in-depth interviews with key resource persons, oral histories from first and second generation settlers, published reports, research material, and literary fiction are used to inform this analysis. This local scale analysis relies heavily on recorded oral histories of first and second generation migrants.

Dislocation: heading east

In the 1940s, following widespread food shortages in Travancore, migrants either took what was the established migratory pathway to Malabar, following in the footsteps of the agricultural capitalists[28], or a relatively shorter migration to Travancore's own eastern hills to the areas fringing Ranni, Konni and Achenkovil forest divisions. Their choice of destination depended on a number of factors such as the availability of finances to travel, familial as well as village-level links to previous migrants, and prompting from external actors such as politicians and newspapers. Most of the settlers remember the 1945-46 demarcation of the Food Production Areas (this was the official designation of these sites under the Grow More Food Campaigns) within the Ghats as the brainchild of Sir. C.P. Ramaswamy Iyer, the then Dewan of Travancore. This publicised availability of lands (in the form of forests to be converted) for lease and the exhortations to move from various fronts were perhaps the most significant catalysts of migration in a region which had a historical shortage of agricultural land. To justify their presence in the landscape, settlers often reiterate that the government enticed them to move (see Varghese 2009 for details of this motivational politics). Both poverty in their native villages and the promise of land allotments in the hills has been put forward as the most compelling reasons that precipitated their journey eastwards.

The beginning of large-scale deforestation in the Ranni landscape is clearly linked to the demarcation of Food Production Areas, beginning at the same time, from 1945 and 1946. Though people moved in from all across Central Travancore, most settlers were

28 This is explained in previous sections. See also Joseph 1988, Varghese 2009, Münster and Münster 2012, etc.).

from nearby locations in the foothills[29]. For families that moved in during this early period (pre-1950s), it was largely a matter of staying afloat during a period of intense

food grain shortage. Many of these families were marginalised and impoverished, some had no land in the plains but lived as tenants, others had small plots of land that were inadequate for sustaining large families. And given that the region had undergone a series of food shortages, food security was an important element in livelihood-related decision-making. Leases were allotted to a number of families who moved in at this stage and the lease amounts were low enough to be afforded by settlers after they sold their land in the plains[30]. The 1950s witnessed the next wave of migrations of people, who moved in for better agricultural opportunities. Some of these moves were inspired by the fact that relatives, friends and acquaintances who moved were successful in acquiring allotments. Even during this phase, forest clearing happened on a large-scale, although plots that were being abandoned by those who went back were also available for sale. Other families were prompted by individuals such as contractors and officials who knew how to work the system to their advantage. These influential people brought retinues of labour from their villages and also recruited extended family members and friends. As allotments were easier for ex-servicemen as well as scheduled tribes and castes, a great deal of underhand exchange went in acquiring land through proxy arrangements. Although food grain shortages had more or less subsided, the impression that one could get forest land in the hills persisted even till the 1970s and 80s.

Not everybody who arrived in this landscape eventually stayed on. Some left at the end of four years after the initial lease for rice cultivation ended. Others left because of the constant trouble from elephants. The migrations therefore took the form of waves of settlers coming to clear forests and also occupying plots that previous settlers disposed of. Not everybody who tried to acquire land was successful. Although in the first two phases, a number of richer landlords came with their workers, many of them returned to their villages after leaving their labourers as caretakers. When government allotments

29 These include places such as Vadaserikkara, Thalachira, Kumplampoika, and Ranni town located within 10 - 30 km of the current fringe. Families moving in from places bordering the Kuttanad area such as Kanjiramattam and Kallisery (about 30-70 km away) and even further localities were also not uncommon in the initial years of clearing which took place in the late 1940s.

30 The government order, GO No 11774/52/, was issued for this region as early as 1942.

were carried out on the basis of verification and inspection, only those who physically remained on the land were allotted plots. This enabled a number of labourers to acquire the land in their own names, which in turn resulted in an upgraded economic status.

Forests as unfamiliar spaces

For those migrants who came from far off regions, especially the rice-growing plains of Kuttanad, the journey was a long one and the forests were unfamiliar. They would travel by bullock cart or bus till the road head and walk the final stretch of 20-30 km. For the groups moving in from neighbouring localities, their arrival in the landscape was not a sudden permanent move. They would make several week-long visits to clear the forest, fire the ground, plant crops, etc. and return to their villages. With the passage of time, they gradually increased their periods of stay making more permanent accommodations. In terms of past experience, many migrants were afraid as the impenetrable forests and animal depredations served as fertile ground for fear and anxiety. Further, for those who went into the forests, the overgrown ruins of old temples, graves and habitations induced trepidations about the futility of living in the jungle and fear of the supernatural. As is often true of unknown places, reports of the supernatural abound in unfamiliar landscapes. In this context, Tuan's (1977) analysis of forests as cold forbidding places to migrants coming from the open plains is pertinent here.

Whether one was from a distant place, or a nearby village in the plains, what set this place apart in more distinct terms than any other, was the presence of elephants. Few were familiar with elephant jungle, and the fear of elephants assumed enormous proportions. On their arrival at the fringe, the first activity was the construction of a *madom* or *machan* (a raised platform on a tree) for the family to spend the night in. In some ways, along with the extensive clear felling of forests that was carried out during the period, these tree houses became the defining physical structures of settler place-making and remembrances across the region. Conforming to the tendency among people to disproportionately remember emotionally charged, traumatic events (than those without a great deal of emotional intensity) (Tint 2010), interactions with elephants are among the first things that settlers recollect when asked about their experiences on arrival. They

identify themselves first and foremost as the people who lived in the trees and suffered enormous sacrifices eking out a living. Over the years, there are indications of a distinct dissipation of conflict with elephants. As clearings and habitation increased, incessant crop raiding shifted to occasional depredations closer to the forest boundary. Yet, the odd madom on the forest fringe, signifies a lingering presence of elephants, and that after all these years, this is still an elephant landscape with the potential for occasional visits, raids on crops and threats to lives. These man-made structures are not only the most easily detectable symbols of elephant presence but also emblematic of conflict, both past and current[31].

During the initial years, the damage caused by elephants was expected by the settlers. The opening up of the landscape along with the shift in cropping patterns (especially the shift away from paddy) and the associated response by elephants in the form of longer circuits and occasional raids entailed a move towards tolerance. Over a period of time, there have been adjustments on both sides with respect to coexistence in shared spaces. Settlers became better accustomed to the behaviour of these animals, avoiding the accidental conflict and direct confrontations that were commonplace in the initial years. In other words, they have been finding ways to become local (Raffles 2002), both mentally, such as in the acceptance of a certain level of conflict, as well as physically, pertaining even to basic activities such as walking quietly in the forest, listening out for elephant activity, and avoiding confrontations. Elephants too have learnt to avoid zones of conflict with their advances into cropland declining over the years. In that respect, elephants are seen as starting to respect anthropogenic boundaries. There is a distinct admission that these places initially belonged to elephants, and people encroached into elephant territory in the initial years. Some first generation settlers display what could almost be classified as a sense of nostalgia for their old enemies. For most settlers, there has been a gradual reconciliation with elephants, at least in comparison with the new and more formidable opponent, the wild pig.

31 Individual oral histories of first generation settlers also reveal a very strong sense of place, especially in terms of their own identification of specific localities related to events, construction of houses, location of elephant attacks, elephant trenches, large trees (that afforded space for *machan*s), etc. In fact, some residents even made it a point to step out of their houses and point out exact locations. This is consistent with a number of other studies which report the use of this form of expression to 'anchor' or 'fix' events in terms of locales so that they can serve as mnemonics (e.g.. Tilley 1994; Caftanzeglou 2001).

Places as contested territories between settlers and wildlife

Place-making along the fringe was an interactive process that entailed a significant engagement with non-human actors. Initially, elephants played a decisive role in where people lived and worked. Then, as rice gave way to a variety of other food crops, primarily tapioca, the landscape became more hospitable to a different complement of species led by the wild pig. During the initial years, boars could be killed as hunting was still a permissible activity and the settlers managed to control populations; the occasional wild pig on the menu was also a welcome addition to settler diets[32]. Since the beginning of the conservation era, (under the Wildlife [Protection] Act, 1972, hunting animals became illegal)[33], settler plots have been overrun with wild pigs as well as a number of other species such as deer, porcupines, and arboreal mammals.

In the eyes of the settlers, wild pigs have become the symbol of government apathy towards them. Unlike the elephant with its occasional visits and displays of sentience, the boar, especially one which has lost its fear of humans, is relentless in its purpose. Boars are agents of landscape transformation as people are forced to modify their agricultural choices on the basis of crop damage. In some instances, this amounts to the cessation of agriculture. And unlike elephant visits that are infrequent and are often easily detectable, wild boar raid crops are typically nocturnal, silent and stealthy and have become an almost daily aspect of farmer livelihoods. The impression of the boar as an animal that devours everything in its path and destroys whatever is left by digging, trampling and wallowing is a common one among settlers. Additionally, most pigs head back to the forest at daybreak (although a few brazen animals which have completely lost their fear of man have started staying back in agricultural land) furthering the impression among settlers that pigs belong to the forest and the government, and the latter offers them safe refuge. It is also extremely significant to view this protracted battle between settlers and pigs from the perspective of the landscape as being one which should alleviate food

32 This resonates with Peterson's (1977) 'merits of margins' hypothesis where the fringe is beneficial to both people and wildlife.

33 Gun licenses for crop-protection continued to be issued for several years after that in some areas. However, the settler population was largely dependent on locally manufactured, unlicensed firearms such as muzzle loaders. Most of these were confiscated during the Indian Emergency of 1975.

shortage[34]. Faced with these situations, very often residents implore researchers to see the 'true nature' of those animals which are promoted as charismatic and beloved conservation icons.

Over the years, ill-will towards the Forest Department has steadily built up. Many smallholders destroy seedlings and saplings of protected native trees as they hinder food crop and rubber production. The legacy of uncertain land tenure is reflected in settler claims that the Forest Department is likely to take over their land if too many native trees are present on their land. The Forest Department also restricts the movement of people into the reserve forest and frequently restricts the entry of local tourist vehicles into the connecting road to the Periyar National Park. Local tourism and pilgrimage to the Sabarimala temple which are sources of revenue to villages on the route get affected. On account of all these developments, a series of skirmishes between the forest administration and local people have occurred.

Incidents such as the lynching of animals are emblematic of the increasing frustration of the local community with wildlife. The selection of species that are singled out for retaliation is not coincidental, as those of conservation importance are targeted more. Settlers question the favourable treatment of animals over people. Protection for erring wildlife is regarded as a foreign, elite, urban-centred, animal-loving ethic, especially as something which is embodied in people with poor ties to land. Settlers emphasise the difference between the experience of watching elephants in a national park or studying them and the experience of actually living and working in an elephant landscape. They actively question such ideologies which they argue are spouted by elite groups: they protest what they see as the forcible introduction of extra-local morality into rural landscapes. Resistance to conservation which places animals ahead of people, has become a singular unifying narrative that cuts across this diverse community. Again, in this context, what we see is a clash between romantic views of nature, which have

34 Knight (2006) points to the widespread hatred of wild pigs among farmers in many cultures. Pestilence by wild boar has been known to cause famine, poverty and hunger, especially when combined with favourable human manipulation of the landscape. Wild boar famines have been reported in widely differing places such as Tanzania (Sunseri 1997) and Japan (Walker 2001). Knight's (2006) allusion to the idiom of 'warfare' between pigs and farmers as well as the usage of the language of criminality is also pertinent here.

become identified with conservation and a utilitarian perspective on nature. To settlers on the fringe, the forest is still a problematic entity to be dealt with on a daily basis, whereas, for the Indian conservationist or the urban dweller, it is a place of exhilarating, exotic (and often fleeting) experiences and memories, with their sentiments most likely conditioned by Western romanticist scholarship or Orientalist interpretations of eastern traditions (Inden 1986; Ritvo 2014)[35].

Differing expectations of place and lifestyles

Conflict with wildlife was only one aspect of settler lives and difficulties in the early days. Many settlers moved here as children, and distinctly remember having to leave their schools in Central Travancore. Some lamented this loss of educational opportunities, others were glad to leave. For many children, the trauma of displacement was immediately compounded with the difficulties of living in the forest. Childhood experiences during this period are remembered using the repeated references to being hungry, tired, cold, wet and dirty, confirming Tuan's (1977) observations that children experience and view places differently. For adults too, life was by no means easy. For those who found work in the forest for collection of produce, these entailed long trips and loneliness. Produce had to be carried as head loads to markets that were over a day's walk, and provisions had to be brought back in a similar fashion. The lack of availability of basic items such as salt, that were so freely available and accessible in the plains, meant that provisions had to be stocked carefully and there was a heavy price to pay for forgetfulness. While recounting these events during interviews, a number of settlers expressed the opinion that it is difficult not only for outsiders, but even for their own younger generation to comprehend how much vehicular access can transform a landscape and reconfigure one's view of its scale. Their memories of the past conjure up a different place altogether, where walking embodied the sheer physicality of time, dis-

35 Gissibl (2014, p. 49) also draws our attention to conservationist cosmopolitics which '*alerts us to the conflicts and contestations arising from the rival perceptions of the world that have been involved in the making of a "protected planet."*' As he elaborates further on impressions on Africa's Serengeti, '*The Dresden-based family raising funds for the Frankfurt Zoological Society—by circulating self-made calendars with photographs from their Serengeti safari among their friends—act upon a different Serengeti than the Maasai pastoralist seeking to assert his rights in an ancestral landscape*.' (p. 51,52).

tance and connectivity (Raffles 2002)[36]. Although, they are revealing a set of biographical landscapes (Myers 1997), in their opinion, it is difficult for anybody other than those with similar everyday experiences to comprehend these experiences fully[37].

When settlers recount their arrival in the landscape, one is provided with an initial impression that they colonised an empty forest devoid of food, fellow human beings and sustenance. At a regional socio-political level, as Varghese (2009) argues, settler viewpoints reflected the economic modernity that was emerging in the plains of Central Travancore, that urged people to reclaim 'empty spaces' and to convert them into 'productive locations'. But on a more immediate local level, despite the fact that settlers knew about the existence of forest-dwelling communities, they still considered the forest as empty of people or empty enough that forests could be cleared and settled. In fact, some settlers are of the opinion that while they could in a sense be accused of occupying land that rightly belonged to the elephants, they deny that they took the land that belonged to forest-dwelling communities. Without overt ties to land, or any form of organised resistance against settler appropriation, the rights of forest-dwelling communities figured neither in the minds of the settlers or the government agencies that facilitated the clearing of forest. Unlike in Malabar, where violent appropriation of land was commonplace, the norm in Ranni seems to have been different. While some level of early violent exploitation is evident from settler accounts, there have been numerous accounts of cooperation between these groups in the form of exchange of food items, expeditions to collect forest produce, etc.

At the same time, there is a paradoxical treatment of *adivasi* groups by settlers. In the first instance, they are appreciative, incredulous even, about the ability of the forest-dweller to live in the elephant jungle, to find food and hill produce in what they consider an 'empty' forest, to find paths and safe locations, and in the sheer physical strength of the men and women. On the other hand, settlers make disparaging statements about their eating habits, lack of morals and loose familial bonds. These convoluted

36 This is reminiscent of Raffles' (2002, p.3) interpretation of the difference between passing over and walking through a landscape. Here, Raffles cites Walter Benjamin's One-Way Street: '*Only he who walks the road on foot learns of the power it commands....*'

37 This is similar to Myers' (1997) idea of 'how different people might "see" different places in the same "place" and also to the 'biographical landscapes' of Raffles (2002, p.4).

perspectives reflect the aspirations and cultural values (and inhibitions) of settlers particularly as conditioned by their life in the plains. Although settlers accepted help from these communities, especially food supplements, and assistance with gathering forest produce, these were intended to be of a temporary nature till the forests were cleared, and agriculture was established. Going native was never part of their plan (See Ingold 2000 for a similar perspective). For example, though many forest-dwellers avoided elephant attacks by living in *machans*, settlers used these only as temporary measures and had no intentions to replicate *adivasi* lifestyles the long-term. The lack of discursive or representational linkages with place (at least for groups such as the Hill Pandaram) was also novel to settlers who were used to the stringent land regulation structures of the plains. Moreover, this facilitated an easy appropriation of land, which was actively encouraged by the government at least during the initial phase. Land rights or place-based sensitivities of forest communities were ignored.

The persistence of memory

Nutritional deprivation and the anticipation of better opportunities for agriculture was one of the key reasons for migration. Exhortations such as those by Namboodiripad, not to leave even a single inch of land uncultivated, signified a utilitarian view of place and land, and one that encompassed the wider nationalistic ambitions of independence and self-sufficiency (Varghese 2009). This resonated with Central Travancore where the population pressure on land prompted an exodus into the eastern hills. Although migrants could bring in only what they could physically carry, crops were a priority. Settlers frequently pointed out trees (planted as saplings) brought from the plains *signaling* a continuing emotional link with the plains, at least in terms of the memory of migration. Migrants brought with them seed paddy from the plains, and recall their amazement at the flourishing yields on virgin soils for numerous plains varieties. During the initial years, their imported seeds and farming techniques from the plains provided temporary relief as settlers managed to make profits even after the government levy and their subsistence needs were met. However, after three to four years, declining soil fertility, government disinterest, poor prices and incessant elephant raids necessitated the planting of leguminous plants and other food crops also imported from the plains.

The incoming migrants not only brought their crops and practices, but also their memories of deprivation and a pioneering cultural ethic which aimed to transform empty spaces (or in other words, forests) into productive spaces. An explicit acknowledgement of this role was evident in their designation as 'forward looking' peasants by the media and by politicians (Varghese 2009). In other words, their places of origin travelled with the migrants, not just in terms of the rice and tapioca which they brought from the plains, or the order they imposed on the jungle, but also in terms of their past experiences of scarcity and the conceptualisations relating to the development discourse and economic modernity that was emerging in Central Travancore at the time (Varghese 2009). While colonial development strategies had already reached the hills in the form of commodity expansion during an earlier phase, the role of marginal cultivators as agricultural capitalists was just being realised. Syrian Christians dominated many areas in Central Travancore. With their strong farming tradition, financial mechanisms, and identification with the biblical Exodus, exhortations of hard work and toil, and necessary suffering, they fitted the profile of the perfect migrants[38].

Latent memories are also reflected in the importance people give today to growing food crops and the careful tending of agricultural plots however small. Despite heavy crop damage on nearly every food crop, settlers still spend a great deal of daily effort in planting, erecting fences and guarding crops each night. Although rubber is a revenue bearing cash crop, it is in the majority of instances grown with other food crops. This indicates that land use choices and dispositions are perhaps guided more by collective memory (that is, the need to grow food) more than anything else. Here the general message is that memory can perhaps explain what may otherwise seem as counterintuitive land use choices, and one would need to look back in time and the conditions of scarcity to understand why people make these choices. These in turn reflect the 'inner landscapes' referred to often by analysts of memory and of the recreation of familiar landscapes which travel with people (Stewart and Strathern 2003).

38 The Malabar migrations are referred to by some as Christian migrations. See Varghese, 2005, 2006, 2009 for more details.

Place and settler identity: sharing hardships, remembering migration

Settler pockets have been spaces where disparate migrant groups were thrown together and worked side by side to make places. Here again, collective memories of past experiences, especially common experiences of hardships relating to the forest have resulted in the formation of a distinct settler identity centred on place. While localities or communities in the plains are (or at least used to be) characterised by religious or caste-based characterisations (e.g. a Syrian Christian or a Nair village), settler pockets stand out because their residents are identified – and identify themselves - first as settlers (*kudikedappukar*, Mal.) brought together as 'communities of fate' (Scott 1990)[39].

A distinct 'settler' identity forged by common experiences of isolation and overcoming of hardships seems to have gained primacy over caste- and class-based identities that define the communities in the plains. Settlers unhesitatingly speak of themselves as a cohesive group. One could say that previously this cohesiveness was utilised in collective efforts in clearing the forest and in dealing with marauding wildlife, but later on it acquired the form of organised resistance against evictions and in articulating demands for the community as a whole. A wider settler identity that connects these settlements across Kerala is also evident in the links and traffic between settler pockets throughout the state and including links to settler pockets in Malabar. During the 'kudiyettam' (the migration into the forest and the establishment of settlements) different groups within large families moved to various localities. Marriage alliances between families in settler localities scattered across the state are common. Although derived from mainstream groups in Central Travancore, their initial as well as subsequent marginalisation and isolation has resulted in the settlers ('*kudikidappukar*') being treated as a distinct social category.

39 The construction of this identity resonates with Scott's (1990, p. 134) analysis of 'communities of fate' brought together by the common trauma of displacement and settlement in a harsh landscape. Identity development is also consistent with the identification of a set of conditions that maximise cohesion (e.g. isolation, close mutual dependence and lack of differentiation from within). In Scott's opinion, a greater degree of antagonism/ militancy can be observed among groups whose day to day experiences are marked with exceptional degrees of physical danger (e.g. miners, lumberjacks, longshoremen, merchant seamen, etc.) where mutual help is critical for minimising threats.

Outsiders' perceptions of settler landscapes are also critical components of identity formation. People from the plains consider settler pockets as problematic sites of criminality and social disorder with their unholy mix of communities, individuals and offspring whose antecedents are unknown. High levels of alcoholism propagated through a number of open-air speakeasies in the forest, frequent run-ins with government authority facilitated by the presence of temporary work camps with transient labour and a large male-biased workforce, and associated aspects of hyper-masculine culture such as brawls and violence among men working in timber coupes, dam sites, etc. historically set these remote frontier spaces apart from the lowland villages (that typically were characterised by greater degrees of informal social control) (e.g. see Turner 1893; Hoefle 1999; Carrington et al. 2010). As a result, marriage links among settler groups dispersed across Kerala are common as opposed to a preference of such relations between settlers and plains people. It could also be speculated that in some ways, settlers have been rendered powerless as a consequence of their move, having lost the social status that was automatically afforded to them in their native villages by virtue of their just being there and being part of a long-embedded community.

As amply demonstrated by the scholarship on the intergenerational transmission of experiences related to trauma and conflict (e.g. Tint 2010), memories of poverty and hardships of place that the first generation faced are ingrained deeply in the next. Old stories are often retold. These repeated retellings cement relationships with place not just for the older generation but also for the new. This explains why memories of the long periods of distress from food shortages and the ensuing ameliorations promoted by the government and specific interest groups are strong among first, second and third generation settlers, as opposed to the plains of Central Travancore where this is a more or less forgotten history (especially among the current generation). At the same time, despite the fact that it gave them sustenance during a period of distress, the settler view of this place continues to be a negative one. Settlers frequently refer to this landscape as a hellhole, their vocabularies of remembrance are littered with constant references to toils, difficulties, hardships and sacrifices, that they suffered to make this place liveable. Such sentiments about place speak volumes of their personal histories, as people of the plains and foothills, places which they considered to be more civilised, developed and

better networked. They feel that their displacement, though more or less voluntary, was a step backward into a vastly more rustic situation than they were initially accustomed to. The plains meanwhile have seen rapid progress while they are left behind in a forgotten frontier with few real opportunities and continuing hardships.

4.7 Identifying Points of Entry

An analysis of place, as viewed, constructed, and contested by different groups of people is a useful way to understand key local relationships that can used to identify local points of entry or potential locations of intervention into a system. Following from an overall analysis of place in relation to different stakeholder groups in the preceding sections, an attempt is made in this section to narrow down the themes that are especially relevant in resolving conservation-centred conflicts in the region. While most of the themes identified in this section are generalisable to settler landscapes across the Western Ghats, some also have a wider geographical relevance especially in the context of conservation conflict and contestations over land.

Latent memories of deprivation and landscapes of conflict

Memory in its different forms is of significance not only in the case of people who are long-time inhabitants of a place but also in the contexts of displacement, migration and resettlement. An analysis of memories and experiences is of significant import in understanding how settler groups relate to their past experiences or construct their identities and contestations in a landscape of conflict. Halbwachs's (1992) [1941,1952] clarification of memory and history as opposing ways of recalling the past is significant here. As opposed to a 'singular authoritative history' (Phillips 2004) of this forest-fringe (which may or may not be objective or accurate), the attempt is to utilise the notion of multiple memories of the past as well as their interactions with the present to see how people view their own histories or injustices. An understanding of this perception is of critical importance in designing appropriate solutions as settler support in this area is essential for conservation.

Settler descriptions of place-making reveal both experiences of deprivation as well as cumulative trauma related to the production of a settlement in a harsh environment that also entailed a long-drawn out battle with marauding wildlife. Drawing parallels with a number of studies which show that distress is remembered disproportionately in contexts of trauma and displacement (e.g Tint 2010), individual histories that were recounted during interviews are weighted heavily in favour of memories of the initial periods of food shortage in Central Travancore and ensuing migrations and conflict in the forest. This is true even for second generation individuals who not only highlight the sacrifices of the pioneers of the older generation, but also retain the emotional sentiments attached to these events. In fact, as mentioned before, these remembrances are in contrast with the plains where the era of food shortage hardly figures in public consciousness. The shared as well as the collective memories focus on the nationalistic and patriotic imperatives of the period immediately after Indian independence and to the role of the settlers as progressive farmers and catalysts of Malayalee migrations to the rest of the world.

Most significantly, with relevance to the land use in the area, settler engagements can be viewed from a perspective of continuing tensions between habitus (Bourdieu 1977 [1972]) and memory as drivers of dispositions or current attitudes and choices. Significantly, they provide an inkling as to why settlers persist with agriculture despite poor returns. Settlers continue to cultivate even on marginal soils and counter extensive levels of crop-raiding by guarding crops at night and erecting fences and other forms of protection which are largely ineffective against species such as elephants, wild boar and macaques. Moreover, they considered their activities related to clearing the forest as a series of obstacles that had to be overcome in order to produce the order and familiarity reminiscent of their native villages. In their effort to promote tree growth and biodiversity, the Forest Department and conservationists promote a different view of place by threatening to unmake decades of hard labour, signaling the reversal of cultivation back to forest. In the eyes of the community, the native tree preservation legislation that prohibits tree-felling in the ghats, ignores pleas for subsistence use by households and the fact that the plots were largely clear-felled and then planted by the settlers or the product of secondary growth. A history of evictions and land tenure uncertainties further exacerbates this situation making it a major flashpoint for conflict in the area. Since land

tenure uncertainties and opposition to tree preservation are a widespread feature across settler pockets in the Western Ghats, this result is relevant to the region as a whole. As a generalisable insight, conservation interventions, especially those aimed at increasing public support and maintenance of vegetation indicators in private lands should factor into account-specific aspects of the complex engagement that people have had with land tenure, trees and wildlife conflict in such regions. Interventions such as payments for ecosystem services and tree preservation schemes that have gained recent popularity and which are typically administered with limited social evaluations are likely to result in poor outcomes, because, as this case study shows, latent issues such as uncertainty related to land tenure are seldom interrogated as part of short-term evaluations. Conservation arrangements that promote at least a limited level of use of trees as well as those backed by appropriate social evaluations are likely to be effective in the long run, as they signify a middle of the road approach in local governance and are more compatible with a local use-based ethic.

Settler identity, distributive justice and the scope for political action

A key set of relationships in this landscape pertains to a unique settler identity that has transcended caste and class relations of the plains. This identity is not only one that is tied to the immediate locality which settlers worked together to produce, but can be characterised as a binary one that is bound together with their memory as migrants and the places they came from. Settlers who moved into the hills were unified by experiences of impoverishment and landlessness and the widespread regional atmosphere of poverty and deprivation that was prevalent at that time in the plains of Central Travancore. Elements of this identity as tied to their immediate surroundings can be discerned from often repeated stories that recount shared experiences and reinforce collective action in the face of hardships. At the present juncture, this form of solidarity holds strong and is channelled towards generating an almost unanimous and united opposition to perceived injustices such as government restrictions on the removal of troublesome wildlife or the restrictions imposed on them that forbids the cutting of trees on private lands. The retaliatory killings of animals such as leopards are a case in point where the animals that are widely as considered state property are targeted for elimination with collective sanction

from the community.

At the same time, the motivations from the social transformations, the colonial push for agrarian capitalism and (in later years) political motivations of a nationalistic nature that were central to the politics of the plains are embedded in settler memories. Borrowing from Raffles (1999, p. 324), '*places travel with people*'. This also seems to imply that settlers still view themselves in part as outsiders (Appadurai 1988b). Their ability to step outside or move to and fro between places, physically as well as mentally in terms of expectations and aspirations, belies a desire for the 'development' that has occurred in the plains. In this sense, the plains still hold sway over settler motivations. This can be compared to the 'material and imaginative translocality' of Massey (1994), and the 'multi-locality' of Rodman (1992). In this landscape, settlers by virtue of their being sandwiched between the forest and peri-urban centres are intensely aware of the (at times imagined and at times very real) shortcomings of their situation in terms of connectivity, employment opportunities, lifestyles, and social status. This connectedness is evident in the way they compare their situations with that of the plains from where they came, and frequently project themselves as captives of nature and as helpless citizens languishing in a marginalised region while the plains have witnessed extensive development. And unlike their compatriots who either moved to Malabar (a region they believe was better looked after by the state government) or made their fortunes overseas, their situation as migrants on the fringe has placed them in a precarious position in terms of livelihoods. Firstly, compared to large landowners (or lessees) with cash crops such as rubber whose fortunes are determined largely by non-local forces and cushioned by corporate investment, small-holder settler livelihoods are locally determined and dependent on their overcoming of uncertain land tenure, agrarian distress, local political upheavals and extended periods of human-wildlife conflict. Second, they are aware of their poor bargaining power, i.e., even inferior to that of *adivasi* groups (who again in their opinion are privileged by the government and conservation groups as a matter of political correctness and on account of them being 'natives'[40]). Frequent references to 'isolation' and 'backwardness', 'assertive self-negation' and notions of 'incarceration' are almost

40 However, see Appadurai's (1988b) critique of the term 'native' for the problems association with such characterisations.

identical to the Amazonian rural context as analysed by Raffles (1999). Their perception of themselves as a marginalised group that does not receive the benefits of development activities in the plains (where such initiatives are more frequently mooted to bring Kerala at par with other industrialised states), but at the same time is forced to bear the costs (because they are farming sites that are targeted for environmental protection on account of their location in the Ghats) brings the issue of distributive justice to the fore.

Elements of Turner's (1893) frontier thesis (despite many of its problematic assumptions and logical flaws) could perhaps in part explain the development of the settler identity in terms of egalitarianism and banding together of people from different caste denominations, as well as the reorganisation by communities in terms of religion. The recent events concerning political mobilisation within the community indicate that there are challenges to the conservative forces of the state from political parties with strong support in these agrarian landscapes[41]. This includes several factions of the Kerala Congress Party, which enjoy a great deal of support from Christian settler communities from different parts of Central Travancore. This regional party which operates on the ideology of secular democracy and fights for the rights of the toiling classes, is traditionally the third largest political party in the state. As a result, it wields considerable bargaining power because its role as a coalition partner offers valuable support for both the Congress and communist political parties of the state. In a similar vein, religious activities underwent restructuring with features like revival and itinerant preaching that have been characteristic elements of frontier life in other regions such as North America. The Syro Malabar Church which has been supportive of the activities of Christian settlers also plays a significant political role. In some of these areas Christians still dominate the vote bank. Political and religious institutional support for settler communities is an important relationship that can not only influence settler activities, but can also serve as a potential avenue for entry into the system while planning conservation. In the current scenario, there is an increasing convergence between political and religious support for communities towards opposing conservation, and has the potential to result in new 'zones of anomaly' (Sivaramakrishnan 1996) or unprecedented opposition towards conservation

41 It is also important to note that the shifts in politics at the centre plays a fairly limited role in these regions as local concerns related to forest protection, underdevelopment and distributive justice override the politics of this region.

activities unless reconciliation is planned.

Land as an emerging element in forest dweller articulations

In the forests of the Western Ghats, *adivasi* communities include a diverse group of stakeholders, some of whom have explicit articulated and representative links to forests (e.g. the Mala Arayar) whereas other groups (e.g the Hill Pandaram) have few visible links to place or forest. The latter are nevertheless, heavily embedded and closely identified with forest systems, perhaps even more than other groups. In the contemporary atmosphere of *adivasi* resurgence, a key characteristic is the deliberate articulation of ties to land and forests by the communities involved in the movement in an effort to gain access to lands from which they have been displaced. Forest dweller strategies of the articulation of close relationships with the forest could be interpreted on the one hand, as an inability to resist wider mainstream approaches (i.e. the passive subordination or 'misrecognition' outlined by Bourdieu and Passeron 1977), or, on the other, as a plasticity in terms of adapting to change. For groups such as the Hill Pandaram in Ranni, in representative terms, theirs is a reluctant participation. Such groups rarely seek attention on their own, but they are often actively rounded up by the mainstream *adivasi* and *dalit* coalitions who are involved in this debate. The latter identify groups such as the Hill Pandaram as facing destitution and landlessness despite having strong links to forests. Here, Appadurai's (1988b) warning about the misconception of natives as people confined and incarcerated to places, and imprisoned by their modes of thought, remains valid not only in the perceptions of settlers or officials, but also of that within the *adivasi* community itself. Here, some groups that are integrated into the mainstream culture play hierarchically dominant roles and view other groups as confined in terms of places and modes of thought. The *adivasi* articulation of collective identity as pointed out by Hall (1990, 1996) can be thought of in terms of an 'articulated positioning' whereby diverse groups come together under a collective umbrella to transform themselves into a social force and then re-articulate their differences at a later stage on the basis of different histories or articulations to place (See Kjosavik 2006).

The Hill Pandaram in Ranni Forest Division remain among the few forest-dwelling

communities in the southern Western Ghats who have continued to resist the influence of mainstream policies despite their lengthy history of contact with lowland groups for several centuries. Their role as forest traders is reinforced by their mobility, self-sufficiency, egalitarian community organisation and a high level of knowledge about forests. These qualities have also enabled them to avoid sedentarisation and maintain a high degree of self-sufficiency. Their lack of overt links to place as well as the lack of ritual and their preference for forest-dwelling lifestyles even in present conditions set them apart from most forest-dwelling communities in the region. While attempts by other groups to incorporate the Hill Pandaram into the mainstream *adivasi* movement or efforts by government organisations need to be viewed with caution, the additional problem of who speaks on their behalf is also very significant considering their own reluctance to engage in such debates. An important lesson from these engagements in terms of generalisable results is that researchers should resist the tendency to club indigenous or *adivasi* groups into a single monolithic category. Many landscapes are peopled by diverse communities with varying links to land and differing levels of representative visibility in terms of articulations and power. Often the least heard voices are the most marginalised.

Resistance to top-down/ extra-local control

An emerging mobilisation across communities has been the questioning of top-down and extra-local modes of control imposed on the region. Settlers have been at the forefront of these agitations and call for democratic, local-level solutions to these issues. Examples include resistance to restrictions imposed by the Forest Department as well as lobbying by conservationists. Restrictions on day-to-day use and access are considered violations of basic livelihood necessities, and in addition to frequent skirmishes with the authorities, the settler community has begun to mobilise itself politically at the level of the Panchayat Raj institutions and higher political units. This is evident in the context of a series of events that curbed the rights of way and access as imposed by the Forest Department without adequate consultation at the local level, the restrictions on the removal of crop-raiding wildlife, as well as the enclosure of a part of the Ranni Forest Division into the neighbouring Periyar National Park that negatively impacted the livelihoods of a section of the community involved in reed extraction. Settlers have also been the key

participants in the alliance opposing the implementation of the recommendations of two expert-derived reports on the Western Ghats that were characterised by a lack of consultation with local communities. Moreover, in addition to livelihood-centred restrictions, settler communities also question the imposition by outside groups of conservation laws and species conservation on moral and ethical grounds, particularly that of urban conservationists who in their opinion are hardly aware of on-ground realities in rural contexts. In such developments, there are countless parallels with resistance to conservation and similar top-down impositions in other parts of the world. Here too, forestry and conservation have spawned everyday acts of resistance (Scott 1985) as a common form of opposition to conservation. As pointed out by numerous others (e.g., Hobsbawm 1981, Jacoby 2001), the responses to criminalisation of local livelihoods and practices have also resulted in a familiar notion of support for detractors of conservation at the local level. In the current scenario, this results in a distinct potential for further politicisation and polarisation which could make the adoption of middle grounds untenable.

Drawing from this understanding of local relationships with top-down control, it can be assumed that conservation interventions in the region have to take into account the specificities of local contexts and be grounded in local support. The significance of democratic decision-making for garnering local community support in this scenario cannot be stressed enough as a failure to do so is likely to legitimise existing power relationships that are biased in favour of top-down control.

4.8 Conclusion

Rodman's (1992) 'multilocality' which argues for multiple notions of place or the creation of social or biographical landscapes is significant for understanding how different stakeholder groups form and view their relationships with places. Similarly, material, symbolic and imaginative notions of 'translocality' stemming from the work of Massey (1994) and Appadurai (1988a,b) which address the social as well as spatial interconnectedness in relation to groups that are characterised by migration and mobility are equally significant. In this context, settler place-making included extensive transformation of the forest by means of the labour of individuals as well as that which involved the transcrip-

tion of memories, rituals and choices that individuals brought from their native villages in the lowlands. Settlers aimed to create places in the image of their native villages, having been motivated to leave those plains villages both because of regional food scarcities brought about by the war and because of the ongoing influences of modernity by way of agrarian capitalism and nationalistic ideals. However, this envisioning has been actively curtailed not only by marauding wildlife that found the fringe to be a beneficial margin, but also by emerging protectionist forest policy challenges that eventually led to the formation of a contested landscape.

Forest-dwelling communities constructed places differently and reacted to these transformations in varied ways. Their responses encompass a spectrum of reactions that range from emerging attempts to gain land by allying with mainstream *adivasi* and dalit groups as well as further retreats into the forest. This symbolises the idea of forests as refuge despite a lack of overt ties to land or ritual. Forestry, plantation agriculture, hydro-electric power development and wildlife conservation activities signaled an erasure of local meanings of place in favour of evolving metrics that were in line with colonial, national and global priorities of the time. The processes linked to conservation are especially notable in their transformation – both materially and symbolically – of forests that were utilised by people into 'pristine' spaces that ignored local use values and were eventually made out of bounds to communities from the plains as well as to many forest-dwelling groups. Viewing the situation from another perspective, as opposed to individuals and groups that physically entered this landscape and their lived experiences, place-making by large-scale processes also involved the integration of influences from extra-local drivers and actors who were never physically present in the landscape but were nevertheless influential in its transformation through ideologies and policies.

In summary, typically explored dichotomies pitching either state vs. the poor peasant or that of state vs. tribal communities are likely to provide an inadequate understanding of complex conservation scenarios. In contexts such as that explored in this study, a multitude of actors and influences have shaped the transformations of the fringe and have in turn been shaped by it. Stakeholder groups themselves are heterogenous entities requiring careful interrogation. Additionally, it is important to view the landscape as a product

of interlinked social and ecological histories, e.g., the multiple restructurings of land use and agricultural production over the years have been a consequence not only of human engagements, they are in considerable part a product of non-human agency, climate and terrain.

This component of the study has been a largely descriptive exercise that interrogates a set of historical and contemporary contexts. Therefore, a general caution that can serve as a caveat is the potential for deterministic hindsight bias (Fischoff 1975) since the outcomes of most of the events and process described here are already known. As a next step to the analyses carried out in this chapter and the ecological explorations of the previous one, the plasticity of network-based analysis is used to integrate data and results stemming from different epistemologies.

Chapter 5: Exploring and integrating different disciplinary perspectives: a case study of conservation conflict along the forest-agriculture fringe

5.1 Introduction

As demonstrated in the previous chapters, conservation contexts in modified landscapes such as the forest-agriculture fringe can be attributed to a dynamic interaction between several historical and contemporary factors. These range from the ecological interactions underlying species-habitat relationships, to diffused social, political and cultural impacts, and their embedded power differentials. In such multi-dimensional contexts, the challenge is to integrate different types of insights within a holistic framework, and in a manner that is useful for conservation planning in the future. This chapter attempts such an integration, using insights from different thematic explorations. The integration is explored using conservation conflict as a representative case in point. The choice of topic is relevant on two counts. Firstly, conservation conflict exemplifies a multi-pronged problem with several interacting components, and is hence an ideal subject for interdisciplinary exploration. Second, as the most pervasive problem affecting everyday life in the study area, there are practical advantages to analysing this challenge. Drawing from a long history of use of networks and chains of explanation based approaches, this approach attempts to incorporate different interacting components within a single predictive framework. Here the networks serve as enabling metaphors for progressively contextualising linkages of interest. The predictive framework is also an intuitively simple probabilistic network that is based on qualitative reasoning (see Figure 5.1 for a conceptual road map of this process).

The progressive contextualisation approach used in this study utilises insights and information from several sources. These include the ecological, historical and political ecological linkages gleaned from analyses carried out in the previous chapters as well as additional themes that were specifically explored on account of their relevance to conservation conflict in the study area[42]. Together, these sources help in the construction

42 Additional sources of information include some location-specific data on crop-raiding incidences, agrarian distress and vulnerability, baseline data for households, etc. This dataset was derived from a survey of 480 households in the study area.

of a structural view of conservation conflict, as well as in the development of a basic predictive model. While this chapter focuses on the methodological aspects of integration, the preliminary network developed in the study can also be used to explore practical benefits for conservation in the study area at a very basic level.

5.2 Research on conservation conflict in India

Conservation conflicts, arising from an ever-widening divide between people with contrasting objectives for the management of natural or modified landscapes, are an increasing global phenomenon (Redpath et al. 2013). In this respect, forest-fringe landscapes across the developing tropics are increasingly seen as contested sites where the needs of people and wildlife conflict with each other (Manfredo and Dayer 2004; Woodroffe et al. 2005; Barua et al. 2013). Negative interactions with large mammals, many of which are of conservation significance, because they are threatened by habitat loss, hunting, etc., are a defining feature of such areas, prompting Dunn (2010) to refer to the situation as an ecosystem disservice and as 'the unspoken reality that nature sometimes kills us'. In contrast to the sensational nature of incidents such as direct conflicts with wildlife, like those with leopards and elephants that capture public attention, conservation conflict also takes root in the form of 'slow violence' (Nixon 2011) or an attritional violence built up over the years in response to marginalisation, dispossession and disempowerment giving rise to 'everyday resistance' and other forms of covert opposition which have been described as the 'weapons of the weak' (Scott 1985). Conservation conflict is therefore often a highly context-dependent phenomenon contingent on various drivers and circumstances.

Conflict between people and wildlife has been a pervasive problem dating back to the origins of settled agriculture in the Indian subcontinent. However, contemporary conflict in India has a different face. In addition to traditional forms of human-wildlife conflict (between people and animals), conservation conflict (or tussles between people with different attitudes towards wildlife and environmental protection) is an emerging phenomenon across the country. The latter conundrum is exemplified by India's abundance of large herbivores and problematic large carnivores, which are routinely implicated in

conflict, and their dual role as charismatic flagships enjoying the benefits of increased protection as conservation icons. In today's conservation scenario, both these types of confrontations need to be addressed while attempting to resolve conflict.

Forest fringe landscapes often remain hotbeds of contention where protected animals spill over into human-dominated landscapes. The presence of some species, especially long-lived large herbivores such as elephants in these landscapes is driven by a combination of the attraction of crops and by farmland encroachment into their home ranges and migratory routes. Pockets of chronic elephant conflict characterised by human and elephant mortalities, loss of agricultural incomes and diminished psychosocial well-being remain problematic issues in a number of northeastern (e.g. Assam, Bengal) and southern (Karnataka, Tamil Nadu, Kerala) Indian states (e.g. Choudhary 2004; Varma et al. 2011; Bhaskaran et al. 2013). Building on a baseline of extensive studies on elephant biology and ecology (Sukumar 2003), current research on human-elephant conflict has embraced a diversity of ecological, socio-cultural and political aspects of conflict (e.g Barua et al. 2013, 2014; Goswami et al. 2014). Carnivores such as leopards which can survive in human-dominated landscapes including agricultural land and even cityscapes, have a long history of conflict with people. Interactions with this species include human mortality from man eaters in Himalayan districts of Garhwal and Kumaon, through predation on farm animals, to coexistence and tolerance in other areas such as the Western Ghats. Recent scholarship in places such as the Western Ghats have been instrumental in understanding the entwined biological and socio-political aspects of engagements with this species (e.g Athreya et al. 2013; Ghosal and Kjosavik 2015). A similar diversity of experiences has occurred with tigers, turtles, wolves and a number of other species in different parts of India.

The emerging scholarship on conflict in India during the last decade can be distinguished from studies solely focusing on species biology, crop raiding and compensation to a broader examination of both ecological as well as social factors that are implicated in conflict. At the same time, much of this research has also been backgrounded by a historical interest in charismatic species such as tigers, turtles and elephants, leaving behind significant gaps in research and understanding. For instance, studies on the Indian

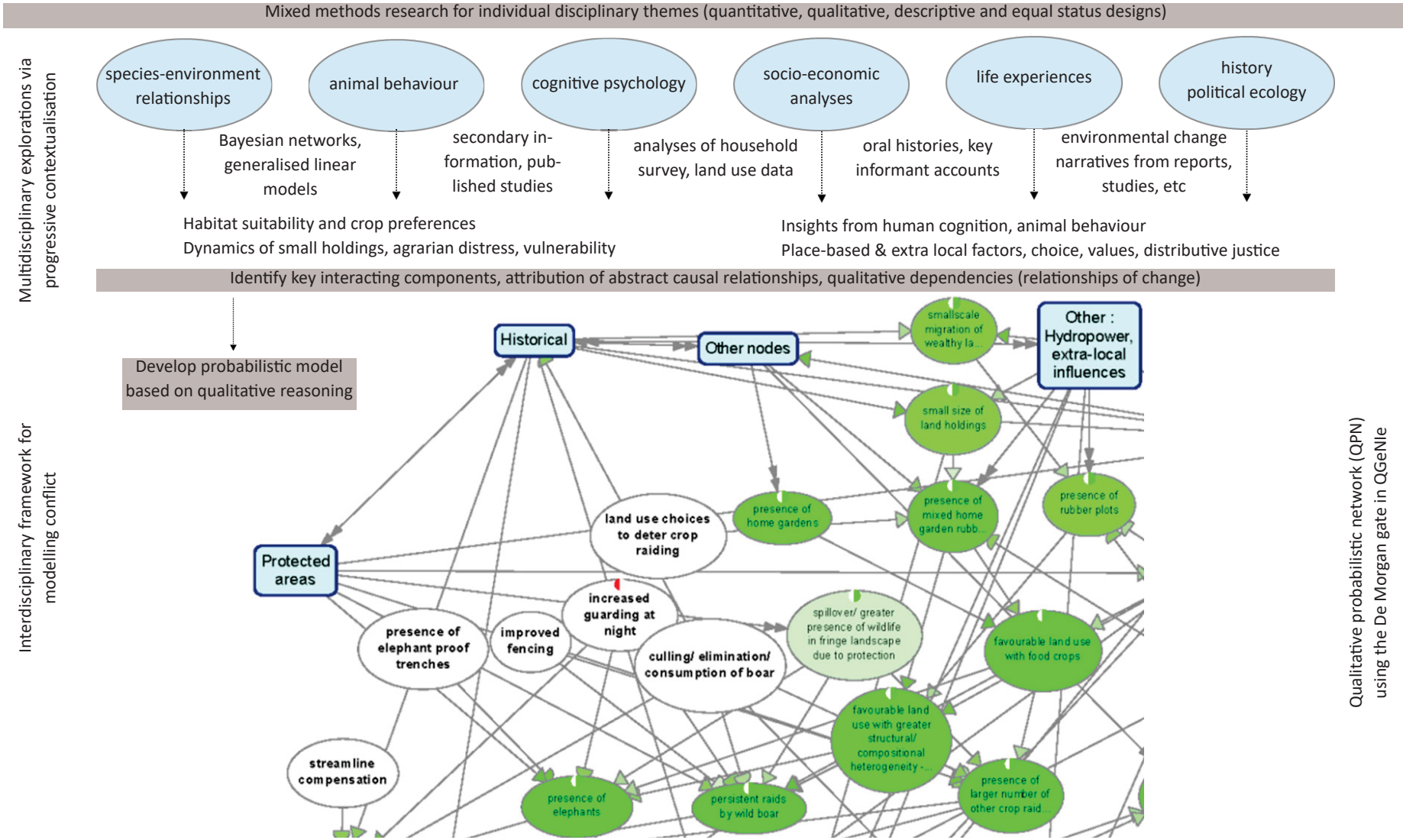


Figure 5.1: A roadmap for an integrative model explaining conservation conflict in a forest fringe landscape.

wild pig, which is considered to be the most problematic species in agrarian landscapes along the forest fringe are virtually non-existent. In a recent study conducted in the Western Ghats, this species remained the top-ranked crop-raider in most sites (Karanth et al. 2013). However, research effort on this species remains negligible in comparison to work carried out on other species which have been judged to be of conservation significance either because their existence is threatened or because they have been invested with heavy emotive burdens as icons of 'nation' or 'nature' itself.

5.3 Concepts and justification

Like numerous other contemporary environmental issues, conflicts surrounding conservation can be characterised by a lack of separation between social and bio-geographic linkages (e.g. Kinzig 2001). Despite this interlinked nature of conflict, researchers have largely approached this problem from standalone disciplinary perspectives. Many of these focus on species judged to be of conservation significance or on specific aspects of conflict such as livestock depredation, crop-raiding, socio-economic impacts, cultural relationships with specific species, etc. but rarely go beyond an immediate cursory interrogation of the problem outside their disciplinary training. While this form of one-dimensional research is no doubt significant on several counts, the common drawback of confining research to a single disciplinary framework is that it inhibits the evaluation of the interconnected nature of drivers and impacts. Narrow conservation querying also precludes the identification of root causes which often go beyond immediate-material differences to the less visible differences and inequalities that are tied to power relations generated by socio-political and historical contexts (Dickman 2010, Redpath et al. 2013; Rissman and Gillon 2016). In recent years, this realisation has prompted a number of researchers to emphasize the need to view conservation conflict in a more holistic manner and have proposed frameworks that integrate different but interrelated components using interdisciplinary and cross-disciplinary approaches and inputs from multiple disciplinary paradigms (e.g. Dickman 2010, White and Ward 2010; Guerbois et al. 2012; Redpath et al. 2013). Similarly, integrative frameworks such as the social-ecological systems frameworks are increasingly used to identify pointers for conservation action and policy implementation (Guerrero and Wilson 2016).

In this chapter, a multidisciplinary exploration of conservation conflict is attempted first, followed by an integration of different thematic components to arrive at an interdisciplinary explanatory model. Based on long-term ecological and social research on this system (and drawing on some of the analyses presented in the previous chapters), a set of broad topics of enquiry were identified for detailed examination. These provide the necessary background for construction of the model. A positivist tradition of science is followed for enquiry into specific ecological and economic aspects, and relativist motivations are used to understand notions of social relations, power, and culturally rooted perspectives. Though not entirely congruent due to significant overlaps, these themes are roughly analogous to ecological, economic, behavioural, historical, anthropological and political ecological inputs. Specific themes that are identified include ecological factors relating to crop depredations such as habitat suitability and crop-preferences, socio-economic factors underlying agrarian distress and vulnerability, inputs from the cognitive sciences to understand human choices and experiences as well as species level differences, and the analysis of historical and political ecological chains of explanations. This form of thematic exploration reduces the chances of missing key components of conflict. By looking at conflict along the fringe from several perspectives, the aim is to complement traditionally explored themes (e.g ecological modeling approaches, economic analyses, etc.) with inputs from the social sciences and humanities (e.g phenomenonological studies, political ecological analyses, etc.) which are typically missing from conservation studies. In the latter analyses, by focusing on discursive methods, the goal is to explicitly integrate some of the conventionally less visible perspectives, especially that of marginalised and subaltern groups into conservation science. In doing this, particular attention is paid to the societal context (Dickman 2010), to elements of cross-cultural research (Manfredo and Dayer 2004) and the more intimate scales of analyses (Barua et al. 2013) that highlight people's experiences, concerns and histories.

The synthesis of disciplinary strains to obtain an interdisciplinary model is easier said than done, given disciplinary chauvinisms and a variety of other barriers. As Karlqvist (1999) notes, the challenge of interdisciplinarity lies in the translation of an appealing idea from theory into an operational method. Interdisciplinarity not only involves the application of theories and methods of different established disciplines, but more sig-

nificantly, undertaking significant additional effort in bridging these disciplinary bodies of work to gain new insights (Karlqvist 1999). When it comes to modeling complex problems, Simon's (1969) and Diamond's (1987) observation that the soft sciences are often harder than the hard sciences holds true. Moreover, the concept itself has multiple definitions. Even within conservation biology, interdisciplinarity refers to a variety of categorisations based on the levels of integration, types of interaction, conceptual and institutional distances between disciplines, the purpose of integration, etc. (Newing 2010). The nature of conservation biology as a crisis discipline and its focus on real-world problem solving has resulted in a greater emphasis on instrumental interdisciplinarity as opposed to other forms of integration. In practical terms, the organic growth of interdisciplinarity in conservation biology has been through the increasing integration of 'human dimensions' (via social science) research with the traditional natural-science streams of conservation biology. Therefore, it is pertinent to warn against a silver bullet approach to interdisciplinarity both in theory or in method, and to stress that the type, form and extent of integration is likely to depend on the question at hand and the disciplines under consideration.

The interdisciplinary component of this study attempts to distil key issues and drivers from thematic evaluations and their integration within a single modeling framework. For this purpose, a network format based on qualitative reasoning is adopted, that is amenable to several methodological and explanatory avenues that have been pursued in this study. Research frameworks analogous to the network approach include exploratory research strategies such as 'progressive contextualisation' (Vayda 1983), 'chains of explanation' (Blaikie and Brookfield 1987), and 'webs of relation' (Rocheleau 2008). Though an emerging area of research in conflict studies elsewhere (especially in that of complex emergencies and military applications), the use of network and graph theories that help in investigating social structures, events and processes have found limited exploration in conservation conflict. Such an approach has several advantages. Firstly, network structures are useful as they map on to political ecological and historical explanatory frameworks that explore structural connections along spatial and temporal axes. In doing so, networks not only offer the advantage of intuitive understanding, they also embody aspects such as connectivity and translocality that are difficult to project

using conventional methodologies. Second, since conflict is based on divergent ideas, it is also important to adopt frameworks that can depict the way in which they are articulated in stakeholder conceptualisations. Based on analyses of information from the natural and social sciences, a qualitative probabilistic network (QPN) model is created. This model expresses the researcher's (subjective) understanding of causal relationships and the degree of beliefs operational in the system. Although the different relationships identified in the model are informed by different types of data collection[43] and different epistemological claims[44], these differences are reconciled when context-specificity is introduced[45].

The QPN format also provides a way to incorporate decision-making based on different value systems and conflicting viewpoints arising from the motivations of different stakeholder groups (e.g choices between culling a problem species vs. fencing or guarding crops). While both solutions may be scientifically viable, their adoption may not find consensus across various stakeholder groups. In some ways, a value neutral view of the situation is depicted within a value-laden network. By linking widely disparate and (apparently) isolated themes, the network approach also demonstrates the capability to depict emergent patterns or behaviours that are different from that of their individual component parts/ themes. Following Klein (2004), the interdisciplinary model is also an attempt to encompass horizontal (e.g. across disciplines) as well as vertical (e.g encompassing experts, practitioners, lay people, etc.) structures, and the crossing of boundaries in understanding a complex problem.

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43 e.g quantitative measurement for ecological variables vs. the search for patterns in language use for historical accounts.

44 e.g the search for value-free/ objective/ universal truth of the natural sciences that is believed to exist independently of human perception versus partial/ situated/ relative/ subjective versions and perceptions offered by postmodernism, post-structuralism and critical theory signifying the dynamic and complex nature of the social world. Additionally, the differing epistemological backgrounds that were assumed to arrive at these causal factors do not invalidate the model when it is framed correctly. At the same time, it is useful to explicitly state these differences as they condition the way in which disciplinary components are conceptualised and researched under different theories of knowledge.

45 For example, a large number studies relating to species visitations in cropland point to a near universal pattern of distance decay with the forest or PA boundary. This holds true not only for the knowledge model that we constructed and is likely to be true across many landscapes adjoining forests the world over. On the other hand, a perception relating to memory and place is admittedly unique to a particular group of stakeholders and their experiences. While this pattern cannot be transplanted or generalised easily into another system (although for some concepts it can be), it remains a significant causal factor nevertheless for the system under study.

An important clarification relevant to the model under consideration relates to assumptions about its development. This model has not been developed as an inferior form or as the poor cousin of a fully instantiated Bayesian network. Without going into the details of the extensive debate on quantitative versus qualitative sciences, this relates to a common misconception among natural scientists (and even among some quantitatively-oriented social scientists) that quantitative models are more rigorous, whereas the social sciences on account of their dependence on qualitative and discursive methods tend to be less so (Lele and Norgaard 2005). Despite evidence to the contrary (e.g., see Hedges 1987), and calls for incorporation of appropriate research designs (involving quantitative or qualitative data), this erroneous perception has been at the root of several problems including a trend towards overfitting and a tendency towards inappropriate quantification (Parsons 2001). Qualitative or structural models when considered appropriately can be used to make powerful statements and predictions (e.g. see Pradhan et al. 1986, Parsons 2001). While quantitative data are easier to acquire and typically solicited in the natural sciences, information gathering in the social sciences is typified by a variety of disparate (albeit entirely appropriate) approaches that include qualitative and even discursive approaches (in this case, oral histories, archival reports, etc.). Often, this type of information assumes critical significance not only because they serve as the 'hidden transcripts' (Scott 1990) or insider perspectives on everyday resistance and power relations specific to place, but also because they constitute the only information available on such topics. This necessitates the development of methods that can effectively integrate this valuable information from different discursive methodologies, particularly phenomenological and ethnographic enquiries.

5.4 The structural and methodological framework for this chapter

The next section (5.5) of this chapter contains four broad topics of enquiry that were explored in order to contextualise the situation of conservation conflict in the study area. These include: 1) habitat suitability and crop preferences, 2) analyses relating to small holdings, agrarian distress and vulnerability, 3) insights from human cognition and animal behaviour, and, 4) the interactions within and between place-based and extra local factors relating to choice, values and distributive justice. Habitat suitability and crop

preferences were explored using insights from the naïve Bayes models developed in Chapter 3 as well as using already available household survey information which looks at incidences of conflict, crop-damage patterns, etc[46]. The analyses related to agrarian distress and vulnerability also uses baseline information made available as part of this survey. Insights on human cognition and animal behaviour are derived from existing published work on these subjects. While these analyses draw upon a large body of work on animal and human behaviour, special attention was paid to research on human-wildlife conflict in India especially in the context of crop raiding by wild boar and that of elephant conflict. Interactions within and between place-based and extra-local factors were abstracted from the historical exploration carried out in Chapter 4. In each of these explorations, the data formats, analytical approaches and methods used are outlined briefly along with a descriptive narrative. Each also incorporates more information than is necessary for the model, and serve as additional sources for those interested in more detailed explanations of specific themes.

In the next section (5.6), a detailed conceptualisation and methodology relating to the construction of a qualitative probabilistic network (QPN) is presented along with the model that was developed. This model is built using qualitative abstractions and statements derived by this researcher from the four topics of enquiry using a set of methods that circumvent the necessity for large amounts of quantitative data (these steps are outlined in section 5.6). With respect to methodological novelty, it is the first time that such a model (which has been typically used in situational awareness scenarios and complex emergencies) has been developed in the context of conservation conflict. When viewed as an applied model, this output needs to be considered as a pilot version which has the potential to be improved using further field data and expert contributions. The final section in this chapter (5.7) outlines further possibilities and pathways towards designing decision theoretic models. To summarise, this study attempts an integration of different aspects of conflict in a way that has not been carried out before. More significantly, this research demonstrates and underscores the need for a holistic evaluation of issues relating to contemporary conservation problems including but not restricted to conservation

46 Household surveys were carried out as part of independent projects carried out by this researcher at various points. Baseline results presented here are from reports submitted to the Critical Ecosystem Partnerships Fund and the International Foundation for Science.

conflict. Figure 5.1 represents a conceptual and methodological roadmap for the analyses carried out in this chapter.

5.5 Exploring multi-disciplinary possibilities

Modeling habitat suitability and crop preferences: what can we expect to find in subsistence and commodity land uses?

The forest fringe in the southern Western Ghats is characterised by numerous commodity and subsistence agriculture land uses. These offer varying levels of hospitality to wild species that occur in the forests, many of which come into conflict with local communities at various points in time. Despite considerable research focus on the Western Ghats as a whole, the potential suitability of modified land use types for different species has been poorly understood. Predictive models of occurrence for species and groups of species have been specifically lacking and have the potential to be a valuable addition especially in the context of novel ecosystems that incorporate various combinations of commodity and subsistence agriculture. Data deficiency remains a continued hindrance to such exercises as tropical modified landscapes are often problematic spaces hosting large numbers of species, high levels of human threats and uncertainty associated with novel ecosystems, all of which make the task of data collection prohibitively expensive and logistically arduous (Gardner et al. 2009). As part of the ecological analysis relating to this study (Chapter 3), an attempt was made to model the potential of these landscapes to host different species in modified land uses. This was carried out by using methodologies that incorporate the use of easily available existing information (published and expert elicited information) and heuristic algorithms for variable selection, and the development of a robust predictive model that combined the benefits of these types of information. Published information, expert elicitation, and frugal sets were utilised to arrive at a small, yet powerful suite of habitat variables that were further used to predict the probabilities of occurrence of different species. A simple naïve Bayes framework was adopted for this analysis. The detailed methodology used in the development of this model is described in Chapter 3.

From the species-based predictive outputs, models were shortlisted for the fifteen species of non-volant terrestrial mammals, identified to cause significant crop-damage in the study area. Crop-raiding species only comprise a subset of species involved in actual human-wildlife conflict as a number of carnivores (felids, canids, vivverids and mustelids) are also involved in livestock depredation and other forms of conflict with local communities. Based on the naïve Bayes models, potential probabilities of occurrence were derived for the 15 different commodity and subsistence land use types found in the southern Western Ghats (Table 5.1). For this step of the analysis, probabilities were assigned assuming hypothetical scenarios of immediate proximity to forests. According to the calculated probabilities, home gardens, cardamom plantations with native cover and home gardens mixed with rubber crop had the highest number of species with high probabilities of occurrence indicating high conflict landscapes (Table 5.1). These landscapes were characterised by moderate to high levels of food availability. As expected, the lowest number of species was recorded (at low probabilities) for land uses such as tea, rubber monoculture and eucalyptus plantations which offered very little in terms of nutritional inputs for even generalist crop raiders.

Sample outputs for species and habitats are provided in Figures 5.2 and 5.3. In Figure 5.2, two naïve Bayes models are depicted for the bonnet macaque (*Macaca radiata*), a key crop raiding arboreal frugivore: the first uses all variables (represented as a tree-augmented naïve Bayes), and the second, using only select variables. Figure 5.3 demonstrates another way of visualising the results from this modeling exercise by showing the probability of likelihood of presence of the Indian elephant (*Elephas maximus indicus*) and the wild boar (*Sus scrofa*) in home gardens located at the forest fringe. The most important habitat attributes identified in this study with respect to crop-raiding species included those related to structural complexity and food availability in the landscapes. When combined with landscape-level field data or published information supporting general patterns (e.g. diversity decreases with distance from forest), the models can be incorporated into wider landscape-level network model. This form of data and probabilities can also be combined to provide probabilities of occurrence for specific groups of species that share life history or functional similarities. For example, Figure 5.4 shows the probability of occurrence of crop-raiding arboreal mammals in a

habitat with poor food availability (in this case teak plantations). This form of modeling can also be used to estimate the probability of occurrence of species in different ecosystems by changing the properties of key predictor variables. This property of Bayesian networks to predict potential probabilities under different scenarios and combinations of predictors is critically useful not only in the context of existing land use types but also in the context of novel ecosystems.

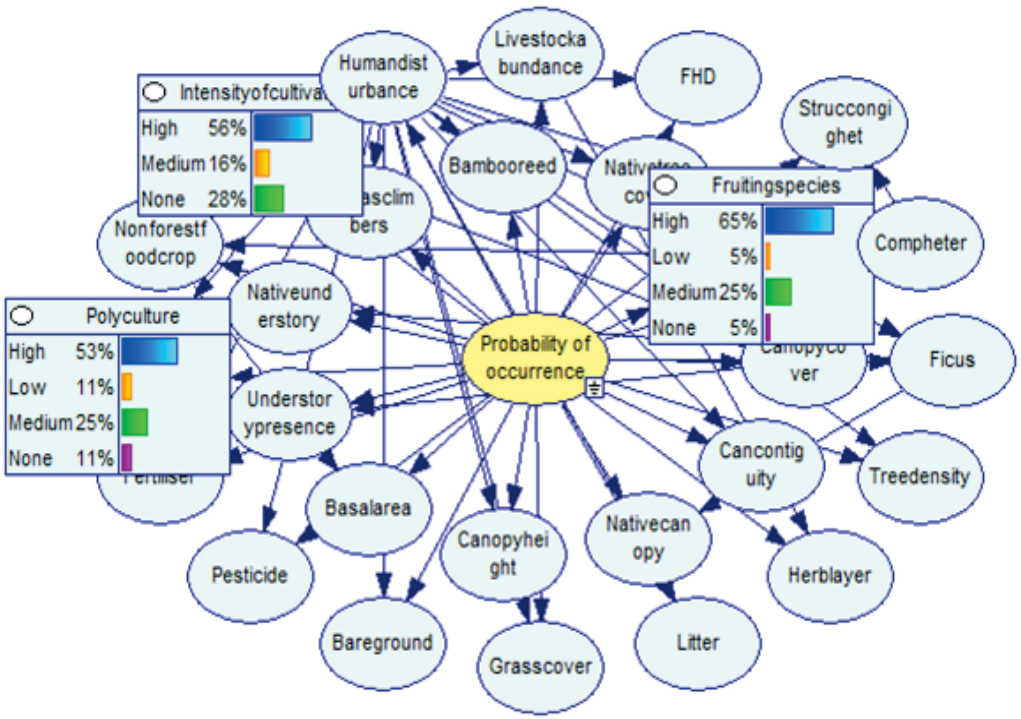
Table 5.1: Hospitality of different land use types for crop-raiding wildlife. The table shows the number of species and their potential probability of occurrence (high, medium, low, very low) for different land use types in the Western Ghats.

Land use type	**High**	**Medium**	**Low**	**Very low**
Forest	15			
Home gardens	15			
Cardamom (native shade)	11	3	1	
Rubber x home garden	11	4		
Coffee (native shade)	6	9		
Rubber 0-4 years	1	4	9	1
Cardamom (sun)			2	13
Coffee (exotic shade)		12	2	1
Coffee (sun)		1	8	6
Eucalyptus		3	9	3
Rubber (tapped/ mature)		7	6	2
Rubber 4-8 years			4	8
Tea			3	12
Tea (shade)			1	14
Teak		1	10	4

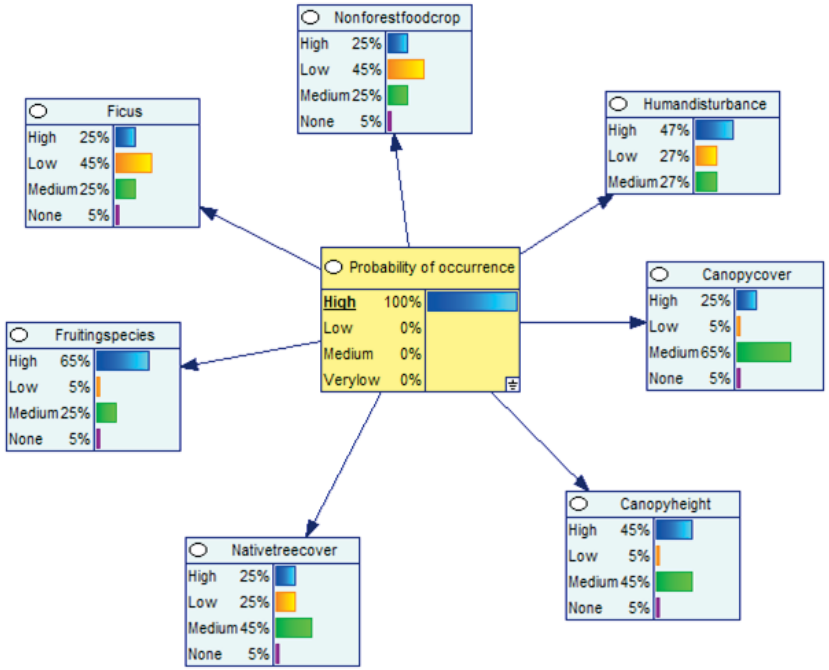
The current analysis was performed to serve as an initial template as well as a starting point for future models with more nuanced predictive capacities. For example, this exercise did not model the effect of key landscape level factors such as distance to forest, type of matrix, landscape context, etc. which are frequently identified in literature as key local-level predictors. Evidence in support of these factors is however strong, allowing these variables to be included in the model without actually incorporating primary data. These models will also benefit from field testing which is being planned and further improvement. They, however, provide researchers with an opportunity to adapt the models to particular local contexts by providing spatial information and adding other variables that maybe locally significant.

The frequent visitation of mammalian crop-raiders in home gardens prompted a more detailed exploration of the dynamics of crop preferences. The idea of a resource selection function (RSF) which can be defined as a function that is proportional to the probability of use by an organism was used to explore associations between selected species and crops (Manly 1985; Manly et al. 1993). As opposed to the previously attempted naïve Bayes models which were constructed using variables selected on the basis of published information and exert opinion, the RSF was calculated directly from the local level dataset which can be considered as one incorporating availability and use. For this analysis, individual land-holding level information on the crops planted and damage-causing species reported was evaluated using a binomial generalised linear model, in this case logistic regression. This analysis was carried out for wild boar and bonnet macaques, which were the most frequently reported crop-raiders in the study area, and also for elephants, which despite fewer visitations are often responsible for catastrophic conflict events and hence figure in public consciousness as an extremely problematic species. This analysis was also repeated for key groups such as arboreal mammals, ungulates, etc.

The results show a diffused pattern of association between crops and species visitations. When viewed on the basis of conventional thresholds of significance for p values, plantain, tapioca and other food crops had a general positive association with the reported visitations of species. Ginger, galango and turmeric had a negative association in many cases (Tables 5.2 and 5.3).

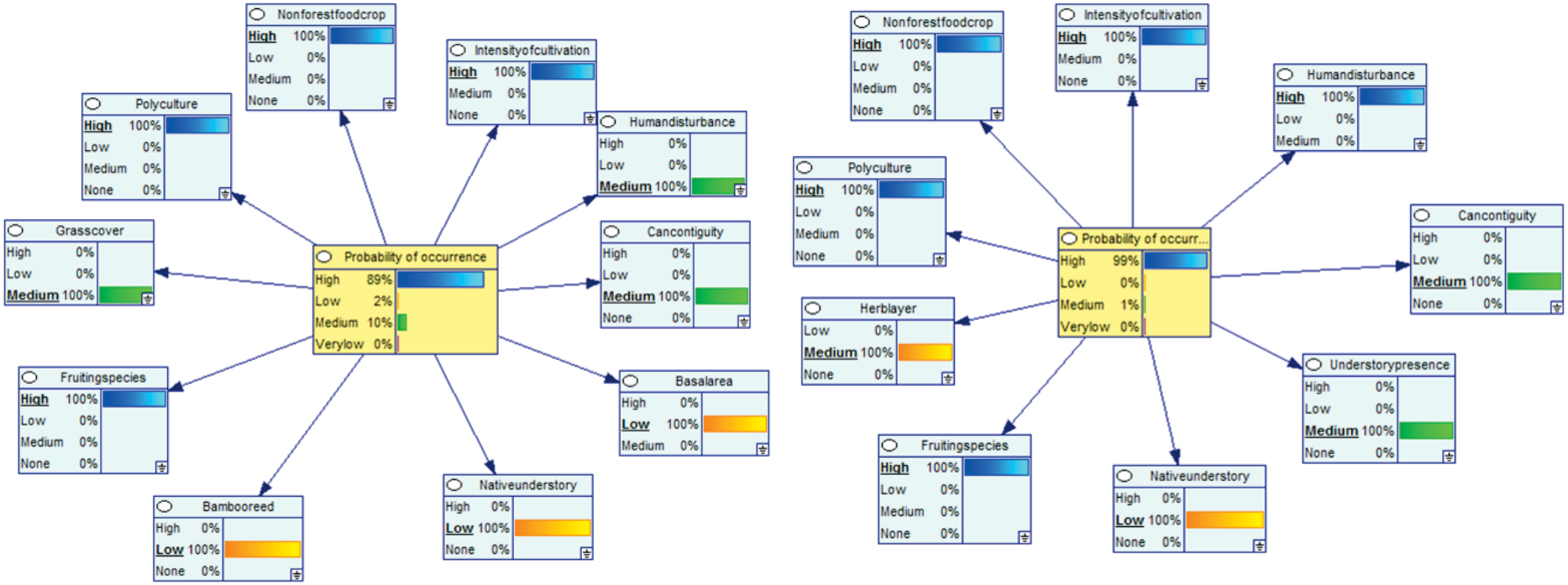


Tree-augmented network (TAN) with all variables



Naïve Bayes network with key variables

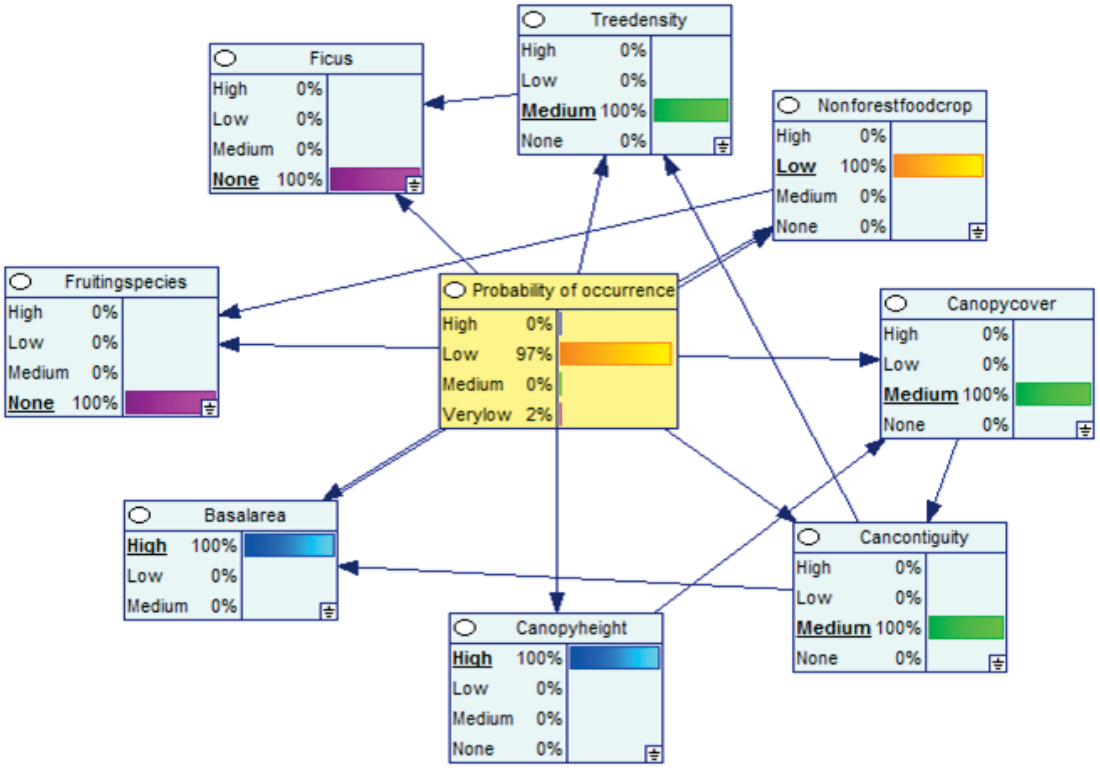
Figure 5.2: Predictive models showing status of habitat correlates of high probability of occurrence for the bonnet macaque, a crop-raiding species



Asian elephant

Wild boar

Figure 5.3: Predictive models for Asian elephant and wild boar in home gardens proximate to forests



Species included

Bonnet macaque
Common palm
Three striped palm squirrel
Travancore flying squirrel
Indian flying squirrel
Indian giant squirrel
Spiny dormouse

Habitat variables - frugal set (rank)

Fruiting trees (1)
Basal area (2)
Non-forest food crop (2)
Ficus sp. (3)
Canopy height (3)
Canopy contiguity (4)
Canopy cover (4)
Tree density (5)

Figure 5.4: Arboreal crop-raiding mammals in teak plantations

Table 5.2: Key crop-raiding species and crops. The table shows positive and negative associations of reported visitations of crop raiding species and crops cultivated in land-holdings.

Crop type	Elephant	Wild boar	Bonnet macaque
Rubber	-0.240 (0.538)	0.3043 (0.296)	-0.0662 (0.252)
Coconut	-0.261 (0.543)	0.0492 (0.347)	-0.333 (0.270)
Arecanut	-0.612 (0.571)	-0.3211 (0.317)	-0.286 (0.260)
Pepper	0.514 (0.562)	0.3042 (0.319)	0.214 (0.264)
Ginger	0.579 (0.702)	0.0823 (0.342)*	0.067 (0.306)
Galango	1.293 (0.523)*	0.871 (0.355)*	0.266 (0.261)
Turmeric	-1.129 (0.894)	0.935 (0.394)	0.353 (0.328)
Plantain	-0.339 (0.573)	-1.0170 (0.316)**	-0.258 (0.265)
Tapioca	-0.946 (0.723)	-0.541 (0.329)	-0.579 (0.285)*
Other food crops	-16.248 (995.903)	-1.197 (0.320)***	-0.956 (0.326)**

Notes:
Estimated coefficients and standard errors for species presence/absence and crops; logistic regression
Standard errors in parentheses, Significance codes ***, **,*,^ 0, 0.001, .01, .05; N = 402 land holdings.

The latter pattern also reflects recent strategies adopted by farmers to avoid conflict by switching to aromatics which are the least favoured species by wildlife pests. When all species were considered together, higher levels of crop-raiding were positively associated with the presence of tapioca and other subsistence food crops and negatively associated with that of galango. Though, on the whole, this analysis shows that cash crops such as galango and rubber are suffer the least damage and are therefore better suited for production along the fringe, this needs to be viewed in conjunction with two key issues related to local livelihoods and food security. Firstly, undue dependence on cash crops such as rubber which has shown extreme volatility in global and local prices over several decades is a problematic proposition from the point of view of steady incomes and food security. A second issue relates to the history of the settlers as migrants affected by traumatic events stemming from food shortages in the recent past. As the analysis of oral histories show, their response to these events by means of an inordinate focus on agriculture is reflective of their predispositions. These issues are discussed further in the following sections.

Table 5.3: Key crop-raiding species groups and crops. The table shows positive and negative associations of reported visitations of crop raiding species groups and crops cultivated in landholdings.

Crop type	**Arboreal mammals**	**Ungulates+elephant**	**High level of crop-raiding**
Rubber	0.170 (0.250)	0.300 (0.301)	-0.041 (0.275)
Coconut	-0.346 (0.271)	0.065 (0.354)	-0.390 (0.288)
Arecanut	-0.009 (0.254)	-0.293 (0.322)	-0.484 (0.288)^
Pepper	0.001 (0.258)	0.258 (0.323)	0.357 (0.289)
Ginger	0.125 (0.297)	-0.038 (0.344)	-0.010 (0.341)
Galango	0.412 (0.258)	1.020 (0.372)**	0.614 (0.281)*
Turmeric	0.100 (0.321)	0.901 (0.399)*	-0.092 (0.368)
Plantain	-0.192 (0.257)	-1.024 (0.323)**	-0.115 (0.289)
Tapioca	-0.784 (0.272)**	-0.588 (0.333)^	-0.561 (0.316)^
Other food crops	-1.185 (0.311)***	-1.050 (0.327)**	-0.943 (0.379)*

Notes:

Estimated coefficients and standard errors for groups presence/absence and crops; logistic regression.

Standard errors in parentheses, Significance codes ***, **,*,^ 0, 0.001, .01, .05; N = 402 landholdings

Interrogating the dynamics of small holdings: understanding agrarian distress and vulnerability

Historically, land use transformation in this region has been a dynamic and complex process characterised by conflicts with wildlife and by problematic contestations over forest land by different stakeholder groups. Therefore, conservation planning exercises in the region need to be informed by research on land use and land-holding dynamics at the local scale. As evidenced from the modeling exercise as well as from the primary data collected for this landscape, land use such as home gardens as well as mixed rubber and home garden landscapes are particularly vulnerable to crop raiding. Detailed evaluations were carried out for 480 households, with the surveyed households accounting for approximately 8% of households in the area[47]. Baseline information, information on agricultural practices and history, crop-raiding by wildlife, land tenure history, use of forest resources, attitudes towards forest protection and conservation, etc. were collected from each of these households, along with enumeration of family details such as income, education and occupation. On average, land-holdings were only 89.11 cents (3605 sq.m; 1 cent = 40.46 sq.m), with rubber plots being greater in size (87 cents for monoculture rubber and 115 cents for rubber mixed with home gardens) than home gardens (33 cents). Plots less than 20 cents were deemed uncultivable.

The dominant population in this area is a settler community that colonised these forests from the 1940s to the 1960s when Travancore witnessed localised famines and food shortages. The forests in these areas were cleared by impoverished migrants from different parts of Central Travancore. Compounded marginalisation has been a feature of this area and agrarian distress continues to recur, partly aided by crop-raiding from wildlife. Lack of educational and occupational opportunities also contributes strongly to marginalisation. In order to understand issues relating to agrarian distress and vulnerability, the surveyed households were evaluated along four axes of vulnerability: 1) their designation as above or below the poverty line (A/BPL) by the government by means of a multi-variate assessment of several development indicators, 2) inadequate area of

47 Household surveys were carried out as part of independent projects carried out by this researcher at various points. Baseline results presented here are from reports submitted to the Critical Ec system Partnerships Fund and the International Foundation for Science.

cultivable land for subsistence (approx. less than 10 cents per individual), 3) inadequate per capita income (less than Rs. 1000 per individual per month), 3) lack of sources of supplementary income, 4), the incidence of heavy crop-raiding on the holding (households suffering from persistent crop-raiding by wild boar or by more than 3 species was included). For each of the four components, each household was given a binary score of 0 or 1. The cumulative values of these scores were calculated to characterise an index of vulnerability ranging from low (score = 0) to high (score = 5).

Among the 480 households surveyed, 192 (40%) were listed as below poverty line by the government. These families are also disadvantaged in other ways (e.g. such as marginalisation on the basis of basis of caste or religion). About 30% of families were low income families and had no sources of supplementary income (i.e. income from non-agricultural sources). Subsistence agriculture although an important requisite of survival in this landscape, was not an option for over 36% of surveyed families (176 households) as they had insufficient land. Wildlife depredations by pigs and other ungulates as well as arboreal mammals, continues to be a major problem with nearly every household reporting crop-raiding at some level. Over 67% of households surveyed reported a high degree of crop raiding. Cumulative scores for vulnerability were on the higher side with close to 65% (309) of households recording high or medium levels of vulnerability (values ranging from 3 to 5) (Figure 5.5). Settlers rarely approach the government for compensation citing bureaucratic inefficiency and their past history of animosity with the Forest Department (especially relating to uncertain land tenure). Securing compensation for crop damage is a lengthy process which involves visits to nearby towns for filing applications, supplications (and sometimes payments) to officials to ground truth incidences and occasionally paying bribes to speed up proceedings. Only in rare cases do settlers manage to successfully overcome bureaucratic hurdles, and chances of success are higher in the case of livestock depredation by large carnivores or catastrophic crop damage by elephants. Frequent damage by wild boar or macaques is rarely ever compensated despite the scale of the problem.

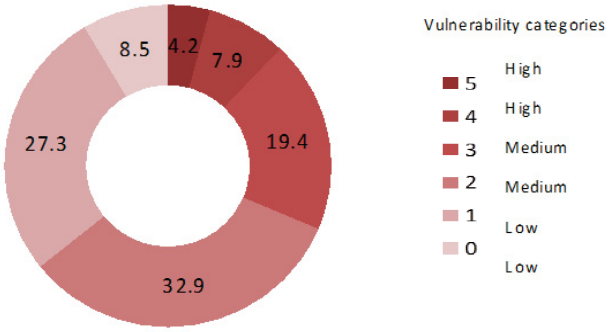
While a high degree of crop-raiding and the protection accorded to wildlife by the government is likely to impact conservation outcomes by way of direct opposition to

Average size of subsistence plots = 33 cents (1335 sq. m)

Average size of landholdings = 89 cents (3605 sq. m)

% of households that reported crop raiding = 80

Indicators of economic vulnerability



% of households below poverty line (BPL) : 40.0
% of households without land for subsistence cultivation: 36.6
% of households with less than Rs. 1000 cash income per month per head: 28.13
% of households with no supplementary income: 31.6
% of land holdings reporting a high degree of crop-raiding: 67.29

Figure 5.5: Percentage of households in different vulnerability categories

conservation, the large number of households that are susceptible to vulnerability and agrarian distress also have the potential to impact conservation success in an indirect manner. A high level of congruence between some of these forms of vulnerability (high and medium scores together account for over 65% of the total number of households surveyed) is a feature of these type of marginal landscapes that are distributed across the foothills of the Western Ghats. These aspects are often overlooked in conservation interventions. The results obtained from this study can be used not only to estimate the prevalence of intersecting issues between biodiversity conservation and agrarian dynamics, they can also be used to identify the needs of individual households and can be used to develop targeted solutions for sustainability as well as livelihoods.

Human and animal behaviour: insights and impacts

The dynamics at the margin are also important from a behavioural perspective. For instance, the 'merits of margins' hypothesis (Peterson 1977) proposes the idea of the fringe as a beneficial landscape for both wild species such as pigs and deer that derive nutritional benefits as well as for farmers who are provided with wild game. The idea that crops provide significant source of sustenance have been explored for species such as elephants in terms of nutritional provisioning, foraging efficiency and high-risk strategies. Cultivated crops are often easily accessible and improve foraging efficiency. In some cases, crops provide better nutrition than wild forage, and have even

been proposed to stimulate higher receptivity and perhaps even addiction in herbivore brains (Sukumar 2003). At the same time, the spatial and temporal use of a landscape by a species for foraging is often driven by fear and an anticipation of risk, resulting in 'landscapes of fear' (Brown et al. 1991; Laundré et al 2001, 2010) making crop raiding a risky strategy. Crop-raiding, which is potentially a high-risk, high-gain foraging behaviour, might also be beneficial for mate choice, sexual selection, and other forms of evolutionary selection (e.g. Sukumar and Gadgil 1998; Sukumar 2003; Chiyo et al. 2011).

In landscapes such the current one, characterised by an altered situation of increasing protective measures, it could be speculated that there is a change in the high-risk, high-gain nature of foraging. It could be argued that bans on hunting and abolition of lethal control of species means that cropland has become more of a low-risk, high-gain environment. For animals such as elephants and pigs, this is perhaps not entirely a low-risk strategy as occasional confrontations still occur, but when compared with the targeted elimination of problem animals during the pre-WLPA period, there is reduced mortality along the fringe and hence a concomitant reduction in the magnitude of risk. Recent studies, introducing the notion of cognition syndrome, point to individual differences in cognition and link it to behavioural types such as boldness, aggressiveness and exploration tendency, and are useful in understanding anti-predator behaviours in human-altered environments (Sih and Del Giudice 2012). Elephants and pigs can perceive the changing nature of risk as both species are known to modify their foraging patterns to avoid detection (Chiyo et al. 2011; Knight 2003), albeit at differing paces, and display other social learning behaviours (Chiyo et al. 2012). In the study area, elephants exhibit cautious behaviour with raids being typically more common at night (as is true for many other places in the Ghats) but wild boar (*Sus scrofa*) which previously employed nocturnal feeding strategies are now raiding crops even during the day. In fact, displaying a lack of fear, many individuals actually take refuge within farmland vegetation during the day which is a break in pattern from their typical retreat to the forests at daybreak. On the other hand, the region has a two thousand year history of significant ivory extraction (De Romanis 2012, 2014), with wild elephants captured using pitfall traps and even occasional *keddahs* in later years. Hunting elephants was a past time for colonial

European as well as native royalty and planting elite. In the adjoining Cardamom Hills sector, Lovatt (in Lovatt and de Jong 1993, citing Jarvis 1834) reports the occurrence of an elephant drive involving native communities and European hunters where 63 elephants were shot within four hours by hunters, and numerous others were captured in pits. The Ranni Division and adjoining areas figure in the survey reports of Ward and Conner (1816) and Bourdillon (1893) as hotbeds of conflict with crop-raiding elephants. Bourdillon (1893), recalls the constantly shifting nature of the fringe as a characteristic feature of this landscape; during the several phases of political unrest when the local population was disarmed, the forest advanced as cultivation was abandoned due to marauding wildlife and the fringe retreated inwards to the forest during times when local people successfully resisted attacks. The cognitive aspects and generational transmission of responses of long-lived species such as elephants to long-term conflict have been poorly understood. Emerging research on multi-species ethnographies, cross-species continuities, and shared social complexities and entanglements between humans and other species (such as elephants) have the potential to inform such engagements (Locke 2014).

Human cognitive responses to conflict are also an interesting complement to the behaviour of wildlife along the fringe. The establishment of the first protected areas in the late colonial period as well as the adoption of conservation legislation such as the Wildlife (Protection) Act, 1972, and other forms of increasing protective measures have largely been carried out in a top-down, non-democratic fashion resulting in strong cultural opposition to state-sponsored conservation. These impositions have the potential to affect the well-being of populations at the fringe that are already marginalised on different counts (Barua et al. 2013). In the study area, this particularly relates to the long-term antagonistic relationship of the impoverished settler community to forests and wildlife. As has been pointed out in the case of conservation refugees in central India, studies that report the impacts of stress on non-WEIRD (Western, Educated, Industrialised, Rich, and Democratic) societies by way of premature telomere shortening reiterate the consequences of compromised physical and psychosocial well-being even among rural populations (Zahran et al. 2015). In the study area, there exists a set of contrasting community responses and attitudes towards elephants and wild boar that can perhaps

be linked to individual species level differences and their invisible psycho-social impacts. An examination of the historical trajectories of conflict involving these species in the region reveal a pattern of declining elephant conflict and a concomitant increase in wild boar depredation. During the initial years of settlement, elephant raids were an almost daily occurrence along the fringe, and a phenomenon which necessitated the construction of *machans* (tree houses/ platforms) where families could spend the nights in safety. Most residents acquired land leased for food grain cultivation (specifically rice), a significant part of which was taxed by the government to alleviate food shortages in the plains. Paddy cultivation was later given up (elephant raids being a significant reason for this along with decline in soil fertility and glut in the plains) in favour of other food crops, and an overall increase in the size of the settlement and decline in forest cover has now resulted in a reduced number of elephant forays into the countryside. At the same time, species such as the wild boar have proliferated as a result of the increased availability of tuber crops and vegetables and reduced pressure from hunting and extermination as a consequence of conservation legislation. At present, wild boar raids have become a chronic phenomenon requiring small holders to undertake arduous crop-guarding exercises on a nightly basis. Farmers who have been unable to grow any food crops have shifted to commodity crops such as ginger, galango and rubber are also not spared from depredations that destroy at least a part of the crop. The health impacts of daily wild boar depredations can be categorised as a scenario of chronic stress, whereas incidents involving elephants which were at one point chronic can now be considered to be of an episodic nature (see Sapolsky 1996, 1998 for an elaboration of this idea). When viewed from the perspective of psycho-social well-being, the settler community can be characterised as having been subject to some form of enduring stress at any given point since their arrival in the landscape from the early 1940s onwards. Persistent conflict generated by one or the other species (elephants or wild boar) has compounded past and ongoing experiences of marginalisation, food deprivation and childhood malnutrition, migration, agrarian distress. And in a situation typical to most rural communities in the low-income world, where the orientation if at all is towards visible and tangible impacts, such hidden costs such as those relating to health, nutrition and psychosocial well-being remain poorly compensated or even recognised at any level (Barua et al. 2013). Of particular concern to this landscape is the need to further dissect

the links between historical nutritional deprivation, health and psychosocial well-being, the current inordinate focus on food production despite heavy crop-damage, and the behavioural responses of these communities in scenarios of conflict. An extensive literature on the combined interactions between memory and displacement (e.g. Kandel 2006; Creet and Kitzmann 2010), nutritional deprivation (e.g Grantham-McGregor et al. 1998; de Rooij et al 2010; Tarantino et al. 2011) and psychosocial stress (Dressler 1991; Sapolsky et al. 1986; Sapolsky 1996, 1998, 2004; Zahran et al. 2015) exists to justify the urgency of such explorations.

At this point, settlers who in the initial years of settlement were extremely hostile to elephants, tend to consider elephants in a more favourable light than wild boar. Older settlers who practically lived their lives in trees during the early years and were active in the elimination of problem animals sometimes sympathise with elephants while recalling past attacks, admitting that they encroached on elephant territories. These differing attitudes can also be explored via numerous factors such as the persistence and increasing regularity of visitation by wild boar, the popular perception of the boar as an animal that eats and destroys wantonly and its apparent lack of charisma (or displays of sentience), the decline in elephant raids, the tendency of elephants to exhibit social and behavioural traits that are identifiable with human social dynamics, cultural symbolism of the elephant involving religion and sentience, etc. (Morris 1967; Knight 2003; Linkie et al. 2006, Stokes 2007; Kansky et al. 2014). The current magnanimity to elephants in this region seem to be contrary to a more typical pattern where individual perceptions seem to be negatively biased against animals that cause occasional, catastrophic forays (elephant) as opposed to persistent small-scale events (wild boar) (see for example, Naughton-Treves 1997, 1998; Naughton-Treves et al. 1999, 2005). There also seems to be a marked change in attitudes towards wild boar especially in the light of protection measures that have resulted in the unavailability of the animal – which was until a few decades ago, a welcome source of protein in a nutritionally marginal landscape – as a source of meat. As pointed out by Sillero-Zubiri et al. (2007), species involved in conflict may be placed along a continuum of species abundance and the decision to adopt lethal or non-lethal control, or other mitigation measures would depend on its status in terms of abundance, conservation significance, etc. For the wild boar, which is an ubiq-

uitous species of the forest fringe that causes widespread and often generalised damage despite extensive crop-protection measures, compensation measures would mean that nearly every farmer in the landscape would need to be compensated. At the same time, proposals for culling wild boar populations to manageable numbers is ideologically opposed by conservationists and animal rights groups outside the study area but nevertheless wield significant top-down influence.

Interactions between place-based, extra-local and historical factors: choice, values and distributive justice

In a majority of case studies, there is a tendency to view historical as well as extra-local factors and scales of analyses as 'context' or 'mere background', rather than as integral interpretive components of the study (Hoefle 2008). Political ecological analyses when integrated with that of cultural anthropological insights provide a way to understand not only the impacts of global and regional forces on local environments and communities but also the resultant consequences in terms of conflict and resistance, as well as differences in power, cultural relations and environmental values (Hoefle 2008, 2013). Such analyses provide us an opportunity not just to analyse the political economic linkages with the environment and the wider world, but also provide us with a framework in understanding related issues such as the institutionalisation of certain knowledge pathways and their oversimplification, the historical roots of marginalisation and social vulnerability (Forsyth 2008).

The social and cultural basis of differential responses to situations by different groups of people can be evaluated from a number of frameworks that have been outlined in the social sciences. In this study which relates significantly to spatial and ideological contestations about land use and wildlife, the concept of 'habitus' as re-introduced by Bourdieu (1977a, but see also Heidegger 1962, Merleau-Ponty 1948) is a useful one as it refers to the individual and collective predispositions of differentially placed groups of people, that are borne out of past experiences and can be linked to current attitudes and choices. Migrant settlers, indigenous groups, external stakeholders, and even animal communities along the fringe can find expression in the analysis of habitus which finds signifi-

cant resonance with two related themes – place and memory (for more details on these themes, see Halbwachs [1992]; Casey 2001a, b; Creet and Kitzmann 2010). Habitus is represented or can be researched in various forms, whether it is in terms of the embodied links that indigenous communities have with the places they inhabit or in terms of the perceptions and attitudes of migrant communities that are shaped by displacement or dispossession. Places serve as indispensable anchors (e.g a 'locatory matrix' Casey 1987) in creating dispositions both for communities embedded in the long-term as well as for those that move (Creet and Kitzmann 2010). Of equal significance is the role of memory in understanding communities that have undergone displacement, relocation, marginalisation or loss. Articulated memories are not only useful in explaining contemporary choices, but also serve as a window to future expectations of place and lifestyles. Although memories run the risk of constant revision and modification (Davis and Starn 1989), individual, collective and social memories are useful in understanding the ways in which they deviate from 'absolute' archival or official histories (Halbwachs [1992]).

Along similar lines, drawing from a rich body of socio-psychological literature that includes the theories of reasoned action (Fishbein and Ajzen 1975) and following from it, planned behaviour (Ajzen 1991), Manfredo and Dayer (2004) suggest the exploration of human cognitive responses to conflict with wildlife as 'directed by attitudes, norms and perceptions of control'[48]. For example, the concept of wildlife value orientations as proposed by Fulton et al. (1996) demonstrates the role that values learnt in early life play a part in situating individuals along an orientation continuum that is characterised by a strong 'wildlife protection' sentiment on the one end and 'wildlife use' on the other. Similarly, cultural character (defined by Manfredo and Dayer (2004) as unique patterns of thought that distinguishes larger groupings such as societies and social groups) could stem from socio-political and ideological orientations that shape attitudes to wildlife (e.g subjugation-domination of nature, religious-scientific, individualist-collective, materialist-post-materialist). Contrasting cultural differences are perhaps most obvious

48 In their words, 'An *attitude* is a favorable or unfavorable disposition toward an action, an issue, an event, etc; a *norm* is an evaluation based on beliefs about the expectations of others; and *perceived behavioral control* is an assessment of whether a person possesses the abilities to affect a behavior. An understanding of why a person performs a particular behavior is found by examining the beliefs that provide the basis for the corresponding attitude, norm, or perception of control. Assessments of attitudes have been the most common type of human dimensions investigations of HWC.'

when one looks at how social groups relate themselves in terms of subjugation by and domination of the environment. Pre-industrial societies could be categorised as embedded and embodied in their environment with which they hold relationships of trust, giving and sharing. For them, the environment exerts a powerful influence, often (mis)articulated by analysts as subjugation. At the same time modern societies consider humans and the environment as separate entities, and this ideological separation is evident in their treatment of the environment as something to be dominated (e.g. forest clearing an farming) or as something which needs to be protected from humans (e.g conservation) (see Ingold 1994, 2000; Milton 1996). In modern societies, the spread of Judeo-Christian faith has been proposed as a catalyst for this separation and the worldview of domination (White 1967) as has been the development of the Calvinist ethic and scientific and rationalist thought in Western societies. The theory of culture change in response to the shifting needs of the state (Inglehart and Baker 2000) points to the shift away from a focus on basic needs (food, shelter, security) to post-materialistic values (e.g. quality of life, self-expression) with the growing affluence of post-industrial societies.

When stakeholder engagements in the study area are explored along a protection-use of wildlife value orientation framework, some broad cultural dispositions appear to be relevant and could eventually be linked with potential mitigation strategies. The settler community that forms the major stakeholder group in the study area appears to be in large part, the product of socio-economic transformations in erstwhile Travancore, and a regional scale agrarian capitalism that eventually transformed the Western Ghats through conduits along the fringe[49]. Colonial capitalist expansion was instrumental in large-scale transformations of the hills by the creation of commodity agriculture, the enclosure of forests and the cessation of supplementary cultivation in the hills. These factors combined with socio-economic transformations and large-scale events (such as the two World Wars) were responsible for the creation of numerous food shortages that afflicted the plains and the subsequent transformation of an immobile subsistence peasantry (once the hallmark of Travancore's feudal system) into a mobile cultivator class that colonised the hills (Joseph 1988). In a migration (that was distinct from that of the exodus to Malabar in the earlier years), a large number of impoverished migrants

49 This has been explored in detail in Chapter 4. Therefore, only a brief account of these impacts is provided in the following paragraphs.

along with a smaller number of rich landowners arrived in Travancore's eastern hills. There was strong political support (from the newly independent India's political class) for the impoverished migrants who were conquering the wilderness under harsh conditions that included the relentless onslaught of wild animals (Varghese 2009). The leading role played by the Syrian Christian community in migration resulted in an ethic driven by connotations with the biblical Exodus and notions of industriousness (Vargehese 2006a,b, 2007). Together these factors were responsible for the cementing of settler values of economic progress which mandated the domination of nature (Varghese 2009). The peasants at the fringe who persevered in the face of incessant crop-raiding by elephants came to be labeled in political circles and in vernacular fiction as the 'progressive/ forward looking farmers' and are commonly believed to be the forerunners of the now ubiquitous Malayalee migrant. The wildlife value orientations of settler communities can therefore still be characterised as having a materialist basis, which puts them in conflict with the demands of the conservationist community whose ideologies correspond to post-materialist values.

From the perspective of habitus, their persistent focus on agriculture even in the face of extensive crop depredation by wild pigs and arboreal mammals belies the significance of memories of deprivation and the aspirations of the early migrants as they are passed down through generations. Settlers practice subsistence agriculture on poor soils with the limited crops being consumed by wildlife. Commodity agriculture in typical small holder plots is usually of a mixed nature with home garden species. Drawing parallels with a number of studies that point to a tendency for distress to be remembered disproportionately in contexts of trauma and displacement, individual histories that were recounted weigh heavily toward the narration of deprivation in the plains, subsequent distress migrations to the hills, and their experiences with marauding wildlife. Varghese's analysis of vernacular literature relating to the Malabar migrations which were ongoing during this period also stresses these points (Vargehese, 2006a,b, 2007). Settler place-making which involved the clearing of extensive stretches of forest to recreate the order and familiarity of their native landscapes eventually come into conflict with forestry that first attempted to evict settlers from what was technically forest land and conservation laws (fueled by global and regional conservation PA establishment and

protectionist agendas) that placed curbs on the removal of trees and native wildlife. To the settlers, this signals the unmaking of decades of hard labour and the potential for regrowth of the forest. The disconnect between forestry laws of the earlier period that focused on revenue generation and the removal of troublesome wildlife and the conservation era laws that protect species in specially designated parks add to the complexity as local communities now consider areas outside PAs as spaces where wildlife should not be occurring.

The occupational differences between the incoming settler groups and forest-dwelling communities also resulted in differing relationships with crop raiding generalists. Agriculture at the fringe was historically fraught with conflict be it forest-dwellers or plains people who carried out these activities. Wildlife especially pigs, elephants and deer that raid crops are the bane of agriculturalists at the fringe, and these communities often share an antagonistic relationship characterised by frequent confrontations with wildlife. The orientation of settler communities towards agrarian capitalism and their aspirations in terms of livelihoods are different from that of the forest-dweller communities who occupied this landscape for centuries. Forest-dwelling agriculturalists practiced a limited, yet distinct form of agriculture which was located out of reach of elephants, but nevertheless entailed a low level of conflict. Forager traders who are the dominant *adivasi* community within the area, currently report negligible levels of conflict with wildlife even though they live well within the boundaries of the protected area. They usually practice a policy of avoidance of dangerous wildlife such as elephants by establishing their encampments in rock shelters and other inaccessible sites and take the necessary precautions while collecting forest produce. In the early years of the settlement, though settlers benefitted from the knowledge that these communities shared in gathering forest produce, building *machans* (tree houses) that were out of reach of elephants, and in sourcing food from the forest, forest dweller lifestyles with their characteristic mobility and unembellished ways of life were however, not what the settlers aspired to emulate, considering that in many ways they considered themselves superior to the former and also as outsiders to the landscape into which they migrated.

The tendency of settler groups to view themselves partly as insiders and partly as outsiders (for details, see Appadurai 1988) and their ability to physically (spatially) as well

as mentally (aspirations, expectations) move to and fro between the plains and the hills offer them a unique comparative perspective (also see the 'translocality' of Appadurai 1988 a,b. the 'material and imaginative translocality' of Massey 1994, and the 'multi-locality' of Rodman 1992). Settlers at the fringe, sandwiched between forests and the peri-urban centres of the plains, seem intensely aware of the 'development' of the plains which they aspire to replicate in the hills but are unable to do so due to state-imposed restrictions. In effect, they perceive themselves as a marginalised group that neither receives the benefits of development in the plains, but at the same time are forced to bear the costs on account of their lands being set aside for environmental protection. The emerging politics relating to *adivasi* mobilisation (by mainstream *adivasi* groups as well as government support and legislation in favour of benefits for forest-dwelling groups) has also resulted in their perceptions of being marginalised at the forest fringe. Their feelings of 'isolation', 'backwardness' and 'incarceration' lead them to question their position in terms of distributive justice (see Raffles 1999 for a similar analysis in the Amazonian context). Even within the hills, settlers feel that priority is given to large plantation agriculture and development activities that are much more detrimental to the environment in comparison to small-holder lifestyles. For instance, although the settlers admittedly benefit financially as their settlements are on the main pilgrimage route to the nearby shrine of Sabarimala (settlers benefit from small businesses that they establish during the pilgrim season), they question the permissive government policies and environmental clearance mechanisms[50] that facilitate the approximately 40 – 50 million visitors to this forest landscape each year.

Settler disenchantment with these situations are dealt with using a typical collective trait that can be characterised as a unique settler identity that has transcended the caste- and class-centred relations of the plains. This identity is formed in part from the locality that the settlers 'made' – that is, that they worked together to produce, the obstacles that they overcame collectively, and their collective memories of landlessness and deprivation in the plains. At the present juncture, this solidarity is channelled to oppose perceived injustices such as government restrictions on the removal of crop-raiding wildlife or

50 Environmental clearance mechanisms relates to the process of evaluating, screening and approving (clearing) development projects and activities that could have a potential adverse impact the environment.

restrictions on cutting trees on private lands. The retaliatory killings of animals such as leopards are a case in point where animals that are widely considered as state property (but are not themselves hugely problematic) are occasionally eliminated with collective sanction from the community. Recent events stemming from these incidents also point to political mobilisation from within the agrarian community that aims to protest against state-imposed sanctions on settler landscapes.

5.6 An interdisciplinary framework for modeling conservation conflict

A conceptual framework for modeling conflict

The integration and presentation of different strands of information from different disciplinary explorations is often a problematic exercise. This is especially true for complex, chaotic systems that are informed by mixed methods research that has yielded both qualitative and quantitative information, inputs from the social as well as natural sciences, and other thematic categories such as data across geographical (e.g. local vs. regional and global influences) and temporal (contemporary vs. historical drivers) scales, etc. Multidisciplinary modeling frameworks often need to be flexible enough to incorporate the information from different sources e.g. different forms of measurement, estimation and elicitation, different interest groups and expert groups, etc. Moreover, operationalising concepts such as conservation conflicts which have interlinked thematic elements is difficult not only on account of data complexity or paucity but also because they require a level of intuitive precision that works outside numeric estimates. This precludes the application of formal, conventional analyses of the natural and social sciences and calls for the inclusion of flexible, innovative frameworks.

Using the various inputs derived from the disciplinary explorations that were carried out in this study, the attempt was to develop and demonstrate in a stepwise fashion, descriptive as well as qualitative reasoning-based models that could integrate the different components of the study. The first hurdle to overcome was the meaningful representation of complex sets of relationships. The model building exercise started with the idea of constructing qualitative aggregate models to represent existing knowledge of the

system in a meaningful manner (Badham 2010). Descriptive models that represent our domain knowledge about a particular theme can be constructed following the idea of concept maps which are increasingly finding use as graphical tools for the representation and structural organisation of knowledge (Novak and Cañas 2008). In this context, Novak and Cañas (2008) define a concept as 'a perceived regularity in events of objects, or records of events or objects, designated by a label'. They propose that concept maps be constructed with reference to a 'focus question' or theme. These models are ideal for understanding and representing issues in a simple, clear fashion, as well as in designing problem structures and deducing linkages between the different components of a system. Several common qualitative models including, concept maps, cognitive maps, and mind maps, influence diagrams and influence nets are commonly used for representation. Their graphical representation is an effective way of representing a set of processes and interlinkages related to a concept or theme. In addition to their visual clarity, when constructed appropriately, qualitative proportionalities can be formalised or quantitively instantiated for further analyses (Kuipers 1994). Probabilistic influences can eventually be encoded within a logically appropriate structure to create probabilistic graphical models and Bayesian networks (Koller et al. 2007).

The organisational structure adopted in this exercise was that of a network (as opposed to alternatives such as flow charts that largely employ hierarchical representations). As mentioned before, the key reason for the adoption of a network-based approach was its potential for seamless integration with several thematic components explored in this study. A network structure intrinsically operationalises political ecology's focus on 'chains of explanation' (Blaikie and Brookfield 1987) and 'webs of relation' (Rocheleau 2008) in analysing complex interacting relationships. In methodological terms, this model could be built to represent a graphical analogue to progressive contextualisation (Vayda 1983) by depicting the series of consequences (intended and unintended) and chains of explanation that constitute the multiple interacting influences on an issue of interest.

The detailed knowledge model therefore represents the investigator's (subjective) understanding of the different drivers of conservation conflict that were identified as part

of this study. In this study, the model was arrived at by using the social and ecological insights from the previous chapters as background and a further progressive contextualisation of individual thematic components. As outlined by Vayda (1983), such a process, though subjective, is a powerful method that encourages researchers to explore themes by progressively moving outward or inward in space, time and focus of enquiry, using methods that require the requisite methodologies and theoretical frameworks pertinent to the question at hand. Such an exercise enabled the creation of a network in which a statement regarding a state of the key variable of interest was linked to nodes which in turn influenced it; nodes were progressively added for secondary nodes and tertiary nodes (etc.) till a theme was adequately addressed by the network as a whole. This process and output is analogous to the draft influence net model described by Hayes and Sand (1999, p.34). Submodels were constructed for key themes. Information on secondary sources from the study area as well as generic concepts (from studies elsewhere) were also included where applicable. The development of this model was a subjective process. Looking at the larger picture of conflict, we are faced with a wide network of interacting influences ranging from historical contingencies to immediate triggers (Figure 5.6).

While knowledge maps, cognitive maps and similar tools are ideal for representations of critical linkages and causal relationships, further insights into model behaviour under conditions of non-trivial complexity and uncertainty (which characterises most of these systems) require a more formal approach. Among the different approaches that are now available to address such issues, probabilistic graphical methods such as Bayesian belief networks (BBNs/ BNs) (Pearl 1988) are accommodative frameworks on account of their flexibility in combining different forms of prior knowledge and data, their robustness to imperfect knowledge, ease of updating, etc. (Jensen and Nielsen 2007). BNs therefore serves as ideal vehicles for graphical representations of our understanding of relationships between different variables (represented as nodes), and connected by arcs which represent the degree of probabilistic dependence or independence (beliefs) between them. They are intuitively attractive as they encode probabilistic data within simple graphical structures and calculate conditional dependencies based on evidential reasoning. They are especially amenable to human tendencies to think causally (Maaskant

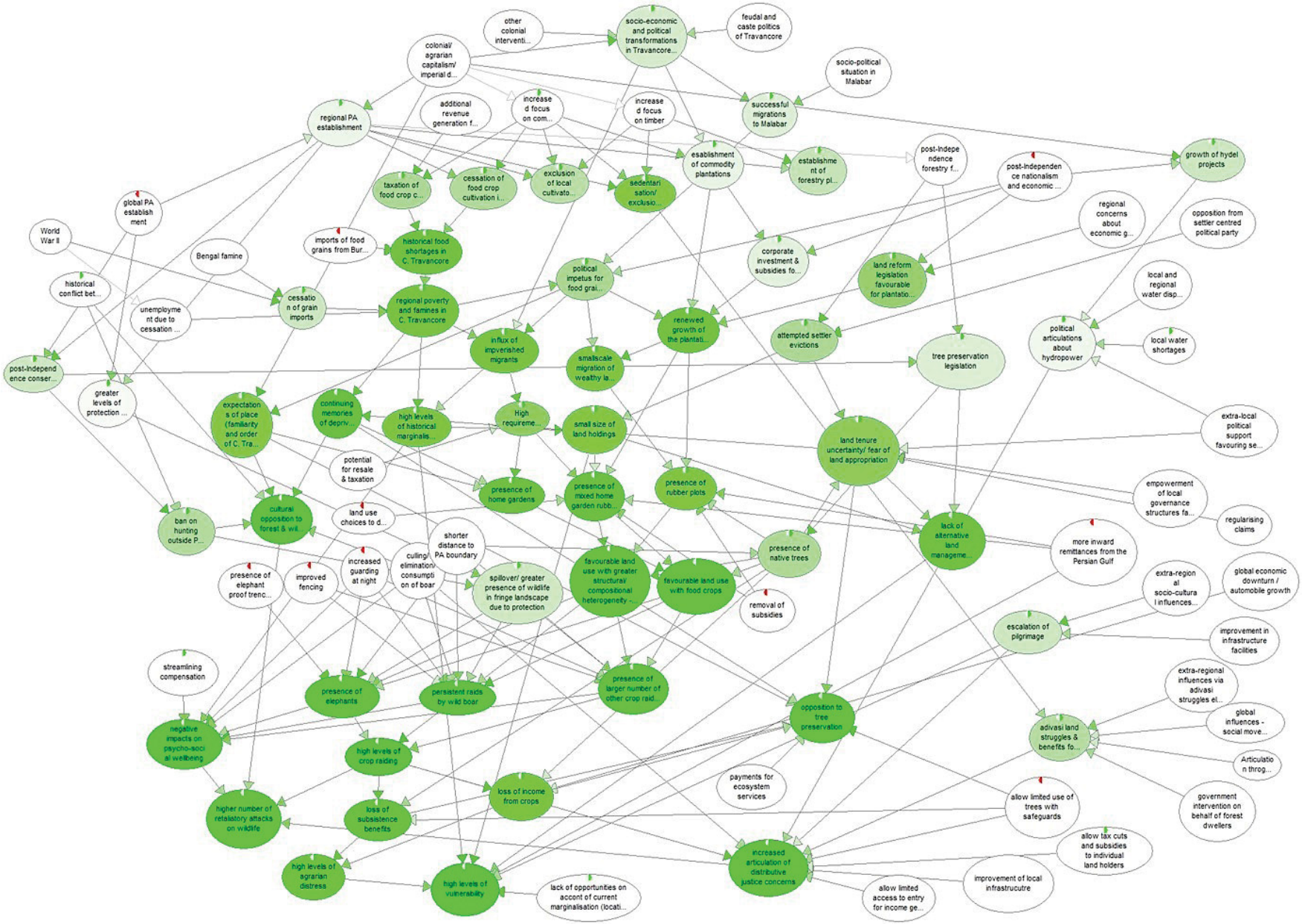


Figure 5.6: Detailed conflict model. This model shows the nodes and causal relationships selected as part of this study and shows conservation conflict as a real-world complex interconnected system. This network can be viewed as a conceptual map, as an influence diagram that displays the graphical structure (without assuming any probabilistic influences) or as a probabilistic graphical network. The darker shades indicates a greater number of positive causal influences on a node.

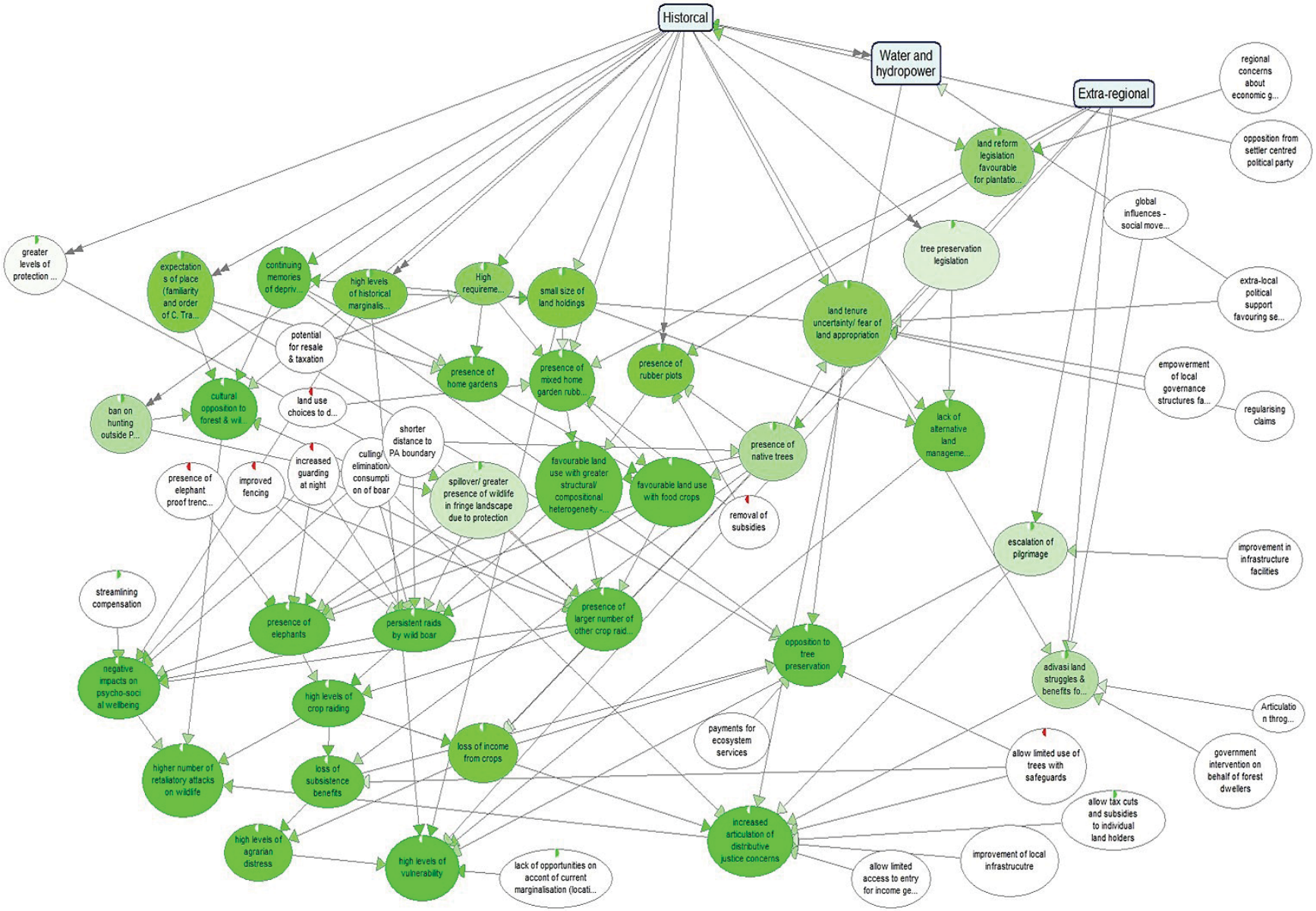


Figure 5.7: Conflict model with sub-models. Each submodel is a collection of nodes from the main model (Figure 5.6) that has been grouped together for easy visualisation. For example, the submodel with historical factors is constituted by a number of causal influences identified during the earlier period as triggering migrations. The submodel for water and hydroelectric power includes nodes relating to colonial and post-Independence establishment of dams and reservoirs and the parallel establishment of exclusionary zones.

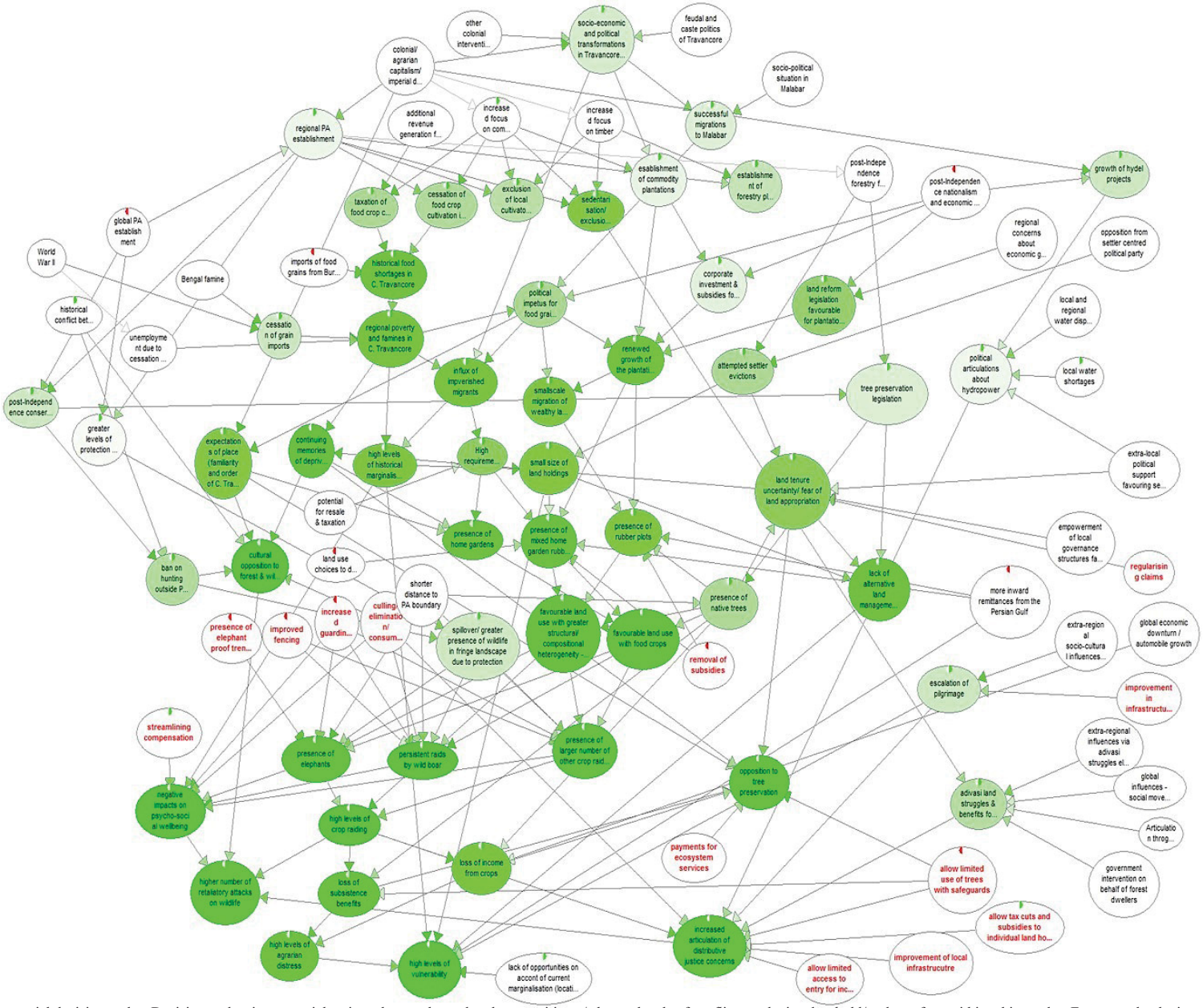


Figure 5.8: Model showing potential decision nodes. Decision nodes, i.e. potential actions that can be undertaken to mitigate/ change levels of conflict are depicted as bold/ red typeface within white nodes. For example, the impact of the node 'streamlining compensation' (on the left side of the figure) on other nodes by explored by switching on this node and selecting its status as TRUE.

2006). This combination of elements of probability and graph theory along with that of modern computational advances and intuitive appeal have made BNs a popular tool in several disciplinary fields. On the flip side, conventional BNs demand a great deal of data that need to be parameterised in the form of conditional probability tables (which increase exponentially with the number of parents for each node), often forcing the incorporation of imprecise information into a model (Pradhan et al. 1986; Parsons 2001; Drużdżel 2009). Moreover, the inherent complexity and multi-dimensionality associated with large systems make some of these models computationally intractable (Gigerenzer 2004).

In the detailed knowledge model that was prepared (Figure 5.6), some of the relationships presented as part of the network can be quantified effectively (as outlined in the previous chapters within the thesis), whereas for others, the links are entirely qualitative. A lack of adequate quantitative information for all relationships within the system therefore makes the construction of conventionally used network-based approaches such as traditional Bayesian networks problematic on several counts. At the same time, in this case, the attribution of abstract causal relationships between nodes is based on background knowledge and experience gained during long-term research and could be sufficient for model construction. In this regard, qualitative abstractions of Bayesian networks have been found to be useful. Qualitative probabilistic networks (QPNs) are derivations of quantitative networks which instead of using conditional probabilities to encode joint probability distributions, encode only qualitative relationships. Like in a traditional BN, here too a node can be a concept, an event or even an idea that influences a particular issue (making these models particularly attractive for representing and decoding the results of discourse analysis). Nodes are connected to each other by links or arcs that prescribe the relationships between the nodes and often imply causality (although this is not a necessary requirement). Depending on the modeling framework used, an arc can be set to behave as a cause, barrier, inhibitor or requirement, or characterised as reinforcing, reversing, etc. (e.g. Maaskant 2006; Drużdżel 2009; De Angelis 2013) (See Appendix F for a simplified representation). Colours, symbols and other notation can also be used to denote the type of note, degree of strength, etc. The relationships are derived from qualitative reasoning which abstracts the value domain

gence, their primary application and subsequent theorisations of QPNs have been in diagnostics relating to military intelligence and conflict situations by defence analysts (e.g. Hayes and Sand 1999; Rosen and Smith 1996; Levine et al. 2009; De Angelis 2013). In this analysis, the De Morgan model was used as opposed to the CAST models as the latter suffers from a lack of clarity in parameter elicitation. The De Morgan gate in QGeNIe is modeled using De Morgan's rules (A U B)' = A' ∩ B'; (A ∩ B)' = A' U B') of inference typically used in set theory and boolean algebra (See Appendix F for a simplified representation). In addition to its model construction capabilities, the flexibility of the model as it is encoded within the QGeNIe software allows for the modeling of 'what if' scenarios whereby variable attributes can be changed to predict the effects of the new evidence. Unlike other predictive modeling exercises which typically extrapolate a value of interest, QPNs can be used to explore multiple alternative scenarios by manipulating attribute values and combinations of attributes within the same model at the same time. Although the computations involved are numeric and are arrived at by Bayesian updating, the visual interface incorporates a graphical output based on colour codes and weights.

To make the data more tractable for a formal analysis, i.e., model construction, the data were simplified by distilling key interacting components (variables) and estimating their qualitative dependencies and proportionalities (relationships of change between them). Each node referred to a clear statement or event, and the statement was informed by quantitative data or qualitative articulations. The nodes and their relationships were specified in terms of clearly defined statements that imply the directionality of causation (e.g. 'shorter distance to PA boundary' has a positive relationship with 'spillover or greater presence of wildlife'). The use of these models are therefore not only amenable to modeling quantitative relationships, but are also easily adaptable to discursive methods such as oral histories and ethnographic data that follow a similar structure in the analysis of language use (and other semiotic systems) that aid in the attribution of causes and meanings in a network. Support for each of the statements and their strengths of influence was elicited using ordinal rankings for each data type used. The strength of influence of variables were estimated on one a scale (ranging from 1 – 5) and then converted to probabilities. The methodology followed the elicitation protocol outlined

of continuous variables to create non-numerical descriptions (i.e. a finite number of ordered symbols) (Travé-Massuyès et al 2003) (Appendix G provides an example of a comparison between quantitative and qualitative networks). This form of reasoning was first adopted for Bayesian networks by Wellman (1990) in the context of qualitative influence diagrams (enhanced BNs with decision nodes) and its applications have been enhanced by recent scholarship. The case for QPNs has been further strengthened by evidence in support of the importance of qualitative structure (i.e., the graphical representation of (in)dependencies) over that of the precision of its numerical parameters (Lu et al. 2000). This has been demonstrated by Pradhan et al. (1986) who show that even highly imprecise inputs of probabilities are unlikely to bring about a significant difference in the diagnostic potential of a network; in other words, BNs have shown to perform diagnostics adequately even in the absence of precise quantification.

Model development and performance

Following the conceptual strategies mentioned above, the graphical model was framed as an influence net that captures the causal relationships between various drivers of conservation conflict. Modelling was carried out in QGeNIe[51], a software that enables the rapid construction of graphical models. Model building was carried out using a subset of 'canonical models' called the independence of causal influences (ICI) models which assume that parent variables influence a child variable in an independent fashion, which in turn reduces the number of parameters required for the model (for more details, see Diez and Drużdżel 2007; Drużdżel 2009). Using ICI logic, QGeNIe uses two related interaction models: the De Morgan and CAST (Causal Strength) models in its repertoire. Although the underlying computations are numerical, the variables in both De Morgan and CAST models are of a propositional in nature with the types of interactions and the degrees of influence denoted by node and arc colours and symbols. Although these models have been widely researched in many sub-fields relating to artificial intelli-

51 The model constructed (using variables refined from this study) was constructed using QGeNIe (Drużdżel 2009, https://dslpitt.org/genie/wiki/QGeNIe_Documentation), a specialised interface of GeNIe (Graphical Network Interface), which is a graphical model construction tool provided by the Decision Systems Laboratory, Pittsburgh. QGeNIe and GeNIe serve as graphical interfaces to SMILE (Structural Modelling, Inference Engine), a Bayesian inference engine that implements graphical decision-theoretic models which are directly amenable to inclusion in intelligent systems (for more details, see https://dslpitt.org/genie/index.php/about).

by Maaskant (2006) and Drużdżel (2009). For causal variables, the strength of influence was calculated as the probability of occurrence of an event (i.e. the child node) due to a selected cause in the absence of all other causes and no barriers. The strength of influence of a barrier (or a variable that negatively influences the child node) was calculated as the probability of occurrence of an event given a selected barrier and in the absence of no other barriers and in the presence of all given causes. For each node, a leak probability was assigned expressing the probability of the effect under partial information. Probability leakage could be considered as type of model error. In other words, when attributing causal effects to a node, there could be other causal effects that are either not observed or observable. However, if the leak parameter is elicited properly, this need not imply that the model is false.

At its most basic level, the advantage of the QPN modeling exercise lies in its ability to enable the best possible visualisation of problem structure. In other words, it shows conservation conflict as a real-world complex interconnected system as opposed to just quantitative extrapolated values that typically constitute research outputs. This visualisation property is of non-trivial significance as it facilitates the use of the network by a broader constituency of users, ranging from academics to lay people. Moreover, this network can be viewed either as a conceptual map or influence diagram that displays the graphical structure (without assuming any probabilistic influences) or as a probabilistic graphical network. When viewed under the latter framework, the attributes of each of the nodes can be changed to view concomitant changes in the system as a whole and the variables of interest. This enables different users to visualise the network according to their disciplinary training or familiarity with such representations. For example, this network (or a relevant set of nodes) can be shown to resident groups within the study area as part of an exercise to verify the chain of influence surrounding their own reasons for migration (i.e., the validation of structure). Based on their knowledge about the system, these individuals can affirm or suggest modifications to the structure. Local managers can take a different approach by changing the values of a decision node (e.g. payments for ecosystem services, streamlining compensation for crop raiding) to see the potential impacts on interacting nodes.

Due to the large number of variables involved, in its original form, the network is large and complex. To make the structure more elegant, a series of sub-models were inserted into the network based on thematic categories. This refined structure facilitates visual analysis and exploration of the model in a simplified manner. Figure 5.7 is an example of a refined model structure where the detailed visual structure is retained only for some nodes of interest, whereas other variables are grouped under sub-models. To make the model more comprehensible, the decision variables relating to potential management inputs have also been labelled. These include different interventionist strategies such as improved fencing technologies, culling or elimination of crop-raiding species, payments for ecosystem services, regularising land claims, etc. The attributes of other variables in the network can also be changed to view system level impacts. To illustrate this, Figure 5.8 highlights decision nodes that could be employed as local solutions.

The network is also adept at depicting the involvement of interacting elements, some of which cannot be encapsulated within single disciplinary or conceptual frameworks. For example, extra-local influences and historical contingencies can be easily included in the visualisation. The former facilitates a view of the translocal and connected nature of material and cultural transmissions, and the impacts of movements of people, goods and ideas. Examples within this network include the far flung impacts of capitalist expansion in creating commodity landscapes, the role of World War II in creating food shortages and the nationalistic influences in motivating the migrations of people. The cumulative impacts of these factors led to the eventual transformation of the fringe. Similarly, the role of historical factors such as colonialism and protected area expansion and their causal interactions in relation to contemporary effects can also be depicted. When looking at contemporary inter-relationships, the network demonstrates the significance of looking beyond conventional scientific measures (e.g. levels of crop damage, results of ecological modeling, etc.) that are traditionally valued by scientists and planners. In this network a large part of conservation conflict in this region can be attributable to distributive justice and vulnerability which rarely figure as key themes in conservation focused studies. These impacts have been ascertained from discursive tools such as stories, anecdotes, personal experiences, values and attachment provided by local communities embedded in a landscape and also by a detailed examination of political ecological net-

works and regional histories.

The network allows the user to set evidence in a binary format (i.e. TRUE or FALSE) for each node. This can be done to examine the impact of a parent node in comparison to that of other parent nodes, to see the change in a child node when changes are made to parent nodes, or when decision nodes are added or removed. To illustrate this with an example, the case of crop-raiding is explored (Figure 5.9). The node 'high levels of crop-raiding' has three parent nodes (presence of elephants, persistent visitations by wild pigs, and the presence of large number of other crop-raiding species) (Figure 5.9a). However, as shown in Figure 5.9b, even upon removal of impacts of elephants and other species, the level of crop-raiding (as understood from the household surveys and interviews) are high. Crop-raiding declines only when, wild boar, the most pervasive crop-raiding species in the area is removed from the network (Figure 5.9c). A visible impact on income from crops is attained only in the last scenario.

Additionally, the interconnected nature of the components provides an initial diagnostic tool towards 'solving for pattern' (Berry 1981). These relate to the property of networks to identify emergent patterns. Conceptually, such an approach alerts managers to the possibility of looking out for potential solutions for multi-pronged problems and in identifying cumulative as well as unintended consequences of interventions. Berry (1981) refers to the first as solving for pattern and to the deleterious ones as solutions that bring about a series of new problems. The latter are likely to spill over beyond the levels and types of expertise that produces such problems, sometimes with multiplicative effect and at other times problems and solutions reciprocally exaggerate each other. Well-structured networks can point to the existence of unintended consequences and surprises.

This model also allows for more nodes as well as accurate information to be injected into this model at later stages or as and when better information becomes available. In this respect, it is important to understand the caveat that the calculations in this network are probabilistic and hence the selection and utilisation of results require the use of good judgement. In this context, the probabilities have been assigned by the researcher, based

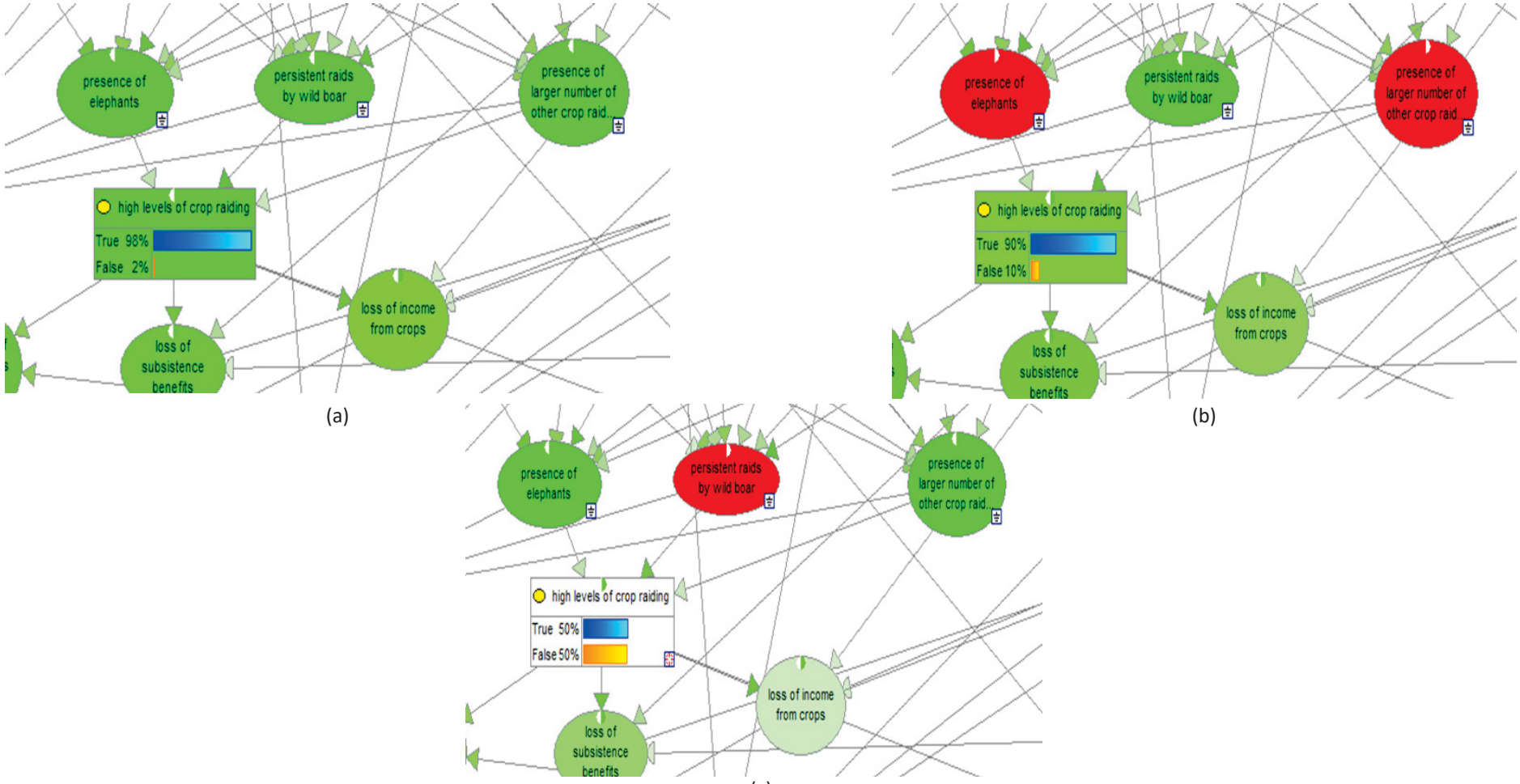


Figure 5.9: Network section: high levels of crop-raiding. This figure shows a section of the network where the influences of nodes have been added and removed to explore changes in the network. (a) The presence of elephants, pigs and other species (e.g. macaques, deer, etc.) gives rise to high levels of crop-raiding in landholdings. Visual examination of the figure shows that the perception about high levels of crop-raiding decline when (b) elephants and other species are removed, and © declines only when wild boar, the most pervasive crop-raider is removed.

on long-term knowledge and familiarity with the system under investigation.

Moving towards decision-making and diagnostics

Integrative frameworks such as QPNs serve as new ways of looking at problems that are caused by diffused interactions between several factors, scales and stakeholders. The network model that was developed provides the necessary background knowledge required for moving towards decision strategies. As it stands, the current model is a complex one intended for showcasing the problem as a multi-pronged one with many interacting elements. At the same time, when exploring decision-making, there arises a need for flensing the structure into a simpler one. These improvements could be based on qualitative network-based advances such as the development of pruning algorithms and frugal strategies that identify the most influential leverage points (e.g. see Levine et al. n.d; Kwisthout 2014). For instance, Levine et al. (n.d.) demonstrate a greedy procedure that selects a single valid explanation by pruning the qualitative network of its variables with the weakest assertions.

However, caution needs to be exercised against undue dependence on complex Bayesian networks in prediction and decision-making frameworks. Though the qualitative form and structure of this system is critical to understanding the nature of a multi-pronged problem, the direct formalisation of complex networks in terms of multivariate analyses or probabilistic predictions (e.g through Bayesian networks) could (especially if they involve elements of human cognition and decision-making) in some cases lead to intractable situations (Gigerenzer 2004). Such exercises can result in a flawed analysis due to the complexity of the system and the limitations in human cognitive processing while dealing with multiple consequences and alternatives, and adjudication among multiple goals. To move from understanding to decision-making, it would be pertinent also to explore other decision-making strategies aided by inputs from sub-fields such as cognitive psychology and frugal heuristics. The contributing stream of scholarship for these stem from the 'behavioural theory of decision-making' and the concepts of 'satisficing' and 'bounded rationality' as proposed by Herbert Simon (1956) and explored extensively by researchers in the field of frugal heuristics (e.g. Gigerenzer and Selten 2001; Martignon

et al. 2003; Gigerenzer 2004). Supported by research on cognitive psychology, these approaches aim towards simplification, and call for the application of realism in the context of decision-making (i.e. predicting real world behaviour as opposed to optimal behaviour) (Callebaut 2007). They promote the use of simple models which demonstrate better robustness in prediction. As Martignon et al. (2003) clarify, the an overly complex tree or model tends to overfit the available data and is hence likely to have poor generalisation and predictive capacities when faced with new data.

5.7 Conclusion

In terms of interdisciplinarity, this exercise is only one way of looking at a complex interacting system. This research explored the linked components of conservation conflict in a way that has not been previously carried out. By demonstrating the usefulness of qualitative probabilistic networks, this study points to the need to resist categorical thinking that is currently prevalent in the context of research relating to complex issues such as conservation conflict and to bring various disciplinary streams together on a common platform. Although these forms of model building and analyses involving qualitative reasoning have found maximum application in defense analytics (especially military responses to complex emergencies), the conceptualisation and methods used as part of this study could be applied to many situations outside this field. A number of scenarios in conservation research and management are characterised by interlinked complexity and would benefit from the creation of simple network and interaction-based models.

Chapter 6: Conclusion

6.1 Understanding forest-fringe landscapes

Human modified landscapes are the products of entwined social and ecological histories. Understanding conservation contexts in such areas requires inputs from multiple disciplines as the relationships between people and their environment cuts across disciplines. Temporal influences are evident in the role of history, and spatial influences sweep across local, regional and global scales. Keeping these aspects in mind, this study focused on different themes related to conservation challenges in a forest-agriculture fringe located in the Western Ghats hotspot. The fringe was explored from the perspective of a modified landscape, as one that is not only impacted by (and impacts) the locally-centred ecologies and social dynamics of different groups of human and non-human actors, but also as a region that has been influenced by translocal as well as regional and global processes over several centuries.

To understand and contextualise engagements related to conservation in this modified landscape, a progressive contextualisation approach starting with a global review of literature and a number of field-based enquiries were adopted. Four key thematic approaches can be outlined within this process. Firstly, a global review of literature relating to the bio-physical and socio-political contexts in tropical modified landscapes was carried out. This exercise provided the necessary background to identify the broad themes of interest that were relevant for the rest of the study. This included the (second) ecological objective of understanding species-habitat relations that are key to understanding the persistence of biodiversity in modified landscapes. This analysis addressed the gap in cost-effective, simple frameworks for species-habitat modeling Thirdly, the social, political ecological, and historical aspects of conservation remain poorly contextualised for most of the tropical developing world. These were analysed using the concepts of place, memory and conflict as central focal points that addressed social relations, and as the building blocks for structural and materialistic insights. The fourth and final objective was a case study (of conservation conflict) which involved the integration of insights from ecological examinations as well as historiography of the region to

develop a predictive framework for a pervasive challenge in the region of interest. The following paragraphs summarise the main findings of these explorations.

6.2 The review

The review of literature was conducted in order to identify recurring issues of ecological and social significance in human-modified landscapes. The main themes that were addressed included the current understanding from research in tropical ecology; the widespread impacts of large-scale historical processes (e.g. colonialism) and contemporary processes (e.g. neoliberalism), their links with poverty and underdevelopment; the centrality of contemporary agricultural practices ranging from subsistence practices, commodity agriculture and the politics of food security and land grabs; and, the material and cultural impacts of different trajectories of conservation and protected area establishment across the developing tropics. In terms of ecological imperatives, long-term research from the tropics points to the need for understanding the persistence of species in modified landscapes which represent complex, uncertain systems. Though species-habitat relationships form the primary focus of studies conducted to date, there is a need to move away from an extreme dependence on conventional data- and effort-intensive methodologies towards simpler structures and inference mechanisms that are more appropriate for diverse, tropical systems. In terms of the social aspects of conservation, the overarching insight from this big-picture exploration is that both large-scale land modification and conservation pathways can be attributed to the impacts of the same socio-economic and political processes. These multi-disciplinary perspectives reflect the interlinked nature of impacts and therefore call for a broadened mandate for conservation science in modified landscapes. This necessitates the revision of research paradigms that investigate the impacts of historical and contemporary large-scale processes, explicitly recognise and analyse the politics of conservation and its links with resistance and under-development, and engage with the connected nature of these processes both in temporal and spatial terms.

6.3 The ecological analysis

The scholarship on tropical ecological systems reveals that despite decades of extensive research, our knowledge about species responses to anthropogenic modification remains fragmented and incomplete. Eventually, this can translate to delayed decision-making and resultant opportunity costs for conservation. Moreover, datasets on tropical systems are characterised by incompleteness and uncertainty, making traditional analytical approaches (typically those addressing known risks) less effective. Keeping in mind these drawbacks and given the diversity of tropical species and land uses, this chapter explored alternative conceptualisations to conventional data gathering techniques (which typically involves time consuming surveys), and analytical methods (such as an extreme dependence on traditional regression-based analyses). Drawing on the broad conceptual foundations of habitat suitability explorations, this component of the study used a combination of techniques to develop simple predictive models that not only compared the effectiveness of existing information, expertise, and frugal methodologies, but also integrated these with heuristic solutions and probabilistic network approaches. The outcomes were a set of simple, yet reasonably robust predictive models of species' presence in modified landscapes. The results of this analysis show that simple models such as the naïve Bayes networks developed using fast and frugal measures have the best potential to provide good enough inferences that can be useful for real world conservation planning. Moreover, both expert- and literature-derived models provided comparable (though marginally lower) accuracies. Combining elements of probability and graph theory, these networks are also flexible enough to incorporate different forms of data and inferences. The networks developed for crop-raiding species contributed a significant part of the ecological inferences for the integrative predictive model. The ecological analyses also show that modified landscapes with a greater complexity in structure and food availability were more conducive to a greater number of species, especially to arboreal mammals and understory species that are common in the Western Ghats. Land uses such as home gardens and cash crop land uses such as cardamom and coffee with native tree cover are preferred by more species. Generalist species, especially those involved in crop-damage were relatively less affected by structure and more by food availability. These patterns can be assumed to be consistent across different sites in

the Western Ghats.

6.4 Analysing social and environmental histories

As a necessary complement to the ecological analyses carried out in this study, a number of thematic explorations cutting across disciplinary boundaries were contextualised to trace the history of the forest-agriculture fringe in the region. Although locally centred and geographically explicit, the analysis of chains of explanations and webs of relation emphatically point to trans-locality and connectivity between wider geographies. The central focus of this exercise has been the analysis of place as viewed, constructed and contested by different stakeholder groups. Here, place-based explorations not only reveal the transformations of the fringe catalysed by regional food shortages and migrations, but also the evolution of place-centred identities, sentiments and embodiments that provide further insights into perceptions related to contestations around conservation. The non-material aspects of place making are particularly relevant in portraying the tension between habitus and memory, the former signaling the imprint of history in the form of lasting dispositions (or how the past shapes the present), and the latter offering a constantly changing dual perspective of past remembrances being shaped by the present-day engagements. The forgotten histories of place are worth retelling particularly with reference to the longstanding human imprints on forests in the region and the diversity of traditional knowledges and practices that accompanied these engagements. Migrant settlers, forest-dwellers and external actors together represent a diverse set of stakeholders whose presence in the fringe has been brought about by various historical contingencies and serve as a reminder of the complex nature of conservation contestations. Together, these themes help in the identification of pressure points or 'local entry points' into the system, some of which can be generalised to similar landscapes and contexts. These include the significance of past memories and conflict, the emergence of a settler identity and its role in mobilising opposition to conservation and other perceived injustices, the emerging significance of land in forest-dweller articulations, and resistance to top-down control. The progressive contextualisation of interacting factors also formed the basis of the integrative exercise that was carried out at the end of this study.

6.5 Integrating ecology, sociology and history

Themes addressing the complexity of natural-social systems are difficult to compartmentalise within conventional disciplinary frameworks. However, their integration is a desirable feature as they offer holistic perspectives that are typically lacking in single disciplinary explorations. At the same time, it is important to keep in mind that there is no silver bullet approach to interdisciplinarity, and that the type and extent of integration will be heavily dependent on context and the problem at hand. To explore the potential for interdisciplinary investigation, the issue of conservation conflict was selected as a multi-dimensional conservation challenge of applied relevance to this region. Both qualitative as well as quantitative data were collected. A number of thematic and structural issues relating to conflict were identified from the ecological and historical explorations carried out as part of this study (a few additional themes relevant to the issue were also examined) and constructed as a progressively contextualised network of interacting events. Drawing upon a long history of use of linkages and networks as enabling metaphors (e.g. the 'rooted networks' of Rocheleau, the 'actor-network theory' of Latour, Blaikie's 'chains of explanations'), this part of the study explored the creation of a qualitative probabilistic network for conservation conflict. Although constructed using estimated probability values for different interactions, these networks offer the potential for evaluating influences in probabilistic terms or just on the basis of their visual structure. Here, the plasticity of networks come in useful as they employ hybrid epistemologies, i.e., some aspects are informed by general universal laws derived from positivist explanations, others make use of local framings of social and environmental problems or relativist explanations. Networks not only capture the complexity of interacting influences, but also offer an intuitive realism that is easily understood by most researchers and stakeholders. Moreover, they enable the integration of widely divergent types of input formats such as qualitative and quantitative data that inform complex everyday problems on the ground. Therefore, this study not only utilised the diversity of data formats and themes, it also attempted their integration through the use of intuitively constructed networks which are an emerging methodology in the study of complex systems.

6.6. Specific recommendations and practical applications

The study focused on a settler landscape located along a forest fringe in the Western Ghats where multiple interacting elements ranging from historical processes, current land use practices and political dynamics have precipitated a situation of conflict. Based on the insights derived from research, a few specific recommendations are proposed:

1. Crop-raiding and the presence of wild species in private lands can be linked to ecological as well as social motivators. Ecological aspects were evaluated by means of habitat suitability examinations which predicted the relative potential for different land uses to host various species. Land uses with higher levels of complexity in terms of structure and composition, and greater prevalence of natural vegetation are likely to host a higher diversity of fauna. Additionally, greater levels of food crop availability and proximity to the forest boundary can be linked to the presence of crop raiding species in this landscape. However, it is important to note that settler communities persist with agricultural practices that are vulnerable to crop-damage. These counterproductive practices can be explained by social and historical factors (summarised in the following paragraphs).
2. Local opposition to conservation actions are backgrounded by latent memories of deprivation as well as conflict with wildlife over the decades. Food crop cultivation, despite low returns remains a priority, reflecting past experiences. More stringent conservation measures over the years has resulted in greater protection for a number of crop-raiding species. Crop losses and daily hardships related to protecting crops from wild boar are particularly problematic issues that have been insufficiently addressed by forestry officials and conservationists. While a notification to bring down wild pig numbers has been mooted by the Kerala Forest Department, this has seen little operationalisation at the local level. For managers, a priority would be to address the specific issue of crop-damage by wild pigs in dialogue with the community leaders such as members of the local panchayat body. The adoption of locally acceptable solutions even if it amounts to lethal control of a small number of pigs need to be viewed in the context of benefits that prevent

retaliatory killings of other species of conservation significance.

3. The native tree preservation legislation that prohibits tree-felling in ecologically sensitive areas of the Western Ghats ignores pleas for subsistence use by households as well as the fact that many plots of land were clear-felled and replanted by settlers (or have been reforested due to secondary growth). Local stakeholders question the lack of such policies in the plains where tree-felling is allowed. The Forest Department on the other hand finds it difficult to monitor the removal of trees from local plots as well as surrounding forests. Uncertain land tenure in areas very close to the forest is also a continuing issue for both the local community and the Forest Department. At the same time, considering that tree cover is essential for the maintenance of these landscapes, it is imperative to find a mutually acceptable solution to this conundrum. From the point of view of distributive justice, it is important to introduce some form of parity either in terms of reduced taxes, provision of subsidies, or allowances for limited use of trees. This is a widespread problem across settler pockets in the Western Ghats that calls for innovative solutions that are also locally and culturally appropriate. Since state-initiated protection measures have often been met with resistance, a first step in this direction would be to invite the participation of local governing bodies in the development of alternate strategies.

4. Opposition to conservation can arise from a number of causes ranging from monetary losses and impacts on livelihoods to perceived inequalities and injustices arising out of power differentials. In comparison to the more prosperous communities of the plains of Kerala, the settler community is an economically and socially vulnerable group that has been struggling to overcome their historical conditions of marginalisation. While a well known fact locally and regionally, this insight regarding the social context and the concept of distributive justice needs to be kept in mind explicitly while planning conservation action. For this reason, the development of a dedicated regional agenda that combines both ecological gains and livelihood benefits would be useful.

5. Top-down control, viewed in the context of wildlife preservation has been problematic on several counts. Currently, even occasional infractions have the tendency to be exaggerated due to the ongoing animosity between the state agencies and

local people. Perhaps, the most significant avenue towards successful conservation engagements will be the facilitation of dialogue between local community representatives, civil society groups, and the Forest Department. While the establishment of Vana Samrakshana Samitis (VSS) and similar initiatives are a right step in this direction by the Forest Department, the current situation calls for more active consultations between local elected bodies such as *panchayat* institutions and the Forest Department. Democratic solutions for environmental issues such as conservation conflict, are integral as people living on and working the land are the primary stakeholders of any landscape. Changes are likely to more meaningful and long-lasting when catalysed by self-determination and public participation. A nexus between Kerala's politically aware local communities who are cognisant of their rights and responsibilities, and the Kerala Forest Department, which is considered to be one of the most forward-looking institutions in India, would result in positive outcomes for both people and the environment.

6.7 Overarching results and ways forward

In summary, this study researched the ecological and social themes related to conservation in a forest agriculture fringe from several conceptual and methodological perspectives. A few overarching generalisable insights and caveats are worth reiterating in this context:

1. Analyses aimed at gaining ecological insights through predictive models provide a set of results that can be generalised across the region. Similarly, the analysis of social data also provides a set of insights, some of which are embedded and specific to the region and others which can be useful for understanding conservation challenges common to other similar landscapes in the Western Ghats. Future conservation assessments in the Western Ghats can build on both these models and insights. More significantly, this study shows that understanding challenges in modified landscapes need equal attention to both ecological and social aspects. This is by no means a novel finding, but one worth reiterating emphatically. Conservation contexts in modified landscapes in the Western Ghats need to be informed by

insights from contemporary as well as historical processes. The continuing role of historical processes is sometimes instrumental in creating stakeholder perceptions and motivating resistance to conservation. In current conservation scholarship they remain peripheral to ecological assessments. They need to be explored as integral research components in studies, their role being to interrogate not only local histories of place but also extra-local influences. Such engagements also reveal relationships with non-human animals and the environment that are typically ignored. It is important to realise that it is not only humans for whom history is important - as this case study shows, species such as elephants and boar adapt in response to experiences and changing patterns of land use. So the broader view of species interaction and adaptation must be considered, in which human intervention is only one factor in a complex engagement. Contemporary conflict is, therefore, a complex ongoing narrative characterized and fueled by the persistence of human and animal histories and memories as well as by the contrasting views and aspirations related to place.

2. Places – even frontier landscapes such as the forest fringe and the forests beyond them – are highly connected entities, incorporating the transfer of materials, people, events and ideas. Over the centuries, the fringe itself has been a mobile entity constantly shaped by people and influences, and continuing to shape them in return. In this sense, the landscapes of the Western Ghats have been sites of ongoing tension between local and extra-local influences for long periods of time. These influences have not only been of historical significance or of physical transformations, contemporary ideas of distributive justice as voiced by communities in this landscape are highly contingent on that of neighbouring localities and regions. In the hills, settler perceptions of their situation in the hills is compared and contrasted with the economic development and prosperity in the plains. The forest fringe therefore needs to be viewed not as an isolated space, but one that is intimately connected to the landscapes on either side. When viewed this way, conflict is as much a product of trans-local social upheavals such as migration as it is of global influences such as capitalism.

3. The question of distributive justice brings to the fore the expectations and aspirations of the stakeholder communities placed variously in the landscape and mediated by different social and historical engagements. An important outcome of this study is the understanding that it need not necessarily be the most marginalised groups or elite actors on whom conservation interventions should focus. In this study, as the landscape is predominantly peopled by migrant settlers, the success of conservation arrangements is highly contingent on constructive engagements with this group. However, conservationists often tend to regard them as 'inauthentic' residents who by definition are less knowledgeable about the environment than indigenous peoples. In an era dominated by the privileging of indigenous demands and narratives, be it by anthropological researchers or even large conservation organisations, this study shows the value of investigating frequently ignored constituencies such as migrant settlers, who, despite their assumed ordinary status are sometimes the central actors in land transformations. For frequently ignored groups such as migrants and settlers, research is required not only about their 'etic' history in the area but of their own experiences and perceptions (i.e., the 'emic' view). Among displaced communities, traumatic events are known to generate longer lasting and more powerful memories than non-traumatic events, and in turn shape current responses. Therefore, researchers in other areas need to look for the presence of references to such events in their research into perceptions.

4. This does not call for the neglect of indigenous (in this case, forest-dweller) views of place. Indigenous peoples' views and experiences of landscape are critically important because they have long-term engagements with place, their agency and their diverse impacts on the environment need to be recognised. As pointed out in this study, indigenous peoples need not necessarily be isolated in any place. But their agency may have been involved in long established trading networks far outside their area. Moreover, indigenous groups in an area need not be homogenous. They are likely to be composed of diverse groups and cultures, and as a result, their means of relating to place and environment may be correspondingly internally diverse, requiring researchers to be sensitive to such differences. Most significant-

ly, the experiences and identification of indigenous peoples are never static and are likely to be affected by current politics, pressures and opportunities. Extreme viewpoints that label indigenous groups as entirely detrimental to the environment or those that consider them as museumised 'noble savages' are unhelpful in the context of conservation decision-making.

5. Along similar lines, it is also useful to mention that in terms of its geographic focus, this study deviated from what can be considered as what has until now been a metonymic research focus on the Malabar region. Most studies evaluating Travancorean migrations focused on the Malabar region, which has come to represent and encapsulate migrant impacts and the exploitation of forest-dwellers. This study which explores local migrations within Travancore, identifies several similarities and differences between the two. While largely exploitative in nature, Travancorean migrant interactions with their forest-dweller counterparts were less violent, at times more mutually beneficial, and definitely more diverse. The diversity of engagements that come to light as a result of a wider geographical focus and investigations into different stakeholder groups highlights the need for broader perspectives in future research.

6. The exercise of power in the interactions between local and extra-local actors may generate resistance to top-down decision making. Resistance to current or remembered exercises of power is likely to be an element in conservation conflicts, and so conservation researchers should investigate the possibility of its presence. Moreover, actors with an orientation to external, state-level or international-level institutions or ideologies may be government agencies and employees and/or conservation NGOs, whether national or international. Their interactions with indigenous and settler groups are expressions of power relationships and need to be analysed as such. Post-colonial agencies and structures may perpetuate, utilise or replicate power relations developed under colonial systems.

7. Analysing the dynamics of modified landscapes such as the forest fringe calls for the incorporation of methodological pluralism and contextualisations that move

beyond disciplinary silos. These allow for a wider evaluation of themes ranging from ecological analyses that inform specific questions, phenomenological enquiries that interrogate power and social relations, and networks that encapsulate structure and interconnectedness. Although these are by no means the only approaches, methodological tools such as progressive contextualisation and network approaches are avenues that offer a reasonable level of integration. They also have the advantage of being easily comprehensible to different stakeholder groups. Moreover, the different types of systems that are examined in this context – ecological, social or social-ecological – share elements of complexity and uncertainty. Here, concepts such as 'satisficing' and 'bounded rationality' (which deals with decision-making under conditions of limited information) offer a promising avenue for further research. These concepts are particularly useful for the development of ‘good-enough’ solutions for complex problems under conditions of uncertainty. Recent research that aims to develop 'simple solutions for complex problems', such as the approaches taken forward by researchers in the field of frugal heuristics are a valuable field of research for tropical social-ecological systems.

8. In the context of methods, the analyses carried out in this study also need to be viewed in terms of their obvious limitations. Caveats of phenomenological observations include concerns regarding totalised anthropological voices and the privileging of researcher viewpoints over that of the lived experiences of the research subjects. While this research attempts to provide a diverse set of stakeholder viewpoints (which have been analysed through different methods to reduce obvious biases), the overarching narrative embodies the biases of the researcher and has to be viewed as such. Although this study has been backgrounded by long-term experience with the study area, the narrative still remains a second-hand experience as opposed to the lived experience of the researcher. Hindsight bias (a.k.a. creeping determinism), or the post hoc justification of the causes of known outcomes can also be considered as a limitation of historical research. While it could be regarded as an oversimplification of history, the usefulness of such historical explorations could be in future adaptive and constructive learning from past incidents and experiences.

The analyses presented in this study have been inspired by an emerging focus on human-modified landscapes and recent calls for the holistic treatment of interacting social-ecological components. Responding to these calls, this research focused on methods such as progressive contextualisation and network building that view systems as connected, composite entities. This form of integration has allowed for the development of preliminary analytical structures such as qualitative probabilistic models that offer promising avenues for future research. Additionally, by analysing individual thematic components in a comprehensive manner, it is hoped that this study stands apart from interdisciplinary studies that only focus on broad overviews by sacrificing disciplinary depth. The outputs from this study are equally relevant with respect to conservation science in the Western Ghats, and to conflict-ridden forest fringe landscapes across the developing tropics. It is hoped that the theoretical and practical insights gained from this research can serve as the basis for future research on similar systems.

APPENDICES

Appendix A: List of mammal species selected for evaluation

1 Slender loris (*Loris tardigradus*)
2 Bonnet macaque (*Macaca radiata*)
3 Lion-tailed macaque (*Macaca silenus*)
4 Nilgiri langur (*Trachypithecus johnii*)
5 Grey (Hanuman) langur (*Semnopithecus entellus*)
6 Golden jackal (*Canis aureus*)
7 Sloth bear (*Melursus ursinus*)
8 Common palm civet (*Paradoxurus hermaphroditus*)
9 Brown palm civet (*Paradoxurus jerdoni*)
10 Small Indian civet (*Vivvericula indica*)
11 Brown mongoose (*Herpestes brachyurus*)
12 Grey mongoose (*Herpestes edwardsii*)
13 Ruddy mongoose (*Herpestes smithii*)
14 Stripe-necked mongoose (*Herpestes vitticollis*)
15 Nilgiri marten (*Martes gwatkinsi*)
16 Jungle cat (*Felis chaus*)
17 Leopard cat (*Prionailuris bengalensis*)
18 Rusty-spotted cat (*Prionailurus rubiginosus*)
19 Asian elephant (*Elephas maximus*)
20 Wild boar (*Sus scrofa*)
21 Mouse deer (*Moschiola meminna*)
22 Sambar (*Cervus unicolor*)
23 Barking deer (*Muntiacus muntjak*)
24 Gaur (*Bos gaurus*)
25 Indian pangolin (*Manis crassicaudata*)
26 Three-striped palm squirrel (*Funambulus palmarum*)
27 Five-striped palm squirrel (*Funambulus pennantii*)
28 Dusky-striped palm squirrel (*Funambulus sublineatus*)
29 Jungle-striped palm squirrel (*Funambulus tristriatus*)
30 Travancore flying squirrel (*Petinomys fuscocapillus*)
31 Indian flying squirrel (*Petaurista philippensis*)
32 Indian giant squirrel (*Ratufa indica*)
33 Indian crested porcupine (*Hystrix indica*)
34 Black-naped hare (*Lepus nigricollis*)
35 Malabar spiny dormouse (*Platacanthomys lasiurus*)
36 *Bandicota bengalensis*

37 *Golunda ellioti*
38 *Millardia meltada*
39 *Mus booduga*
40 *Mus musculus*
41 *Rattus rufescens*
42 *Rattus satarae*
43 *Rattus blanfordi*
44 *Vandeluria nilagirica*
45 *Vandeluria elioti*
46 *Suncus etruscus*
47 *Suncus murinus*
48 *Suncus niger*

Appendix B: Expert evaluation form for probability elicitation

No	Species	Probability (forest %)	LC%*	Probability (sun coffee %)	LC%	Probability (coffee with exotic shade %)	LC%	Probability (coffee under native shade %)	LC%	Probability (cardamom under native shade %)	LC%	etc.	etc.
1	Slender loris												
2	Bonnet macaque												
3	Lion-tailed macaque												
4	Nilgiri langur												
	etc.												

Experts provided their estimate of the potential probability (or suitability of the land use) for each species in different land use types.

*LC% represents the percentage level of confidence expressed by the expert for the corresponding probability estimate

Appendix C: Representative matrix of structural and compositional attributes for different land use types: categorical values

Variable	Code	Forest	Home gardens	Rubber 0-4 years	Rubber 4-8 years	Rubber (tapped /mature)	Rubber x HG	Coffee (Sun)	Coffee (exotic shade)	Coffee (Native)	Cardamom (Sun)	Cardamom (Native)	Tea	Tea (shade)	Teak	Eucalyptus
Canopy cover	Cancover	H	M	0	M	H	M	0	0	M	0	H	0	L	M	M
Canopy contiguity	Cancontiguity	H	M	0	0	H	M	0	M	M	0	H	0	L	M	M
Native canopy	Nativecan	H	H	0	0	0	M	0	0	M	0	H	0	0	0	0
Tree Canopy height	Canheight	H	M	L	L	H	M	0	M	H	0	H	0	L	H	H
Basal area	Basalarea	H	M	L	M	H	H	L	M	M	M	H	L	L	H	H
Presence of understory	Presunderstory	H	M	M	L	0	M	M	M	M	M	M	M	M	0	0
Native understory	Nativeunderstory	H	L	0	0	0	0	0	0	0	0	0	0	0	0	0
Lianas and climbers	Lianasclimbers	H	L	0	0	0	L	0	0	0	0	0	0	0	0	0
Bamboo and reeds	Bambooreeds	H	L	0	0	0	L	0	0	0	0	0	0	0	0	0
Native tree cover	NTC	H	M	0	0	0	L	0	0	M	0	H	0	0	0	0
Fruiting trees/ plants	Fruitingtrees	H	H	L	0	0	M	H	H	H	0	M	0	0	0	0
Ficus	Ficus	H	M	0	0	0	L	0	0	L	0	L	0	0	0	0
Tree density	Treedensity	H	M	0	0	M	M	0	L	M	0	M	0	L	M	M
Herb layer	Herblayer	M	M	0	0	0	L	0	0	0	0	0	0	0	0	0
Leaf litter	Leaflitter	H	M	L	L	M	M	L	L	M	L	M	L	L	H	H
Grass cover	Grasscover	M	M	H	M	M	M	L	L	L	L	L	L	L	L	M
Bare ground	Bareground	L	M	M	L	L	M	L	L	L	L	L	L	L	L	L
Pesticide value	Pesticide	0	M	H	H	H	H	M	M	M	H	H	H	H	M	M

Variable	Code	Forest	Home gardens	Rubber 0-4 years	Rubber 4-8 years	Rubber (tapped /mature)	Rubber x HG	Coffee (Sun)	Coffee (exotic shade)	Coffee (Native)	Cardamom (Sun)	Cardamom (Native)	Tea	Tea (shade)	Teak	Eucalyptus
Fertiliser value	Fertiliser	0	H	H	M	H	H	M	M	M	M	M	M	M	L	L
Polyculture	Polyculture	H	H	M	L	0	H	0	0	M	L	H	0	0	0	0
Non forest food crop	NFFC	L	H	H	L	L	L	M	M	M	L	L	L	0	L	L
Intensity of cultivation	Intensity-cultivation	0	H	H	M	H	H	H	H	H	H	H	H	H	M	M
Human disturbance	Humandisturbance	L	H	H	M	M	H	M	M	M	L	L	H	H	L	L
Livestock abundance	Livestock	L	H	L	L	L	M	L	L	L	L	L	L	L	L	L
FHD (structural heterogeneity, vert.)	FHD	H	H	L	L	L	H	L	M	M	L	M	L	M	M	M
Structural/ configurational heterogeneity (horiz.)	Structural-heter	H	H	L	L	L	H	L	L	M	L	M	L	L	L	L
Compositional heterogeneity	Comph	H	H	L	L	L	H	L	L	M	L	H	L	L	L	L

None = N = 0, Low = L = 1, Medium = M = 2, High = H = 3

Appendix D: List of studies on mammals and habitat modification in the Western Ghats

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Appendix E: Expert elicitation form for key variables

No	Species	Rank 1			Rank 2			etc.			Distance to forest		Presence/ distance to water		% forest cover in landscape	
		ID	D	S	ID	D	S	ID	D	S	D	S	D	S	D	S
1	Slender loris															
2	Bonnet macaque															
3	Lion-tailed macaque															
4	Nilgiri langur															
	etc.															

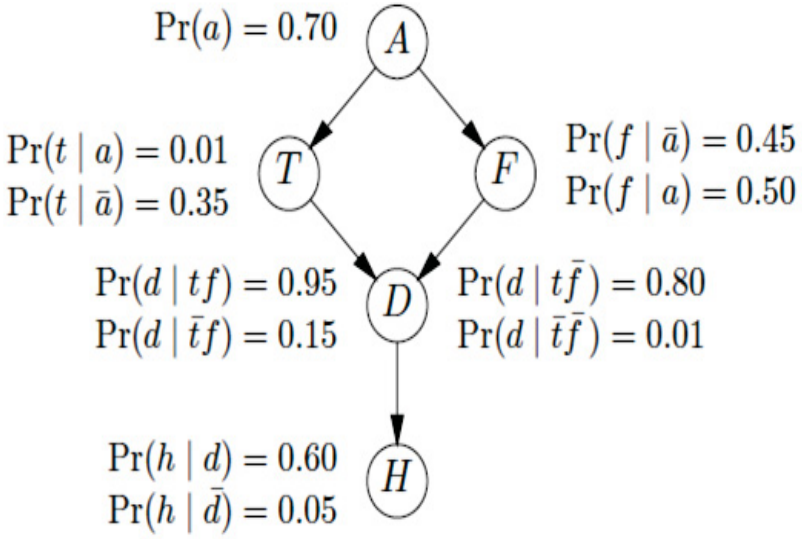
ID = Variable code

D = Directionality

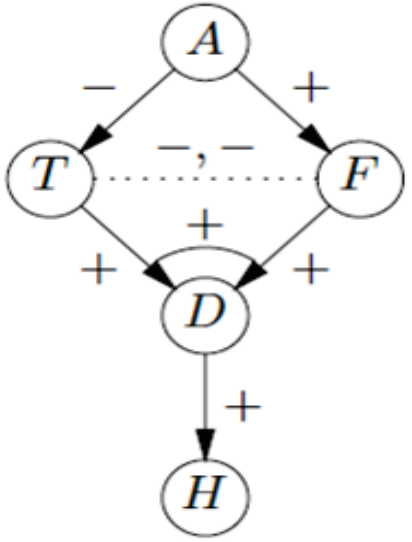
S = Strength of influence

Note: Experts provided their ranking of the what they considered as the most significant variables for each species. Additionally they provided their impression of the directionality (positive, negative, neutral) and strength of influence of each variable.

Appendix F: A parameterised Bayesian network and its qualitative counterpart



The probabilistic antibiotics network



The qualitative antibiotics network

⊗	+	−	0	?
+	+	−	0	?
−	−	+	0	?
0	0	0	0	0
?	?	?	0	?

⊕	+	−	0	?
+	+	?	+	?
−	?	−	−	?
0	+	−	0	?
?	?	?	?	?

Qualitative multiplication and multiplication operators

A – administration of antibiotics

T – Typhoid

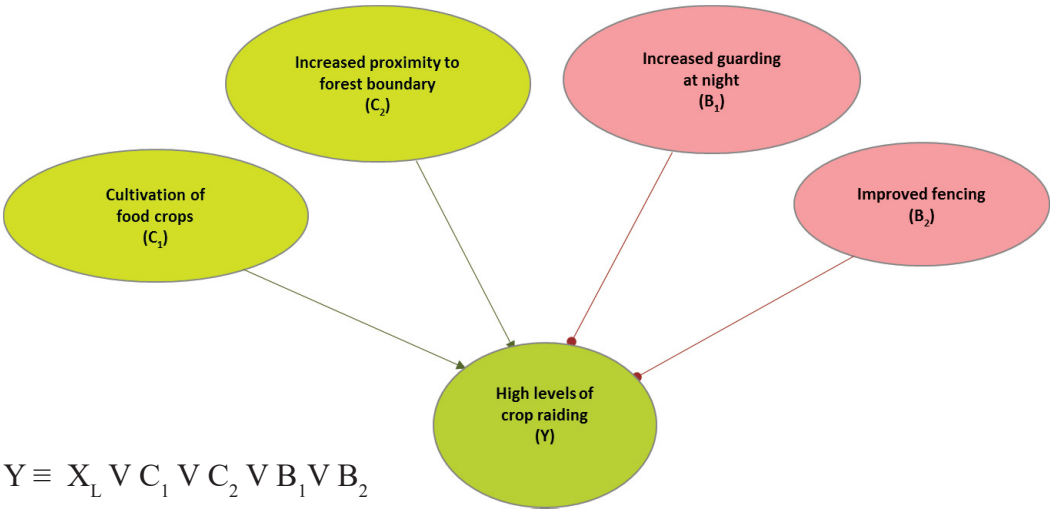
F – Intestinal flora

D – Diarrhoea

H – Dehydration

Adapted from Renooj & van der Gaag 1998

Appendix G: A sample causal model using De Morgan's rules



$$Y \equiv X_L \vee C_1 \vee C_2 \vee B_1 \vee B_2$$

Simple network showing one node and four parent nodes (2 causes and 2 barriers)

C = **Cause** – a parent that has a positive effect on the child

B = **Barrier** – a parent that decreases the probability of the child, but is unable by itself to prevent the child

R = **Requirement**, **I** = **Inhibitor** (not shown in the figure)

L = **Leak parameter** – the probability of the event occurring given the above, i.e., the probability of unmodeled causes

ANNEXURE 1: Linking historical contexts with conservation: stakeholder engagements with place, experience and conservation conflict

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